Vision Soil Analyzer

Product design of a vision based soil analyzer

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Foreword

I can honestly say, that I have exceeded my own expectations. Before I started this minor, I had no knowledge of electrical devices, a limited know-how in programming languages, let alone any noteworthy C++ skills and to my shame I have never ever worked on a Linux computer.

And what a change it has been; Now I'm reluctant to start up my windows computer. I'm more at home with my linux terminal; Customizing and hacking a kernel, been there done that. Programming complex neural networks and Fast Fourier Transformation in C++ with pointers, euhhh whats new. Word, Excel who needs them, when you got LaTeX and Matlab. I can honestly say I have transcended to a new level of nerdiness.

But the best part is, that I came across people in my professional working sphere, whom seemed genuinely interested in this product. So much interested, that, although our main products are big boats and machinelike contraptions straight out of a horror flic, they are willing to give me a shot to further develop this product. Allowing me to creating a device by my own machinations and thus making sure that I have one item checked from my bucket list. For this opportunity I'm thankful. But I suspect my girlfriend doesn't share that gratitude.

Annacarina stick in there, share me just a bit longer with my muse Vision Soil Analyzer.
I still love you more then her!

Jelle Spijker

Summary

This project finds its roots in the minor Embedded Vision Design (EVD) taught at the university of applied sciences HAN. During this minor a portable embedded device was developed which analyses soil samples using a microscope. This Vision Soil Analyzer hereafter referred to as VSA, analyses soil samples using the optical properties.

This product documentation describes the design and realization of a vision based soil analyzer. It does so by describing it functional design, which lies at the heart of the product and explains its main function:

> To analyses a dried soil sample, consisting of particle in the range of $0.02[mm] \leq P \leq 2.0[mm]$ and present a user with information regarding color, texture and structure.

From here the requirements with regard to function and production are extrapolated. The functional requirements quantize the needed performance on color, texture and structure and give condition how to test this performance. While the technical requirements tells how the product is made. Giving constrains on dimension, programing language and electrical devices used.

An important aspect of a vision based soil analyzer is its interaction with a user. This is illustrated by a user interface and manuals describing its interaction protocols from an end-user and administrator perspective.

The technical design dissects the structure into subsystems, such as microcontroller, light environment and sample plate. These and more are necessary to perform its main function. These subsystems have a high level of interaction with each other which are set out in the architecture of the device.

The vision based soil analyzer rest heavenly on vision algorithms, these follow certain established lines, which are set out in the acquisition, enhancement, segmentation, feature extraction and classification steps.

All of the above serve as the basis for realization of a vision based soil analyzer. In order to design and build a prototype the working environment is described. This is a dual booted Windows / Linux laptop, running QT designer, Matlab and Siemens NX. The

project itself is hosted on Github and Upverter.

The technical aspects are described for the disciplines: software, mechanical and electronic engineering. Because the main focus lies on the vision aspects of the device, the previous determine route is set out in detail, describing the acquisition steps and various strategies which can be pursued. The enhancement from intensity to segmentation steps are described, such as blurring and adaptive contrast stretch. The follow up algorithms, transform an intensity picture to individual blobs. This is done by finding an optimal threshold between pixel values which belong to a particle or those that are the background.

Further transformation are performed to ensure each particle is identified. The shape of these are classified by describing the contour in the frequency domain, and feeding the complex numbers, obtained with a Fast Fourier Transform, in to a neural network. The resulting classification is one of angularity. Roundness is categorized with the Hu moments. The size of the particle is determined and used to describe the soil sample as a particle size distribution. All obtained information is presented to the user, through a multitude of means using the graphical user interface and a report generator.

Finally the design is verified against the previous determined requirements and a conclusion is drawn. Throwing a fare-sight into the project to come.

Contents

1. Introduction

This project finds its roots in the minor Embedded Vision Design taught at the university of applied sciences HAN, hereafter named EVD. During this minor an embedded device was developed which analyses soil samples using a microscope. This Vision Soil Analyzer or VSA for short, analyzes samples using the optical properties. It gives an user information on color, texture and structure.

This device is developed in collaboration with Royal IHC and MTI Holland. Royal IHC is one of Holland major shipyard companies and specializes in dredging and offshore. MTI Holland BV is IHC knowledge center. They're a worldwide leading center of expertise in the area of dredging, mining and deep-sea mining processes, their knowledge is translated into specification, design and application of equipment.

Both companies have an interests in knowing the properties of soil, be it to advise their customers or to further facilitate their own research and services. Current methods, like the particle size analysis using a sieve and hydrometer are time consuming and non portable. To facilitate quick, accurate and on location soil research an embedded device has been developed. This VSA analyzes soil samples using a microscope and gives the user acceptable and quick results on its visual properties.

Quick and reliable results are a welcome addition into any laboratory, this combined with a device that is light and portable gives it's users an added benefit of shortened logistical operations for their soil samples. This results in some serious time benefits.

During the first period of the minor a basic prototype has been developed. This prototype ran in Matlab environment on a X64 desktop computer and was a first test case for the algorithms and idea's. In the second period this prototype is developed on an ARMv7 embedded Linux device and is rewritten in C++.

The design and realization of this second prototype is set out in this report, the goal of this document is to:

> Describe the design specifications for a vision based oil analyzer, in such away that it can be reproduced, within a period of 10 weeks.

The project encompasses multiple disciplines (mechanical, electrical and software). The output of each of these disciplines are described, but the focus lies at the vision based algorithms and software that fulfills its main function:

> To analyses a dried soil sample, consisting of particle in the range of $0.02[mm] \leq P \leq 2.0[mm]$ and present a user with information regarding color, texture and structure.

The color of a sample is presented to a user in the CIE Lab color-models. These color model show correlation between soil properties, such as color and organic carbon, related to fertility of soil. Conversion between different color-models are CPU intensive, because each pixel will be transformed using multiple algorithms. It's paramount that calculations are done with an minimum of machine instructions and with acceptable errors.

Texture information is presented to a user via a particle size distribution, hereafter named PSD. This is a cumulative function representing the ratio of different particle sizes in the soil sample. Due to the nature of a two dimensional digital image numerous problems arise. These are overlap of smaller particles by bigger particles, this gives a distortion in the PSD results, because the smaller particle is registered as part of the bigger particle.

Information about the structure of the soil is extrapolated from its individual particles shapes. These are describes in the frequency domain, using a Fast Fourier Transform which are fed into a Neural Network which classifies these shapes into standard soil categories. These are time consuming operations and therefore should be done with a minimum of machine instructions and efficient programming.

This document follows the following structure: In part I the design is laid out. In this part the following chapters describe basic design; Chapter 2 explores the function the device needs to fulfill and which specifications it has to have. While chapter 3 illustrate the user interaction and interface. This serves as input for chapter 4, where the user interaction is described in the form of a manual. The technical design is illustrated in chapter 5 and the vision design is outlined in chapter 6.

Part II tells how the design is transformed in to a working prototype and how it can be reproduced. This is achieved by first describing the development environment in chapter 7. In this chapter the setup for software, modeling and electronics engineering are described in detail. Armed with this setup the technical realization is described in chapter 8. Lastly the vision realization is recounted, this is the focal point of this documentation and can be found in chapter 9.

Verification of the design takes place in part III. In chapter 10 is the prototype verified against the previous determined specifications. Lastly the conclusion is set out in chapter 11. All addenda chapters, such as bibliography, index and appendices are to be found in part IV.

Design

2. Functional design

A functional design lays at the heart of a product. It is an abstract representation of a device and it illustrates its main function. In this chapter the workings of a vision based soil analyzer is laid out. It explains which role a vision based soil analyzer needs to fulfills in order to satisfy a user generated need. This main functionality and its output is visualized in an Input-Process-Output (IPO) diagram. This diagram aids in deciding the specification and setting up a user interface. These in turn dictate the interaction with the outside world.

2.1 Global input-process-output

The main function of a vision based soil analyzer is evident from its name. The user can expect a device which performs an analysis of a soil sample. It does so by capturing and digitizing reflected light of the individual soil particles. This function is illustrated below in an Input-Process-Output (IPO) diagram, see figure 2.1. This is a so called black box approach. It shows an input, an output and a process, where the inner workings are not yet known and relevant.

Technical system

Prototype of an intelligent soil microscope

Main function

To analyses a dried soil sample, consisting of particle in the range of $0.02[mm] \leq P \leq 2.0[mm]$ and present a user with information regarding color, texture and structure.

Figure 2.1: Main Input-Process-Output diagram

2.2 Specifications

With the global input-process-output in mind the functional specifications can be written. This is done by identifying requirements that lie at the hearth of it's main functionality. These are specification that define a product. It is important to note that there are two types of requirements: functional and technical requirements; Each requirement can either be constant or a variable. The constant requirements are the baseline. If the product doesn't fulfills these, it can't be called a soil analyzer. Whilst variable requirement determine how well a product can perform.

Functional requirements

Functional requirements describe the purpose of the product.

ID	Description	Type
F1	**Quantify color**	
F1.1	Determine the color in a RGB color model, from all visually (by human eye) discernible particles	Const.
F1.2	Chromatic a* values must lie within 3σ	Const.
F1.3	Chromatic b* values must lie within 3σ	Const.
F2	**Quantify texture**	
F2.1	The result of an analyzed sample should fall within a probability of at least $P = 0.95$ % when compared against the result of the same sample, but obtained using the established sieve method. These results are to be compared by Welch's t-test	Const.
F2.2	PSD bins should have the same range as the fractions used in the sieving method	Const.
F3	**Quantify structure**	
F3.1	Roundness should be assigned in three categories	Const.
F3.2	Angularity should be assigned in six categories	Const.
F3.3	Predicted values should have at least a linear regression value of $R \geq 0.9$ when compared to expertly classified particles	Const.
F4	**General specifications**	
F4.1	Analyze particle with sizes within the range $200\mu m \leq P_{size} \leq 2mm$	Const.
F4.2	No more then 2% of the extracted blobs may be connected particles	Const.
F4.3	Analyzing a sample should take no longer then $1min$ (rearanging of sample between shot disregarded)	Const.
F5	**Interaction**	
F5.1	Show individual particles	Const.
F5.2	Show PSD graph with particle size in logarithmic scale	Const.
F5.3	Show Angularity in histogram	Const.
F5.4	Show Roundness in histogram	Const.
F5.5	Show probability distribution function in the histogram	
F5.6	Information can be shown on a screen	Const.
F5.7	Exporting to pdf file	Const.

Table 2.1: Functional requirements

Technical requirements

Technical requirements describe the functionality of the device with regards to its peripherals and its technical environment. They're described in such a way that they are either true or false. They act as constrains, providing a border with a know interface to the outside world.

ID	Description	Type
T1	**Software environment**	
T1.1	The software should run on an Linux device	Const.
T1.2	The software should be written in C++	Const.
T1.3	The software should be written as OOP and be reusable	Const.
T1.4	The software should be written with revision control	Const.
T1.5	Easily portable to Windows environment	Const.
T1.6	Easily portable to Android environment	Const.
T2	**Hardware environment**	
T2.1	Should run on an ARMv7 or higher device	Const.
T2.2	Should run on a x86 or x64 device	Const.
T2.3	At least $1GHz$ processing power	Const.
T2.4	At least $128MB$ memory	Const.
T2.5	At least $2GB$ storage	Const.
T3	**Peripherals**	
T3.1	USB connection	Const.
T3.2	Ethernet LAN and/or WAN connection	Const.
T3.3	GPS unit	Optional
T3.4	Light controller	Const.
T4	**General specifications**	
T4.1	Sample file size should not exceed $10mb$	Const.
T4.2	Guard the maximum size of particles to $2mm$	Const.
T5	**Prototype specifications**	
T5.1	Dimensions should not exceed $400[mm] \times 200[mm] \times 200[mm]$	Const.
T5.2	The total weight may not exceed $5[kg]$	Const.

Table 2.2: Technical requirements

3. User interface

The User Interface is responsible for interaction with a user. It does so by accepting input, such as a soil sample and gives feedback in human interpretable information. In order to guarantee accurate result, a certain work flow has to be followed. This work flow is described in detail in the manuals, which are depicted in section 4. In the follow sections the global work flow is illustrated as well as the graphical and hardware user interface.

3.1 Global work flow

The soil sample is dried and the user makes sure the particle don't bond together. A small portion of the sample is placed on a sample plate. Taking care to separate the individual particles as much as possible. The cover is closed and a microscopic camera is positions, in an environment where the light conditions are controlled.

The user takes a snapshot, rearranges the sample on the sample plate and takes an other snapshot. This is repeated for an multitude of times, until enough particles are analyzed to give accurate statistical results.

The results are presented to the user via a graphical user interface which are show when the device is hooked to a monitor carrying a HDMI input. It is also possible to present a report in pdf or a native format which can downloaded from the device using a LAN network device or optional WI-Fi or Blue-tooth. Basic human interaction can be performed via an on-board encoder, or optional USB keyboard and/or mouse.

3.2 Graphical User Interface

Most information is conveyed through the graphical user interface or GUI for short. The complete GUI encompasses different windows and dialogs, all these can be found in appendix A. The main window consist of the following parts:

1. **Shape selector** - This widget allows a user to see and change the shape category of the focused particle.
2. **Particle browser** - This widget allows a user to browse through the individual particles in the soil sample.
3. **FFT Graph** - A graph showing the absolute value of the Fast Fourier Transform for the particle edge.
4. **Sphericity histogram** - A histogram which shows the sphericity of the sample with a probability function and mean value.
5. **Particle Size Distribution** - A cumulative function of the particle sizes on a logarithmic scale.
6. **Angularity histogram** - A histogram which shows the angularity of the sample with a probability function and mean value.
7. **Toolbar** - A buttonbar for the most common actions: *New Sample, Save Sample, Load Sample* ...

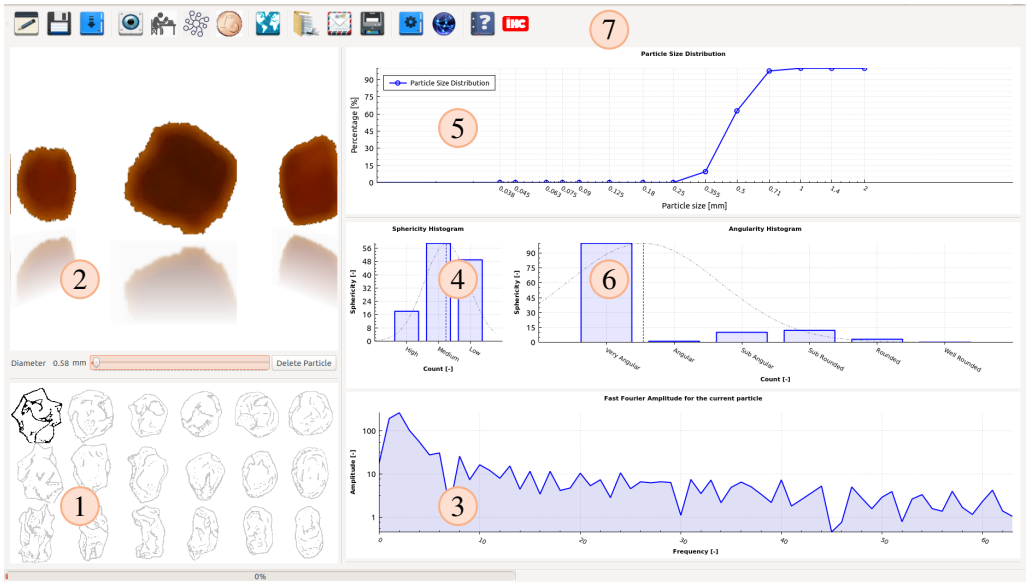


Figure 3.1: Main Graphical User Interface

4. Manuals

Interaction between user and the device is illustrated with the following basic manuals. These manuals differentiate between end-user and administrator. The end-user is the normal operator of the machine, the one who wants to know the properties of a specific soil sample, whilst the administrator maintains the device.

4.1 User manual

When a user wants to analyses a soil sample he first has to make sure, the device is connected to a power outlet with an adapter that provides a DC voltage of 5V with at least 2A. Any generic HDMI monitor which support 720p (HD-ready) can serve is its main user interface. It is optional that the device is hooked to a network using the UTP connection or directly to a x86 or x64 computer (running windows 7 or higher and Linux kernel 2.19 or higher) through USB connector. When communication with third parties is needed the network or gateway computer needs to be connected to a WAN[1]. The enable learning button (figure 4.1) has to be grayed out for normal operation.

Figure 4.1: Learning button

[1] Wide Area Network

4.1.1 Analyzing a soil sample

Most of the user interactions in the steps below have to be initiated through the toolbar, figure 4.2.

Figure 4.2: The toolbar

Step 1: Filling the sample plate

The user places a dried soil sample on the disc, as shown in figure 4.3, he make sure it is evenly placed. Making use of the complete area of the disc.

Figure 4.3: Evenly spaced soil sample

Step 2: Placing the sample plate under the microscope

The disc is placed in a slot under the microscope. The slot only allows particle to be placed under the microscope with a height of 2$[mm]$ or smaller. This step is shown in figure 4.4

Figure 4.4: Placing the sample under the microscope

Step 3: Creating a new sample

When a user presses the "New Sample" icon (figure: 4.2 button 1) on the toolbar the microscope takes a shot of the sample. When the sample needs to be rearranged for additional shots, a dialog will appear, prompting a user to shake the disc. This is done by repeating step 1 and 2. Step 1 till 3 has to be performed for the amount of times specified by the administrator. This is usually 10 times.

Step 4: browsing through the sample

The segmented particles are shown in the particle browser, a user move through these individual particles by clicking on the left or right particle, or by moving the slider below the display. Below the particle browser is the suggested shape category depicted. If a user deems the particle wrongly categorized, he simply selects the new category. These

new categories are used to further improve this classification process and serves a new learning datasets for the neural network.

Step 5: Deleting doubles

It is possible when using the current prototype, that it sees multiple connected particle as one. Because these connected particle distort the statistical analysis, a user has to delete these manually. He does so by clicking the "delete particle" button.

Step 6: Comparing the sample against a know PSD

When pressing the right mouse button on the PSD graph a popup menu appears. Which allows CSV[2] files to be loaded as comparison.

Step 7: Saving or emailing the sample

Pressing the save button (figure 4.2, button 2) allows a sample to be saved on local storage device. Depending on the size of the individual particles and the total amount, the file size various between 1 and 10 mb. The internal storage is 2gb of allocated space for storage. It is recommended to save the sample on an external device using the send email button (figure 4.2, button 10). This button sends the opened sample to a previously selected email address of choice.

4.1.2 Generate report

If the user wants a standard human readable report of the analyzed soil sample he has the option to select the generate report button (figure 4.2, button 9). This button opens a new window (figure 4.5) with the generated report. An example report is shown in appendix B. The device has to have working Internet connection in order to download a map of the location.

When the report generator is open the user can fill in additional information, regarding the origin of the sample. When all is according to satisfaction the report can be saved locally, send to an email address or a network printer.

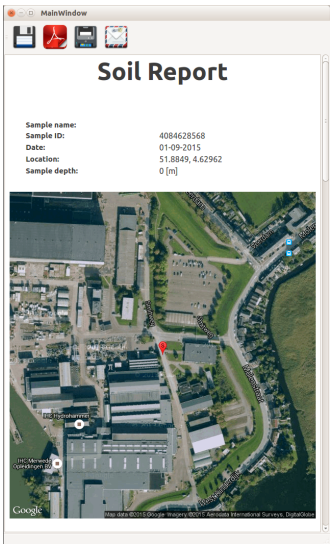


Figure 4.5: Report generator

[2]Comma Separated Values

4.2 Administrator manual

The VSA runs on an embedded Linux operating system, an administrator is expected to have prior knowledge of this operating system, such as working of the command prompt. Administration is performed through a dedicated network connection. It is expected that the ip address of the VSA is known.

4.2.1 Maintenance and upgrade process

Connect to a WAN is needed in order to upgrade the system. An administrator has the option to login through a console using the following credentials:

```
Username: ubuntu
Password: temppwd
```

Upgrading the OS can be performed with the usual steps:

```
~$ sudo apt-get update
~$ sudo apt-get upgrade
```

Upgrading the software can be performed by:

```
~$ cd git/VisionSoilAnalyzer
~/git/VisionSoilAnalyzer$ git pull
Enter the following credentials:
username: VSA_Admin@VSA.com
password: VSAisThabomb
~/git/VisionSoilAnalyzer$ TAG=$(git for-each-ref refs/tags –sort=-taggerdate –format=
'%(refname)' –count=1)
~/git/VisionSoilAnalyzer$ git checkout tags/$TAG
~/git/VisionSoilAnalyzer$ cd Linuxscripts
~/git/VisionSoilAnalyzer/Linuxscripts$ ./config.sh
~/git/VisionSoilAnalyzer/Linuxscripts$ ./make.sh
~/git/VisionSoilAnalyzer/Linuxscripts$ ./install.sh
```

Afterwards you can logout.

4.2.2 Teaching the Neural Network

The Neural Network can learn from previous analyzed samples, this is done on the VSA itself. By pushing the Neural Network button, a new dialog window appears, as shown in figure A which can be found in appendix A. In this dialog the user can select a set of previous analyzed samples which serve as a learning data set.

When the button "Open Settings" is pressed the windows depicted in figure 4.6 is shown. In this window the user can select the preferred network configuration.

Setting up the neural net

The user configures the neural net by first specifying the number of input neurons, these describe the amount Fast Fourier descriptors used in describing the shape of particle, a number between 8 and 20 is usually more then enough. Here after the hidden neurons are to be specified. the maximum amount is 200. Finally the output neurons are to be specified. At the current time these are set in 18 categories and can't be changed.

Setting up the learning mode

The Genetic Algorithm allows the user to specify the learning variables. This is done by determining the maximum number of generations, or iterations. Secondly the population size has to be specified as well as the mutation rate. Thirdly the number of elite population member are to be set. These are population members that are guaranteed to be part of the next generation. Fourthly the acceptable end error has to be specified. As well as the minimum and maximum allowed weight. Lastly the user has the option to select the revolution mode. This mode can be useful when the error gets stuck on a certain level. It starts a fresh by killing the elite and mutate the rest of the population to ushers in a new era.

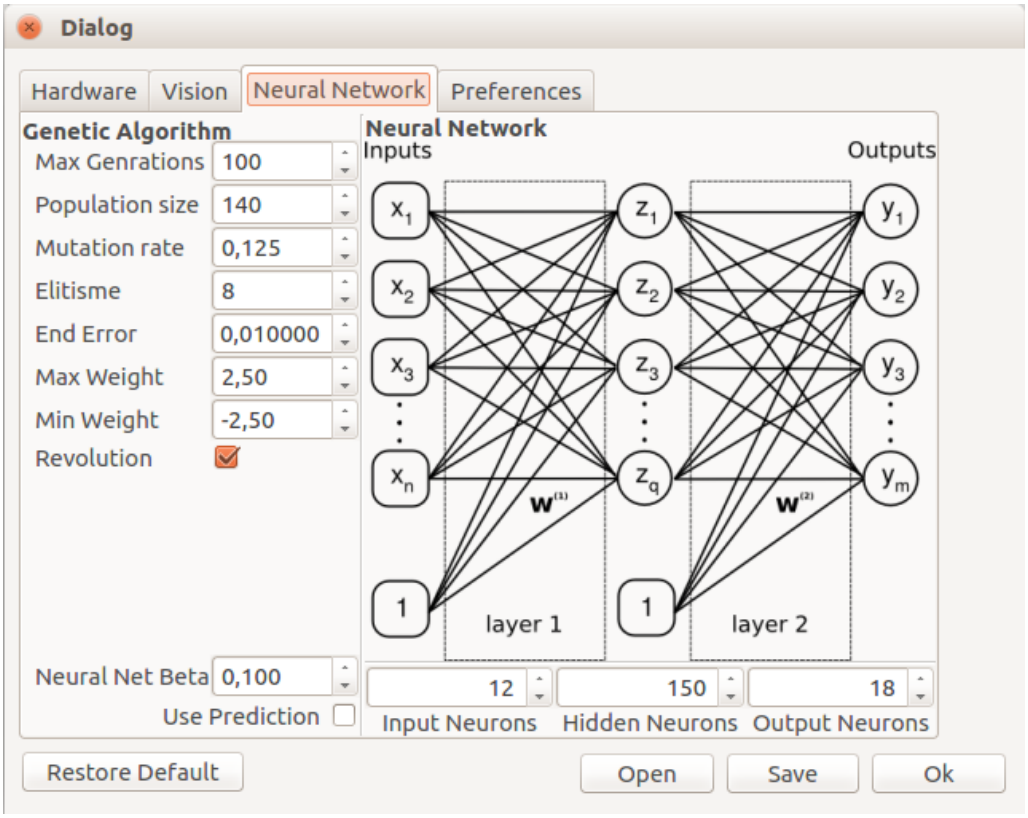


Figure 4.6: Settings Neural Network Interface

5. Technical design

The technical design describes the sub-systems and their interaction. These are set out in a hierarchical structure, identifying the individual sub-systems. Where their underlying interactions are described in the architecture. The picture which is illustrated with the hierarchical structure and the architecture serves as the basis for a detailed IPO.

5.1 Hierarchical structure

The system can be divided in the subsystems depicted in figure 5.1. These sub-systems have a high level of interaction and are in a whole responsible for the fulfillment of the VSA main function.

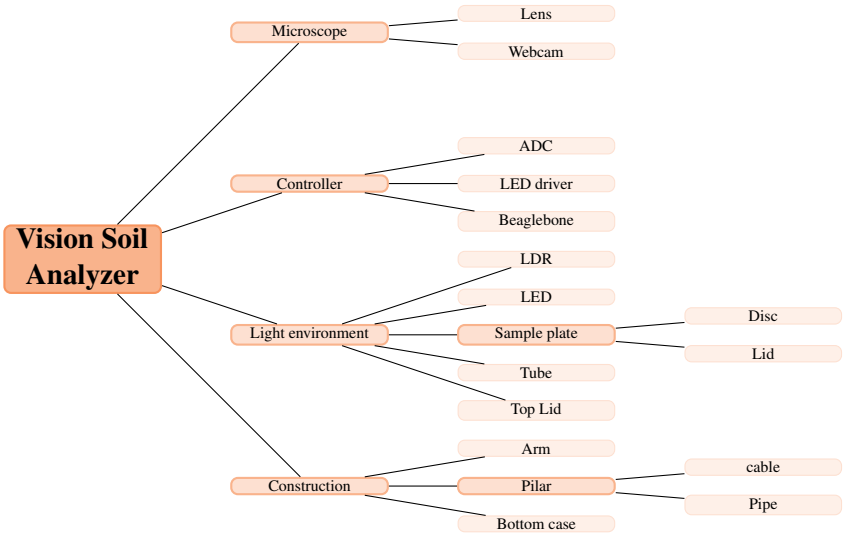


Figure 5.1: Hierarchical diagram of the vision soil analyzer

5.2 Architecture

The architecture diagram belows depicts the cohesion between the different electronically systems. It is obvious that the microcontroller plays a pivotal role in these relationships.

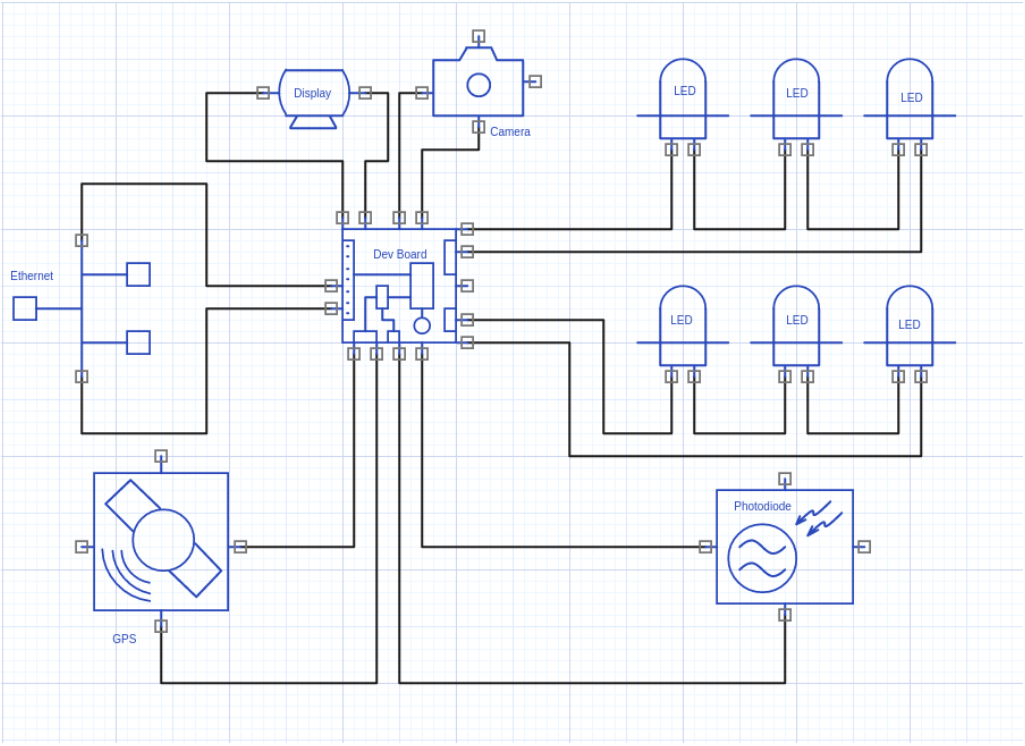


Figure 5.2: System design

5.3 Detailed Input-Process-Output schematics

The main detailed IPO is illustrated below:

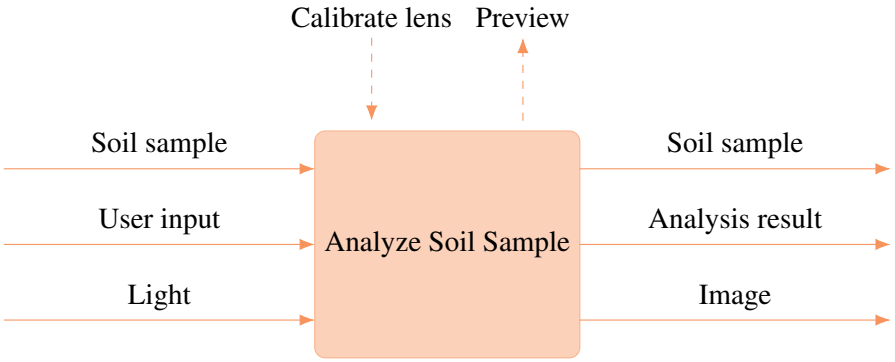


Figure 5.3: Main detailed Input-Process-Output diagram

6. Vision design

The main focus of a vision based soil analyzer lies on the vision algorithms. These lie at the heart of the device. Are to be described in detail in this document. The design and connectedness between these algorithms is described below and depicted in the flow diagram (figure 6.1).

The embedded Linux device takes a snapshot which is analyzed using the following computer algorithms: First the individual soil particles are identified in the image, using various algorithms, such as adaptive contrast stretch, Gaussian blurring, Otsu's method – optimal thresholds separation. The color information is determined with various matrix calculations, translating the RGB pixel value tot CIE Lab and Redness Index.

The texture information is determined by counting the number of discrete pixels for each individual article. From this the volume is determined. If the scale of each pixel is known, the volume can be given in SI units.

The structure of an individual particle is determined by getting the edge of the pixels. This is done by creating a mask with a morphological erosion algorithm this mask is subtracted of the original image. The contour is translated to a function using the Dijkstra shortest path algorithm. Where each pixel is described as an imaginary complex number representing the radius towards the center of the particle. The vector holding these values are transformed to the frequency space using the Fast Fourier Transformation. The describing complex numbers gained during this transformation are fed into a Neural Network, which is optimized using Genetic Algorithms and a previously determined learning data set. The output is presented as a probability that a certain particle belongs to a predefined category.

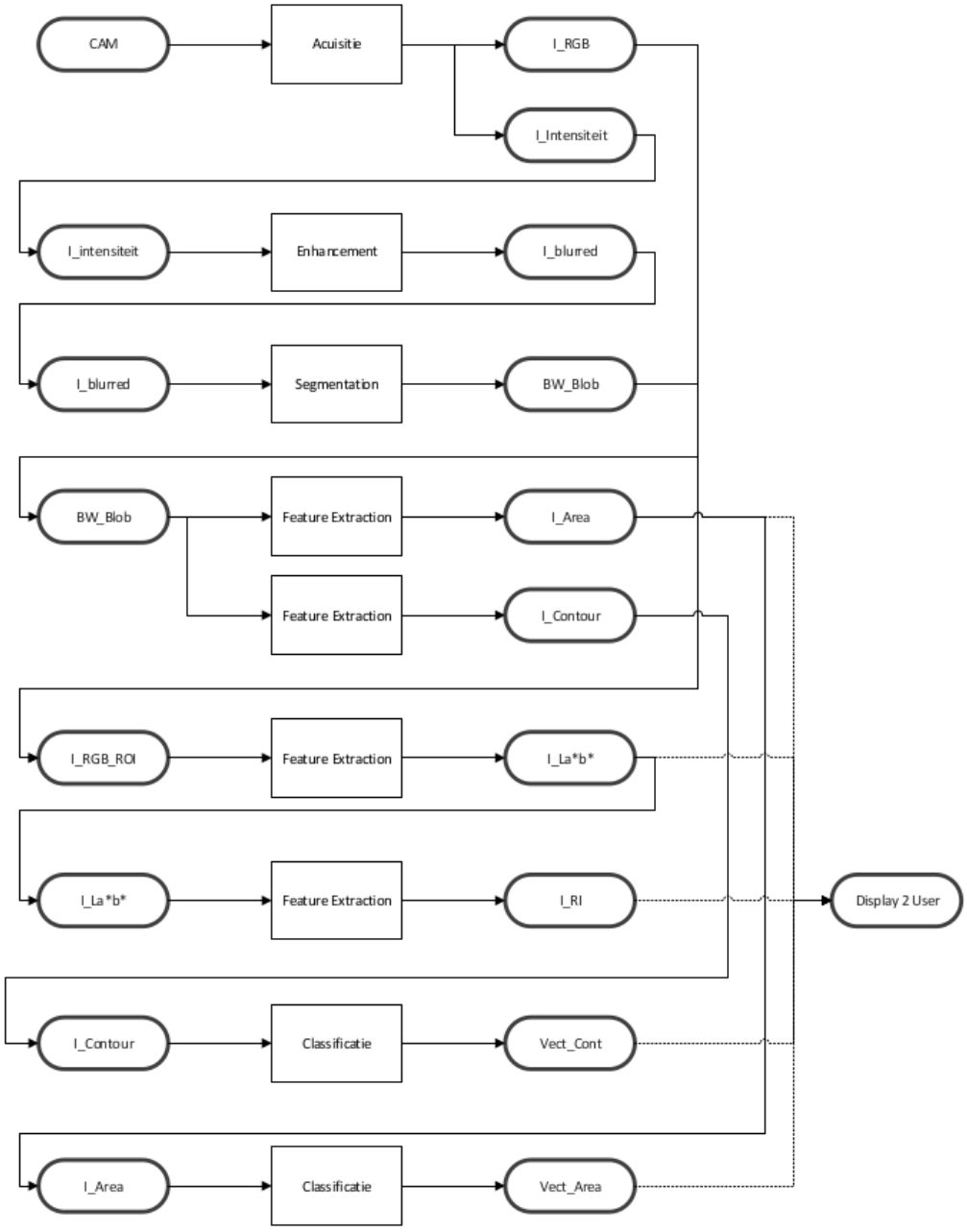


Figure 6.1: Vision flow

II Realization

7. Development Environment

The project is developed using three major disciplines; These are mechanical, electrical and software engineering. Each of these disciplines require their own setup and tools. All three are described in their own section below. As indicated in previous chapters the current focus lies on the software development stage, electrical en mechanical systems are described, but with less detail.

At the basis of all three development environments lies the hardware. The specifications given below, describe the current development computer. It is guaranteed that the project can be recreated with a similar computer.

- Intel(R) Core(TM) i5-4210U CPU @ 1.70GHz
- 8gb memory
- Nvidia 820M
- SSD 128 gb
- HDD 500 gb
- Dual boot Ubuntu 15.04 / Windows 10

7.0.1 Code naming conventions

The release are named after anime or manga characters in alphabetical follow up. The first release is dubbed "Gaara" from the anime "Naruto". Gaara is a ninja who can control sand. The following alpha en beta release have preceded version 1.0(Gaara):

Akira version 0.9.0
Bunpuku version 0.9.5
Chouji version 0.6.6
Dot PYXIS version 0.9.7
Enryuu version 0.9.8
Father version 0.9.9

Figure 7.1: Gaara of the sand

7.0.2 Software development environment

The software for the VSA runs on an embedded Linux device. This environment is described in chapter 8.1. It is highly recommended that the software development environment mirrors this configuration. From the kernel and the operating system towards the package and libraries.

When development takes place in a Linux environment, a tight integration with the prototype is ensured. Eliminating the need to setup the environmental settings and script for multiple operating systems. This also adds the option to debug the software on the development computer.

Programming language

The software for the VSA is written in C++. This language was chosen because of its efficiency and high level of abstraction. Most image processing algorithms look at each individual pixel. Since the image obtained with the VSA microscope are in the order of $10 \times 10^6[Pixels]$ a lot of machine instructions can be eliminated by programming in C++. One of its main strength is, that it allows for direct memory access without type checking and error checking. As Bjarne Stroustrup, the creator of C++, puts it [5] :

> C++ is a general-purpose programming language providing a direct and efficient model of hardware combined with facilities for defining lightweight abstractions.

Integrated Development Environment

Development is performed on a desktop computer running Linux 3.19.0-18-generic #. Ubuntu 15.04. The preferred Integrated Development Environment, or IDE is QT Creator Community edition. This is open-source IDE and available for Linux /

Windows / Mac. Version control is handled using the services of Github the main project page is VisionSoilAnalyzer - project page (`http://peer23peer.github.io/VisionSoilAnalyzer/Webpage/index.html`). Access to the Github page requires collaboration privileges.

The basic list of installed packages is given below. The complete list of packages and installation steps are depicted in appendix F.

- Environment
  - Kernel Linux 3.19.0-18-generic
  - Ubuntu 15.04
- IDE-tools
  - Clang 3.6 compiler
  - C++ GNU compiler
  - QT Creator
  - Valgrind
  - Doxygen
  - Git
  - Cmake
- Libraries
  - OpenCV 3.0 beta
  - CUDA 7.0 SDK
  - ZLib
  - Boost 1.58
  - Video4Linux
  - GStreamer

It is a fact that computers and their environment evolve. New settings, packages and development changes are described in the project wiki. Which is actively maintained during the complete development phase. This wiki can be found at `https://github.com/peer23peer/VisionSoilAnalyzer/wiki`

Object Orientated

The software for the VSA is object orientated and written in such a way that external parties can work on section of the code while remaining unaware of the complete picture. This is achieved by writing classes, or so called shared libraries. These are individual projects, which are compiled individually and will be called from the main program during runtime. These classes can be reused with other projects.

Readability

It is common practice to document the routines and functions, explaining the code to third parties and improving the overall readability. These comments are scattered through out the source code and can be extracted with Doxygen into software references documentation. The resulting reference manual can be found in appendix Q.

Directory structure

When cloning the git the folder structure is automatically applied. This is not the case for the build folder. This folder hold the compiled source code and from here te program is executed. Since it is important that links between project are maintained, the directory structure as given in appendix F has to be obeyed.

Testing and benchmarking

Testing is done using the QT unit test framework results are verified against know results. Which are calculated via Matlab, Mathematica or Python. Benchmarks are done using the QT unit test framework and will test multiple solutions. Solutions that are deemed obsolete by the benchmark results will not be removed but be renamed with a _ in front of the function name _FunctionName. **Valgrind** is used to determine memory leakages and function profiles. These profiles will be the guide which determine the priority of functions to be optimized.

7.0.3 Modeling development environment

The modeling of the casing is performed with Siemens NX 10 running on a Windows 10 operating system. The models are placed in the folder **3Dmodel**\<Release name>. The hierarchical design set out in section 5.1, this has to be followed as much as possible. That means multiple assemblies and the most basic component are single parts. Each part has to be correctly named and the materials are to be specified.

Production drawings or models are to be placed **3Dmodel**\<Release name>\Production files . 2D production files are to be made according to the mono-system and saved in PDF file formats. 3D models necessary for CNC-machining or 3D-printing are to be saved as STL files. 2D production files for laser cutters are to be provided in Autocad DXF (2007) format.

7.0.4 Electronic development environment

Design of the electronic systems are to be made on Upverter.com. Upverter can be described as Github for electronic designs. the current schematic is to be found at `https://upverter.com/UniversityofAppliedSciencesHAN/9f177d2bd16397c8/Gaara/`. Simulation of the different electronic parts are to be performed in Matlab Simulink in the SimElectronics environment.

8. Technical Realization

In the subsequential chapter the various designs are worked out. These are the running environment, electrical design, The casing prototype and the program structure. Although all designs disciplines are described the focus lies on the vision and software routines.

8.1 Run Environment

Although the software is build to run on any Linux enable device, it is intended to be run on embedded ARM device. The choice for the basic run environment is made for the Beaglebone black or BBB for short. It is a low-cost community supported development platform made for prototype developers and hobbyists. It has the following specifications:
Processor AM335x 1GHz ARM®
RAM 512[MB] DDR3
flash storage 4[GB] 8-bit eMMC on-board flash storage
GPU 3D graphics accelerator
floating point accelerator NEON
PRU 2x 32-bit microcontroller (Programmable Real-time Units)
OS Ubuntu 14.04 with kernel V4.1.x

The following packages have to be installed:

- IDE-tools
  - Clang 3.6 compiler
  - C++ GNU compiler
  - QT Creator
  - Valgrind
  - Doxygen
  - Git
  - Cmake
- Libraries
  - OpenCV 3.0 beta
  - CUDA 7.0 SDK

- ZLib
- Boost 1.58
- Video4Linux
- GStreamer

The complete installation steps and how to compile the custom kernel are set out in appendix G

8.2 Electrical design

The schematic depicted below shows the how the electronic parts are to be connected to the pin-out on the Beaglebone black. It consist of two LED drivers, a light level meter and a global position unit. All the datasheet can be found at /Electronics/Prototype Gaara (V1.0)/Datasheets.

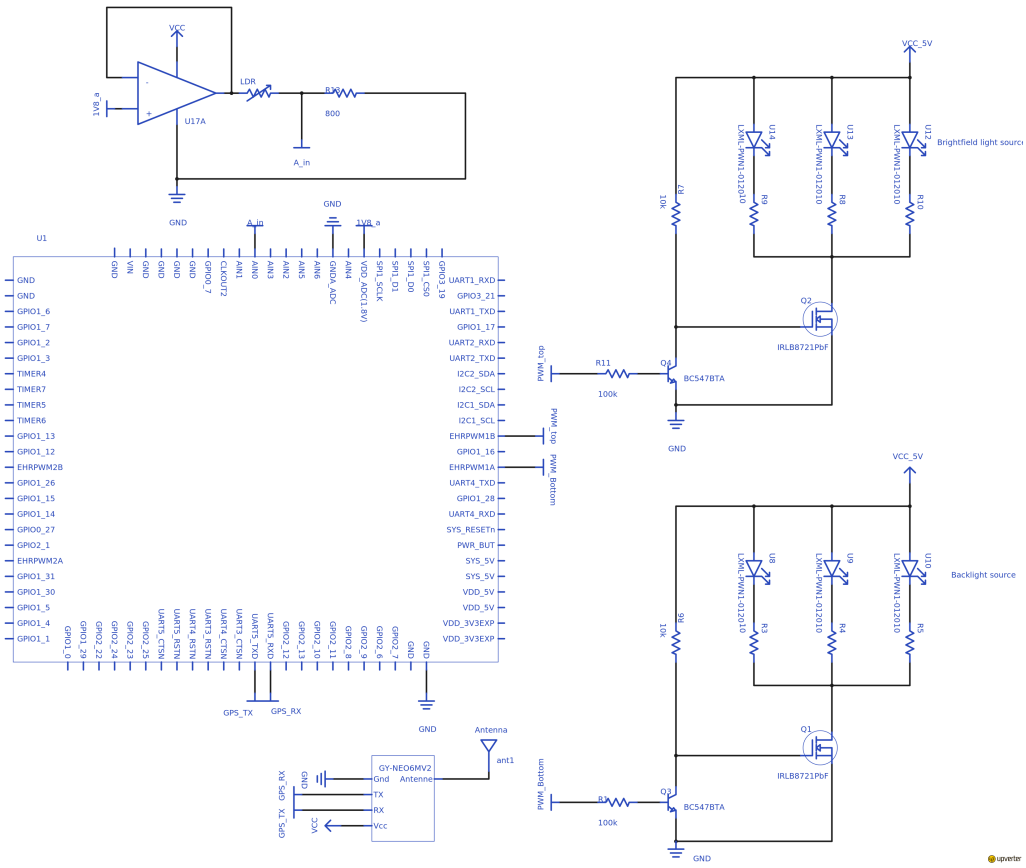


Figure 8.1: Schematic Design

8.2.1 Led driver

Each led driver consists of three Philips LUXEON Rebel white leds. These leds are chosen because the emit a cool white 10.000K color profile and generate 180 lumen each over a 160 degree cone. Each of these leds have a forward current of 450mA, which is quite high. Since the maximum allowed current to flow through a BBB GPIO[1] pin cannot succeed 10mA a MOSFET IRLB8721PbF is used. Although this type of MOSFET allows

[1] General Purpose Input Output

the flow of current around $V_{GS(th,max)} = 2.35[V]$ The current doesn't exceed 1A. As shown in figure 8.2. The setup is further expended by using BC547 NPN transistor, where the base is connected to the GPIO and the current flows from the 5[V] power rail.

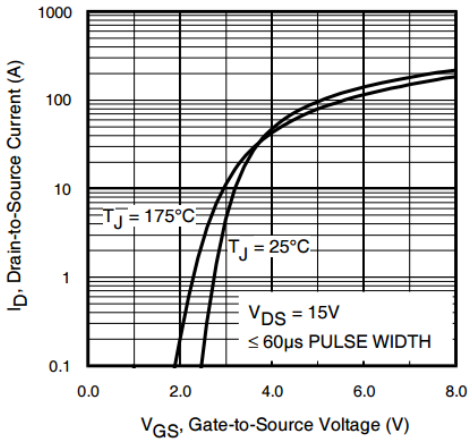


Figure 8.2: Typical Transfer Characteristic (Source: IRLB8721PbF datasheet)

The complete driver is controlled using a PWM[2] pin on the Beaglebone Black.

8.2.2 Light level meter

The light level is measured in the light environmental room. This is done by using the 12-bit ADC chip of the Beaglebone black which uses 1.8[V]. It works on the principle of a simple voltage divider circuit Because hooking the LDR[3] directly on the 1.8[V] power rail of the Beaglebone, the circuit will draw current and acts as a variable load, which will in turn effect the voltage level and thus effect the measurement. This problem is solved by building a small voltage follower circuit using an LM358P op-amp. This op-amp uses the 1.8[V] power-rail as reference and draws it current from the 5[V] power rail.

8.2.3 Global position unit

Due to a defective unit on arrival, the global position unit has yet to be implemented.

[2]Pulse Width Modulation
[3]Light Dependant Resistor

8.3 Case design

The Case is design in Siemens NX 10 and consists of 21 seperate parts and assemblies. Figure 8.3 shows the main assembly drawing. Numbering the individual parts. The casing parts 6 ,11, 12 ,20 are designed to be printed using a 3D-printer

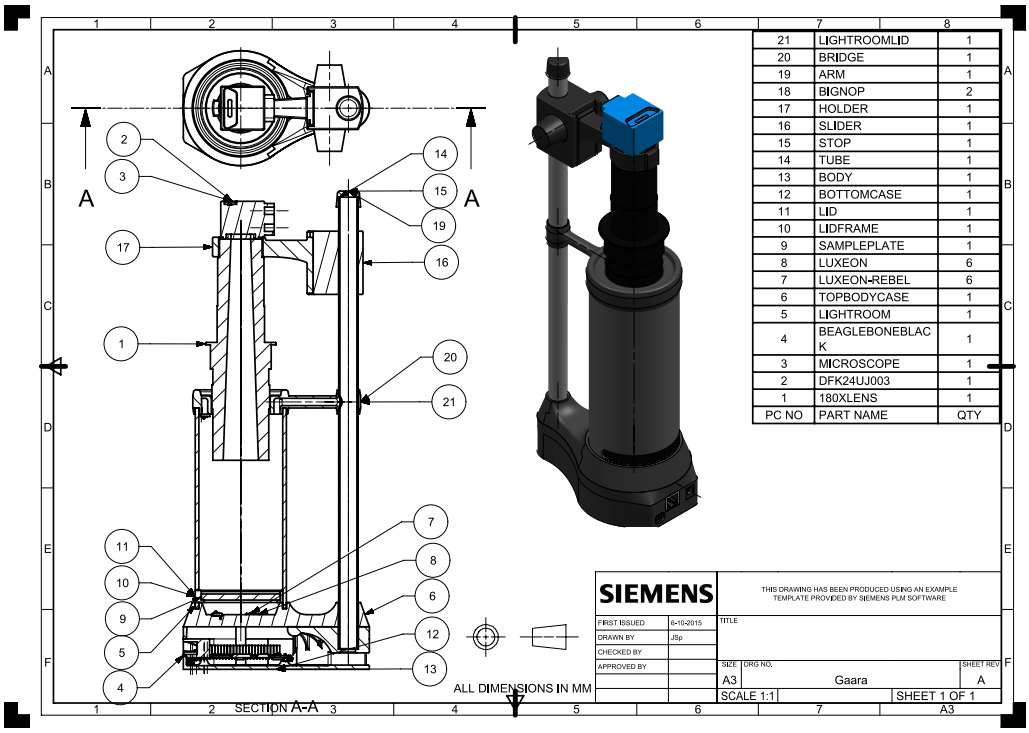


Figure 8.3: Prototype assembly

8.4 Program structure

The program is designed such that the code can be reused. This is done with an object orientated approach. The main interaction with the user is through the graphical user interface or GUI for short, which is described in detail in chapter 3.2. All the windows used by this GUI can be found in the appendix A at page 73.

The GUI is loaded from the command prompt with the following syntax:

```
#./VSA
```

The GUI is load through the **VSAMainwindow** class. This class is the main executable. figure 8.4 depicts the collaboration diagram for this class in its libraries. The structure depicted in the following paragraphs is a simplified rendition of the program structure. The complete reference file including documentation for all the namespaces and classes including inheritance and collaboration diagrams can be found in appendix Q at 363.

VSAMainwindow

This class is responsible for setting up the environment and providing user interaction. It start by loading the user setting in to memory this class is called **SoilSettings**. It then starts up communication with the microscope, taking in to a account error handling. It

handles user interruptions, menu and toolbar actions and signals from other classes, such as progress updates.

namespace SoilMath

This library is used extensively by the other libraries and consists of the following classes: FFT (Fast Fourier Transform), GA (Genetic Algorithms), Stats (Statistics), PSD (particle size distribution), NN (Neural Network), Sort (quick sort routine) and common math operations, type and error handling.

namespace SoilHardware

This library performs the hardware communication, it basically consist of two sections; Those are camera communication with the class Microscope and Beaglebone black specific classes, GPIO[4], ADC[5], eQEP[6] and PWM[7]. Although the Hardware class compiles on a x64 architecture the BeagleBone specific classes don't work there.

namespace SoilVision

This library performs all vision related operations and is explained in detail in section 9. It consist of the following classes: Conversion (color conversion), Enhance (Image enhancement), MorphologicalFilter, Segment and VisionDebug (Enables easy vision debugging operations).

namespace SoilAnalyzer

The SoilAnalyzer combines all the above classes in such away that the particles are segmented from the background and analyzed. It consist of the following classes: Analyzer (the actual analyzer engine), Sample (The storage container for the complete soilsample), Particle (A storage container for a single particle) and the SoilSettings (A storage class the allow easy setting movement between classes).

Serialization properties

Many of the above mentioned classes are setup in such away that the object can be (de-)serialized to a file. This allows storage and transport of the soil sample and the user settings.

GUI helper classes

The following QWidgets and Qdialog classes are there to present user readable information. They consist of QOpenCVQT (convert the OpenCV image storage to QT image storage), QParticleDisplay (Particle browser), QParticleSelector (Shape selector for an individual particle), QReportGenerator (PDF report generator of the analyzed sample), DialogNN (Learning center of the Neural Network) and DialogSettings (Dialog window where the user settings can be adjusted).

[4] General Purpose Input and Output
[5] Analogue Digital Convertor
[6] enhanced Quadrature Encoder Pulse
[7] Pulse Width Modulation

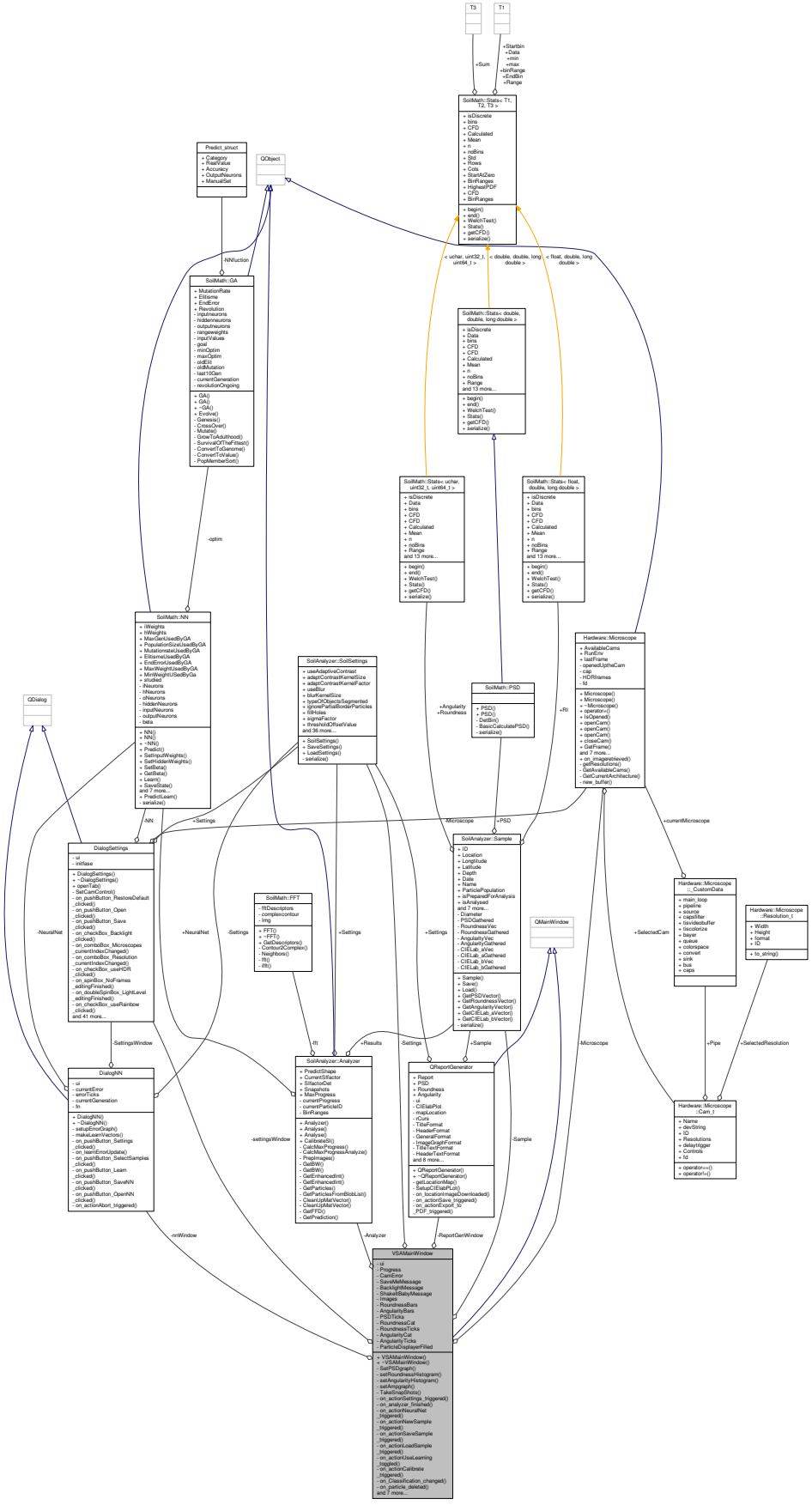


Figure 8.4: Collaboration diagram of the main program

9. Vision realization

This chapter describes the used vision processing techniques. The current prototype and work flow is developed to allow for different routines. The user has multiple options and strategies available to achieve optimum results. Each of these are explained in the sequential subsection below. It begins with the acquisition of image(s), which are then enhanced to allow for optimal segmentation of pixels related to sand particles. These pixels are used to determine the features of each particle, which serve as input for the classification algorithms.

9.1 Image acquisition

A thorough review of the current literature [4] identified three properties that can be used in vision based analyzing. These properties are structure (shape), color and texture (size). When looking closely at sand sample, you notice a multitude of shapes, colors and sizes, each particle is unique and differs from its neighbor. This diversity brings it own challenges. The shape of a particle determines how it will rest on the sample plate. The color and the translucency of the particle, determines how easily it can be segmented or identified from the background. Whilst the size determines the needed focus depth of the microscope.

R In samples, where the particles show a huge spread in size, compared to the mean size, there will be a noticeable difference in focus, between big and small particles.

Acquisition strategies

The first prototype is developed in such a way that multiple acquisition strategies can be implemented. Each of these tackle different challenges. The quality of the acquired image is the biggest factor in the successful extraction of a particle, but in order to make any valid claim about the sample, a certain amount of particles have to examined. To determine the minimum sample size , the following equation can be derived:

Let the reliability be 95% $\therefore z = 1.96$, the probability be $P = 50\%$ and the accuracy be $\alpha = 5\%$; consider the function:

$$z\sqrt{\frac{p \times (1-P)}{n}} \leq \alpha \rightarrow n \geq \frac{-p \times (P-1) \times z^2}{\alpha^2} \tag{9.1}$$

This brings the minimum amount of particles to 384. With the predefined range of particle sizes ($0.2[mm] \leq P_{size} \leq 2[mm]$ where P defines a particle) and the limited work area under the microscope, multiple shots have to be taken. Where the sample is rearranged. Between fifteen and twenty shots are usually enough.

R The process of rearranging the particles, will be automated in the future. Student of the minor Machine design and major electrical engineering both taught at the university of applied sciences HAN, can choice to work on the assignment. The project are to be two weeks in length and the output will serve as input for the second prototype. These project will be executed under the auspice of MTI Holland and the author. The assignments are described in appendix C and D.

Acquisition

Each sample is placed in a light condition room, and laid out on a semitransparent white acrylate plate. The sample can be illuminated with a bright field light source, where the light is aimed directly at an object or the particle can be lit with back lighting. See the course notes [8] for a more in-depth description. The choice for back lighting can be made because translucent particle are harder to segment in a bright field light. The trade off is extra processing time.

After the sample is placed in the light condition room, the microscope takes a image with bright field illumination and, if the option is selected, another one with back lighting. Hereafter the sample is rearranged, this is a manual procedure. Once the sample is rearranged a new set of shots is taken. Each image that is acquired from the microscope is defined by a matrix were the values are triples for the RGB (red, green and blue) values and these are defined by an unsigned byte.

Each image is stored in a vector using a custom container. This container consists of a bright field image, back light image and a SI-conversion factor . Each time the height is changed, the microscope has to be calibrated so that the relation between pixel and [mm] can be determined. This is done by taking a shot of a disc with known dimensions. A single euro cent can serve for this purpose.

R The image is stored in the OpenCV matrix (cv::Mat) container. This container is designed to handle image processing data and routines. It makes use of memory management and smart pointers to handle the data effectively.

9.2 Image enhancement

Image enhancement prepares the RGB image for conversion to a binary image. It eliminates noise and brings out wanted features, by using filters.

Intensity image

The first step in this process step is the conversion from the RGB color space to an scalar valued image which represent the luminosity, also known as a intensity image. This luminosity is calculated using a weighted average and is done for bright field and back lit images.

Let $\mathbf{I}$ and $\mathbf{R},\mathbf{G},\mathbf{B}$ be a matrices with dimensions $n \times m$ derived from the color matrix $\mathbf{RGB}$ with dimensions $n \times m \times 3$; The weighted average can be calculated with the following equation:

$$\mathbf{I} = 0.2126 \times \mathbf{R} + 0.7152 \times \mathbf{G} + 0.0722 \times \mathbf{B} \tag{9.2}$$

Adaptive contrast stretch

After the conversion from RGB to an intensity image, the user has the choice to apply an adaptive contrast stretch to the bright field images. This process is used to enhance the contrast of the intensity image. For every pixel and its surrounding area the mean and standard deviation are calculated. If the value of the pixel is above or below the mean than the following rule is used to determine the new value: $\mathbf{I}_{n,m} = \mathbf{I}_{n,m} \times \alpha \pm \sigma$, where α is a scaling factor and σ is the standard deviation of the old pixel value with it's neighboring kernel pixels.

Blur

As a second enhancement the user can apply a blurring operation to the bright field images, in essence the opposite of the contrast stretch. The blur operation also determines the mean for every pixels within a given area: the kernel. The mean value of the kernel is assigned to the pixel.

Cropping

The above operations described in the paragraph 9.2 and 9.2, leave the border pixels unaffected in their calculations. This offset is determined by half of the biggest kernel size. These pixels are discarded for the next step. The enhanced intensity matrix is used for particle segmentation, see section 9.3. Whilst the intensity matrix of the bright field image is used for the conversion to the CIE La*b* colorspace, as explained in section 9.3.2.

9.3 Feature extraction

The individual particles have to be identified end segmented from the background. These operations are performed on the enhanced intensity matrix. If the user opted to use back lit and bright field matrices, the enhanced intensity matrices where calculated from the back lit intensity matrices. Otherwise the bright field intensity matrices are used.

9.3.1 Shape features

One of the main features that are of interest are those that describe shape, be it the contour or area of a particle. The feature are extracted using the algorithms below.

Segmentation

The images are segmented by calculating a threshold value. This value is determined by using the Otsu threshold. Xu et al. [7] describe that the Otsu threshold is equal to the average of the mean levels of two classes partitioned by this threshold. This threshold value can be iteratively determined.

Let $\vec{h}$ be a vector of dimension 256 which represent a count of values in the enhanced

intensity matrix $\mathbf{I} \subset \mathbb{Z}^n \rightarrow \{0,255\}$ with dimensions $m \times n$

$$\frac{1}{t_o}\sum_{i=1}^{t_o}\vec{h}_i = t_o - \frac{1}{256-t_o}\sum_{i=t_o}^{256}\vec{h}_i \tag{9.3}$$

In order to get more control over the segmentation process, the normal Otsu's method, as shown above is altered. A user now has the option to choose whether bright or dark object are segmented and how much the intensity values may deviation from the mean value. The mean value obtained from equation 9.3 is modified with a scaling factor and the standard deviation, as shown in equation 9.4 and 9.5.

Let $t_o \subset \mathbb{Z}^n \rightarrow \{0 \leq t \leq 255\}$ be the threshold value obtained with the iteration algorithm used to solve equation 9.3, α be the a multiplication factor given by the user and let $\vec{h} \subset \mathbb{Z}^n$ be a vector of dimension 256 which represent a count of values in the enhanced intensity matrix $\mathbf{I} \subset \mathbb{Z}^n \rightarrow \{0,255\}$ with dimensions $m \times n$
If dark objects are to be obtained

$$t = \frac{1}{t_o}\mu + \frac{1}{2}\alpha\sigma \text{ where } \sigma = \sqrt{\frac{1}{t_o}\sum_{i=1}^{t}(\vec{h}_i - \mu)^2}, \text{ and } \mu = \frac{1}{t_o}\sum_{i=1}^{t}\vec{h}_i \tag{9.4}$$

else

$$t = \frac{1}{t_o}\mu - \frac{1}{2}\alpha\sigma \text{ where } \sigma = \sqrt{\frac{1}{256-t_o}\sum_{i=t}^{256}(\vec{h}_i - \mu)^2}, \text{ and } \mu = \frac{1}{256-t_o}\sum_{i=t}^{256}\vec{h}_i \tag{9.5}$$

Binary Image

The binary image is calculated by using the previous obtained threshold value as illustrated in equation 9.6.

Let $\mathbf{B} \subset \mathbb{Z}^n \rightarrow \{0,1\}$ and $\mathbf{I} \subset \mathbb{Z}^n \rightarrow \{0,255\}$ both with dimensions $m \times n$ and let $t \subset \mathbb{Z}^n \rightarrow \{0 \leq t \leq 255\}$

$$\mathbf{B} = \left\lfloor \frac{\mathbf{I}}{t} \right\rfloor \tag{9.6}$$

Labeled blobs

If the threshold value was correctly ascertained then the binary image will consist of zeros and ones. Particles are represented by islands of connected elements with a designated value of one in an ocean of zeros. The individual particles, which are dubbed "blobs" will be identified with a two-pass connected-component labeling algorithm.

This algorithm passes each element in a binary image in a consecutive manner. When the current element belongs to a particle, it will check if previously processed neighboring pixels belong to an earlier labeled blob. If this is not the case it will assign a new label value to the current element. If it finds that one of the neighbors belong to one or more blobs, it assigns the lowest value and writes the other value to a queue. To store the connected labels.

In order to determine the lowest value of the connected component, a graphs matrix is generated, see figure 9.2. Each branch on these trees are followed till the lowest value is ascertained. All the leafs on the tree are then set to this value. These values are placed in a Look-Up-Table. With the second loop through the previously labeled image each

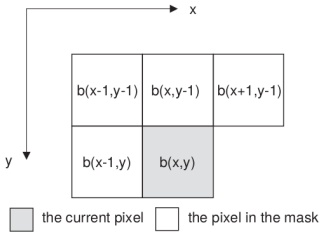


Figure 9.1: Neighboring elements Source: [2]

value is replaced by looking up the lowest value in LUT.

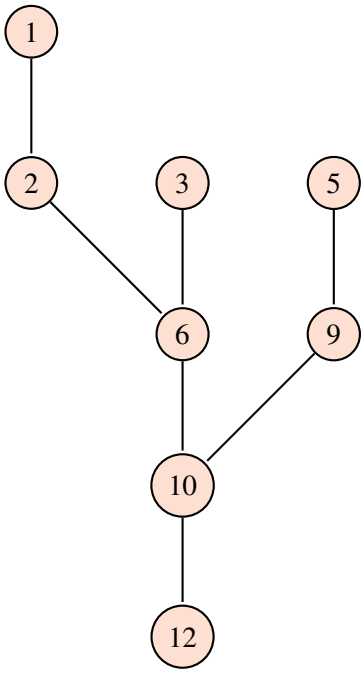


Figure 9.2: Connected Queue

A Look-Up-Table (LUT) is an array where a new value can be obtained with a simple array indexing operation. This is a very effective operation since looking up a value in memory cost less machine instructions then perform computation on each matrix element. A LUT consist of 256 elements for a unsigned byte, while a image matrix has roughly 5 million elements.

The numbering of the labels are made consecutive using an adapted quick sorting algorithm. These numbers are used to identify the individual particles in a sample. For each unique particle a type is created. This type is stored in vector and represent the sample.

For each particle a region of interest or ROI is obtained looking for the minimum and maximum value of the labeled blob within the labeled image. This ROI, is used to extract the same blob from the bright field RGB image.

Hu moments

The Hu moments are determined for the individual blobs. A Hu moment is a certain particular weighted average, or moment, of pixels in an image and can be defined as

follows for a discrete image.

Let $\mathbf{B} \subset \mathbb{Z}^n \to \{0,1\}$ with dimensions $m \times n$

$$M_{i,j} = \sum_m \sum_n m^i n^j B_{m,n} \tag{9.7}$$

The first order or raw moment gives the total area of the particle, while the second order gives the centroid. Which is used when describing complex contour. This will be explained later on. The second order can be used to determine the orientation of the particle. By constructing a covariance matrix the rotation can be extracted from the angle of the eigenvector associated with the largest eigenvalue.

$$\Theta = \frac{1}{2} \arctan\left(\frac{2(M_{11}/M_{00} - \bar{x}\bar{y})}{(M_{20}/M_{00} - \bar{x}^2) - (M_{02}/M_{00} - \bar{y}^2)}\right) \tag{9.8}$$

Particle rotation

When the above orientation deviates from a horizontal or vertical axis, the particle is rotated. This is done by expanding the matrix in all four directions. Padding the borders. And applying the rotation matrix. When old pixels don't completely fall within the new grid. The new pixel value is obtained with linear interpolation.

R The orientation of a particle is relevant because it allows for easy determination of the smallest diameter. The VSA uses a equivalent diameter to calculate the Particle Size Distribution. Normally this equivalent diameter is calculated with the assumption that the particle is round. This gives a distortion when comparing against particles that are sieved. The mesh size of the sieve allows oval particle to pass by their smallest cross-section.

Particle edge

Using the binary image from the individual particle an edge is obtained. This is done by applying the morphological operation of erosion. With this algorithm the blobs are eroded using the following principle

Let $\mathbf{B} \subset \mathbb{Z}^n \to \{0,1\}$ and $\mathbf{K} = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$

$$\mathbf{B} \ominus \mathbf{K} = \bigcap_{k \in \mathbf{K}} \mathbf{K}_{-b} \tag{9.9}$$

The previous obtained ROI is used to extract the edges from the individual particles. This edge is used in the Fast Fourier Transformation. In order to obtained a continuous function from the edge, a depth-first searching algorithm is applied.

Depth-first search

This starts at the top-left edge pixels and looks at its neighboring pixels. If it finds more then two neighboring pixels it stores the additional values in a queue and it moves to the first pixel new pixel. Here it performs the above decision process again. If it doesn't it only finds one neighboring pixel it know it's at a dead end. The algorithm will backtrack and start at the first branch in the queue. Subsequently storing the previously walked path, so it doesn't traverses again down this branch. This process is repeated until it find the

starting pixel. Each individual branch that is processed in this way is stored in a vector of coordinates.

Complex contour

These coordinate are stored as complex numbers where the real part is the row and the imaginary part is the column. Both are taken with respect to the center of gravity, which is obtained with the first order of the Hu moments, see earlier paragraph. The shortest vector of connected coordinates that form a loop is determined to represent the edge of the particle.

R By choosing the shortest path of neighboring edge pixels as a complex contour. The roughness of the edge is represented slightly less rough then the pixel suggest that is. This effect is negated, because of the discrete nature of the digital representative of a particle compared with continuous real curve of actual particle.

9.3.2 CIE La*b* extraction

The conversion from the RGB color model to the CIE La*b* model is done for each individual particle. According to Spijker [4] its easier to ascertain a correlation between the amount of organic carbon (OC) in a soil samples when the data is presented on the chromatic a* and b* axis then in the RGB space. The L value represent the luminosity value of a pixel while the a* values indicate the color on a chromatic axis between green (negative) and magenta (positive)

The relation diagram below show that there has to be a conversion from RGB to CIE XYZ first in order to traverse to CIE La*b*. The bright field RGB images serve as a starting point. From this image the blobs are extracted, using the previously obtained ROI or region of interests. The calculations are only performed on pixels that belong to a particle. Background pixels are ignored. After these conversions, the mean a* and b* values are calculated for each particle.

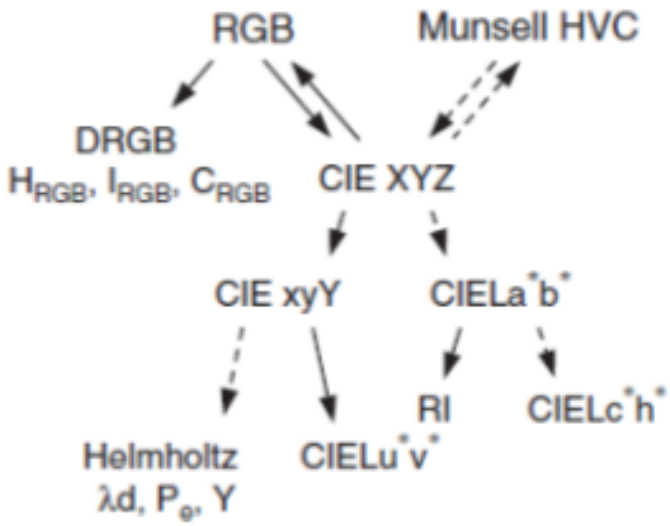


Figure 9.3: Conversion steps to different color models (Source: Viscarra Rossel, Fouad, and Walter [6])

Let $\mathbf{XYZ} \subset \mathbb{R}^n \rightarrow \{0 \leq \mathbf{XYZ}_{m,n} \leq 1\}$ and $\mathbf{RGB} \subset \mathbb{Z}^n \rightarrow \{1 \leq \mathbf{RGB}_{m,n} \leq 256\}$ both with dimension $m \times n$ The following transformation takes place for each pixel that belongs to a particle.

$$\begin{bmatrix} \mathbf{XYZ}_{i,j,1} \\ \mathbf{XYZ}_{i,j,2} \\ \mathbf{XYZ}_{i,j,3} \end{bmatrix} = \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119194 & 0.950227 \end{bmatrix} \cdot \begin{bmatrix} \mathbf{RGB}_{i,j,1} \\ \mathbf{RGB}_{i,j,2} \\ \mathbf{RGB}_{i,j,3} \end{bmatrix} \tag{9.10}$$

After the conversion to the CIE XYZ color model the particle pixels are converted to the CIE La*b* color model. This is done with the equations depicted below.

Here the following definitions stand $\mathbf{LAB} \subset \mathbb{R}^n \rightarrow \{-128 \leq \mathbf{LAb}_{m,n} \leq 128\}$ and $\mathbf{XYZ} \subset \mathbb{R}^n \rightarrow \{0 \leq \mathbf{XYZ}_{m,n} \leq 1\}$ These transformations are performed for each pixel that belongs to a particle.

$$\begin{aligned} \mathbf{LAB}_{i,j,1} &= \begin{cases} 116(\frac{\mathbf{XYZ}_{i,j,1}}{100})^{\frac{1}{3}} & , \frac{\mathbf{XYZ}_{i,j,1}}{100} > 0.008856 \\ 903.3(\frac{\mathbf{XYZ}_{i,j,1}}{100})^{\frac{1}{3}} & , \frac{\mathbf{XYZ}_{i,j,1}}{100} \geq 0.008856 \end{cases} \\ \mathbf{LAB}_{i,j,2} &= \left[\left(\frac{\mathbf{XYZ}_{i,j,1}}{95.047} \right)^{1/3} - \left(\frac{\mathbf{XYZ}_{i,j,2}}{100} \right)^{1/3} \right] \\ \mathbf{LAB}_{i,j,3} &= \left[\left(\frac{\mathbf{XYZ}_{i,j,2}}{100} \right)^{1/3} - \left(\frac{\mathbf{XYZ}_{i,j,3}}{108.883} \right)^{1/3} \right] \end{aligned} \tag{9.11}$$

9.3.3 Fast Fourier Descriptors

Fourier descriptor provide away to describe a shape of a two-dimensional object by taking the Fourier transform of the boundary. Every row and column in the sparse matrix that belong to the edge of a particle, is mapped to a complex number $c + ir$ with its relation to an earlier obtained center of gravity. The process of obtaining the complex vector of coordinates is explained in detail in section 9.3.1.

The Fast Fourier Transform is obtained, with an divide and conquer technique and is based upon the *Cooley-Tukey algorithm*. According to Canale and Chapra [1] the idea behind the these algorithms is that a DFT (Discrete Fourier Transform) of length N is decomposed, or "decimated" in to successively smaller DFTs. This process is illustrated in figure 9.4 and 9.5 for a $m = 8$ DFT. The decimation takes place in the frequency domain and is sliced between even and odd steps. The only constrained that is placed on the computations is that $N = 2^m$ where m is the number of complex coordinates describing the contour. This complex contour first has to be validate with this constrained. This can be tested with equation 9.12, if it holds false, then the complex vector is appended with $0 + i0$.

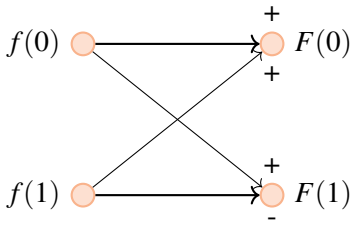


Figure 9.4: Fundamental computation of a Fast Fourier Transform

This condition can be tested with the equation below

$$\left\lfloor \frac{\log_{10} m}{\log_{10} 2.0} \right\rfloor = \frac{\log_{10} m}{\log_{10} 2.0} \tag{9.12}$$

The flow diagram depicted in figure 9.5 is implemented as algorithm 9.3.1. When this

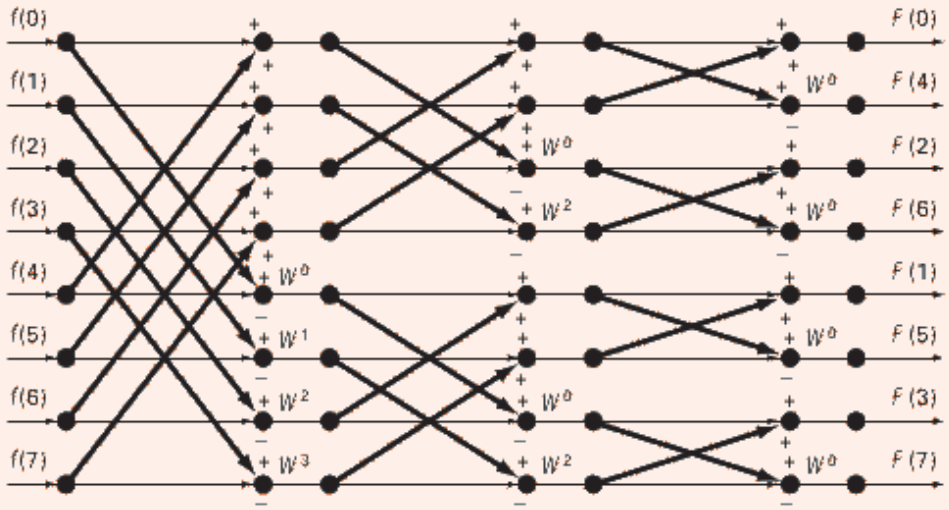


Figure 9.5: Decimation of a $m = 8$ DFT (Source: Canale and Chapra)

pseudo code is translated to a C++ object the code in appendix H at page 108 is the result.

Let $\vec{c}$ be a complex vector of which size is assumed to be an integral of power 2
Algorithm 9.3.1: FFT($\vec{c}$)

$N \leftarrow size(\vec{c})$
if $N <= 1$
  then return (0)
$i \leftarrow 0$
$\vec{e} \leftarrow null$
$\vec{o} \leftarrow null$
for each $c \in \vec{c}$
  do **if** $\mod \frac{i}{2} = 0$
    then $\vec{e}_{\lfloor i/2 \rfloor} \leftarrow \vec{c}_i$
    else $\vec{o}_{\lfloor i/2 \rfloor} \leftarrow \vec{c}_i$
  $i \leftarrow i+1$
FFT($\vec{e}$)
FFT($\vec{o}$)
for $k \leftarrow 0$ **to** $\frac{N}{2}$
  do $\vec{t} \leftarrow$ STD::POLAR$(1, \frac{-2 \cdot \pi \cdot k}{N}) \cdot \vec{o}_k$
  $\vec{c}_k = \vec{a}_k + \vec{t}$
  $\vec{c}_{k+N/2} = \vec{k} - \vec{t}$

9.3.4 Particle Size Distribution

A common test to measure a particle size distribution is the sieve analysis method. In this test the PSD is obtained by allowing a soil sample to pass through a stack of sieves. These are placed in a consecutive order. Where the biggest mesh size is placed on top and the smallest below. The stack of sieves is placed in a mechanical shaker and shakes for

approximately $10[min]$. This results in a segregation of the soil sample in ranges, where the demarcation is between the last mesh size that allowed a particle to pass and the first one that retained it.

Because the sieve analysis method is a commonly accepted test, the visual measured PSD has to mimic its characteristics traits. Early test suggested an offset when a soil sample was tested against a known sample. The sieved samples seemed to favor lower ranged bins when compared with the visual analyzed sample. This effect seemed to increase when the particles became less round. This implies a correlation between sphericity and the equivalent diameter, used in the particle size distribution. This theory is described in theorem 9.3.1 but needs additional proofing and or testing.

Obtaining the diameter of a particle

The size of each individual particle can be obtained by counting the pixels that belong to that particle. Determining the equivalent diameter with $\frac{4}{\pi}\sqrt{A}$ and applying a conversion from pixel to millimeter, which was obtained when the initial images where acquired, see section 9.1 paragraph acquisition. As stated above and shown in theorem 9.3.1 It still needs to be corrected for it's sphericity. This conversion factor was obtained previously when the Hu moments where calculated. For now this factor is treated as a linear correction. The complete equation is shown below.

Let $\mathbf{B} \subset \mathbb{Z}^n \to \{0,1\}$ with dimensions $m \times n$ be a matrix with a single connected particle, where pixels belonging to that particle are assigned the value 1 and background pixels 0. And let $\alpha \subset \mathbb{R}^n \to \{0,1\}$ as a conversion factor between pixel and millimeter. Let $\sigma \subset \mathbb{R}^n \to \{0,1\}$ be defined as the sphericity obtained using equation **??**, see section9.4.1

$$\frac{2\alpha\sigma}{\pi}\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n}\mathbf{B}_{m,n}} \tag{9.13}$$

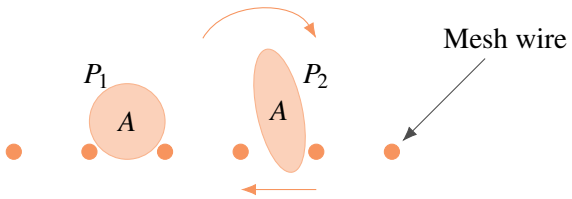


Figure 9.6: Sieving motion

Theorem 9.3.1 — Correlation between sphericity and equivalent particle diameter (obtained by sieving). The equivalent diameter of a arbitrary area A needs to be decreased with a factor when the ratio between the two axes describing that particle decreases.

Proof. The sieve mesh size can be perceived as a cross-section of a particle. A particle that passes a certain mesh size must have a smaller cross-section then the opening in the mesh itself. When cross-sections of particles are assumed as being elliptical in shape. It consist of two axis that describe it a and b. If both axes are equal it is a circle.

The orientation of a particle is relevant when it passing through the openings in a

sieve. The shaking motion, introduced by the sieve analysis method, allows elliptical shaped particle to stand upright when passing the cross-section of a sieve. Once the tip of an elliptical particle is caught in the mesh cross-section, the momentum of that same particle and the constrained of the mesh wires allows it to orient itself upright. Thus passing the mesh by it smallest cross-section. This is illustrated in figure 9.3.4.

Since both particles P_1 and P_2 have the same area but P_2 is allowed to pass to a lower sieve or bin. It can be stated that when the sphericity decreases, lower valued bins will be favored in statistical calculations.

Because the largest ellipse that fits within a square is the inscribed circle, as proven in theorem 9.3.2. An equivalent diameter will need to be corrected with a factor. This factor can be determined with the roundness value obtained by the Hu moment ascertained in section 9.3.1. ■

Theorem 9.3.2 — The largest ellipse that fits within a square is the inscribed circle. The largest ellipse that fits within a square is the inscribed circle.

Proof. It's clear that the largest ellipse touches all four sides of a square. If this isn't the case the ellipse has to be scaled in the direction where there is a gap between ellipse and square side. This will increase the area of the ellipse as well.

Its axes must lie on the square's diagonals, when the largest ellipse touches the sides. Because of the symmetric properties, . The coordinate system can in which the square is positioned can be chosen, such the corners lie on $(0,\pm 1)$ and $(\pm 1,0)$; The ellipse will then have the equation $ax^2+by^2=1$ for some a and b.

The relation between a and b can be found because the line $y=1-x$ must be tangent to the ellipse. Therefore the discriminant of the equation $ax^2+b(1-x)^2=1$ must be 0. This can be reworked to $b=\frac{a}{a-1}$

The area of the ellipse is $\frac{\pi}{4ab}$. In order to maximize this area $ab=\frac{a^2}{a-1}$ must be minimized. This is done by solving $\frac{\mathrm{d}}{\mathrm{d}a}\left(\frac{a^2}{a-1}\right)=0$ where $a=2\vee a=0$. Therefore $b=\frac{2}{2-1}=2$ and thus $a=b$. Which describes a circle. ■

Calculating the statistics

When each particle equivalent diameter is obtained with equation 9.13. Various statistical algorithms are performed. These are written in a generic template class, which allows the class to work on many different data types without being rewritten for any one.

Because a particle size distribution doesn't follow an evenly spaced bin range. The PSD class is introduced this class inherits from the statistic class. This class uses the following bin range steps:
$[0,0.038,0.045,0.063,0.075,0.09,0.125,0.18,0.25,0.355,0.5,0.71,1,1.4,2]$. It gives information with regard to the number of particles, the mean, minimum and maximum particle size and the standard deviation.

R The statistical class, lies at the heart of many functions. For instances determining the threshold in the Otsu algorithm (section 9.3) or when applying the adaptive contrast stretch (section 9.2). But also to calculate the mean and standard deviation of the color properties (RGB, Intensity, CIE La*b*). Since this class is called many time, sometimes as much a 200×10^6 times, a great deal of effort was put in optimizing this function, while still maintaining maximum re-usability. The statistical class can be found in appendix H, page 123. Detailed information with regard to the inheritance and collaboration is given in the reference manual, in appendix Q.

9.4 Classification

The shape of a particle has a correlation with multiple properties, such as tool wear, permutation and erosion. This shape is categorized by trained humans, by comparing the particle with sixteen different classes, which are sorted according sphericity and angularity. This is illustrated in figure 9.7.

The sphericity and angularity category are both derived using vastly different techniques. These are explained in the subsection below.

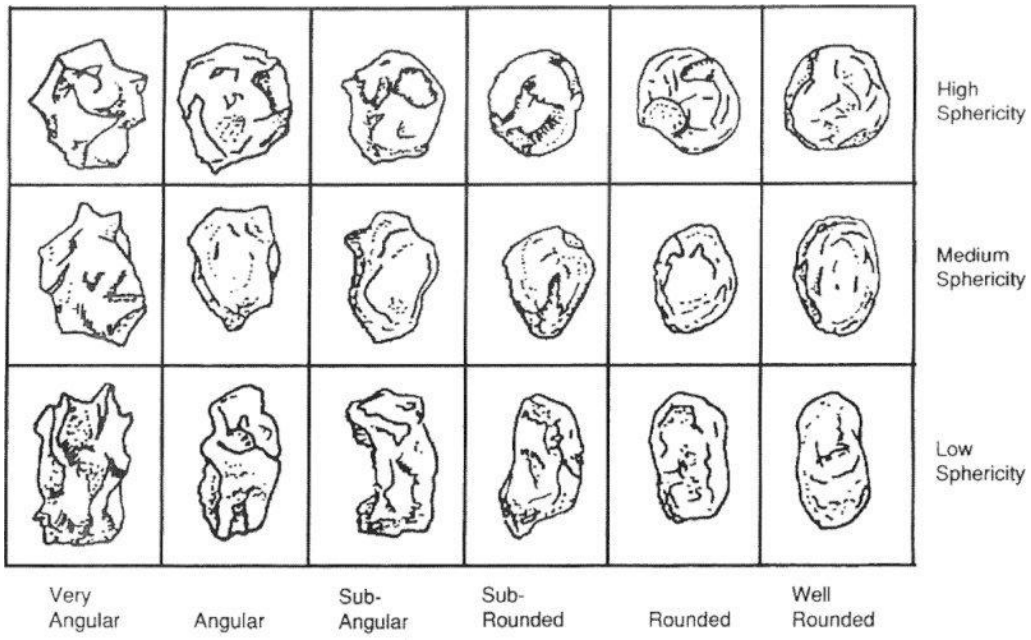


Figure 9.7: Sand shape categories (Source: Miller and Henderson [3])

9.4.1 Sphericity using Hu moments

The sphericity of a particle is the factor with which it deviates from a perfect circle. This factor can be obtained using the previous obtained Hu moments. This ensure that the shape is invariant with regard to the orientation of the particle. The equation 9.14 calculate the sphericity as a ratio and is also used as a correction factor in the PSD calculations. This can be classified using equation 9.15.

The Hu moments $M_{i,j}$ can be obtained using equation 9.7. Let σ be defined as $\sigma \subset \mathbb{R}^n \to \{0,1\}$ and σ_{class} be defined as $\sigma_{class} \subset \mathbb{Z}^n \to \{0,2\}$

$$\left.\begin{aligned} \mu'_{20} &= \frac{M_{20}}{M_{00}} - \left(\frac{M_{10}}{M_{00}}\right)^2 \\ \mu'_{02} &= \frac{M_{02}}{M_{00}} - \left(\frac{M_{01}}{M_{00}}\right)^2 \\ \mu'_{11} &= \frac{M_{11}}{M_{00}} - \frac{M_{10}}{M_{00}}\frac{M_{01}}{M_{00}} \\ \Delta\mu_2 &= \mu'_{20} - \mu'_{02} \end{aligned}\right\} \sigma = \sqrt{1 - \frac{2\sqrt{\Delta\mu_2 + 4{\mu'_{11}}^2}}{\sqrt{\Delta\mu_2 + 4{\mu'_{11}}^2} + \mu'_{02} + \mu'_{20}}} \tag{9.14}$$

$$\sigma_{class} = \lfloor 2\sigma \rfloor \tag{9.15}$$

9.4.2 Angularity using a Neural Network

The angularity is categorized using a neural network or NN for short. These constructs are based upon the inner workings of a brain and can be approached as black boxes where the inner architecture is build up from interlinked neurons. Which sum up input and fires output once a threshold is obtained. They have the ability to learn and they consists of an input layer, a hidden layer and an output layer. Each layer in turn consists of individual neurons.

Neurons

The workings of a single neurons is depicted in figure 9.8 and can be described as follows; A neuron receives its input from all the neurons in a previous layer. Each of these inputs is modified with a weight ω_n. These values are summed up. When the sum of these values reach a certain threshold The neuron fires a 1. This threshold is modeled as a sigmoid value in order to have a continuous function which is needed when the neural net has to be taught.

Both $g(k) \subset \mathbb{R}^n \to \{0,1\}$ and $k \subset \mathbb{R}^n \to \{0,1\}$ are real numbered values. $g(k)$ is the sigmoid function and k determines the steepness of the threshold.

$$g(k) = \frac{1}{1+e^{-k}} \tag{9.16}$$

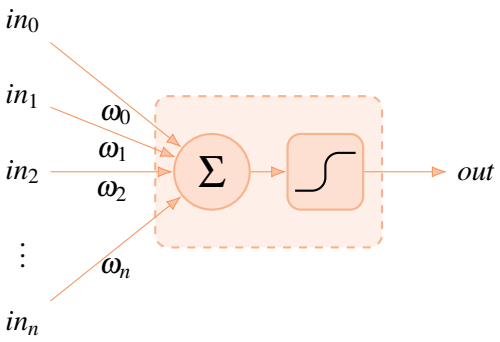


Figure 9.8: A single neuron

Programming approach

Programming of a neural network can be approached in two different ways. Object oriented, where the neurons and layers are classes or imperative oriented where the state of the program chances. The latter approach is chosen for this project. Although the code will be less reusable it will also have less overhead in machine instruction which are a result of (de-)construction of the objects.

Neural Network architecture

The architecture of the Neural Network is setup according to figure 9.9. It consists of a layer of input, hidden,and output neurons. The input neurons are fed the complex Fourier Descriptors obtained with algorithm 9.3.1. The absolute values are determined from these complex number, because the magnitude of chance is the only aspect that is of interest when the angularity is to be described.

Spijker [4] describes that nine till twelve descriptor are usually enough to describe a particle contour. Any higher and the discrete nature of the pixels will start to influence

the Fourier descriptors. The number of input neurons need to resemble the amount of descriptors used. These input neurons fire feed the next hidden layers of neurons and are multiplied by a weight, which are to be determined when the network is being taught.

Each hidden neuron sums up its input and transforms it with the threshold function. These values are fired to the next layer of output neurons, which performs the same summation and transformation. The output neuron with the highest value is selected as the most probable category. There are as many output neurons as categories, which is eighteen for the Vision Soil Analyzer.

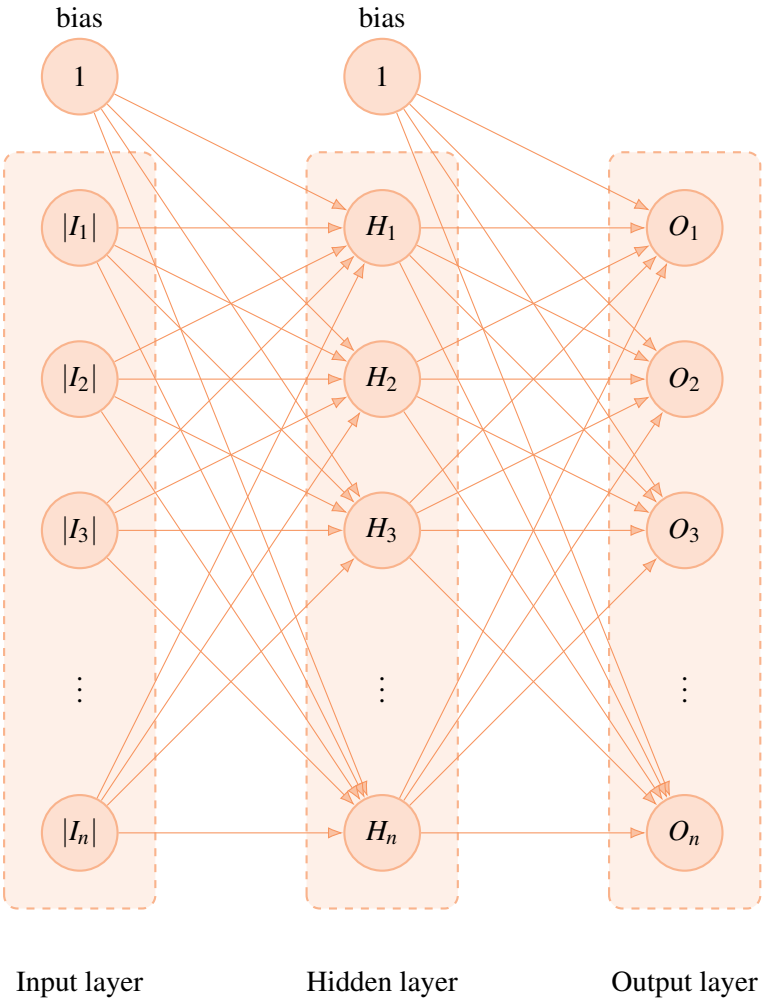


Figure 9.9: A neural network

Teaching the neural net

In order to determine the weights of the neural network it has to be taught. The network is optimized by feeding it input calculating the output and comparing it against the expected result. There are numerous algorithms and approaches to teach a neural net, the current approach is using a genetic algorithm.

9.4.3 Genetic Algorithm

Genetic algorithm are described as random search approaches, which have the ability to convergence to a global optimum. These algorithms are based on the theory of evolution,

where each sequentiality population is better adapted to its environment. The flow of the algorithm is shown in figure 9.10. This flow deviates slightly from the standard algorithm and introduces a new concept named "revolution".

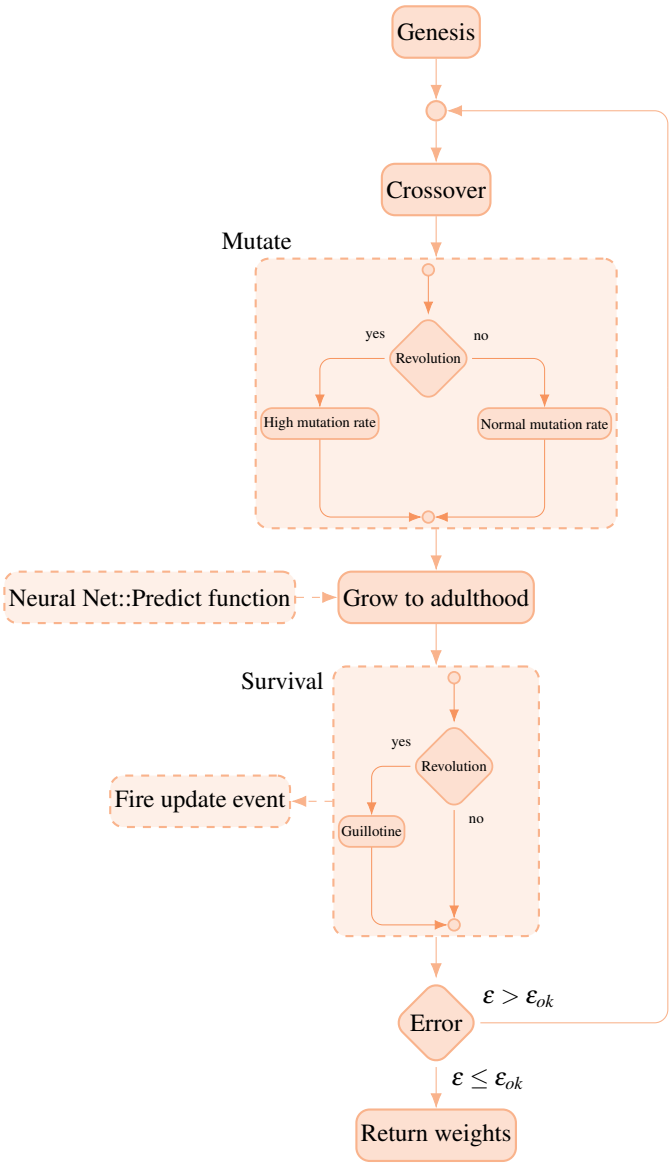


Figure 9.10: Genetic algorithm used to solve the weights of the Neural Network

Viva la revolution!

When a genetic algorithm get stuck on what is to be presumed to be local optimum, and the error isn't changed over a given number of generations, it is time to usher in a new era, one where the ruling class or elite population members are led to the guillotine and the general population undergoes great chances. Viva la revolution[1] This spreads out the previous homogeneous population and allows it to move away from the local optimum.

[1] As far as the knowledge of the author extends, the concept of moving away of a local minimum, by use of a revolution is a new concept. And because the author has been writing for 14 consecutive hours, he is willing to make some pun and call it a "revolution" in the field of Genetic Algorithms.

III

Verification

10. Comparing against specifications

It is important to measure how effective a prototype is. This is done by comparing it against the requirements that were set out at the start of this document. Not every aspect could be tested at this current stage, that is because the prototype is being finalized. Preliminary iterations of the prototype where all fitted with a simple generic webcam.

The new DFK24UJ003 camera became available at a later stage in the project. Fitting this camera in the project, required rewriting the software driver for this device. This has just finished. But it came to late to perform the necessary test with regards to accuracy. The test that measure these effect will be performed at the start of the next iteration[1].

Functional requirements

The functional requirements describe the functions which the device has to fulfill. These requirements were tested if possible and these results are given below. It becomes clear that the measurements that matter most are the ones that haven't been tested yet. All others are fulfilled and checked. As soon as the prototype is operational additional test will be performed and added as an addenda to this report.

ID	Description	Achieved
F1	**Quantify color**	
F1.1	Determine the color in a RGB color model, from all visually (by human eye) discernible particles	Not yet tested
F1.2	Chromatic a* values must lie within 3σ	Not yet tested
F1.3	Chromatic b* values must lie within 3σ	Not yet tested
F2	**Quantify texture**	

[1] This next iteration will be part of my thesis, where the focus will lie on quality and reproduction of the results.

ID	Description	Achieved
F2.1	The result of an analyzed sample should fall within a probability of at least $P = 0.95$ % when compared against the result of the same sample, but obtained using the established sieve method. These results are to be compared by Welch's t-test	Not yet tested
F2.2	PSD bins should have the same range as the fractions used in the sieving method	Yes
F3	**Quantify structure**	
F3.1	Roundness should be assigned in three categories	Yes
F3.2	Angularity should be assigned in six categories	Yes
F3.3	Predicted values should have at least a linear regression value of $R \geq 0.9$ when compared to expertly classified particles	Not yet tested
F4	**General specifications**	
F4.1	Analyze particle with sizes within the range $200\mu m \leq P_{size} \leq 2mm$	Yes
F4.2	No more then 2% of the extracted blobs may be connected particles	Not yet tested
F4.3	Analyzing a sample should take no longer then $1min$ (rearranging of sample between shot disregarded)	Yes
F5	**Interaction**	
F5.1	Show individual particles	Yes
F5.2	Show PSD graph with particle size in logarithmic scale	Yes
F5.3	Show Angularity in histogram	Yes
F5.4	Show Roundness in histogram	Yes
F5.5	Show probability distribution function in the histogram	Yes
F5.6	Information can be shown on a screen	Yes
F5.7	Exporting to pdf file	Yes

Table 10.1: The functional requirements compared against the product

Technical requirements

The technical requirements describe the production constrains placed on the design and realization. These requirements where checked against the current prototype. It becomes clear that most of these were fulfilled. The light controller hasn't been implemented, although the actuator (LED driver) and the sensor (LDR) are in place. This controller can be build as a soft- or hardware PI(D)-controller. And it will be implemented in the next iteration. Due to defective GPS unit on arrival, the optional GPS unit isn't implemented. Although this unit is optional at this stage, it will become an integral part of the next iteration.

ID	Description	Achieved
T1	**Software environment**	
T1.1	The software should run on an Linux device	Yes
T1.2	The software should be written in C++	Yes
T1.3	The software should be written as OOP and be reusable	Yes
T1.4	The software should be written with revision control	Yes
T1.5	Easily portable to Windows environment	Yes
T1.6	Easily portable to Android environment	Unknown
T2	**Hardware environment**	
T2.1	Should run on an ARMv7 or higher device	Yes
T2.2	Should run on a x86 or x64 device	Yes
T2.3	At least $1GHz$ processing power	Yes
T2.4	At least $128MB$ memory	Yes
T2.5	At least $2GB$ storage	Yes
T3	**Peripherals**	
T3.1	USB connection	Yes
T3.2	Ethernet LAN and/or WAN connection	Yes
T3.3	GPS unit	No
T3.4	Light controller	No
T4	**General specifications**	
T4.1	Sample file size should not exceed $10mb$	Yes
T4.2	Guard the maximum size of particles to $2mm$	Yes
T5	**Prototype specifications**	
T5.1	Dimensions should not exceed $400[mm] \times 200[mm] \times 200[mm]$	Yes
T5.2	The total weight may not exceed $5[kg]$	Yes

Table 10.2: Comparing technical requirements against the product

11. Conclusion

Many parties such as royal IHC and MTI holland have an interest in knowing the properties of soil, although these can be examined using conventional methods such as a particle size analysis using a mechanical sieve, these methods are often time consuming and cumbersome, consisting of bulky devices, which are none portable. Because it is useful to known the properties on site, a lightweight vision based soil analyzer was developed.

This device analyzes soil samples using its optical characteristics and describing them in to human readable reports. Because this device is highly portable, it gives a user a benefit of shorten logistical operations which are usually necessary to analyze a soil sample.

This product report describe the design specifications for a vision based oil analyzer, in such away that it can be reproduced, within a period of 10 weeks. It does so by exploring the main function a device such as this has to fulfill and translate these into requirements. These requirements serve as input for the technical and vision-based designs. The focus of this document lies on the vision related algorithm and the software aspect.

The designs are realized for the disciplines, mechanical, electrical and software engineering. In such away that the prototype can be reproduced within a period of ten weeks. The working environment and protocols are described as well as the expected output. This complete environment can be found at Github as a private repository.

The prototype was tested against the previous determined requirements and fulfilled many of these. But because of a set back in implementation of a new camera, the most noteworthy requirements could not be properly tested. It is therefore still unknown how well the prototype performs in comparison with a conventional sieve test.

Because this product will serve as the basis for the thesis of my major phase. Which will have a focus on a market ready quality device. These test will still be performed. They are after all to be used as a starting point for the next iteration. Although the current product still stands as good stepping stone, there are still many questions to be answered.

Such as: Is there a market for this device? What does a customer expect? How well does it perform?

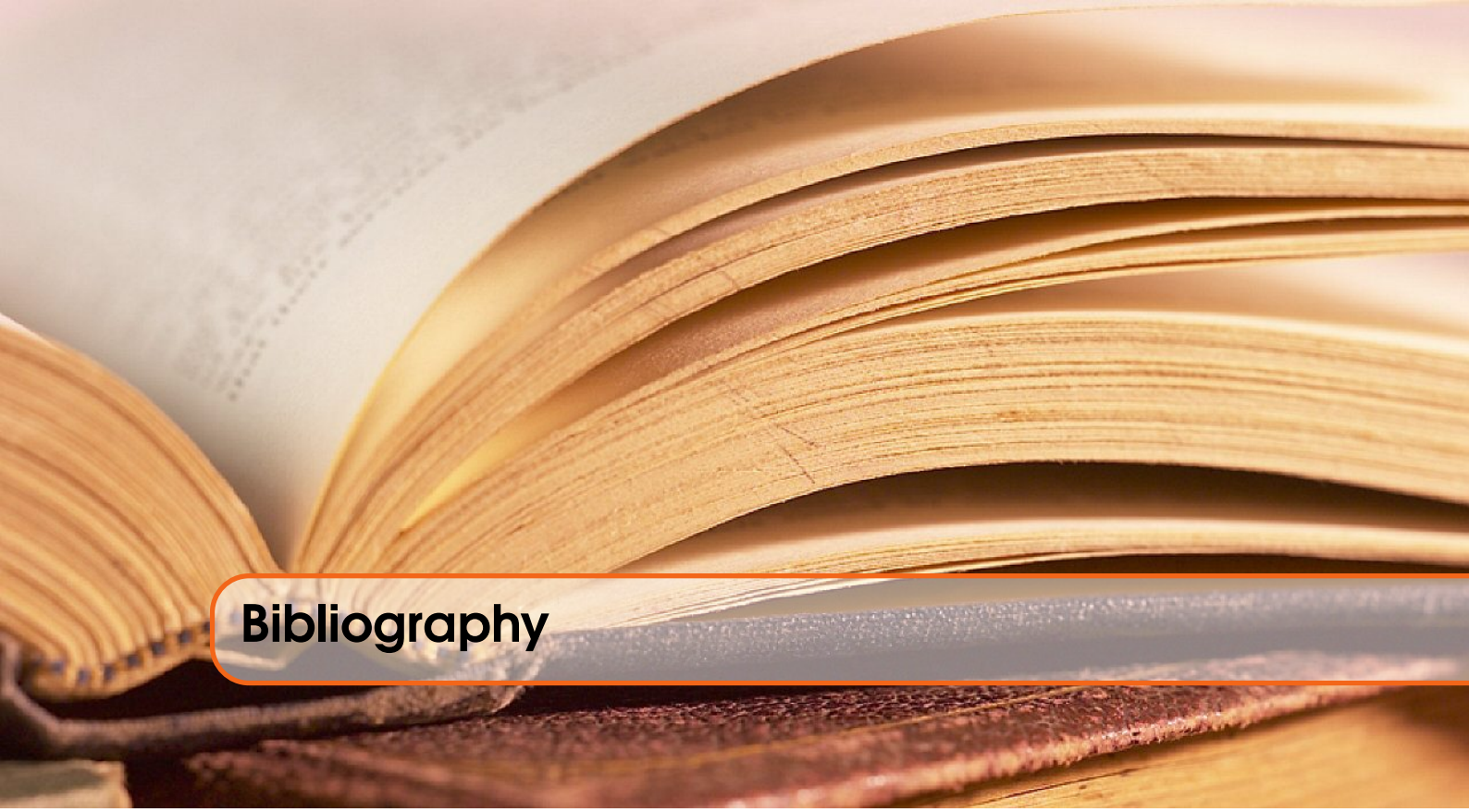
These question and more will be addressed by my thesis. In other words:

To be continued.....

Figure 11.1: The final prototype, with new camera

IV

Addenda



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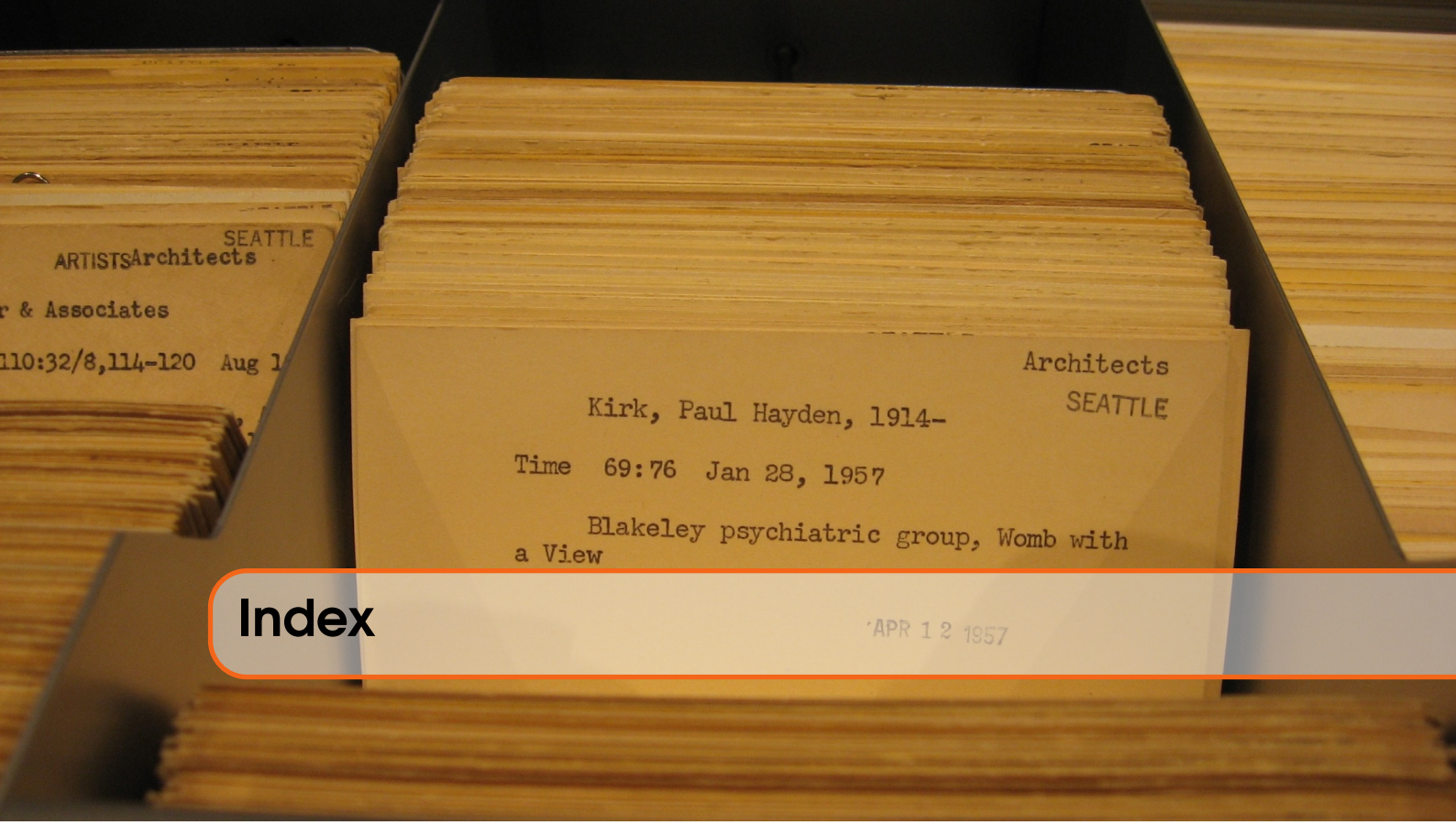


Index

A. Graphical User Interface

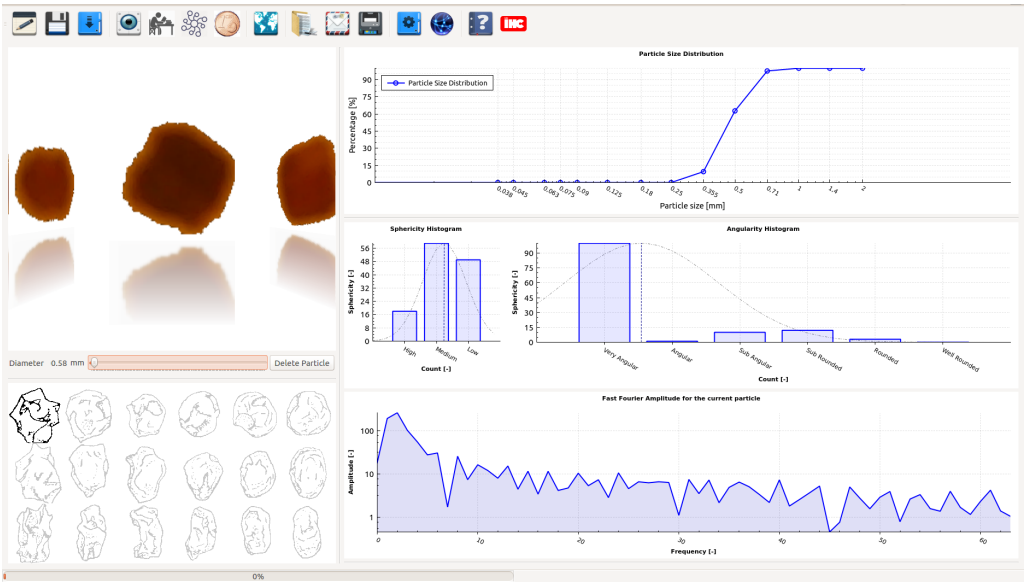


Figure A.1: Main Graphical User Interface

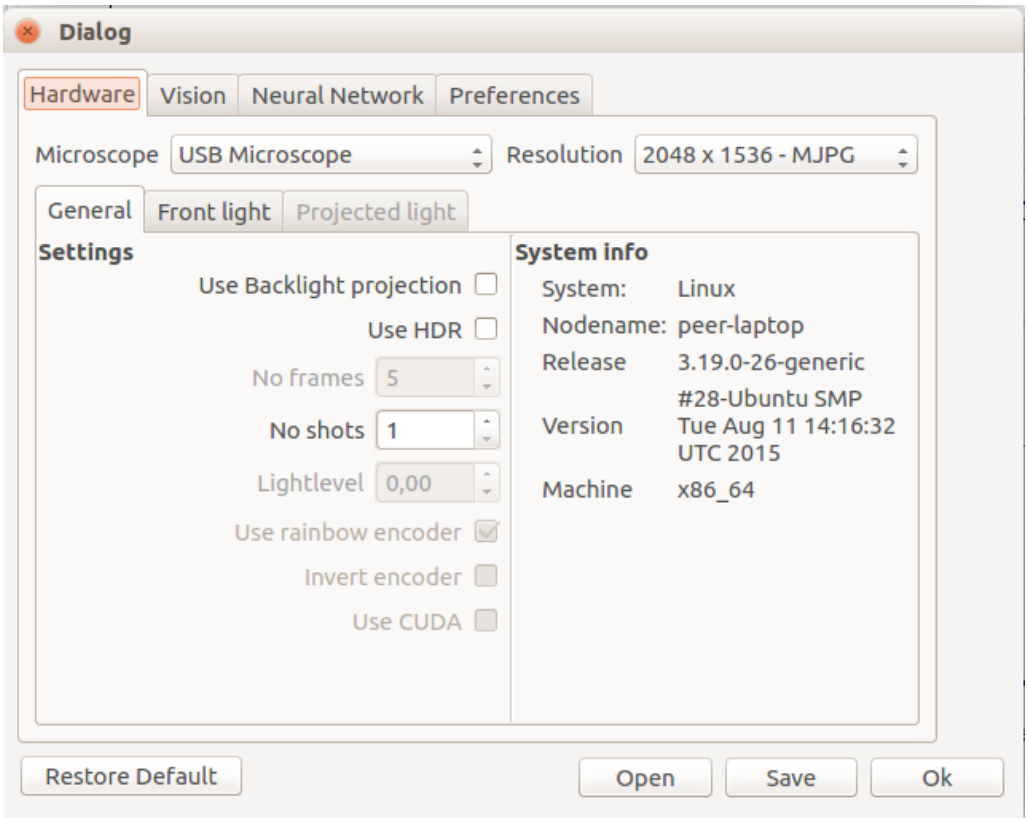


Figure A.2: Settings Hardware Interface

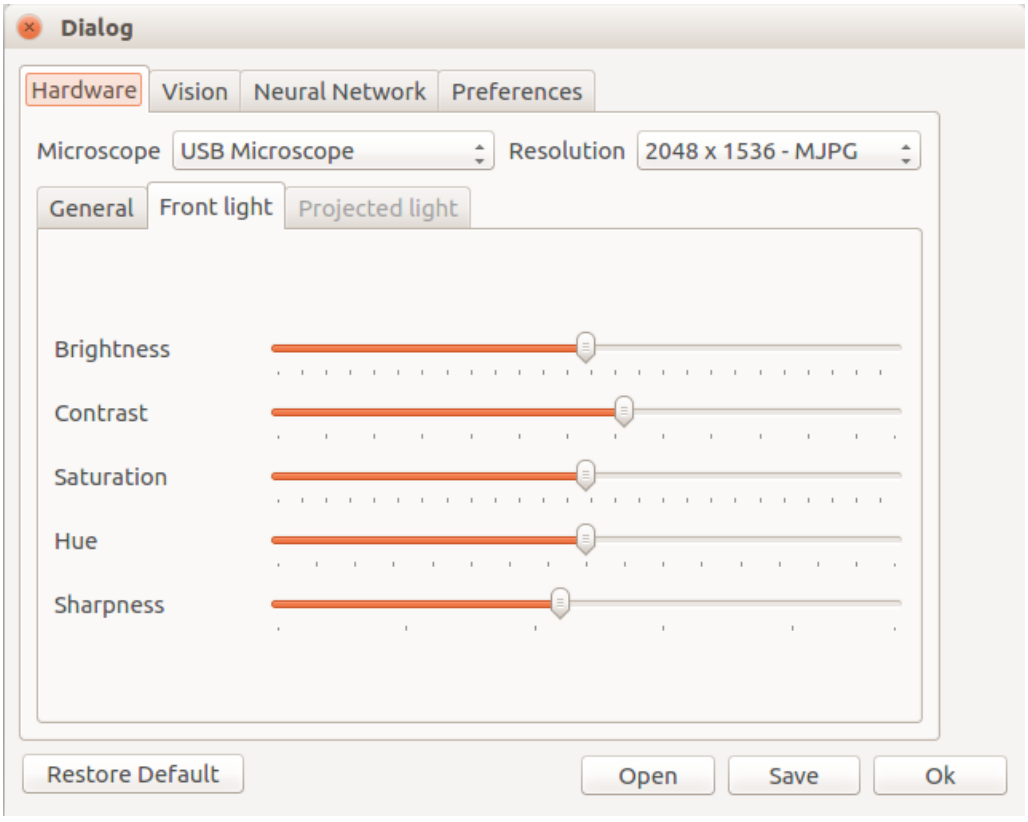


Figure A.3: Settings Hardware Cam Interface

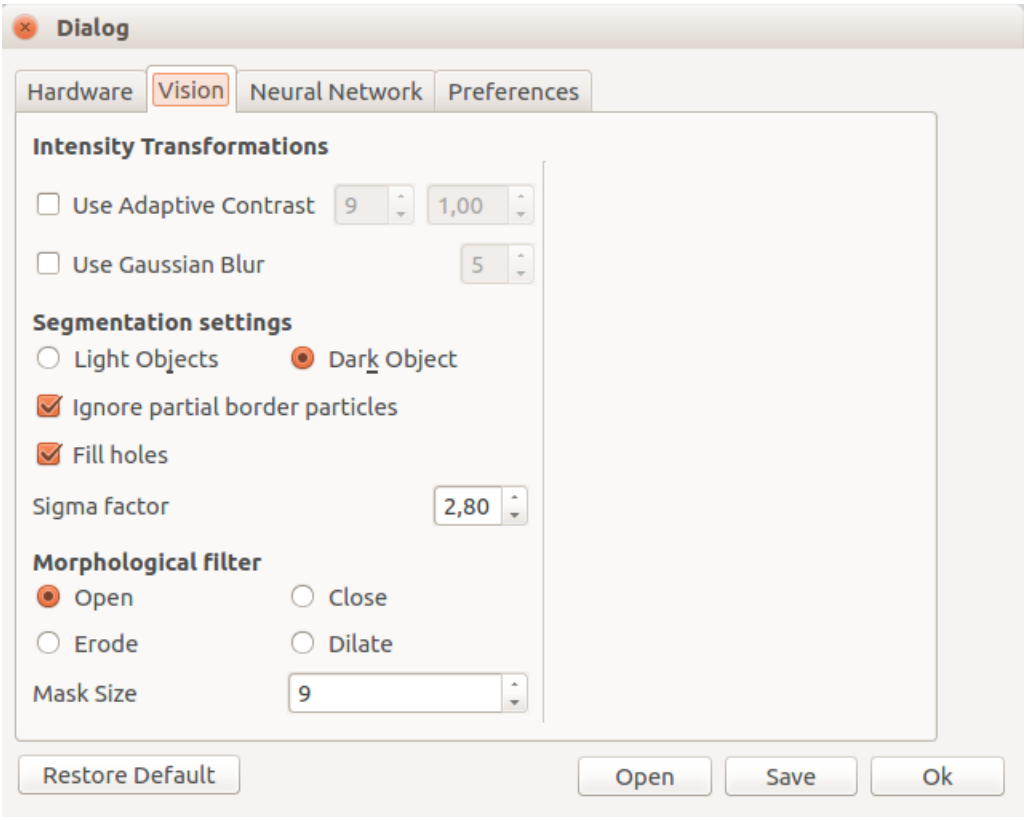


Figure A.4: Settings Vision Interface

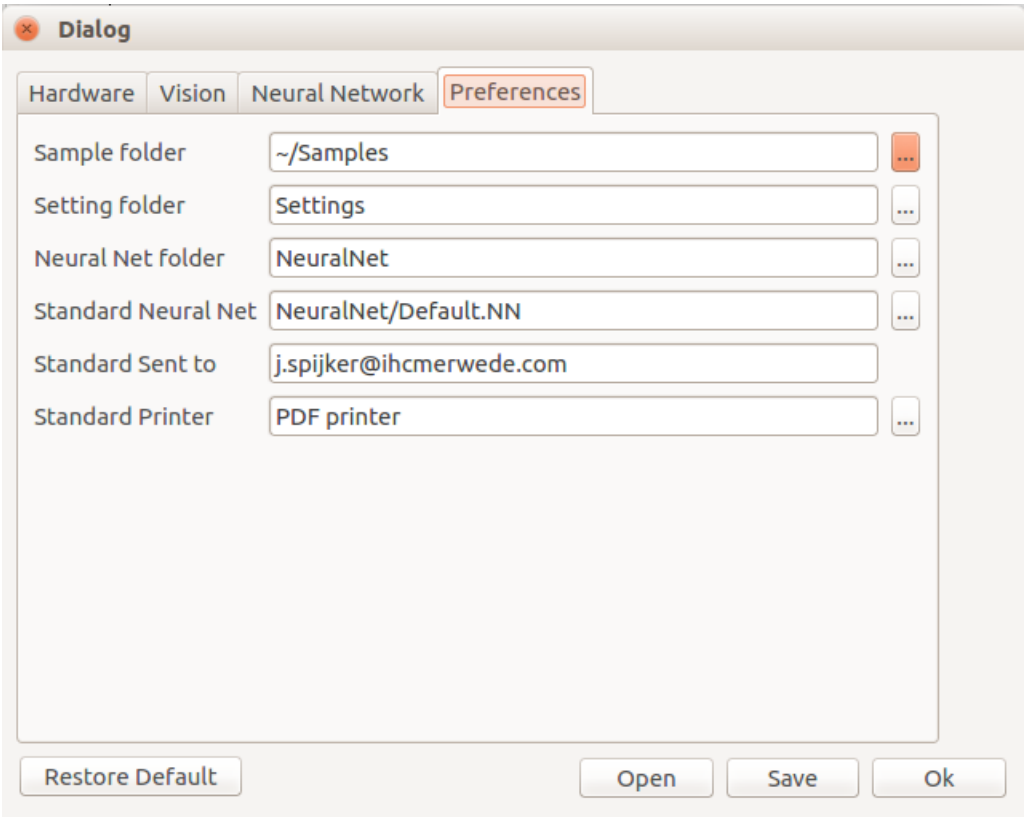


Figure A.5: Settings Preference Interface

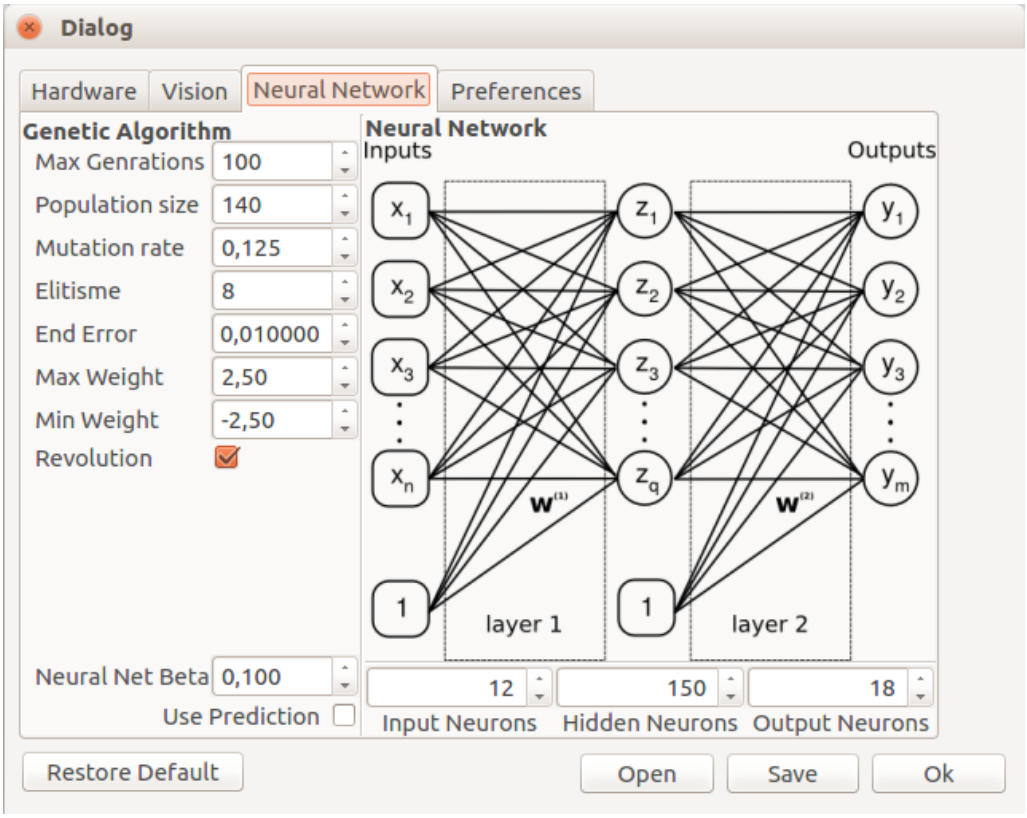


Figure A.6: Settings Neural Network Interface

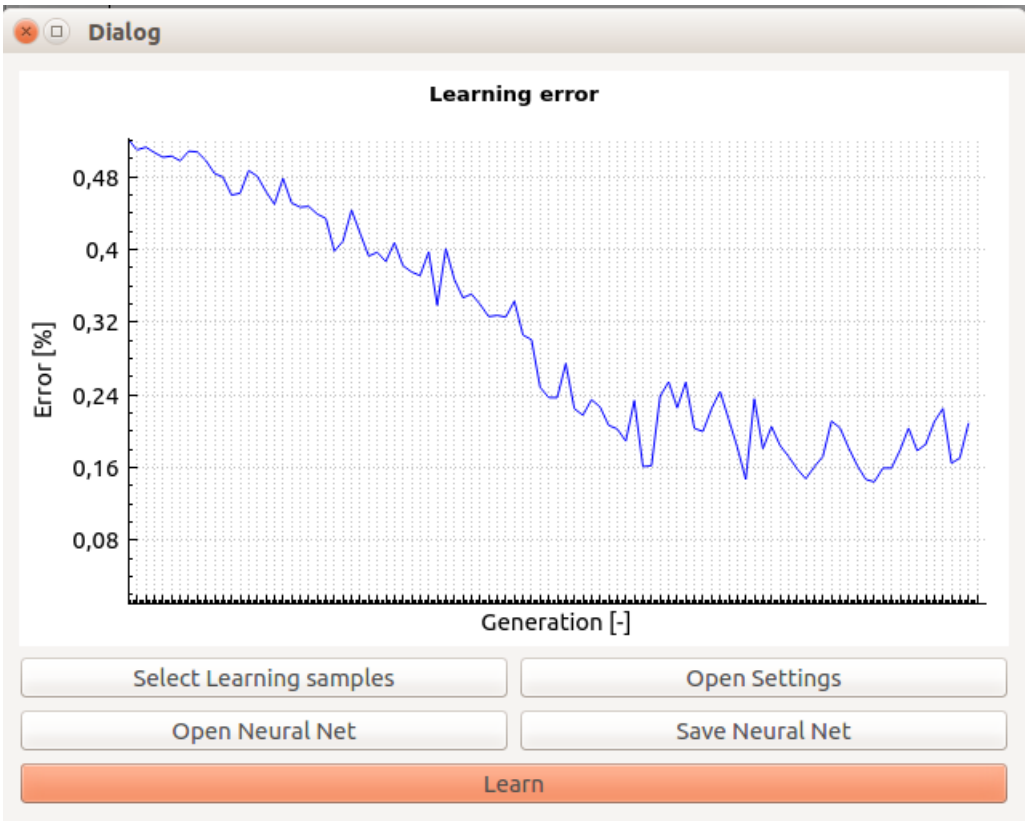


Figure A.7: Neural Network Learning Interface

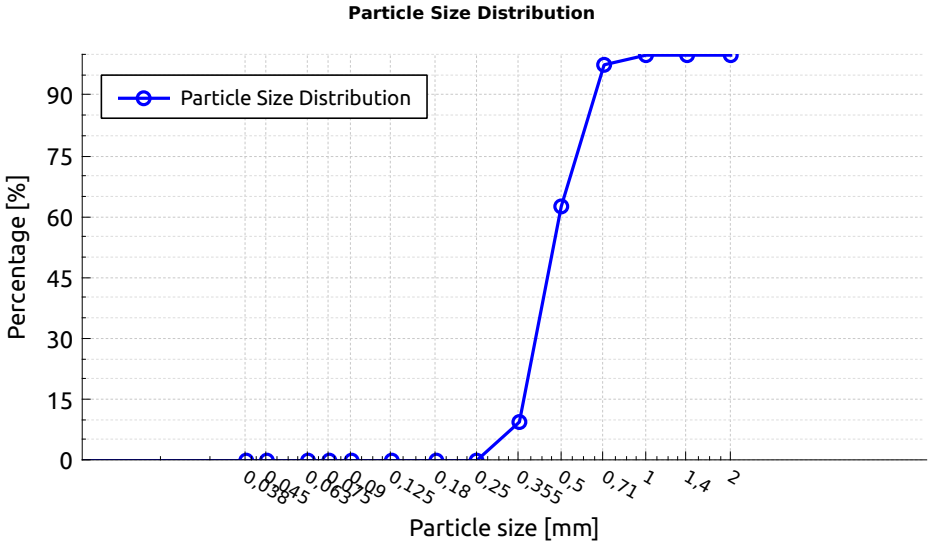
B. Example Soil Report

Soil Report

Sample name:	
Sample ID:	4084628568
Date:	01-09-2015
Location:	51.8849, 4.62962
Sample depth:	0 [m]

Particle Size Distribution

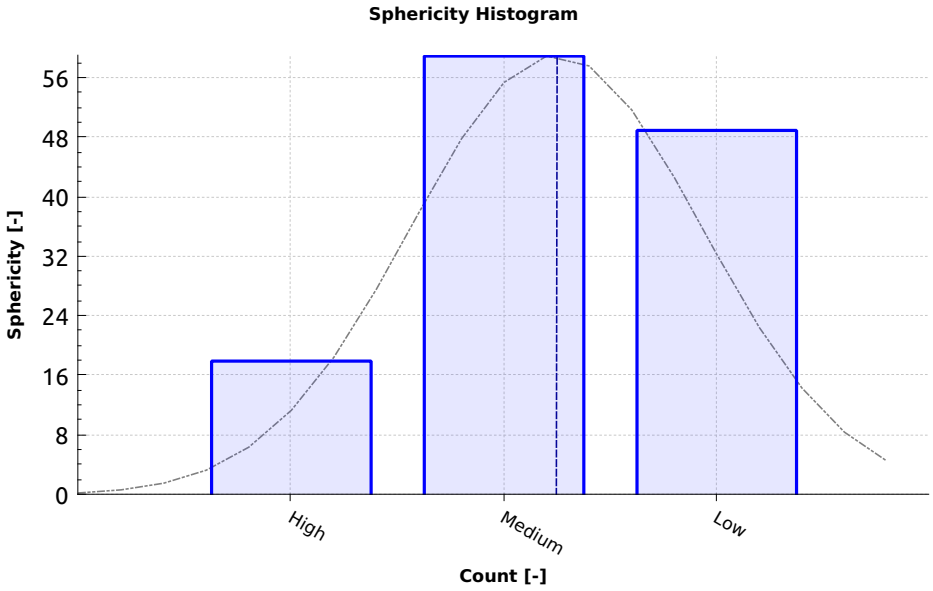
No of particles:	126
Mean:	0.673049
Minimum:	0.407876
Maximum:	1.14742
Range:	0.739541
Standard deviation:	0.142802



Mesh Size [mm]	Cummulatief [%]	Retained [-]
2	100	0
1.4	100	0
1	100	3
0.71	97.619	44
0.5	62.6984	67
0.355	9.52381	12
0.25	0	0
0.18	0	0
0.125	0	0
0.09	0	0
0.075	0	0
0.063	0	0
0.045	0	0
0.038	0	0
0	0	0

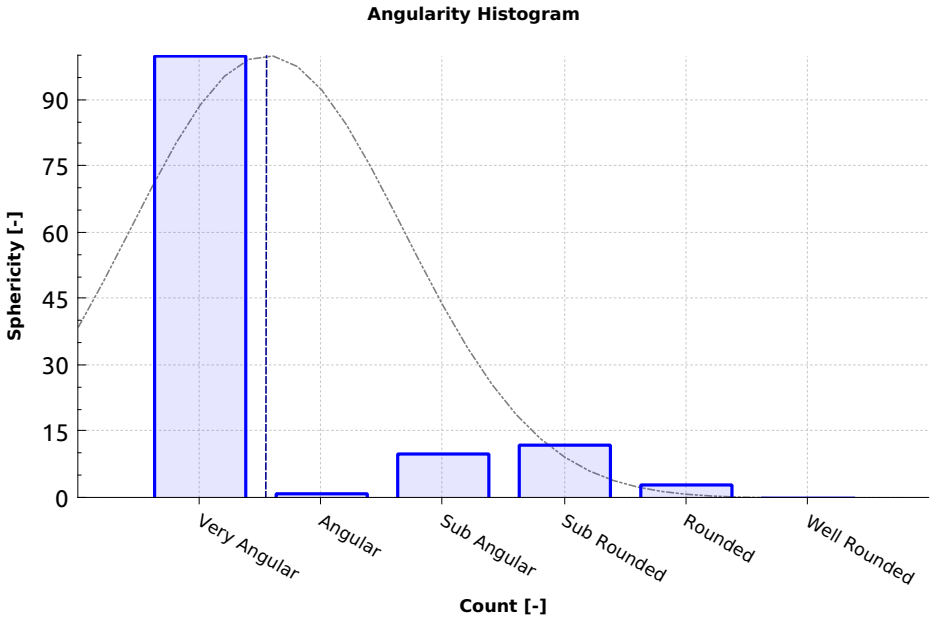
Sphericity Classification

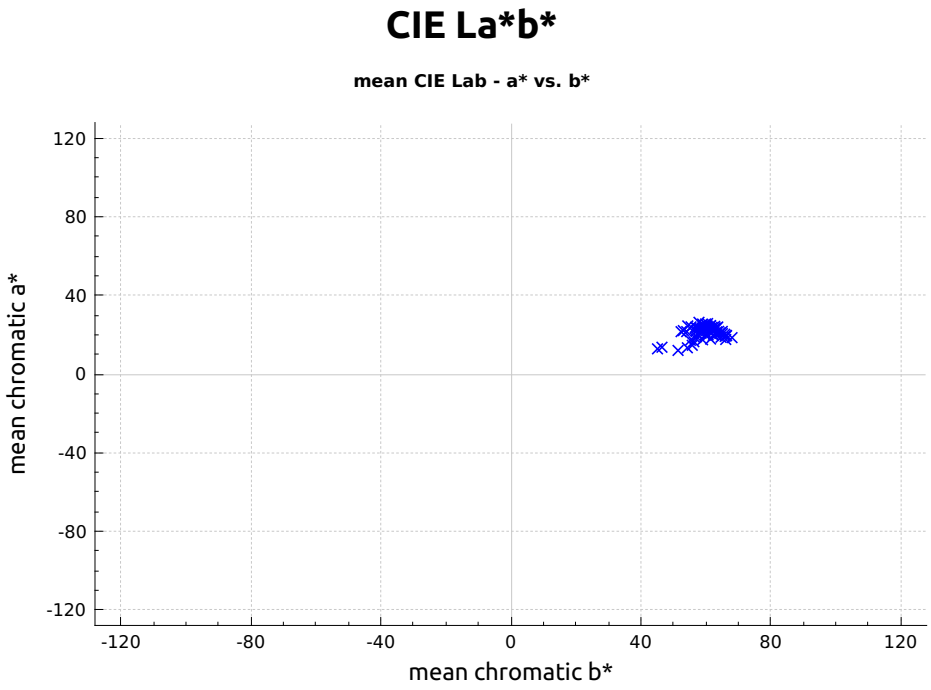
No of particles:	126
Mean:	2.24603
Minimum:	1
Maximum:	3
Range:	2
Standard deviation:	0.686451



Angularity Classification

No of particles:	126
Mean:	1.54762
Minimum:	1
Maximum:	5
Range:	4
Standard deviation:	1.1241




CIE La*b*
mean CIE Lab - a* vs. b*
mean chromatic a*
mean chromatic b*
120
80
40
0
-40
-80
-120
-120
-80
-40
0
40
80
120

C. HAN minor Machine design: Student assessmer

Subject: RDM Student project
Author: Jelle Spijker

Introduction

This project finds its roots in the minor Embedded Vision Design (EVD) taught at the university of applied sciences HAN. During this minor a portable embedded device was developed which analyses soil samples using a microscope. This Vision Soil Analyser hereafter referred to as VSA, analyses soil samples using the optical properties. It's main function is: Presenting quantifiable information to a user on the properties of soil: such as colour, texture and structure.

The VSA takes a snapshot from a soil sample, which is placed under a microscope in an closed environment. This digital image is analysed using a multitude of computer vision algorithms. Statistical data is presented to the user in the form a Particle Size Distribution (PSD) and a histogram of the shape classification. The PSD is obtained by calculating the number of pixels for each individual particle, whilst shape classification is determined by describing the contour of each individual particle as mathematical function which undergoes a transformation to the frequency domain. This complex vector then serves as input for an Artificial Neural Network (ANN) where the output classifies each particle in a certain category.

The prototype developed during the minor EVD will serve as a basis for a graduation project of that same student, which initialized the project. This is done for his main course mechanical engineering at the HAN. This graduation project is done under the auspices of MTI Holland. The goal during this second stage is to develop a field ready prototype. In conjunction with the necessary documentation (Technical Dossier). Due to the scale of the project, several key problems are identified and separated from the main project. These problems can be tackled by separated student groups.

Problem description

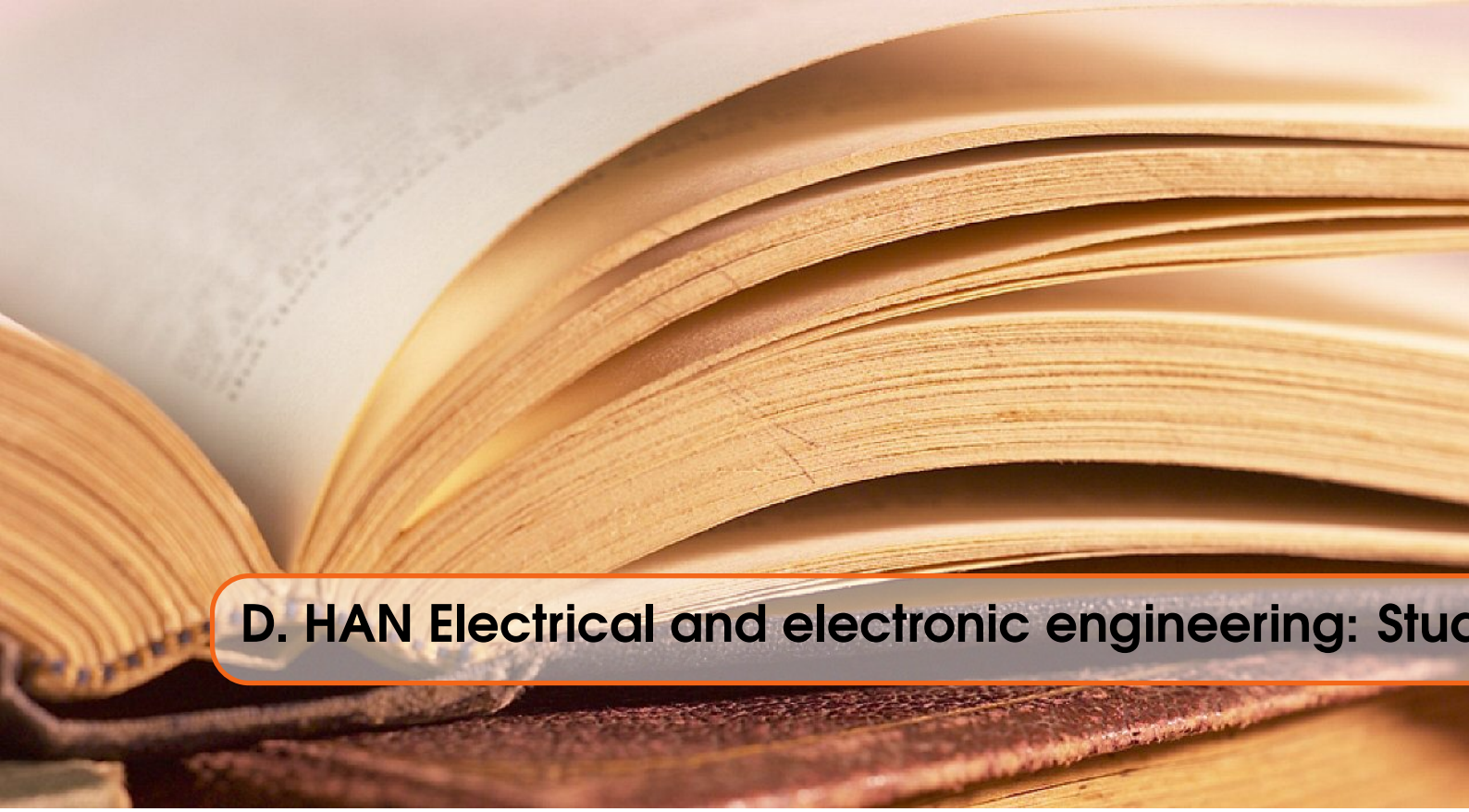
Due to the transformation from 3D particles to a discrete 2D image certain data is lost. This degradation of data introduces errors in the statistical data. One of the forms of degradations is the overlap of bigger particle onto smaller particles. These particles are identified as an particle with at least the size and the contour of the biggest particles. Thus giving false negatives for the smaller particles and often false positives for the bigger particle.

A solution that will be explored during this stage is the execution of multiple analysis of the same discrete particle population. This will result in an accurate statistical representation of the soil sample placed under the microscope.

The project that the RDM students can tackle can be described as follow:

> Design and build a prototype with which the placement of particles, relative to each other and ranging in sizes from 0.02 - 2 [mm] are randomly changed in a time span of 1 [sec], which is tightly integrated with the main prototype.

The prototype is to be CE compliant and should be build according to technical specifications. It should be described in a Technical Dossier, containing all necessary documents such as: technical drawings (according to mono system), bill of materials, calculation, analysis and design reports.



D. HAN Electrical and electronic engineering: Stud

Subject: RDM Student project
Author: Jelle Spijker

Introduction

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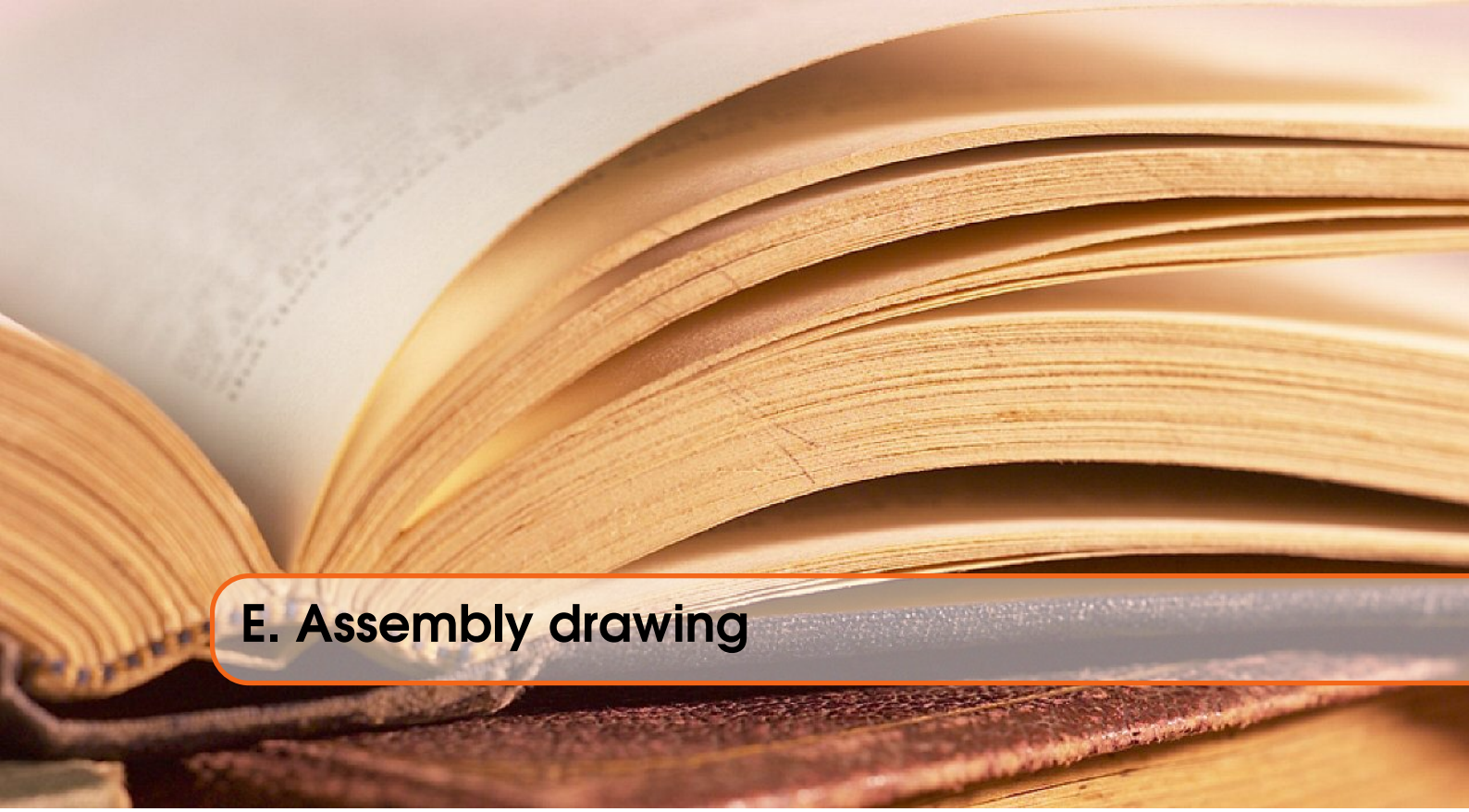
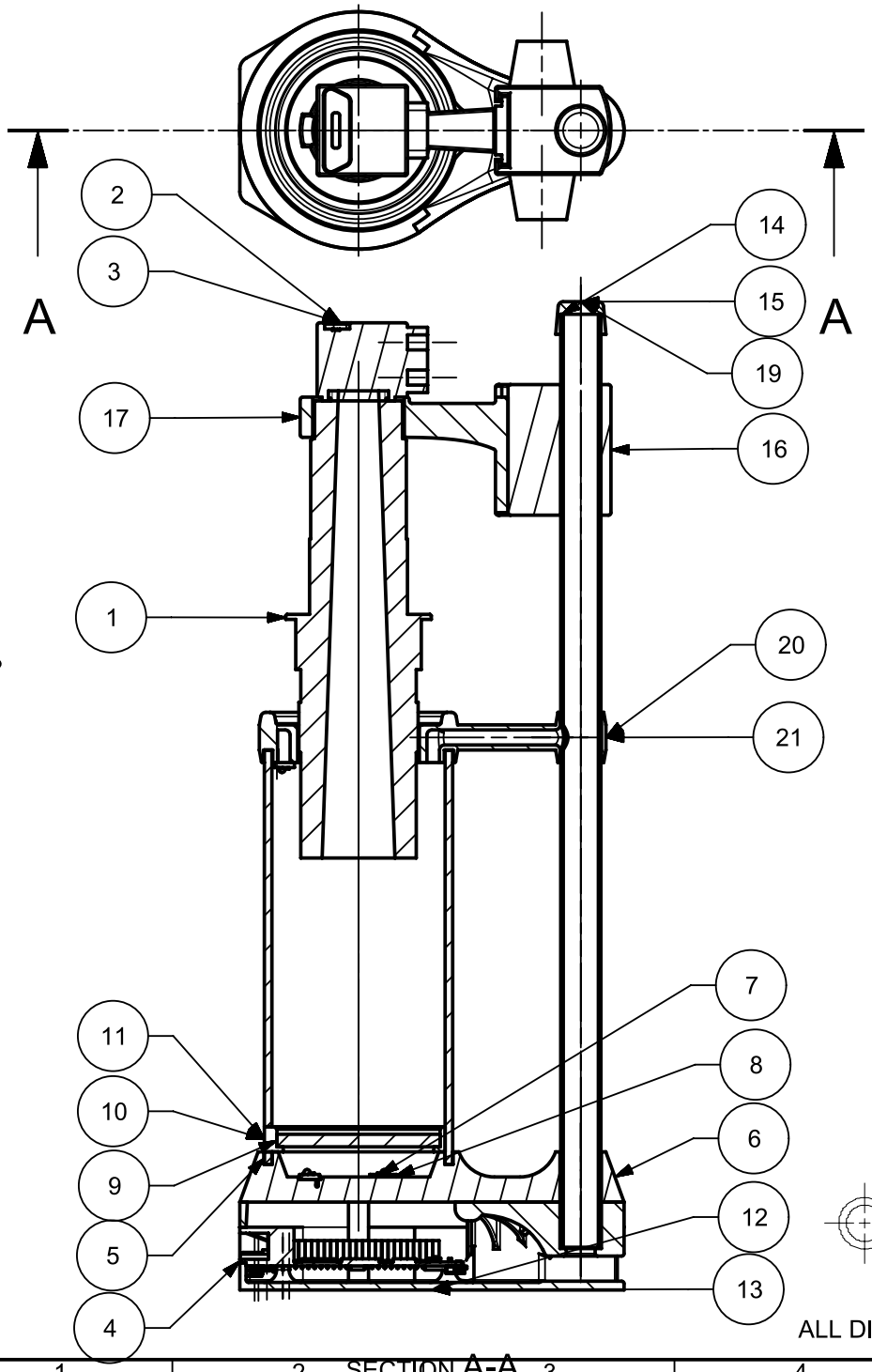
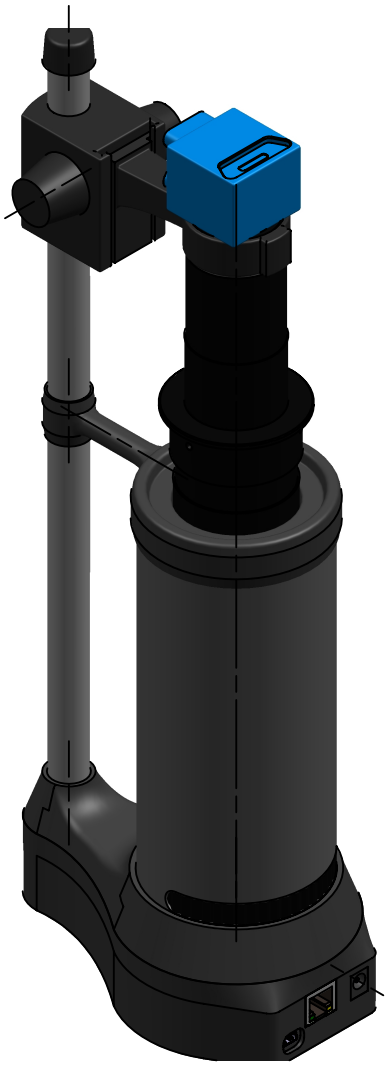


E. Assembly drawing



SECTION A-A



PC NO	PART NAME	QTY
21	LIGHTROOMLID	1
20	BRIDGE	1
19	ARM	1
18	BIGNOP	2
17	HOLDER	1
16	SLIDER	1
15	STOP	1
14	TUBE	1
13	BODY	1
12	BOTTOMCASE	1
11	LID	1
10	LIDFRAME	1
9	SAMPLEPLATE	1
8	LUXEON	6
7	LUXEON-REBEL	6
6	TOPBODYCASE	1
5	LIGHTROOM	1
4	BEAGLEBONEBLACK	1
3	MICROSCOPE	1
2	DFK24UJ003	1
1	180XLENS	1

ALL DIMENSIONS IN MM

SIEMENS

THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE

FIRST ISSUED	6-10-2015
DRAWN BY	JSp
CHECKED BY	
APPROVED BY	

TITLE

SIZE	DRG NO.	SHEET REV
A3	Gaara	A

SCALE 1:1 | SHEET 1 OF 1

Chapter E. Assembly drawing

F. Development Environment setup

Below is a list of used libraries during and their installation instructions:

Common packages

```
sudo apt-get install build-essential cmake git libgtk2.0-dev pkg-config libavcodec-dev libavformat-dev libswscale-dev python-dev python-numpy libtbb2 libtbb-dev libjpeg-dev libpng-dev libtiff-dev libjasper-dev libdc1394-22-dev libv4l-dev v4l-utils libqt5multimediawidgets5 clang libboost-all-dev cheese cmake-qt-gui qt-sdk libgstreamer0.10-dev libgstreamer-plugins-base0.10-dev libv4l-dev libtbb-dev libqt4-dev libfaac-dev libmp3lame-dev libopencore-amrnb-dev libopencore-amrwb-dev libtheora-dev libvorbis-dev libxvidcore-dev x264 v4l-utils unzip libopencv-dev build-essential cmake git libgtk2.0-dev pkg-config python-dev python-numpy libdc1394-22 libdc1394-22-dev libjpeg-dev libpng12-dev libjasper-dev libavcodec-dev libavformat-dev libswscale-dev libxine2-dev libtiff5-dev libgstreamer0.10-dev libpython3-all-dev libpython-all-dev libbz2-dev valgrind python3-numpy
```

Nvidia driver (820M)

```
sudo apt-get purge nvidia*
sudo add-apt-repository ppa:graphics-drivers/ppa
sudo apt-get update
sudo apt-get install nvidia-355 nvidia-settings
sudo nvidia-xconfig
sudo apt-get install bumblebee bbswitch-dkms primus
sudo systemctl enable bumblebeed
sudo echo "i915" » /etc/modules-load.d/modules.conf && sudo echo "bbswitch" » /etc/modules-load.d/modules.conf
sudo ln -s /usr/lib/nvidia-current /usr/lib/nvidia-355
sudo ln -s /usr/lib32/nvidia-current /usr/lib32/nvidia-355
sudo nano /etc/bumblebee/bumblebee.conf
```

change the parameter ‘Driver=‘ > ‘Driver=nvidia
change the parameter ‘KernelDriver=nvidia-current‘ > ‘KernelDriver=nvidia-355
restart the computer

CUDA

wget http://developer.download.nvidia.com/compute/cuda/7_0/Prod/local_installers/rpmdeb/cuda-repo-ubuntu1410-7-0-local_7.0-28_amd64.deb
sudo dpkg -i cuda-repo-ubuntu1410-7-0-local_7.0-28_amd64.deb
sudo apt-get update
sudo apt-get install cuda
export PATH=/usr/local/cuda-7.0/bin:$PATH
export LD_LIBRARY_PATH=/usr/local/cuda-7.0/lib64:$LD_LIBRARY_PATH

Qt and Qt Creator

wget http://download.qt.io/official_releases/online_installers/qt-unified-linux-x64-online.run
sudo chmod +x qt-unified-linux-x64-online.run
./qt-unified-linux-x64-online.run

OpenCV 3.0 beta

cd ~
git clone https://github.com/Itseez/opencv.git
cd opencv
mkdir release
cd release
Enter the following command for an NVIDIA CUDA enabled environment:
cmake -D CMAKE_BUILD_TYPE=RELEASE -D CMAKE_INSTALL_PREFIX=/usr/local -D BUILD_CUDA_STUBS=ON -D BUILD_DOCS=OFF -D BUILD_JPEG=ON -D BUILD_PNG=ON -D BUILD_TESTS=OFF -D BUILD_WITH_DEBUG_INFO=OFF -D CUDA_FAST_MATH=ON -D ENABLE_FAST_MATH=ON -D WITH_CUBLAS=ON WITH_OPENGL=ON WITH_QT=ON ..
Or the command below for a computer that has no NVIDIA CUDA capabilities:
cmake -D CMAKE_BUILD_TYPE=RELEASE -D CMAKE_INSTALL_PREFIX=/usr/local -D WITH_CUDA=OFF -D BUILD_DOCS=OFF -D BUILD_JPEG=ON -D BUILD_PNG=ON -D BUILD_TESTS=OFF -D BUILD_WITH_DEBUG_INFO=OFF -D ENABLE_FAST_MATH=ON -D WITH_OPENGL=ON -D WITH_QT=ON ..
make -jnumber of processors
sudo make install
sudo /bin/bash -c ’echo "/usr/local/lib" > /etc/ld.so.conf.d/opencv.conf’
sudo ldconfig

ZLib

wget http://zlib.net/zlib-1.2.8.tar.gz
tar xf zlib-1.2.8.tar.gz
cd zlib-1.2.8
./configure
make -jnumber of processors

```
sudo make install
```

Folder structure

```
/
├── src
│   ├── pictureflow-qt
│   ├── qcustomplot
│   ├── QOpenCVQT
│   ├── QParticleDisplay
│   ├── QReportGenerator
│   ├── SoilAnalyzer
│   ├── SoilHardware
│   ├── SoilMath
│   ├── SoilVision
│   ├── Tests
│   │   ├── ComparisionPictures
│   │   ├── Microscope_Test
│   │   ├── SoilMath_Test
│   │   ├── Soil_Test
│   │   └── Vision_Test
│   ├── tiscamera
│   └── VSA
│       ├── Icons
│       ├── Images
│       ├── NeuralNet
│       ├── Settings
│       ├── SoilSamples
│       └── TestedSamples
└── build
    ├── debug
    │   ├── pictureflow-qt
    │   ├── qcustomplot
    │   ├── QOpenCVQT
    │   ├── QParticleDisplay
    │   ├── QReportGenerator
    │   ├── SoilAnalyzer
    │   ├── SoilHardware
    │   ├── SoilMath
    │   └── SoilVision
    └── install
        ├── pictureflow-qt
        ├── qcustomplot
        ├── QOpenCVQT
        ├── QParticleDisplay
        ├── QReportGenerator
        ├── SoilAnalyzer
        ├── SoilHardware
        ├── SoilMath
        └── SoilVision
```

```
/
├── build
│   ├── release
│   │   ├── pictureflow-qt
│   │   ├── qcustomplot
│   │   ├── QOpenCVQT
│   │   ├── QParticleDisplay
│   │   ├── QReportGenerator
│   │   ├── SoilAnalyzer
│   │   ├── SoilHardware
│   │   ├── SoilMath
│   │   └── SoilVision
│   └── Tests
│       ├── ComparisionPictures
│       ├── Microscope_Test
│       ├── SoilMath_Test
│       ├── Soil_Test
│       └── Vision_Test
└── doxygen
    ├── html
    └── latex
```

G. Run Environment setup

Building the Kernel

First setup the cross-compile environment on the develpment PC.

Linaro

```
wget -c https://releases.linaro.org/14.09/components/toolchain/binaries/gcc-linaro-arm-linux-gnueabihf-4.9-2014.09_linux.tar.xz
tar xf gcc-linaro-arm-linux-gnueabihf-4.9-2014.09_linux.tar.xz
export CC=‘pwd‘/gcc-linaro-arm-linux-gnueabihf-4.9-2014.09_linux/bin/arm-linux-gnueabihf-
```

Bootloader: U-Boot

```
git clone git://git.denx.de/u-boot.git
cd u-boot/
git checkout v2015.10-rc2 -b tmp

    Apply the Beaglebone patch against the cloned boot-loader, make sure you are in the ˜/u-boot directory
    git revert –no-edit 0a9e34056fcf86fb64e70bd281875eb7bbdbabde
wget -c https://rcn-ee.com/repos/git/u-boot-patches/v2015.10-rc2/0001-am335x_evm-uEnv.txt-bootz-n-fixes.patch
patch -p1 < 0001-am335x_evm-uEnv.txt-bootz-n-fixes.patch
```

OS ubuntu 14.04 Download the Ubuntu 14.04 OS

```
wget -c https://rcn-ee.com/rootfs/eewiki/minfs/ubuntu-14.04.2-minimal-armhf-2015-06-09.tar.xz tar xf ubuntu-14.04.2-minimal-armhf-2015-06-09.tar.xz
```

Setup the SD card

```
export DISK=/dev/mmcblk0
sudo dd if=/dev/zero of=${DISK} bs=1M count=10
sudo dd if=./u-boot/MLO of=${DISK} count=1 seek=1 bs=128k
sudo dd if=./u-boot/u-boot.img of=${DISK} count=2 seek=1 bs=384k
sudo sfdisk –in-order –Linux –unit M ${DISK} «-__EOF__
1,,0x83,*
__EOF__
sudo mkfs.ext4 /dev/mmcblk0p1 -L rootfs
```

remember that initial user and password are **ubuntu** and **temppwd**

Setup pinmuxing

Enable Beaglebone overlays for kernel 4.1.x by cloning Robert C. Nelson bb.org-overlays do this on the BBB. Check if the kernel has the CONFIG_BONE_CAPEMGR=y option

```
zcat /proc/config.gz | grep CONFIG_BONE_CAPEMGR
```

Update the kernel, not needed on a fresh build.

```
cd /opt/scripts/tools
git pull
sudo ./update_kernel.sh –lts –bone-channel
```

check if the DTC version is atleast Version: DTC 1.4.1-g2341721b

```
dtc –version
```

Install the overlays

```
git clone https://github.com/RobertCNelson/bb.org-overlays.git
cd bb.org-overlays
sudo ./dtc-overlay.sh
sudo ./install.sh
```

Install the universal IO device tree for easy PWM and GPIO acces

```
git clone https://github.com/cdsteinkuehler/beaglebone-universal-io.git
sudo sh -c "echo 'cape-universaln' > /sys/devices/platform/bone_capemgr/slots"
sudo cp config-pin /bin/
```

Setting up the software

The following software should be installed on the BBB

OpenCV

```
cmake -D CMAKE_BUILD_TYPE=RELEASE -D CMAKE_INSTALL_PREFIX=/usr/local
-D WITH_CUDA=OFF -D WITH_CUFFT=OFF -D WITH_CUBLAS=OFF -D WITH_NVCUVID=OFF
-D WITH_OPENCL=OFF -D WITH_OPENCLAMDFFT=OFF -D WITH_OPENCLAMDBLAS=OFF
-D BUILD_opencv_apps=OFF -D BUILD_DOCS=OFF -D BUILD_PERF_TESTS=OFF
-D BUILD_TESTS=OFF -D ENABLE_NEON=on ..
```

H. SoilMath Library

Genetic Algorithm Class

```
1  /* Copyright (C) Jelle Spijker - All Rights Reserved
2   * Unauthorized copying of this file, via any medium is
        strictly prohibited
3   * and only allowed with the written consent of the author (
        Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  //! Genetic Algorithmes used for optimization problems
9  /*!
10   * Use this class for optimization problems. It's currently
         optimized for
11  * Neural Network optimzation
12   */
13 #pragma once
14
15 #include <bitset>
16 #include <random>
17 #include <string>
18 #include <algorithm>
19 #include <chrono>
20 #include <math.h>
21 #include <list>
22
23 //#include "NN.h"
24 #include "SoilMathTypes.h"
25 #include "MathException.h"
26
27 #include <QtCore/QObject>
28 #include <QDebug>
```

```
29 #include <QThread>
30 #include <QtConcurrent>
31
32 #include <boost/bind.hpp>
33
34 namespace SoilMath {
35
36 class GA : public QObject {
37   Q_OBJECT
38
39 public:
40   float MutationRate = 0.075f; /**< mutation rate*/
41   uint32_t Elitisme = 4;       /**< total number of the
        elite bastard*/
42   float EndError = 0.001f;     /**< acceptable error between
         last itteration*/
43   bool Revolution = true;
44
45   /*!
46  * \brief GA Standard constructor
47  */
48   GA();
49
50   /*!
51    * \brief GA Construction with a Neural Network
         initializers
52    * \param nnfunction the Neural Network prediction
         function which results will
53    * be optimized
54    * \param inputneurons the number of input neurons in the
         Neural Network don't
55    * count the bias
56    * \param hiddenneurons the number of hidden neurons in
         the Neural Network
57    * don't count the bias
58    * \param outputneurons the number of output neurons in
         the Neural Network
59    */
60   GA(NNfunctionType nnfunction, uint32_t inputneurons,
        uint32_t hiddenneurons,
61      uint32_t outputneurons);
62
63   /*!
64    * \brief GA standard de constructor
65    */
66   ~GA();
67
68   /*!
69    * \brief Evolve Darwin would be proud!!! This function
         creates a population
70    * and itterates
71    * through the generation till the maximum number off
         itterations has been
72    * reached of the
73    * error is acceptable
```

```
74      * \param inputValues complex vector with a reference to
            the inputvalues
75      * \param weights reference to the vector of weights which
             will be optimized
76      * \param rangeweights reference to the range of weights,
            currently it doesn't
77      * support indivudal ranges
78      * this is because of the crossing
79      * \param goal target value towards the Neural Network
            prediction function
80      * will be optimized
81      * \param maxGenerations maximum number of itterations
            default value is 200
82      * \param popSize maximum number of population, this
            should be an even number
83      */
84    void Evolve(const InputLearnVector_t &inputValues,
          Weight_t &weights,
85                  MinMaxWeight_t rangeweights,
                       OutputLearnVector_t &goal,
86                  uint32_t maxGenerations = 200, uint32_t
                       popSize = 30);
87  signals:
88    void learnErrorUpdate(double newError);
89
90  private:
91    NNfunctionType NNfuction; /**< The Neural Net work
          function*/
92    uint32_t inputneurons;    /**< the total number of input
          neurons*/
93    uint32_t hiddenneurons;   /**< the total number of hidden
          neurons*/
94    uint32_t outputneurons;   /**< the total number of output
          neurons*/
95
96    MinMaxWeight_t rangeweights;
97    InputLearnVector_t inputValues;
98    OutputLearnVector_t goal;
99
100   float minOptim = 0;
101   float maxOptim = 0;
102   uint32_t oldElit = 0;
103   float oldMutation = 0.;
104   std::list<double> last10Gen;
105   uint32_t currentGeneration = 0;
106   bool revolutionOngoing = false;
107
108   /*!
109    * \brief Genesis private function which is the spark of
           live, using a random
110    * seed
111    * \param weights a reference to the used Weight_t vector
112    * \param rangeweights pointer to the range of weights,
           currently it doesn't
113    * support indivudal ranges
```

```
114     * \param popSize maximum number of population, this
            should be an even number
115     * \return
116     */
117    Population_t Genesis(const Weight_t &weights, uint32_t
           popSize);
118
119    /*!
120     * \brief CrossOver a private function where the partners
            mate with each other
121     * The values or PopMember_t are expressed as bits or ar
            cut at the point
122     * CROSSOVER
123     * the population members are paired with the nearest
            neighbor and new members
124     * are
125     * created pairing the Genome_t of each other at the
            CROSSOVER point.
126     * Afterwards all
127     * the top tiers partners are allowed to mate again.
128     * \param pop reference to the population
129     */
130    void CrossOver(Population_t &pop);
131
132    /*!
133     * \brief Mutate a private function where individual bits
            from the Genome_t
134     * are mutated
135     * at a random uniform distribution event defined by the
            MUTATIONRATE
136     * \param pop reference to the population
137     */
138    void Mutate(Population_t &pop);
139
140    /*!
141     * \brief GrowToAdulthood a private function where the new
             population members
142     * serve as the
143     * the input for the Neural Network prediction function.
            The results are
144     * weight against
145     * the goal and this weight determine the fitness of the
            population member
146     * \param pop reference to the population
147     * \param inputValues a InputLearnVector_t with a
            reference to the inputvalues
148     * \param rangeweights pointer to the range of weights,
            currently it doesn't
149     * support indivudal ranges
150     * \param goal a Predict_t type with the expected value
151     * \param totalFitness a reference to the total population
             fitness
152     */
153    void GrowToAdulthood(Population_t &pop, float &
           totalFitness);
154
```

```
155   /*!
156    * \brief SurvivalOfTheFittest a private function where a
           battle to the death
157    * commences
158    * The fittest population members have the best chance of
           survival. Death is
159    * instigated
160    * with a random uniform distibution. The elite members
           don't partake in this
161    * desctruction
162    * The ELITISME rate indicate how many top tier members
           survive this
163    * catastrophic event.
164    * \param inputValues a InputLearnVector_t with a
           reference to the inputvalues
165    * \param totalFitness a reference to the total population
            fitness
166    * \return
167    */
168   bool SurvivalOfTheFittest(Population_t &pop, float &
         totalFitness);
169
170   /*!
171    * \brief PopMemberSort a private function where the
           members are sorted
172    * according to
173    * there fitness ranking
174    * \param i left hand population member
175    * \param j right hand population member
176    * \return true if the left member is closser to the goal
           as the right member.
177    */
178   static bool PopMemberSort(PopMember_t i, PopMember_t j) {
179     return (i.Fitness < j.Fitness);
180   }
181
182   /*!
183    * \brief Conversion of the value of type T to Genome_t
184    * \details Usage: Use <tt>ConvertToGenome<Type>(type,
           range)</tt>
185    * \param value The current value wich should be converted
            to a Genome_t
186    * \param range the range in which the value should fall,
           this is to have a
187    * Genome_t
188    * which utilizes the complete range 0000...n till 1111...
           n
189    */
190   template <typename T>
191   inline Genome_t ConvertToGenome(T value, std::pair<T, T>
         range) {
192     uint32_t intVal = static_cast<uint32_t>(
193         (UINT32_MAX * (range.first + value)) / (range.second
               - range.first));
194     Genome_t retVal(intVal);
195     return retVal;
```

```
196   }
197
198   /*!
199    * \brief Conversion of the Genome to a value
200    * \details Usage: use <tt>ConvertToValue<Type>(genome,
          range)
201    * \param gen is the Genome which is to be converted
202    * \param range is the range in which the value should
          fall
203    */
204   template <typename T>
205   inline T ConvertToValue(Genome_t gen, std::pair<T, T>
         range) {
206     T retVal =
207         range.first +
208         (((range.second - range.first) * static_cast<T>(gen.
              to_ulong())) /
209          UINT32_MAX);
210     return retVal;
211   }
212 };
213 }
```

```
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       strictly prohibited
3   * and only allowed with the written consent of the author (
       Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #include "GA.h"
9
10 namespace SoilMath {
11 GA::GA() {}
12
13 GA::GA(NNfunctionType nnfunction, uint32_t inputneurons,
       uint32_t hiddenneurons,
14         uint32_t outputneurons) {
15   this->NNfuction = nnfunction;
16   this->inputneurons = inputneurons;
17   this->hiddenneurons = hiddenneurons;
18   this->outputneurons = outputneurons;
19 }
20
21 GA::~GA() {}
22
23 void GA::Evolve(const InputLearnVector_t &inputValues,
       Weight_t &weights,
24                 MinMaxWeight_t rangeweights,
                       OutputLearnVector_t &goal,
25                 uint32_t maxGenerations, uint32_t popSize) {
26   minOptim = goal[0].OutputNeurons.size();
27   minOptim = -minOptim;
28   maxOptim = 2 * goal[0].OutputNeurons.size();
```

```
29    oldElit = Elitisme;
30    oldMutation = MutationRate;
31    this->inputValues = inputValues;
32    this->rangeweights = rangeweights;
33    this->goal = goal;
34
35    // Create the population
36    Population_t pop = Genesis(weights, popSize);
37    float totalFitness = 0.0;
38    for (uint32_t i = 0; i < maxGenerations; i++) {
39      CrossOver(pop);
40      Mutate(pop);
41      totalFitness = 0.0;
42      GrowToAdulthood(pop, totalFitness);
43      if (SurvivalOfTheFittest(pop, totalFitness)) {
44        break;
45      }
46    }
47    weights = pop[0].weights;
48  }
49
50  Population_t GA::Genesis(const Weight_t &weights, uint32_t
       popSize) {
51    if (popSize < 1)
52      return Population_t();
53
54    Population_t pop;
55    unsigned seed = std::chrono::system_clock::now().
         time_since_epoch().count();
56    std::default_random_engine gen(seed);
57    std::uniform_real_distribution<float> dis(rangeweights.
         first,
58                                              rangeweights.
                                                 second);
59
60    for (uint32_t i = 0; i < popSize; i++) {
61      PopMember_t I;
62      for (uint32_t j = 0; j < weights.size(); j++) {
63        I.weights.push_back(dis(gen));
64        I.weightsGen.push_back(
65            ConvertToGenome<float>(I.weights[j], rangeweights)
                 );
66      }
67      pop.push_back(I);
68    }
69    return pop;
70  }
71
72  void GA::CrossOver(Population_t &pop) {
73    Population_t newPop; // create a new population
74    PopMember_t newPopMembers[2];
75    SplitGenome_t Split[2];
76
77    for (uint32_t i = 0; i < pop.size(); i += 2) {
78
79      for (uint32_t j = 0; j < pop[i].weights.size(); j++) {
```

```
80        // Split A
81        Split[0].first = std::bitset<CROSSOVER>(
82            pop[i].weightsGen[j].to_string().substr(0,
                  CROSSOVER));
83        Split[0].second = std::bitset<GENE_MAX - CROSSOVER>(
84            pop[i].weightsGen[j].to_string().substr(CROSSOVER,
85                                                    GENE_MAX -
                                                        CROSSOVER
                                                        ));
86
87        // Split B
88        Split[1].first = std::bitset<CROSSOVER>(
89            pop[i + 1].weightsGen[j].to_string().substr(0,
                  CROSSOVER));
90        Split[1].second = std::bitset<GENE_MAX - CROSSOVER>(
91            pop[i + 1].weightsGen[j].to_string().substr(
                  CROSSOVER,
92                                                        GENE_MAX
                                                            -
                                                        CROSSOVER
                                                        ));
93
94        // Mate A and B to AB and BA
95        newPopMembers[0].weightsGen.push_back(
96            Genome_t(Split[0].first.to_string() + Split[1].
                  second.to_string()));
97        newPopMembers[1].weightsGen.push_back(
98            Genome_t(Split[1].first.to_string() + Split[0].
                  second.to_string()));
99      }
100     newPop.push_back(newPopMembers[0]);
101     newPop.push_back(newPopMembers[1]);
102     newPopMembers[0].weightsGen.clear();
103     newPopMembers[1].weightsGen.clear();
104   }
105
106   // Allow the top tiers population partners to mate again
107   uint32_t halfN = pop.size() / 2;
108   for (uint32_t i = 0; i < halfN; i++) {
109     for (uint32_t j = 0; j < pop[i].weights.size(); j++) {
110       Split[0].first = std::bitset<CROSSOVER>(
111           pop[i].weightsGen[j].to_string().substr(0,
                  CROSSOVER));
112       Split[0].second = std::bitset<GENE_MAX - CROSSOVER>(
113           pop[i].weightsGen[j].to_string().substr(CROSSOVER,
114                                                   GENE_MAX -
                                                       CROSSOVER
                                                       ));
115
116       Split[1].first = std::bitset<CROSSOVER>(
117           pop[i + 2].weightsGen[j].to_string().substr(0,
                  CROSSOVER));
118       Split[1].second = std::bitset<GENE_MAX - CROSSOVER>(
```

```
119             pop[i + 2].weightsGen[j].to_string().substr(
                    CROSSOVER,
120                                                         GENE_MAX
                                                                -
                                                            CROSSOVER
                                                            ));
121
122         newPopMembers[0].weightsGen.push_back(
123             Genome_t(Split[0].first.to_string() + Split[1].
                    second.to_string()));
124         newPopMembers[1].weightsGen.push_back(
125             Genome_t(Split[1].first.to_string() + Split[0].
                    second.to_string()));
126       }
127       newPop.push_back(newPopMembers[0]);
128       newPop.push_back(newPopMembers[1]);
129       newPopMembers[0].weightsGen.clear();
130       newPopMembers[1].weightsGen.clear();
131     }
132     pop = newPop;
133   }
134
135   void GA::Mutate(Population_t &pop) {
136     unsigned seed = std::chrono::system_clock::now().
          time_since_epoch().count();
137     std::default_random_engine gen(seed);
138     std::uniform_real_distribution<float> dis(0, 1);
139
140     std::default_random_engine genGen(seed);
141     std::uniform_int_distribution<int> disGen(0, (GENE_MAX -
          1));
142
143     QtConcurrent::blockingMap<Population_t>(pop, [&](
          PopMember_t &P) {
144       for (uint32_t j = 0; j < P.weightsGen.size(); j++) {
145         if (dis(gen) < MutationRate) {
146           P.weightsGen[j][disGen(genGen)].flip();
147         }
148       }
149     });
150   }
151
152   void GA::GrowToAdulthood(Population_t &pop, float &
        totalFitness) {
153
154     QtConcurrent::blockingMap<Population_t>(pop, [&](
          PopMember_t &P) {
155       // std::for_each(pop.begin(), pop.end(), [&](PopMember_t
            &P) {
156       for (uint32_t j = 0; j < P.weightsGen.size(); j++) {
157         P.weights.push_back(ConvertToValue<float>(P.weightsGen
              [j], rangeweights));
158       }
159       Weight_t iWeight(P.weights.begin(),
160                        P.weights.begin() + ((inputneurons + 1)
                             * hiddenneurons));
```

```
161       Weight_t hWeight(P.weights.begin() + ((inputneurons + 1)
              * hiddenneurons),
162                        P.weights.end());
163
164       for (uint32_t j = 0; j < inputValues.size(); j++) {
165         Predict_t results = NNfuction(inputValues[j], iWeight,
                hWeight,
166                                       inputneurons,
                                          hiddenneurons,
                                          outputneurons);
167         // See issue #85
168         bool allGood = true;
169         float fitness = 0.0;
170         for (uint32_t k = 0; k < results.OutputNeurons.size();
                k++) {
171           bool resultSign = std::signbit(results.OutputNeurons
                  [k]);
172           bool goalSign = std::signbit(goal[j].OutputNeurons[k
                  ]);
173           fitness += results.OutputNeurons[k] / goal[j].
                  OutputNeurons[k];
174           if (resultSign != goalSign) {
175             allGood = false;
176           }
177         }
178         fitness += (allGood) ? results.OutputNeurons.size() :
                0;
179         P.Fitness += fitness;
180       }
181     });
182
183     for_each(pop.begin(), pop.end(), [&](PopMember_t &P) {
184       P.Fitness /= inputValues.size();
185       totalFitness += P.Fitness;
186     });
187   }
188
189   bool GA::SurvivalOfTheFittest(Population_t &pop, float &
        totalFitness) {
190     bool retVal = false;
191     uint32_t decimationCount = pop.size() / 2;
192
193     unsigned seed = std::chrono::system_clock::now().
          time_since_epoch().count();
194     std::default_random_engine gen(seed);
195
196     std::sort(pop.begin(), pop.end(),
197               [](const PopMember_t &L, const PopMember_t &R) {
198                 return L.Fitness < R.Fitness;
199               });
200
201     float maxFitness = pop[pop.size() - 1].Fitness * pop.size
          ();
202     uint32_t i = Elitisme;
203     while (pop.size() > decimationCount) {
204       if (i == pop.size()) {
```

```
205         i = Elitisme;
206       }
207       std::uniform_real_distribution<float> dis(0, maxFitness)
            ;
208       if (dis(gen) > pop[i].Fitness) {
209         totalFitness -= pop[i].Fitness;
210         pop.erase(pop.begin() + i);
211       }
212       i++;
213     }
214
215     std::sort(pop.begin(), pop.end(),
216               [](const PopMember_t &L, const PopMember_t &R) {
217                 return L.Fitness > R.Fitness;
218               });
219
220     float learnError = 1 - ((pop[0].Fitness - minOptim) / (
          maxOptim - minOptim));
221
222     // Viva la Revolution
223     if (currentGeneration > 9) {
224       double avg = 0;
225       for_each(last10Gen.begin(), last10Gen.end(), [&](double
            &G) { avg += G; });
226       avg /= 10;
227       double minMax[2] = {avg * 0.98, avg * 1.02};
228       if (learnError > minMax[0] && learnError < minMax[1]) {
229         if (!revolutionOngoing) {
230           qDebug() << "Viva la revolution!";
231           oldElit = Elitisme;
232           Elitisme = 0;
233           oldMutation = MutationRate;
234           MutationRate = 0.25;
235           revolutionOngoing = true;
236         }
237       } else if (revolutionOngoing) {
238         qDebug() << "Peace has been restort";
239         Elitisme = oldElit;
240         MutationRate = oldMutation;
241         revolutionOngoing = false;
242       }
243       last10Gen.pop_front();
244       last10Gen.push_back(learnError);
245     } else {
246       last10Gen.push_back(learnError);
247     }
248     currentGeneration++;
249     emit learnErrorUpdate(static_cast<double>(learnError));
250     if (learnError < EndError) {
251       retVal = true;
252     }
253     return retVal;
254 }
255 }
```

Fast Fourier Transform Class

```
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3   * and only allowed with the written consent of the author (Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #pragma once
9
10 #include <vector>
11 #include <complex>
12 #include <cmath>
13 #include <valarray>
14 #include <array>
15 #include <deque>
16 #include <queue>
17 #include <iterator>
18 #include <algorithm>
19 #include <stdint.h>
20 #include <opencv2/core.hpp>
21 #include "SoilMathTypes.h"
22 #include "MathException.h"
23
24 namespace SoilMath {
25 /*!
26  * \brief Fast Fourier Transform class
27  * \details Use this class to transform a black and white blob presented as a
28  * cv::Mat with values 0 or 1 to a vector of complex values representing the Fourier
29  * Descriptors.
30  */
31 class FFT {
32 public:
33   /*!
34  * \brief Standard constructor
35  */
36   FFT();
37
38   /*!
39   * \brief Standard deconstructor
40   */
41   ~FFT();
42
43   /*!
44    * \brief Transforming the img to the frequency domain and returning the
45    * Fourier Descriptors
46    * \param img contour in the form of a cv::Mat type CV_8UC1. Which should
47    * consist of a continous contour. \f$ \{ img \in \mathbb{Z} | 0 \leq img \leq
```

```
48      * 1 \} \f$
49      * \return a vector with complex values, represing the
            contour in the
50      * frequency domain, expressed as Fourier Descriptors
51      */
52     ComplexVect_t GetDescriptors(const cv::Mat &img);
53
54   private:
55     ComplexVect_t
56         fftDescriptors; /**< Vector with complex values which
               represent the
57                             descriptors*/
58     ComplexVect_t
59         complexcontour; /**< Vector with complex values which
               represent the
60                             contour*/
61     cv::Mat Img;        /**< Img which will be analysed*/
62
63     /*!
64      * \brief Contour2Complex a private function which
            translates a continous
65      * contour image
66      * to a vector of complex values. The contour is found
            using a depth first
67      * search with
68      * extension list. The alghorithm is based upon <a
69      * href="http://ocw.mit.edu/courses/electrical-engineering
            -and-computer-science/6-034-artificial-intelligence-
            fall-2010/lecture-videos/lecture-4-search-depth-first-
            hill-climbing-beam/">MIT
70      * opencourseware
71      * 6-034-artificial-intelligence lecture 4</a>
72      * \param img contour in the form of a cv::Mat type
            CV_8UC1. Which should
73      * consist of a continous contour. \f$ \{ img \in \mathbb{
            Z} | 0 \leq img \leq
74      * 1 \} \f$
75      * \param centerCol centre of the contour X value
76      * \param centerRow centre of the contour Y value
77      * \return a vector with complex values, represing the
            contour as a function
78      */
79     ComplexVect_t Contour2Complex(const cv::Mat &img, float
          centerCol,
80                                   float centerRow);
81     /*!
82      * \brief Neighbors a private function returning the
            neighboring pixels which
83      * belong to a contour
84      * \param 0 uchar pointer to the data
85      * \param pixel current counter
86      * \param columns total number of columns
87      * \param rows total number of rows
88      * \return
89      */
```

```
90    iContour_t Neighbors(uchar *0, int pixel, uint32_t columns
          , uint32_t rows);
91
92    /*!
93     * \brief fft a private function calculating the Fast
           Fourier Transform
94     * let \f$ m \f$ be an integer and let \f$ N=2^m \f$ also
95     * \f$ CA=[x_0,\ldots,x_{N-1}] \f$ is an \f$ N \f$
           dimensional complex vector
96     * let \f$ \omega=\exp({-2\pi i\over N}) \f$
97     * then \f$ c_k={\frac{1}{N}}\sum_{j=0}^{j=N-1}CA_j\omega
           ^{jk} \f$
98     * \param CA a \f$ CA=[x_0,\ldots,x_{N-1}] \f$ is an \f$ N
           \f$ dimensional
99     * complex vector
100    */
101   void fft(ComplexArray_t &CA);
102
103   /*!
104    * \brief ifft
105    * \param CA
106    */
107   void ifft(ComplexArray_t &CA);
108 };
109 }
```

```
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3   * and only allowed with the written consent of the author (
        Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #include "FFT.h"
9
10 namespace SoilMath {
11 FFT::FFT() {}
12
13 FFT::~FFT() {}
14
15 ComplexVect_t FFT::GetDescriptors(const cv::Mat &img) {
16   if (!fftDescriptors.empty()) {
17     return fftDescriptors;
18   }
19
20   complexcontour = Contour2Complex(img, img.cols / 2, img.
         rows / 2);
21
22   // Supplement the vector of complex numbers so that N = 2^
         m
23   uint32_t N = complexcontour.size();
24   double logN = log(static_cast<double>(N)) / log(2.0);
25   if (floor(logN) != logN) {
26     // Get the next power of 2
```

```
27      double nextLogN = floor(logN + 1.0);
28      N = static_cast<uint32_t>(pow(2, nextLogN));
29
30      uint32_t i = complexcontour.size();
31      // Append the vector with zeros
32      while (i++ < N) {
33        complexcontour.push_back(Complex_t(0.0, 0.0));
34      }
35    }
36
37    ComplexArray_t ca(complexcontour.data(), complexcontour.
        size());
38    fft(ca);
39    fftDescriptors.assign(std::begin(ca), std::end(ca));
40    return fftDescriptors;
41  }
42
43  iContour_t FFT::Neighbors(uchar *O, int pixel, uint32_t
      columns,
44                            uint32_t rows) {
45    long int LUT_nBore[8] = {-columns + 1, -columns, -columns
        - 1, -1,
46                             columns - 1,  columns,  1 +
                                 columns,  1};
47    iContour_t neighbors;
48    uint32_t pEnd = rows * columns;
49    uint32_t count = 0;
50    for (uint32_t i = 0; i < 8; i++) {
51      count = pixel + LUT_nBore[i];
52      while (count >= pEnd && i < 8) {
53        count = pixel + LUT_nBore[++i];
54      }
55      if (i >= 8) {
56        break;
57      }
58      if (O[count] == 1)
59        neighbors.push_back(count);
60    }
61    return neighbors;
62  }
63
64  ComplexVect_t FFT::Contour2Complex(const cv::Mat &img, float
      centerCol,
65                                     float centerRow) {
66    uchar *O = img.data;
67    uint32_t pEnd = img.cols * img.rows;
68
69    std::deque<std::deque<uint32_t>> sCont;
70    std::deque<uint32_t> eList;
71
72    // Initialize the queue
73    for (uint32_t i = 0; i < pEnd; i++) {
74      if (O[i] == 1) {
75        std::deque<uint32_t> tmpQ;
76        tmpQ.push_back(i);
77        sCont.push_back(tmpQ);
```

```
78        break;
79      }
80    }
81
82    if (sCont.front().size() < 1) {
83      throw Exception::MathException(
           EXCEPTION_NO_CONTOUR_FOUND,
84                                     EXCEPTION_NO_CONTOUR_FOUND_NR
                                          );
85    } // Exception handling
86
87    uint32_t prev = -1;
88
89    // Extend path on queue
90    for (uint32_t i = sCont.front().front(); i < pEnd;) {
91      iContour_t nBors =
92          Neighbors(0, i, img.cols, img.rows); // find
              neighboring pixels
93      std::deque<uint32_t> cQ = sCont.front(); // store first
           queue;
94      sCont.erase(sCont.begin());              // erase first
           queue from beginning
95      if (cQ.size() > 1) {
96        prev = cQ.size() - 2;
97      } else {
98        prev = 0;
99      }
100     // Loop through each neighbor
101     for (uint32_t j = 0; j < nBors.size(); j++) {
102       if (nBors[j] != cQ[prev]) // No backtracking
103       {
104         if (nBors[j] == cQ.front() && cQ.size() > 8) {
105           i = pEnd;
106         } // Back at first node
107         if (std::find(eList.begin(), eList.end(), nBors[j])
              ==
108             eList.end()) // Check if this current route is
                  extended elsewhere
109         {
110           std::deque<uint32_t> nQ = cQ;
111           nQ.push_back(nBors[j]); // Add the neighbor to the
                queue
112           sCont.push_front(nQ);   // add the sequence to the
                front of the queue
113         }
114       }
115     }
116     if (nBors.size() > 2) {
117       eList.push_back(i);
118     } // if there are multiple choices put current node in
          extension List
119     if (i != pEnd) {
120       i = sCont.front().back();
121     } // If it isn't the end set i to the last node of the
          first queue
122     if (sCont.size() == 0) {
```

```
123         throw Exception::MathException(
                EXCEPTION_NO_CONTOUR_FOUND,
124                                        EXCEPTION_NO_CONTOUR_FOUND_NR
                                               );
125       }
126     }
127
128     // convert the first queue to a complex normalized vector
129     Complex_t cPoint;
130     ComplexVect_t contour;
131     float col = 0.0;
132     // Normalize and convert the complex function
133     for_each(
134         sCont.front().begin(), sCont.front().end(),
135         [&img, &cPoint, &contour, &centerCol, &centerRow, &col
                ](uint32_t &e) {
136           col = (float)((e % img.cols) - centerCol);
137           if (col == 0.0) {
138             cPoint.real(1.0);
139           } else {
140             cPoint.real((float)(col / centerCol));
141           }
142           cPoint.imag((float)((floorf(e / img.cols) -
                  centerRow) / centerRow));
143           contour.push_back(cPoint);
144         });
145
146     return contour;
147   }
148
149   void FFT::fft(ComplexArray_t &CA) {
150     const size_t N = CA.size();
151     if (N <= 1) {
152       return;
153     }
154
155     //!< Divide and conquor
156     ComplexArray_t even = CA[std::slice(0, N / 2, 2)];
157     ComplexArray_t odd = CA[std::slice(1, N / 2, 2)];
158
159     fft(even);
160     fft(odd);
161
162     for (size_t k = 0; k < N / 2; ++k) {
163       Complex_t ct = std::polar(1.0, -2 * M_PI * k / N) * odd[
             k];
164       CA[k] = even[k] + ct;
165       CA[k + N / 2] = even[k] - ct;
166     }
167   }
168
169   void FFT::ifft(ComplexArray_t &CA) {
170     CA = CA.apply(std::conj);
171     fft(CA);
172     CA = CA.apply(std::conj);
173     CA /= CA.size();
```

```
174 }
175 }
```

Neural Network Class

```
1  /* Copyright (C) Jelle Spijker - All Rights Reserved
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        strictly prohibited
3   * and only allowed with the written consent of the author (
        Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #pragma once
9
10 #include <stdint.h>
11 #include <vector>
12 #include <string>
13 #include <fstream>
14
15 #include <boost/archive/xml_iarchive.hpp>
16 #include <boost/archive/xml_oarchive.hpp>
17 #include <boost/serialization/vector.hpp>
18 #include <boost/serialization/version.hpp>
19
20 #include "GA.h"
21 #include "MathException.h"
22 #include "SoilMathTypes.h"
23 #include "FFT.h"
24
25 #include <QtCore/QObject>
26
27 namespace SoilMath {
28 /*!
29  * \brief The Neural Network class
30  * \details This class is used to make prediction on large
        data set. Using self
31  * learning algoritmes
32  */
33 class NN : public QObject {
34   Q_OBJECT
35
36 public:
37   /*!
38  * \brief NN constructor for the Neural Net
39  * \param inputneurons number of input neurons
40  * \param hiddenneurons number of hidden neurons
41  * \param outputneurons number of output neurons
42  */
43   NN(uint32_t inputneurons, uint32_t hiddenneurons, uint32_t
        outputneurons);
44
45   /*!
46    * \brief NN constructor for the Neural Net
47    */
48   NN();
49
50   /*!
```

```
51      * \brief ~NN virtual deconstructor for the Neural Net
52      */
53     virtual ~NN();
54
55     /*!
56      * \brief Predict The prediction function.
57      * \details In this function the neural net is setup and
            the input which are
58      * the complex values descriping the contour in the
            frequency domein serve as
59      * input. The absolute value of these im. number because I
            'm not interrested
60      * in the orrientation of the particle but more in the
            degree of variations.
61      * \param input vector of complex input values, these're
            the Fourier
62      * descriptors
63      * \return a real valued vector of the output neurons
64      */
65     Predict_t Predict(ComplexVect_t input);
66
67     /*!
68      * \brief PredictLearn a static function used in learning
            of the weights
69      * \details It starts a new Neural Network object and
            passes all the
70      * paramaters in to this newly created object. After this
            the predict function
71      * is called and the value is returned. This work around
            was needed to pass
72      * the neural network to the Genetic Algorithm class.
73      * \param input a complex vector of input values
74      * \param inputweights the input weights
75      * \param hiddenweights the hidden weights
76      * \param inputneurons the input neurons
77      * \param hiddenneurons the hidden neurons
78      * \param outputneurons the output neurons
79      * \return
80      */
81     static Predict_t PredictLearn(ComplexVect_t input,
           Weight_t inputweights,
82                                   Weight_t hiddenweights,
                                          uint32_t inputneurons,
83                                   uint32_t hiddenneurons,
                                          uint32_t outputneurons);
84
85     /*!
86      * \brief SetInputWeights a function to set the input
            weights
87      * \param value the real valued vector with the values
88      */
89     void SetInputWeights(Weight_t value) { iWeights = value; }
90
91     /*!
92      * \brief SetHiddenWeights a function to set the hidden
            weights
```

```
93      * \param value the real valued vector with the values
94      */
95     void SetHiddenWeights(Weight_t value) { hWeights = value;
           }
96
97     /*!
98      * \brief SetBeta a function to set the beta value
99      * \param value a floating value ussualy between 0.5 and
            1.5
100     */
101    void SetBeta(float value) { beta = value; }
102    float GetBeta() { return beta; }
103
104    /*!
105     * \brief Learn the learning function
106     * \param input a vector of vectors with complex input
            values
107     * \param cat a vector of vectors with the know output
            values
108     * \param noOfDescriptorsUsed the total number of
            descriptos which should be
109     * used
110     */
111    void Learn(InputLearnVector_t input, OutputLearnVector_t
           cat,
112               uint32_t noOfDescriptorsUsed);
113
114    /*!
115     * \brief SaveState Serialize and save the values of the
            Neural Net to disk
116     * \details Save the Neural Net in XML valued text file to
             disk so that a
117     * object can
118     * be reconstructed on a latter stadia.
119     * \param filename a string indicating the file location
            and name
120     */
121    void SaveState(std::string filename);
122
123    /*!
124     * \brief LoadState Loads the previouse saved Neural Net
            from disk
125     * \param filename a string indicating the file location
            and name
126     */
127    void LoadState(std::string filename);
128
129    Weight_t iWeights; /**< a vector of real valued floating
           point input weights*/
130    Weight_t hWeights; /**< a vector of real valued floating
           point hidden weight*/
131
132    uint32_t MaxGenUsedByGA = 200;
133    uint32_t PopulationSizeUsedByGA = 30;
134    float MutationrateUsedByGA = 0.075f;
135    uint32_t ElitismeUsedByGA = 4;
```

```
136   float EndErrorUsedByGA = 0.001;
137   float MaxWeightUsedByGA = 50;
138   float MinWeightUSedByGa = -50;
139
140   uint32_t GetInputNeurons() { return inputNeurons; }
141   void SetInputNeurons(uint32_t value);
142
143   uint32_t GetHiddenNeurons() { return hiddenNeurons; }
144   void SetHiddenNeurons(uint32_t value);
145
146   uint32_t GetOutputNeurons() { return outputNeurons; }
147   void SetOutputNeurons(uint32_t value);
148
149   bool studied =
150       false; /**< a value indicating if the weights are a
              results of a
151                     learning curve*/
152
153 signals:
154   void learnErrorUpdate(double newError);
155
156 private:
157   GA *optim = nullptr;
158   std::vector<float> iNeurons; /**< a vector of input values
          , the bias is
159                                     included, the bias is
                                        included and
160                                       is the first value*/
161   std::vector<float>
162       hNeurons; /**< a vector of hidden values, the bias is
              included and
163                           is the first value*/
164   std::vector<float> oNeurons; /**< a vector of output
          values*/
165
166   uint32_t hiddenNeurons = 50; /**< number of hidden neurons
         minus bias*/
167   uint32_t inputNeurons = 20;  /**< number of input neurons
          minus bias*/
168   uint32_t outputNeurons = 18; /**< number of output neurons
          */
169   float beta; /**< the beta value, this indicates the
          steepness of the sigmoid
170                    function*/
171
172   friend class boost::serialization::access; /**< a private
          friend class so the
173                                                   serialization
                                                        can
                                                      access
                                                      all
174                                                   the needed
                                                      functions
                                                      */
175   /*!
176    * \brief serialization function
```

```
177     * \param ar the object
178     * \param version the version of the class
179     */
180   template <class Archive>
181   void serialize(Archive &ar, const unsigned int version) {
182     if (version == 0) {
183       ar &BOOST_SERIALIZATION_NVP(inputNeurons);
184       ar &BOOST_SERIALIZATION_NVP(hiddenNeurons);
185       ar &BOOST_SERIALIZATION_NVP(outputNeurons);
186       ar &BOOST_SERIALIZATION_NVP(iWeights);
187       ar &BOOST_SERIALIZATION_NVP(hWeights);
188       ar &BOOST_SERIALIZATION_NVP(beta);
189       ar &BOOST_SERIALIZATION_NVP(studied);
190       ar &BOOST_SERIALIZATION_NVP(MaxGenUsedByGA);
191       ar &BOOST_SERIALIZATION_NVP(PopulationSizeUsedByGA);
192       ar &BOOST_SERIALIZATION_NVP(MutationrateUsedByGA);
193       ar &BOOST_SERIALIZATION_NVP(ElitismeUsedByGA);
194       ar &BOOST_SERIALIZATION_NVP(EndErrorUsedByGA);
195       ar &BOOST_SERIALIZATION_NVP(MaxWeightUsedByGA);
196       ar &BOOST_SERIALIZATION_NVP(MinWeightUSedByGa);
197     }
198   }
199 };
200 }
201 BOOST_CLASS_VERSION(SoilMath::NN, 0)
```

```
1  /* Copyright (C) Jelle Spijker - All Rights Reserved
2   * Unauthorized copying of this file, via any medium is
        strictly prohibited
3   * and only allowed with the written consent of the author (
        Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #include "NN.h"
9  using namespace std;
10
11 namespace SoilMath {
12 NN::NN() { beta = 0.666; }
13
14 NN::NN(uint32_t inputneurons, uint32_t hiddenneurons,
       uint32_t outputneurons) {
15   // Set the number of neurons in the network
16   inputNeurons = inputneurons;
17   hiddenNeurons = hiddenneurons;
18   outputNeurons = outputneurons;
19   // Reserve the vector space
20   iNeurons.reserve(inputNeurons + 1);  // input neurons +
        bias
21   hNeurons.reserve(hiddenNeurons + 1); // hidden neurons +
        bias
22   oNeurons.reserve(outputNeurons);     // output neurons
23
24   beta = 0.666;
25 }
```

```
26
27 NN::~NN()
28 {
29   if (optim != nullptr) {
30       delete optim;
31     }
32 }
33
34 void NN::LoadState(string filename) {
35   std::ifstream ifs(filename.c_str());
36   boost::archive::xml_iarchive ia(ifs);
37   ia >> boost::serialization::make_nvp("NeuralNet", *this);
38 }
39
40 void NN::SaveState(string filename) {
41   std::ofstream ofs(filename.c_str());
42   boost::archive::xml_oarchive oa(ofs);
43   oa << boost::serialization::make_nvp("NeuralNet", *this);
44 }
45
46 Predict_t NN::PredictLearn(ComplexVect_t input, Weight_t
     inputweights,
47                            Weight_t hiddenweights, uint32_t
                                inputneurons,
48                            uint32_t hiddenneurons, uint32_t
                                outputneurons) {
49   NN neural(inputneurons, hiddenneurons, outputneurons);
50   neural.studied = true;
51   neural.SetInputWeights(inputweights);
52   neural.SetHiddenWeights(hiddenweights);
53   return neural.Predict(input);
54 }
55
56 Predict_t NN::Predict(ComplexVect_t input) {
57   if (input.size() != inputNeurons) {
58     throw Exception::MathException(
         EXCEPTION_SIZE_OF_INPUT_NEURONS,
59                                    EXCEPTION_SIZE_OF_INPUT_NEURONS_NR
                                        );
60   }
61   if (!studied) {
62     throw Exception::MathException(
         EXCEPTION_NEURAL_NET_NOT_STUDIED,
63                                    EXCEPTION_NEURAL_NET_NOT_STUDIED_NR
                                        );
64   }
65
66   iNeurons.clear();
67   hNeurons.clear();
68   oNeurons.clear();
69
70   // Set the bias in the input and hidden vector to 1 (real
       number)
71   iNeurons.push_back(1.0f);
72   hNeurons.push_back(1.0f);
73
```

```
74    Predict_t retVal;
75    uint32_t wCount = 0;
76
77    // Init the network
78    for (uint32_t i = 0; i < inputNeurons; i++) {
79      iNeurons.push_back(static_cast<float>(abs(input[i])));
80    }
81    for (uint32_t i = 0; i < hiddenNeurons; i++) {
82      hNeurons.push_back(0.0f);
83    }
84    for (uint32_t i = 0; i < outputNeurons; i++) {
85      oNeurons.push_back(0.0f);
86    }
87
88    for (uint32_t i = 1; i < hNeurons.size(); i++) {
89      wCount = i - 1;
90      for (uint32_t j = 0; j < iNeurons.size(); j++) {
91        hNeurons[i] += iNeurons[j] * iWeights[wCount];
92        wCount += hNeurons.size() - 1;
93      }
94      hNeurons[i] = 1 / (1 + pow(2.71828f, (-hNeurons[i] *
           beta)));
95    }
96
97    for (uint32_t i = 0; i < oNeurons.size(); i++) {
98      wCount = i;
99      for (uint32_t j = 0; j < hNeurons.size(); j++) {
100       oNeurons[i] += hNeurons[j] * hWeights[wCount];
101       wCount += oNeurons.size();
102     }
103     oNeurons[i] =
104         (2 / (1.0f + pow(2.71828f, (-oNeurons[i] * beta))))
              -
105         1; // Shift plus scale so the learning function can
              be calculated
106   }
107
108   retVal.OutputNeurons = oNeurons;
109   retVal.ManualSet = false;
110   return retVal;
111 }
112
113 void NN::Learn(InputLearnVector_t input, OutputLearnVector_t
      cat,
114                uint32_t noOfDescriptorsUsed __attribute__((
                     unused))) {
115   if (optim == nullptr) {
116       optim = new SoilMath::GA(PredictLearn, inputNeurons,
             hiddenNeurons, outputNeurons);
117     }
118   connect(optim, SIGNAL(learnErrorUpdate(double)), this,
        SIGNAL(learnErrorUpdate(double)));
119
120   optim->Elitisme = ElitismeUsedByGA;
121   optim->EndError = EndErrorUsedByGA;
122   optim->MutationRate = MutationrateUsedByGA;
```

```
123
124   ComplexVect_t inputTest;
125   std::vector<Weight_t> weights;
126   Weight_t weight(((inputNeurons + 1) * hiddenNeurons) +
127                       ((hiddenNeurons + 1) * outputNeurons),
128                   0);
129   // loop through each case and adjust the weights
130   optim->Evolve(input, weight,
131                 MinMaxWeight_t(MinWeightUSedByGa,
                        MaxWeightUsedByGA), cat,
132                 MaxGenUsedByGA, PopulationSizeUsedByGA);
133
134   this->iWeights = Weight_t(
135       weight.begin(), weight.begin() + ((inputNeurons + 1) *
              hiddenNeurons));
136   this->hWeights = Weight_t(
137       weight.begin() + ((inputNeurons + 1) * hiddenNeurons),
              weight.end());
138   studied = true;
139 }
140
141 void NN::SetInputNeurons(uint32_t value) {
142   if (value != inputNeurons) {
143     inputNeurons = value;
144     iNeurons.clear();
145     iNeurons.reserve(inputNeurons + 1);
146     studied = false;
147   }
148 }
149
150 void NN::SetHiddenNeurons(uint32_t value) {
151   if (value != hiddenNeurons) {
152     hiddenNeurons = value;
153     hNeurons.clear();
154     hNeurons.reserve(hiddenNeurons + 1);
155     studied = false;
156   }
157 }
158
159 void NN::SetOutputNeurons(uint32_t value) {
160   if (value != outputNeurons) {
161     outputNeurons = value;
162     oNeurons.clear();
163     oNeurons.reserve(outputNeurons);
164     studied = false;
165   }
166 }
167 }
```

Statistical Class

```
1  /* Copyright (C) Jelle Spijker - All Rights Reserved
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       strictly prohibited
3   * and only allowed with the written consent of the author (
       Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #pragma once
9  #define MAX_UINT8_VALUE 256
10 #define VECTOR_CALC 1
11
12 #include <stdint.h>
13 #include <utility>
14 #include <vector>
15 #include <cstdlib>
16 #include <cmath>
17 #include <limits>
18 #include <typeinfo>
19 #include <string>
20
21 #include <fstream>
22
23 #include <boost/archive/binary_iarchive.hpp>
24 #include <boost/archive/binary_oarchive.hpp>
25 #include <boost/serialization/version.hpp>
26 #include <boost/math/distributions/students_t.hpp>
27
28 #include "MathException.h"
29 #include "SoilMathTypes.h"
30 #include "CommonOperations.h"
31
32 namespace SoilMath {
33
34 /*!
35  * \brief Stats class
36  * \details Usage Stats<type1, type2, type3>Stats() type 1,
       2 and 3 shoudl be of
37  * the same value and concecuative in size
38  */
39 template <typename T1, typename T2, typename T3> class Stats
       {
40 public:
41   bool isDiscrete = true; /**< indicates if the data is
       discrete or real*/
42
43   T1 *Data = nullptr;       /**< Pointer the data*/
44   uint32_t *bins = nullptr; /**< the histogram*/
45   double *CFD = nullptr;    /**< the CFD*/
46   bool Calculated = false;  /**< indication if the data has
       been calculated*/
47   float Mean = 0.0;         /**< the mean value of the data
       */
```

```
48    uint32_t n = 0;             /**< number of data points*/
49    uint32_t noBins = 0;        /**< number of bins*/
50    T1 Range = 0;               /**< range of the data*/
51    T1 min = 0;                 /**< minimum value*/
52    T1 max = 0;                 /**< maximum value*/
53    T1 Startbin = 0;            /**< First bin value*/
54    T1 EndBin = 0;              /**< End bin value*/
55    T1 binRange = 0;            /**< the range of a single bin*/
56    float Std = 0.0;            /**< standard deviation*/
57    T3 Sum = 0;                 /**< total sum of all the data
          values*/
58    uint16_t Rows = 0;          /**< number of rows from the
          data matrix*/
59    uint16_t Cols = 0;          /**< number of cols from the
          data matrix*/
60    bool StartAtZero = true;    /**< indication of the minimum
          value starts at zero
61                                    or could be less*/
62    double *BinRanges = nullptr;
63    double HighestPDF = 0.;
64
65    uint32_t *begin() { return &bins[0]; }    /**< pointer to
          the first bin*/
66    uint32_t *end() { return &bins[noBins]; } /**< pointer to
          the last + 1 bin*/
67
68    /*!
69     * \brief WelchTest Compare the sample using the Welch's
           Test
70     * \details (source:
71     * http://www.boost.org/doc/libs/1_57_0/libs/math/doc/html
           /math_toolkit/stat_tut/weg/st_eg/two_sample_students_t
           .html)
72     * \param statComp Statiscs Results of which it should be
           tested against
73     * \return
74     */
75    bool WelchTest(SoilMath::Stats<T1, T2, T3> &statComp) {
76      double alpha = 0.05;
77      // Degrees of freedom:
78      double v = statComp.Std * statComp.Std / statComp.n +
79                 this->Std * this->Std / this->n;
80      v *= v;
81      double t1 = statComp.Std * statComp.Std / statComp.n;
82      t1 *= t1;
83      t1 /= (statComp.n - 1);
84      double t2 = this->Std * this->Std / this->n;
85      t2 *= t2;
86      t2 /= (this->n - 1);
87      v /= (t1 + t2);
88      // t-statistic:
89      double t_stat = (statComp.Mean - this->Mean) /
90                      sqrt(statComp.Std * statComp.Std /
                            statComp.n +
91                           this->Std * this->Std / this->n);
92      //
```

```
93      // Define our distribution, and get the probability:
94      //
95      boost::math::students_t dist(v);
96      double q = cdf(complement(dist, fabs(t_stat)));
97
98      bool rejected = false;
99      // Sample 1 Mean == Sample 2 Mean test the NULL
            hypothesis, the two means
100     // are the same
101     if (q < alpha / 2)
102       rejected = false;
103     else
104       rejected = true;
105     return rejected;
106   }
107
108   /*!
109    * \brief Stats Constructor
110    * \param rhs Right hand side
111    */
112   Stats(const Stats &rhs)
113       : bins{new uint32_t[rhs.noBins]{0}}, CFD{new double[
              rhs.noBins]{}},
114         BinRanges{new double[rhs.noBins]{}} {
115     this->binRange = rhs.binRange;
116     this->Calculated = rhs.Calculated;
117     this->Cols = rhs.Cols;
118     this->EndBin = rhs.EndBin;
119     this->isDiscrete = rhs.isDiscrete;
120     this->max = rhs.max;
121     this->Mean = rhs.Mean;
122     this->min = rhs.min;
123     this->n = rhs.n;
124     this->noBins = rhs.noBins;
125     this->n_end = rhs.n_end;
126     this->Range = rhs.Range;
127     this->Rows = rhs.Rows;
128     this->Startbin = rhs.Startbin;
129     this->Std = rhs.Std;
130     this->Sum = rhs.Sum;
131     std::copy(rhs.bins, rhs.bins + rhs.noBins, this->bins);
132     std::copy(rhs.CFD, rhs.CFD + rhs.noBins, this->CFD);
133     std::copy(rhs.BinRanges, rhs.BinRanges + rhs.noBins,
            this->BinRanges);
134     this->Data = rhs.Data;
135     this->StartAtZero = rhs.StartAtZero;
136     this->HighestPDF = rhs.HighestPDF;
137   }
138
139   /*!
140    * \brief operator = Assigmnet operator
141    * \param rhs right hand side
142    * \return returns the right hand side
143    */
144   Stats &operator=(Stats const &rhs) {
145     if (&rhs != this) {
```

```
146         Data = rhs.Data;
147
148         if (bins != nullptr) {
149           delete[] bins;
150           bins = nullptr;
151         }
152         if (CFD != nullptr) {
153           delete[] CFD;
154           CFD = nullptr;
155         }
156         if (BinRanges != nullptr) {
157           delete[] BinRanges;
158           BinRanges = nullptr;
159         }
160
161         bins = new uint32_t[rhs.noBins];     // leak
162         CFD = new double[rhs.noBins];        // leak
163         BinRanges = new double[rhs.noBins]; // leak
164         this->binRange = rhs.binRange;
165         this->Calculated = rhs.Calculated;
166         this->Cols = rhs.Cols;
167         this->EndBin = rhs.EndBin;
168         this->isDiscrete = rhs.isDiscrete;
169         this->max = rhs.max;
170         this->Mean = rhs.Mean;
171         this->min = rhs.min;
172         this->n = rhs.n;
173         this->noBins = rhs.noBins;
174         this->n_end = rhs.n_end;
175         this->Range = rhs.Range;
176         this->Rows = rhs.Rows;
177         this->Startbin = rhs.Startbin;
178         this->Std = rhs.Std;
179         this->Sum = rhs.Sum;
180         this->Data = &rhs.Data[0];
181         std::copy(rhs.bins, rhs.bins + rhs.noBins, this->bins)
              ;
182         std::copy(rhs.CFD, rhs.CFD + rhs.noBins, this->CFD);
183         std::copy(rhs.BinRanges, rhs.BinRanges + rhs.noBins,
              this->BinRanges);
184         this->StartAtZero = rhs.StartAtZero;
185         this->HighestPDF = rhs.HighestPDF;
186       }
187       return *this;
188     }
189
190     /*!
191      * \brief Stats Constructor
192      * \param noBins number of bins with which to build the
           histogram
193      * \param startBin starting value of the first bin
194      * \param endBin end value of the second bin
195      */
196     Stats(int noBins = 256, T1 startBin = 0, T1 endBin = 255)
          {
197       min = std::numeric_limits<T1>::max();
```

```
198       max = std::numeric_limits<T1>::min();
199       Range = std::numeric_limits<T1>::max();
200       Startbin = startBin;
201       EndBin = endBin;
202       this->noBins = noBins;
203       bins = new uint32_t[noBins]{0};    // leak
204       CFD = new double[noBins]{};        // leak
205       BinRanges = new double[noBins]{}; // leak
206
207       if (typeid(T1) == typeid(float) || typeid(T1) == typeid(
              double) ||
208           typeid(T1) == typeid(long double)) {
209         isDiscrete = false;
210         binRange = static_cast<T1>((EndBin - Startbin) /
                noBins);
211       } else {
212         isDiscrete = true;
213         binRange = static_cast<T1>(round((EndBin - Startbin) /
                noBins));
214       }
215     }
216
217     /*!
218      * \brief Stats constructor
219      * \param data Pointer to the data
220      * \param rows Number of rows
221      * \param cols Number of Columns
222      * \param noBins Number of bins
223      * \param startBin Value of the start bin
224      * \param startatzero bool indicating if the bins should
             be shifted from zero
225      */
226     Stats(T1 *data, uint16_t rows, uint16_t cols, int noBins =
            256,
227           T1 startBin = 0, bool startatzero = true) {
228       min = std::numeric_limits<T1>::max();
229       max = std::numeric_limits<T1>::min();
230       Range = max - min;
231
232       Startbin = startBin;
233       EndBin = startBin + noBins;
234       StartAtZero = startatzero;
235
236       if (typeid(T1) == typeid(float) || typeid(T1) == typeid(
              double) ||
237           typeid(T1) == typeid(long double)) {
238         isDiscrete = false;
239       } else {
240         isDiscrete = true;
241       }
242
243       Data = data;
244       Rows = rows;
245       Cols = cols;
246       bins = new uint32_t[noBins]{0};
247       CFD = new double[noBins]{};
```

```
248       BinRanges = new double[noBins]{};
249       this->noBins = noBins;
250       if (isDiscrete) {
251         BasicCalculate();
252       } else {
253         BasicCalculateFloat();
254       }
255     }
256
257     /*!
258      * \brief Stats Constructor
259      * \param data Pointer the data
260      * \param rows Number of rows
261      * \param cols Number of Columns
262      * \param mask the mask should have the same size as the
           data a value of zero
263      * indicates that the data pointer doesn't exist. A 1
           indicates that the data
264      * pointer is to be used
265      * \param noBins Number of bins
266      * \param startBin Value of the start bin
267      * \param startatzero indicating if the bins should be
           shifted from zero
268      */
269     Stats(T1 *data, uint16_t rows, uint16_t cols, uchar *mask,
           int noBins = 256,
270           T1 startBin = 0, bool startatzero = true) {
271       min = std::numeric_limits<T1>::max();
272       max = std::numeric_limits<T1>::min();
273       Range = max - min;
274
275       Startbin = startBin;
276       EndBin = startBin + noBins;
277       StartAtZero = startatzero;
278
279       if (typeid(T1) == typeid(float) || typeid(T1) == typeid(
              double) ||
280           typeid(T1) == typeid(long double)) {
281         isDiscrete = false;
282       } else {
283         isDiscrete = true;
284       }
285
286       Data = data;
287       Rows = rows;
288       Cols = cols;
289       bins = new uint32_t[noBins]{0};
290       CFD = new double[noBins]{};
291       BinRanges = new double[noBins]{};
292       this->noBins = noBins;
293       if (isDiscrete) {
294         BasicCalculate(mask);
295       } else {
296         BasicCalculateFloat(mask);
297       }
298     }
```

```
299
300   /*!
301    * \brief Stats Constructor
302    * \param binData The histogram data
303    * \param startC start counter
304    * \param endC end counter
305    */
306   Stats(T2 *binData, uint16_t startC, uint16_t endC) {
307     noBins = endC - startC;
308     Startbin = startC;
309     EndBin = endC;
310     uint32_t i = noBins;
311
312     if (typeid(T1) == typeid(float) || typeid(T1) == typeid(
          double) ||
313         typeid(T1) == typeid(long double)) {
314       isDiscrete = false;
315       throw Exception::MathException(
            EXCEPTION_TYPE_NOT_SUPPORTED,
316                                      EXCEPTION_TYPE_NOT_SUPPORTED_NR
                                         );
317     } else {
318       isDiscrete = true;
319     }
320
321     bins = new uint32_t[noBins]{0};
322     CFD = new double[noBins]{};
323     BinRanges = new double[noBins]{};
324     while (i-- > 0) {
325       bins[i] = binData[i];
326       n += binData[i];
327     }
328     BinCalculations(startC, endC);
329   }
330
331   ~Stats() {
332     Data == nullptr;
333     if (bins != nullptr) {
334       delete[] bins;
335       bins = nullptr;
336     }
337     if (CFD != nullptr) {
338       delete[] CFD;
339       CFD = nullptr;
340     }
341     if (BinRanges != nullptr) {
342       delete[] BinRanges;
343       BinRanges = nullptr;
344     }
345   }
346
347   /*!
348    * \brief BasicCalculateFloat execute the basic float data
          calculations
349    */
350   void BasicCalculateFloat() {
```

```
351     float sum_dev = 0.0;
352     n = Rows * Cols;
353     for (uint32_t i = 0; i < n; i++) {
354       if (Data[i] > max) {
355         max = Data[i];
356       }
357       if (Data[i] < min) {
358         min = Data[i];
359       }
360       Sum += Data[i];
361     }
362     binRange = (max - min) / noBins;
363     uint32_t index = 0;
364     Mean = Sum / (float)n;
365     Range = max - min;
366
367     if (StartAtZero) {
368       for (uint32_t i = 0; i < n; i++) {
369         index = static_cast<uint32_t>(Data[i] / binRange);
370         if (index == noBins) {
371           index -= 1;
372         }
373         bins[index]++;
374         sum_dev += pow((Data[i] - Mean), 2);
375       }
376     } else {
377       for (uint32_t i = 0; i < n; i++) {
378         index = static_cast<uint32_t>((Data[i] - min) /
              binRange);
379         if (index == noBins) {
380           index -= 1;
381         }
382         bins[index]++;
383         sum_dev += pow((Data[i] - Mean), 2);
384       }
385     }
386     Std = sqrt((float)(sum_dev / n));
387     getCFD();
388     Calculated = true;
389   }
390
391   /*!
392    * \brief BasicCalculateFloat execute the basic float data
          calculations with a
393    * mask
394    * \param mask uchar mask type 0 don't calculate, 1
          calculate
395    */
396   void BasicCalculateFloat(uchar *mask) {
397     float sum_dev = 0.0;
398     n = Rows * Cols;
399     uint32_t nmask = 0;
400     for (uint32_t i = 0; i < n; i++) {
401       if (mask[i] != 0) {
402         if (Data[i] > max) {
403           max = Data[i];
```

```
404           }
405           if (Data[i] < min) {
406             min = Data[i];
407           }
408           Sum += Data[i];
409           nmask++;
410         }
411       }
412       binRange = (max - min) / noBins;
413       uint32_t index = 0;
414       Mean = Sum / (float)nmask;
415       Range = max - min;
416       if (StartAtZero) {
417         for (uint32_t i = 0; i < n; i++) {
418           if (mask[i] != 0) {
419             index = static_cast<uint32_t>(Data[i] / binRange);
420             if (index == noBins) {
421               index -= 1;
422             }
423             bins[index]++;
424             sum_dev += pow((Data[i] - Mean), 2);
425           }
426         }
427       } else {
428         for (uint32_t i = 0; i < n; i++) {
429           if (mask[i] != 0) {
430             index = static_cast<uint32_t>((Data[i] - min) /
                  binRange);
431             if (index == noBins) {
432               index -= 1;
433             }
434             bins[index]++;
435             sum_dev += pow((Data[i] - Mean), 2);
436           }
437         }
438       }
439       Std = sqrt((float)(sum_dev / nmask));
440       getCFD();
441       Calculated = true;
442     }
443
444     /*!
445      * \brief BasicCalculate execute the basic discrete data
          calculations
446      */
447     void BasicCalculate() {
448       double sum_dev = 0.0;
449       n = Rows * Cols;
450       for (uint32_t i = 0; i < n; i++) {
451         if (Data[i] > max) {
452           max = Data[i];
453         }
454         if (Data[i] < min) {
455           min = Data[i];
456         }
457         Sum += Data[i];
```

```
458       }
459       binRange = static_cast<T1>(ceil((max - min) /
              static_cast<float>(noBins)));
460       if (binRange == 0) {
461         binRange = 1;
462       }
463       Mean = Sum / (float)n;
464       Range = max - min;
465
466       uint32_t index;
467       if (StartAtZero) {
468         std::for_each(Data, Data + n, [&](T1 &d) {
469           index = static_cast<uint32_t>(d / binRange);
470           if (index == noBins) {
471             index -= 1;
472           }
473           bins[index]++;
474           sum_dev += pow((d - Mean), 2);
475         });
476       } else {
477         std::for_each(Data, Data + n, [&](T1 &d) {
478           index = static_cast<uint32_t>((d - min) / binRange);
479           if (index == noBins) {
480             index -= 1;
481           }
482           bins[index]++;
483           sum_dev += pow((d - Mean), 2);
484         });
485       }
486       Std = sqrt((float)(sum_dev / n));
487       getCFD();
488       Calculated = true;
489     }
490
491     /*!
492      * \brief BasicCalculate execute the basic discrete data
              calculations with
493      * mask
494      * \param mask uchar mask type 0 don't calculate, 1
              calculate
495      */
496     void BasicCalculate(uchar *mask) {
497       double sum_dev = 0.0;
498       n = Rows * Cols;
499       uint32_t nmask = 0;
500       uint32_t i = 0;
501       std::for_each(Data, Data + n, [&](T1 &d) {
502         if (mask[i++] != 0) {
503           if (d > max) {
504             max = d;
505           }
506           if (d < min) {
507             min = d;
508           }
509           Sum += d;
510           nmask++;
```

```
511         }
512       });
513       binRange = static_cast<T1>(ceil((max - min) /
              static_cast<float>(noBins)));
514       Mean = Sum / (float)nmask;
515       Range = max - min;
516
517       uint32_t index;
518       if (StartAtZero) {
519         i = 0;
520         std::for_each(Data, Data + n, [&](T1 &d) {
521           if (mask[i++] != 0) {
522             index = static_cast<uint32_t>(d / binRange);
523             if (index == noBins) {
524               index -= 1;
525             }
526             bins[index]++;
527             sum_dev += pow((d - Mean), 2);
528           }
529         });
530       } else {
531         i = 0;
532         std::for_each(Data, Data + n, [&](T1 &d) {
533           if (mask[i++] != 0) {
534             index = static_cast<uint32_t>((d - min) / binRange
                    );
535             if (index == noBins) {
536               index -= 1;
537             }
538             bins[index]++;
539             sum_dev += pow((d - Mean), 2);
540           }
541         });
542       }
543       Std = sqrt((float)(sum_dev / nmask));
544       getCFD();
545       Calculated = true;
546     }
547
548     /*!
549      * \brief BinCalculations excute the cacluations with the
              histogram
550      * \param startC start counter
551      * \param endC end counter
552      */
553     void BinCalculations(uint16_t startC, uint16_t endC
            __attribute__((unused))) {
554       float sum_dev = 0.0;
555       // Get the Sum
556       uint32_t i = 0;
557       for_each(begin(), end(), [&](uint32_t &b) { Sum += b * (
              startC + i++); });
558
559       // Get Mean
560       Mean = Sum / (float)n;
561
```

```
562     // Get max
563     for (int i = noBins - 1; i >= 0; i--) {
564       if (bins[i] != 0) {
565         max = i + startC;
566         break;
567       }
568     }
569
570     // Get min
571     for (uint32_t i = 0; i < noBins; i++) {
572       if (bins[i] != 0) {
573         min = i + startC;
574         break;
575       }
576     }
577
578     // Get Range;
579     Range = max - min;
580
581     // Calculate Standard Deviation
582     i = 0;
583     for_each(begin(), end(), [&](uint32_t &b) {
584       sum_dev += b * pow(((i++ + startC) - Mean), 2);
585     });
586     Std = sqrt((float)(sum_dev / n));
587     getCFD();
588     Calculated = true;
589   }
590
591   uint32_t HighestFrequency() {
592     uint32_t freq = 0;
593     std::for_each(begin(), end(), [&](uint32_t &B) {
594       if (B > freq) {
595         freq = B;
596       }
597     });
598     return freq;
599   }
600
601   void GetPDFfunction(std::vector<double> &xAxis, std::
        vector<double> &yAxis,
602                       double Step, double start = 0, double
                            stop = 7) {
603     uint32_t resolution;
604     resolution = static_cast<uint32_t>(((stop - start) /
          Step) + 0.5);
605
606     xAxis.push_back(start);
607     double yVal0 = (1 / (Std * 2.506628274631)) *
608                    exp(-(pow((start - Mean), 2) / (2 * pow(
                         Std, 2))));
609     yAxis.push_back(yVal0);
610     HighestPDF = yVal0;
611     for (uint32_t i = 1; i < resolution; i++) {
612       double xVal = xAxis[xAxis.size() - 1] + Step;
613       xAxis.push_back(xVal);
```

```
614         double yVal = (1 / (Std * 2.506628274631)) *
615                       exp(-(pow((xVal - Mean), 2) / (2 * pow(
                              Std, 2))));
616         yAxis.push_back(yVal);
617         if (yVal > HighestPDF) {
618           HighestPDF = yVal;
619         }
620       }
621     }
622
623   protected:
624     uint32_t n_end = 0; /**< data end counter used with mask*/
625
626     /*!
627      * \brief getCFD get the CFD matrix;
628      */
629     void getCFD() {
630       uint32_t *sumBin = new uint32_t[noBins];
631       sumBin[0] = bins[0];
632       CFD[0] = (static_cast<double>(sumBin[0]) / static_cast<
             double>(n)) * 100.;
633       for (uint32_t i = 1; i < noBins; i++) {
634         sumBin[i] = (sumBin[i - 1] + bins[i]);
635         CFD[i] = (static_cast<double>(sumBin[i]) / static_cast
               <double>(n)) * 100.;
636         if (CFD[i] > HighestPDF) {
637           HighestPDF = CFD[i];
638         }
639       }
640       delete[] sumBin;
641     }
642
643     friend class boost::serialization::access; /**<
          Serialization class*/
644
645     /*!
646      * \brief serialize the object
647      * \param ar argument
648      * \param version
649      */
650     template <class Archive>
651     void serialize(Archive &ar, const unsigned int version) {
652       if (version == 0) {
653         ar &isDiscrete;
654         ar &n;
655         ar &noBins;
656         for (size_t dc = 0; dc < noBins; dc++) {
657           ar &bins[dc];
658         }
659         for (size_t dc = 0; dc < noBins; dc++) {
660           ar &CFD[dc];
661         }
662         for (size_t dc = 0; dc < noBins; dc++) {
663           ar &BinRanges[dc];
664         }
665         ar &Calculated;
```

```
666         ar &Mean;
667         ar &Range;
668         ar &min;
669         ar &max;
670         ar &Startbin;
671         ar &EndBin;
672         ar &binRange;
673         ar &Std;
674         ar &Sum;
675         ar &Rows;
676         ar &Cols;
677         ar &StartAtZero;
678         ar &HighestPDF;
679       }
680     }
681 };
682 }
683
684 typedef SoilMath::Stats<float, double, long double>
685     floatStat_t; /**< floating Stat type*/
686 typedef SoilMath::Stats<uchar, uint32_t, uint64_t>
687     ucharStat_t; /**< uchar Stat type*/
688 typedef SoilMath::Stats<uint16_t, uint32_t, uint64_t>
689     uint16Stat_t; /**< uint16 Stat type*/
690 typedef SoilMath::Stats<uint32_t, uint32_t, uint64_t>
691     uint32Stat_t; /**< uint32 Stat type*/
692 BOOST_CLASS_VERSION(floatStat_t, 0)
693 BOOST_CLASS_VERSION(ucharStat_t, 0)
694 BOOST_CLASS_VERSION(uint16Stat_t, 0)
695 BOOST_CLASS_VERSION(uint32Stat_t, 0)
```

```
1  /* Copyright (C) Jelle Spijker - All Rights Reserved
2   * Unauthorized copying of this file, via any medium is
        strictly prohibited
3   * and only allowed with the written consent of the author (
        Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #pragma once
9
10 #include "Stats.h"
11 #include <boost/serialization/base_object.hpp>
12
13 namespace SoilMath {
14 class PSD : public SoilMath::Stats<double, double, long
       double> {
15 private:
16   uint32_t DetBin(float value) {
17     uint32_t i = noBins - 1;
18     while (i > 0) {
19       if (value > BinRanges[i]) {
20         return i;
21       }
22       i--;
```

```
23      }
24      return 0;
25    }
26
27    void BasicCalculatePSD() {
28      float sum_dev = 0.0;
29      n = Rows * Cols;
30      for (uint32_t i = 0; i < n; i++) {
31        if (Data[i] > max) {
32          max = Data[i];
33        }
34        if (Data[i] < min) {
35          min = Data[i];
36        }
37        Sum += Data[i];
38      }
39      uint32_t index = 0;
40      Mean = Sum / (float)n;
41      Range = max - min;
42      for (uint32_t i = 0; i < n; i++) {
43        index = DetBin(Data[i]);
44        bins[index]++;
45        sum_dev += pow((Data[i] - Mean), 2);
46      }
47      Std = sqrt((float)(sum_dev / n));
48      getCFD();
49      Calculated = true;
50    }
51    friend class boost::serialization::access;
52
53    template <class Archive>
54    void serialize(Archive &ar, const unsigned int version) {
55      if (version == 0) {
56        ar &boost::serialization::base_object<
57            SoilMath::Stats<double, double, long double>>(*
                this);
58      }
59    }
60
61  public:
62    PSD() : SoilMath::Stats<double, double, long double>() {}
63
64    PSD(double *data, uint32_t nodata, double *binranges,
        uint32_t nobins,
65        uint32_t endbin)
66        : SoilMath::Stats<double, double, long double>(nobins,
              0, endbin) {
67      std::copy(binranges, binranges + nobins, BinRanges);
68      Data = data;
69      Rows = nodata;
70      Cols = 1;
71
72      BasicCalculatePSD();
73    }
74  };
75  }
```

```
76 BOOST_CLASS_VERSION(SoilMath::PSD, 0)
```

General project files

```
#-------------------------------------------------
#
# Project created by QtCreator 2015-06-06T11:59:21
#
#-------------------------------------------------

QT       += core gui concurrent
greaterThan(QT_MAJOR_VERSION, 4): QT += widgets

TARGET = SoilMath
TEMPLATE = lib
VERSION = 0.9.8

DEFINES += SOILMATH_LIBRARY
QMAKE_CXXFLAGS += -std=c++11
unix:!macx: QMAKE_RPATHDIR += $$PWD/../../../build/install/

@
CONFIG(release, debug|release):DEFINES += QT_NO_DEBUG_OUTPUT
@

SOURCES += \
    NN.cpp \
    GA.cpp \
    FFT.cpp

HEADERS += \
    Stats.h \
    Sort.h \
    SoilMathTypes.h \
    SoilMath.h \
    NN.h \
    MathException.h \
    GA.h \
    FFT.h \
    CommonOperations.h \
    predict_t_archive.h \
    Mat_archive.h \
    psd.h

#opencv
LIBS += -L/usr/local/lib -lopencv_core -lopencv_highgui
INCLUDEPATH += /usr/local/include/opencv
INCLUDEPATH += /usr/local/include

#boost
DEFINES += BOOST_ALL_DYN_LINK
INCLUDEPATH += /usr/include/boost
LIBS += -L/usr/lib/x86_64-linux-gnu/ -lboost_serialization -
    lboost_iostreams

#Zlib
LIBS += -L/usr/local/lib -lz
INCLUDEPATH += /usr/local/include
```

```
54
55 unix {
56     target.path = $PWD/../../../build/install
57     INSTALLS += target
58 }
```

```
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6   */
7
8  /*! \brief Collection of the public SoilMath headers
9   * Commonpractice is to include this header when you want to
       add Soilmath
10  * routines
11  */
12 #pragma once
13
14 #include "Stats.h"
15 #include "Sort.h"
16 #include "FFT.h"
17 #include "NN.h"
18 #include "GA.h"
19 #include "CommonOperations.h"
20 #include "SoilMathTypes.h"
21 #include "psd.h"
22 #include "Mat_archive.h"
23 #include "predict_t_archive.h"
```

```
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6   */
7
8  #pragma once
9  #define COMMONOPERATIONS_VERSION 1
10
11 #include <algorithm>
12 #include <stdint.h>
13 #include <math.h>
14 #include <vector>
15
16 namespace SoilMath {
17 inline uint16_t MinNotZero(uint16_t a, uint16_t b) {
18   if (a != 0 && b != 0) {
19     return (a < b) ? a : b;
20   } else {
21     return (a > b) ? a : b;
```

```
22    }
23  }
24
25  inline uint16_t Max(uint16_t a, uint16_t b) { return (a > b)
        ? a : b; }
26
27  inline uint16_t Max(uint16_t a, uint16_t b, uint16_t c,
      uint16_t d) {
28    return (Max(a, b) > Max(c, d)) ? Max(a, b) : Max(c, d);
29  }
30
31  inline uint16_t Min(uint16_t a, uint16_t b) { return (a < b)
        ? a : b; }
32
33  inline uint16_t Min(uint16_t a, uint16_t b, uint16_t c,
      uint16_t d) {
34    return (Min(a, b) > Min(c, d)) ? Min(a, b) : Min(c, d);
35  }
36
37  static inline double quick_pow10(int n) {
38    static double pow10[19] = {1, 10, 100, 1000, 10000,
        100000, 1000000, 10000000,
39                               100000000, 1000000000,
                                    10000000000, 100000000000,
40                               1000000000000, 10000000000000,
                                    100000000000000,
41                               1000000000000000,
                                    10000000000000000,
42                               100000000000000000,
                                    1000000000000000000};
43    return pow10[(n >= 0) ? n : -n];
44  }
45
46
47  // Source:
48  // http://martin.ankerl.com/2012/01/25/optimized-
      approximative-pow-in-c-and-cpp/
49  static inline double fastPow(double a, double b) {
50    union {
51      double d;
52      int x[2];
53    } u = {a};
54    u.x[1] = (int)(b * (u.x[1] - 1072632447) + 1072632447);
55    u.x[0] = 0;
56    return u.d;
57  }
58
59  static inline double quick_pow2(int n) {
60    static double pow2[256] = {
61        0,     1,     4,     9,     16,    25,    36,    49,
              64,    81,
62        100,   121,   144,   169,   196,   225,   256,   289,
            324,   361,
63        400,   441,   484,   529,   576,   625,   676,   729,
            784,   841,
```

```
64        900,   961,   1024,  1089,  1156,  1225,  1296,  1369,
              1444,  1521,
65        1600,  1681,  1764,  1849,  1936,  2025,  2116,  2209,
              2304,  2401,
66        2500,  2601,  2704,  2809,  2916,  3025,  3136,  3249,
              3364,  3481,
67        3600,  3721,  3844,  3969,  4096,  4225,  4356,  4489,
              4624,  4761,
68        4900,  5041,  5184,  5329,  5476,  5625,  5776,  5929,
              6084,  6241,
69        6400,  6561,  6724,  6889,  7056,  7225,  7396,  7569,
              7744,  7921,
70        8100,  8281,  8464,  8649,  8836,  9025,  9216,  9409,
              9604,  9801,
71        10000, 10201, 10404, 10609, 10816, 11025, 11236,
              11449, 11664, 11881,
72        12100, 12321, 12544, 12769, 12996, 13225, 13456,
              13689, 13924, 14161,
73        14400, 14641, 14884, 15129, 15376, 15625, 15876,
              16129, 16384, 16641,
74        16900, 17161, 17424, 17689, 17956, 18225, 18496,
              18769, 19044, 19321,
75        19600, 19881, 20164, 20449, 20736, 21025, 21316,
              21609, 21904, 22201,
76        22500, 22801, 23104, 23409, 23716, 24025, 24336,
              24649, 24964, 25281,
77        25600, 25921, 26244, 26569, 26896, 27225, 27556,
              27889, 28224, 28561,
78        28900, 29241, 29584, 29929, 30276, 30625, 30976,
              31329, 31684, 32041,
79        32400, 32761, 33124, 33489, 33856, 34225, 34596,
              34969, 35344, 35721,
80        36100, 36481, 36864, 37249, 37636, 38025, 38416,
              38809, 39204, 39601,
81        40000, 40401, 40804, 41209, 41616, 42025, 42436,
              42849, 43264, 43681,
82        44100, 44521, 44944, 45369, 45796, 46225, 46656,
              47089, 47524, 47961,
83        48400, 48841, 49284, 49729, 50176, 50625, 51076,
              51529, 51984, 52441,
84        52900, 53361, 53824, 54289, 54756, 55225, 55696,
              56169, 56644, 57121,
85        57600, 58081, 58564, 59049, 59536, 60025, 60516,
              61009, 61504, 62001,
86        62500, 63001, 63504, 64009, 64516, 65025};
87    return pow2[(n >= 0) ? n : -n];
88  }
89
90  static inline long float2intRound(double d) {
91    d += 6755399441055744.0;
92    return reinterpret_cast<int &>(d);
93  }
94
95  /*!
96   * \brief calcVolume according to ISO 9276-6
97   * \param A
```

```
98   * \return
99   */
100 static inline float calcVolume(float A) {
101   return (pow(A, 1.5)) / 10.6347f;
102 }
103
104 static inline std::vector<float> makeOutput(uint8_t value,
       uint32_t noNeurons) {
105   std::vector<float> retVal(noNeurons, -1);
106   retVal[value - 1] = 1;
107   return retVal;
108 }
109
110 /*!
111  * \brief calcDiameter according to ISO 9276-6
112  * \param A
113  * \return
114  */
115 static inline float calcDiameter(float A) {
116   //return sqrt((4 * A) / M_PI);
117   return 1.1283791670955 * sqrt(A);
118 }
119 }
```

```
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6   */
7  #pragma once
8
9  #define GENE_MAX 32  /**< maximum number of genes*/
10 #define CROSSOVER 16 /**< crossover location*/
11
12 #include <stdint.h>
13 #include <bitset>
14 #include <vector>
15 #include <complex>
16 #include <valarray>
17 #include <array>
18
19 typedef unsigned char uchar;   /**< unsigned char*/
20 typedef unsigned short ushort; /**< unsigned short*/
21 typedef unsigned int uint32_t;
22
23 typedef std::complex<double> Complex_t;       /**< complex
       vector of doubles*/
24 typedef std::vector<Complex_t> ComplexVect_t; /**< vector of
       Complex_t*/
25 typedef std::valarray<Complex_t> ComplexArray_t; /**<
       valarray of Complex_t*/
26 typedef std::vector<uint32_t> iContour_t;        /**< vector
       of uint32_t*/
```

```
27 typedef std::bitset<GENE_MAX> Genome_t; /**< Bitset
      repressenting a genome*/
28 typedef std::pair<std::bitset<CROSSOVER>, std::bitset<
      GENE_MAX - CROSSOVER>>
29     SplitGenome_t; /**< a matted genome*/
30
31 typedef std::vector<float> Weight_t;     /**< a float vector
      */
32 typedef std::vector<Genome_t> GenVect_t; /**< a vector of
      genomes*/
33 typedef struct PopMemberStruct {
34   Weight_t weights;       /**< the weights the core of a
        population member*/
35   GenVect_t weightsGen;   /**< the weights as genomes*/
36   float Calculated = 0.0; /**< the calculated value*/
37   float Fitness = 0.0;    /**< the fitness of the population
         member*/
38 } PopMember_t;            /**< a population member*/
39 typedef std::vector<PopMember_t> Population_t; /**< Vector
      with PopMember_t*/
40 typedef std::pair<float, float>
41     MinMaxWeight_t; /**< floating pair weight range*/
42
43 typedef struct Predict_struct {
44   uint8_t Category = 1; /**< the category number */
45   float RealValue = 1.;  /**< category number as float in
        order to estimate how
46                          precise to outcome is*/
47   float Accuracy = 1.;   /**< the accuracy of the category*/
48   std::vector<float> OutputNeurons; /**< the output Neurons
        */
49   bool ManualSet = true;
50 } Predict_t;                        /**< The prediction
      results*/
51 typedef Predict_t (*NNfunctionType)(
52     ComplexVect_t, Weight_t, Weight_t, uint32_t, uint32_t,
53     uint32_t); /**< The prediction function from the Neural
        Net*/
54
55 typedef std::vector<ComplexVect_t>
56     InputLearnVector_t; /**< Vector of a vector with complex
         values*/
57 typedef std::vector<Predict_t> OutputLearnVector_t; /**<
      vector with results*/
```

```
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6  */
7
8 // Source:
```

```
9  // http://stackoverflow.com/questions/16125574/how-to-
       serialize-opencv-mat-with-boost-xml-archive
10 #pragma once
11
12 #include <boost/archive/binary_iarchive.hpp>
13 #include <boost/archive/binary_oarchive.hpp>
14 #include <boost/serialization/access.hpp>
15 #include <opencv/cv.h>
16 #include <opencv2/core.hpp>
17
18 namespace boost {
19 namespace serialization {
20 /*!
21  * \brief serialize Serialize the openCV mat to disk
22  */
23 template <class Archive>
24 inline void serialize(Archive &ar, cv::Mat &m, const
       unsigned int version __attribute__((unused))) {
25   int cols = m.cols;
26   int rows = m.rows;
27   int elemSize = m.elemSize();
28   int elemType = m.type();
29
30   ar &cols;
31   ar &rows;
32   ar &elemSize;
33   ar &elemType; // element type.
34
35   if (m.type() != elemType || m.rows != rows || m.cols !=
         cols) {
36     m = cv::Mat(rows, cols, elemType, cv::Scalar(0));
37   }
38
39   size_t dataSize = cols * rows * elemSize;
40
41   for (size_t dc = 0; dc < dataSize; dc++) {
42     ar &m.data[dc];
43   }
44 }
45 }
46 }
```

```
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6   */
7
8  // Source:
9  // http://stackoverflow.com/questions/16125574/how-to-
       serialize-opencv-mat-with-boost-xml-archive
10 #pragma once
11
```

```
12 #include <boost/archive/binary_iarchive.hpp>
13 #include <boost/archive/binary_oarchive.hpp>
14 #include <boost/serialization/access.hpp>
15 #include <boost/serialization/vector.hpp>
16 #include <boost/serialization/complex.hpp>
17 #include "SoilMathTypes.h"
18
19 namespace boost {
20 namespace serialization {
21 /*!
22  * \brief serialize Serialize the openCV mat to disk
23  */
24 template <class Archive>
25 inline void serialize(Archive &ar, Predict_t &P, const
      unsigned int version __attribute__((unused))) {
26   ar &P.Accuracy;
27   ar &P.Category;
28   ar &P.OutputNeurons;
29   ar &P.RealValue;
30 }
31 }
32 }
```

```
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6   */
7
8  #define EXCEPTION_MATH "Math Exception!"
9  #define EXCEPTION_MATH_NR 0
10 #define EXCEPTION_NO_CONTOUR_FOUND
                                                    \
11   "No continuous contour found, or less then 8 pixels long!"
12 #define EXCEPTION_NO_CONTOUR_FOUND_NR 1
13 #define EXCEPTION_SIZE_OF_INPUT_NEURONS
                                                  \
14   "Size of input unequal to input neurons exception!"
15 #define EXCEPTION_SIZE_OF_INPUT_NEURONS_NR 2
16 #define EXCEPTION_NEURAL_NET_NOT_STUDIED "Neural net didn't
      study exception!"
17 #define EXCEPTION_NEURAL_NET_NOT_STUDIED_NR 3
18 #define EXCEPTION_TYPE_NOT_SUPPORTED
                                                    \
19   "Type not supported for operation exception!"
20 #define EXCEPTION_TYPE_NOT_SUPPORTED_NR 4
21
22 #pragma once
23 #include <exception>
24 #include <string>
25
26 namespace SoilMath {
27 namespace Exception {
```

```
28 class MathException : public std::exception {
29 public:
30   MathException(std::string m = EXCEPTION_MATH, int n =
       EXCEPTION_MATH_NR)
31       : msg(m), nr(n){};
32   ~MathException() _GLIBCXX_USE_NOEXCEPT{};
33   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); };
34   const int *id() const _GLIBCXX_USE_NOEXCEPT { return &nr;
       }
35
36 private:
37   std::string msg;
38   int nr;
39 };
40 }
41 }
```

```
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6   */
7
8  #pragma once
9  #include <stdint.h>
10
11 namespace SoilMath {
12 /*!
13  * \brief The Sort template class
14  */
15 class Sort {
16 public:
17   Sort() {}
18   ~Sort() {}
19
20   /*!
21    * \brief QuickSort a static sort a Type T array with i
         values
22    * \details Usage: QuickSort<type>(*type , i)
23    * \param arr an array of Type T
24    * \param i the number of elements
25    */
26   template <typename T> static void QuickSort(T *arr, int i)
       {
27     if (i < 2)
28       return;
29
30     T p = arr[i / 2];
31     T *l = arr;
32     T *r = arr + i - 1;
33     while (l <= r) {
34       if (*l < p) {
```

```
35          l++;
36        } else if (*r > p) {
37          r--;
38        } else {
39          T t = *l;
40          *l = *r;
41          *r = t;
42          l++;
43          r--;
44        }
45      }
46      Sort::QuickSort<T>(arr, r - arr + 1);
47      Sort::QuickSort<T>(l, arr + i - l);
48    }
49
50    /*!
51     * \brief QuickSort a static sort a Type T array with i
          values where the key
52     * are also changed accordingly
53     * \details Usage: QuickSort<type>(*type *type , i)
54     * \param arr an array of Type T
55     * \param key an array of 0..i-1 representing the index
56     * \param i the number of elements
57     */
58    template <typename T> static void QuickSort(T *arr, T *key
        , int i) {
59      if (i < 2)
60        return;
61
62      T p = arr[i / 2];
63
64      T *l = arr;
65      T *r = arr + i - 1;
66
67      T *lkey = key;
68      T *rkey = key + i - 1;
69
70      while (l <= r) {
71        if (*l < p) {
72          l++;
73          lkey++;
74        } else if (*r > p) {
75          r--;
76          rkey--;
77        } else {
78          if (*l != *r) {
79            T t = *l;
80            *l = *r;
81            *r = t;
82
83            T tkey = *lkey;
84            *lkey = *rkey;
85            *rkey = tkey;
86          }
87
88          l++;
```

```
89          r--;
90
91          lkey++;
92          rkey--;
93        }
94      }
95      Sort::QuickSort<T>(arr, key, r - arr + 1);
96      Sort::QuickSort<T>(l, lkey, arr + i - l);
97    }
98 };
99 }
```

I. Hardware Library

Microscope Class

```
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6   */
7
8  /*! \class Microscope
9  Interaction with the microscope
10 */
11
12 #pragma once
13
14 #include <stdint.h>
15 #include <vector>
16 #include <string>
17 #include <utility>
18 #include <algorithm>
19
20 #include <sys/stat.h>
21 #include <sys/utsname.h>
22 #include <sys/ioctl.h>
23 #include <fstream>
24 #include <fcntl.h>
25
26 #include <linux/videodev2.h>
27 #include <linux/v4l2-controls.h>
28 #include <linux/v4l2-common.h>
29
```

```
30 #include <boost/filesystem.hpp>
31 #include <boost/regex.hpp>
32
33 #include <opencv2/photo.hpp>
34 #include <opencv2/imgcodecs.hpp>
35 #include <opencv2/opencv.hpp>
36 #include <opencv2/core.hpp>
37
38 #include <gst/gst.h>
39 #include <gst/app/gstappsink.h>
40
41 #include <QtCore/QObject>
42 #include <QEventLoop>
43 #include <QDebug>
44
45 #include "MicroscopeNotFoundException.h"
46 #include "CouldNotGrabImageException.h"
47
48 namespace Hardware {
49 class Microscope : public QObject {
50   Q_OBJECT
51
52 public:
53   enum Arch { ARM, X64 };
54
55   enum PixelFormat { YUYV, MJPG, GREY };
56
57   struct Resolution_t {
58     uint16_t Width = 2048;
59     uint16_t Height = 1536;
60     PixelFormat format = PixelFormat::MJPG;
61     std::string to_string() {
62       std::string retVal = std::to_string(Width);
63       retVal.append(" x ");
64       retVal.append(std::to_string(Height));
65       if (format == PixelFormat::MJPG) {
66           retVal.append(" - MJPG");
67         }
68       else if (format == PixelFormat::YUYV){
69           retVal.append(" - YUYV");
70         }
71       else {
72           retVal.append(" - GREY");
73         }
74       return retVal;
75     }
76     uint32_t ID;
77   };
78
79   struct Control_t {
80     std::string name;
81     int minimum;
82     int maximum;
83     int step;
84     int default_value;
85     int current_value;
```

```
86      uint32_t ID = V4L2_CID_BASE;
87      bool operator==(Control_t &rhs) {
88        if (this->name.compare(rhs.name) == 0) {
89          return true;
90        } else {
91          return false;
92        }
93      }
94      bool operator!=(Control_t &rhs) {
95        if (this->name.compare(rhs.name) != 0) {
96          return true;
97        } else {
98          return false;
99        }
100     }
101   };
102
103   typedef std::vector<Control_t> Controls_t;
104
105   typedef struct _CustomData {
106   GMainLoop *main_loop;
107   GstElement *pipeline;
108   GstElement *source;
109   GstElement *capsfilter;
110   GstElement *tisvideobuffer;
111   GstElement *tiscolorize;
112   GstElement *bayer;
113   GstElement *queue;
114   GstElement *colorspace;
115   GstElement *convert;
116   GstElement *sink;
117   GstBus *bus;
118   GstCaps *caps;
119   Hardware::Microscope *currentMicroscope;
120   } CustomData;
121
122   struct Cam_t {
123     std::string Name;
124     std::string devString;
125     uint32_t ID;
126     std::vector<Resolution_t> Resolutions;
127     uint32_t delaytrigger = 1;
128     Resolution_t *SelectedResolution = nullptr;
129     Controls_t Controls;
130     CustomData Pipe;
131     int fd;
132     bool operator==(Cam_t const &rhs) {
133       if (this->ID == rhs.ID || this->Name == rhs.Name) {
134         return true;
135       } else {
136         return false;
137       }
138     }
139     bool operator!=(Cam_t const &rhs) {
140       if (this->ID != rhs.ID && this->Name != rhs.Name) {
141         return true;
```

```
142         } else {
143           return false;
144         }
145       }
146   };
147
148   std::vector<Cam_t> AvailableCams;
149   Cam_t *SelectedCam = nullptr;
150   Arch RunEnv;
151
152   Microscope();
153   Microscope(const Microscope &rhs);
154
155   ~Microscope();
156
157   Microscope operator=(Microscope const &rhs);
158
159   bool IsOpened();
160   bool openCam(Cam_t *cam);
161   bool openCam(int &cam);
162   bool openCam(std::string &cam);
163
164   bool closeCam(Cam_t *cam);
165
166   void GetFrame(cv::Mat &dst);
167   void GetGstreamFrame(cv::Mat &dst);
168   void GetHDRFrame(cv::Mat &dst, uint32_t noframes = 3);
169
170   Control_t *GetControl(const std::string name);
171   void SetControl(Control_t *control);
172
173   Cam_t *FindCam(std::string cam);
174   Cam_t *FindCam(int cam);
175   cv::Mat lastFrame;
176
177   void SendImageRetrieved();
178
179 public slots:
180   void on_imageretrieved();
181
182 signals:
183   void imageretrieved();
184
185 private:
186   static void new_buffer(GstElement *sink, CustomData *data)
        ;
187   void getResolutions(Cam_t &currentCam, int FormatType);
188   bool openedUptheCam = false;
189   cv::VideoCapture *cap = nullptr;
190
191   std::vector<cv::Mat> HDRframes;
192
193   std::vector<Cam_t> GetAvailableCams();
194   Arch GetCurrentArchitecture();
195   int fd;
196 };
```

```
197 }
```

```
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        strictly prohibited
3   * and only allowed with the written consent of the author (
        Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #include "Microscope.h"
9
10 namespace Hardware {
11
12 Microscope::Microscope() {
13   RunEnv = GetCurrentArchitecture();
14   AvailableCams = GetAvailableCams();
15   for_each(AvailableCams.begin(), AvailableCams.end(), [](
        Cam_t &C) {
16     C.SelectedResolution = &C.Resolutions[C.Resolutions.size
          () - 1];
17   });
18   connect(this, SIGNAL(imageretrieved()), this, SLOT(
        on_imageretrieved()));
19 }
20
21 Microscope::Microscope(const Microscope &rhs) {
22   std::copy(rhs.AvailableCams.begin(), rhs.AvailableCams.end
        (),
23             this->AvailableCams.begin());
24   this->RunEnv = rhs.RunEnv;
25   this->SelectedCam = rhs.SelectedCam;
26   this->cap = rhs.cap;
27   this->fd = rhs.fd;
28   this->HDRframes = rhs.HDRframes;
29   connect(this, SIGNAL(imageretrieved()), this, SLOT(
        on_imageretrieved()));
30 }
31
32 Microscope::~Microscope() { delete cap; }
33
34 Microscope::Arch Microscope::GetCurrentArchitecture() {
35   struct utsname unameData;
36   Arch retVal;
37   uname(&unameData);
38   std::string archString = static_cast<std::string>(
        unameData.machine);
39   if (archString.find("armv7l") != string::npos) {
40     retVal = Arch::ARM;
41   } else {
42     retVal = Arch::X64;
43   }
44   return retVal;
45 }
46
```

```
47 std::vector<Microscope::Cam_t> Microscope::GetAvailableCams
       () {
48   const string path_ss = "/sys/class/video4linux";
49   const string path_ss_dev = "/dev/video";
50   std::vector<Cam_t> retVal;
51   struct v4l2_queryctrl queryctrl;
52   struct v4l2_control controlctrl;
53
54   // Check if there're videodevices installed
55   // Itterate through the cams
56   for (boost::filesystem::directory_iterator itr(path_ss);
57        itr != boost::filesystem::directory_iterator(); ++itr
           ) {
58     string videoln = itr->path().string();
59     videoln.append("/name");
60     if (boost::filesystem::exists(videoln)) {
61       Cam_t currentCam;
62       std::ifstream camName;
63       camName.open(videoln);
64       std::getline(camName, currentCam.Name);
65       camName.close();
66       currentCam.ID =
67           std::atoi(itr->path().string().substr(28, std::
              string::npos).c_str());
68
69       // Open Cam
70       currentCam.devString = path_ss_dev + std::to_string(
           currentCam.ID);
71       if ((currentCam.fd = open(currentCam.devString.c_str()
           , O_RDWR)) == -1) {
72         throw Exception::MicroscopeException(
             EXCEPTION_NOCAMS,
73                                              EXCEPTION_NOCAMS_NR
                                                 );
74       }
75
76       // Get controls
77       memset(&queryctrl, 0, sizeof(queryctrl));
78       memset(&controlctrl, 0, sizeof(controlctrl));
79       for (queryctrl.id = V4L2_CID_BASE; queryctrl.id <
           V4L2_CID_LASTP1;
80            queryctrl.id++) {
81
82         if (ioctl(currentCam.fd, VIDIOC_QUERYCTRL, &
             queryctrl) == 0) {
83           if (!(queryctrl.flags & V4L2_CTRL_FLAG_DISABLED))
                {
84             Control_t currentControl;
85             currentControl.ID = queryctrl.id;
86             currentControl.name = (char *)queryctrl.name;
87             currentControl.minimum = queryctrl.minimum;
88             currentControl.maximum = queryctrl.maximum;
89             currentControl.default_value = queryctrl.
                  default_value;
90             currentControl.step = queryctrl.step;
91             controlctrl.id = queryctrl.id;
```

```
92              if (ioctl(currentCam.fd, VIDIOC_G_CTRL, &
                    controlctrl) == 0) {
93                currentControl.current_value = controlctrl.
                      value;
94              }
95              currentCam.Controls.push_back(currentControl);
96            }
97          } else {
98            if (errno == EINVAL)
99              continue;
100           throw Exception::MicroscopeException(
                  EXCEPTION_QUERY,
101                                                 EXCEPTION_QUERY_NR
                                                      );
102         }
103       }
104
105       getResolutions(currentCam, V4L2_PIX_FMT_YUYV);
106       getResolutions(currentCam, V4L2_PIX_FMT_MJPEG);
107       getResolutions(currentCam, V4L2_PIX_FMT_GREY);
108       close(currentCam.fd);
109       retVal.push_back(currentCam);
110     }
111   }
112
113   for (uint32_t i = 0; i < retVal.size(); i++) {
114     if (retVal[i].Resolutions.size() == 0) {
115       retVal.erase(retVal.begin() + i);
116       i--;
117     }
118   }
119
120   return retVal;
121 }
122
123 void Microscope::getResolutions(Cam_t &currentCam, int
      FormatType) {
124   // Get image formats
125   struct v4l2_format format;
126   memset(&format, 0, sizeof(format));
127
128   uint32_t width[10] = {640,  800,  1280, 1280, 1920,
129                         1600, 2048, 2560, 3840, 3872};
130   uint32_t height[10] = {480,  600,  720,  960,  1080,
131                          1200, 1536, 1440, 2160, 2764};
132
133   uint32_t ResolutionID = 0;
134
135   for (uint32_t i = 0; i < 10; i++) {
136     format.type = V4L2_BUF_TYPE_VIDEO_CAPTURE;
137     format.fmt.pix.pixelformat = FormatType;
138     format.fmt.pix.width = width[i];
139     format.fmt.pix.height = height[i];
140     int ret = ioctl(currentCam.fd, VIDIOC_S_FMT, &format);
141     if (ret != -1 && format.fmt.pix.height == height[i] &&
142         format.fmt.pix.width == width[i]) {
```

```
143         Resolution_t res;
144         res.Width = format.fmt.pix.width;
145         res.Height = height[i];
146         res.ID = ResolutionID++;
147         switch (FormatType) {
148         case V4L2_PIX_FMT_YUYV:
149           res.format = PixelFormat::YUYV;
150           break;
151         case V4L2_PIX_FMT_MJPEG:
152           res.format = PixelFormat::MJPG;
153           break;
154         case V4L2_PIX_FMT_GREY:
155           res.format = PixelFormat::GREY;
156           break;
157         default:
158           break;
159         }
160         currentCam.Resolutions.push_back(res);
161       }
162     }
163 }
164
165 bool Microscope::IsOpened() { return openedUptheCam; }
166
167 bool Microscope::openCam(Cam_t *cam) {
168   for (uint32_t i = 0; i < AvailableCams.size(); i++) {
169     if (AvailableCams[i] == *cam) {
170       closeCam(SelectedCam);
171       SelectedCam = cam;
172       for (Controls_t::iterator it = SelectedCam->Controls.
             begin();
173            it != SelectedCam->Controls.end(); ++it) {
174         SetControl(&*it);
175       }
176
177       SelectedCam->Pipe.currentMicroscope = this;
178       gst_init(NULL, NULL);
179
180       SelectedCam->Pipe.pipeline = gst_pipeline_new("SoilCam
             ");
181       if (!SelectedCam->Pipe.pipeline) {
182         throw Exception::MicroscopeException(
183             EXCEPTION_GSTREAM_INIT_EXCEPTION,
184             EXCEPTION_GSTREAM_INIT_EXCEPTION_NR);
185       }
186
187       SelectedCam->Pipe.source = gst_element_factory_make("
             v4l2src", "source");
188       SelectedCam->Pipe.capsfilter =
189           gst_element_factory_make("capsfilter", "filter");
190       SelectedCam->Pipe.colorspace =
191           gst_element_factory_make("ffmpegcolorspace", "
                colorspace");
192       SelectedCam->Pipe.convert =
193           gst_element_factory_make("capsfilter", "convert");
```

```
194         SelectedCam->Pipe.sink = gst_element_factory_make("
                appsink", "output");
195
196         if (!SelectedCam->Pipe.source || !SelectedCam->Pipe.
                capsfilter ||
197             !SelectedCam->Pipe.colorspace || !SelectedCam->
                    Pipe.sink ||
198             !SelectedCam->Pipe.convert) {
199           throw Exception::MicroscopeException(
200               EXCEPTION_GSTREAM_ELEM_EXCEPTION,
201               EXCEPTION_GSTREAM_ELEM_EXCEPTION_NR);
202         }
203
204         if (SelectedCam->Name.compare("DFK 24UJ003") == 0) {
205           SelectedCam->Pipe.tisvideobuffer =
                gst_element_factory_make(
206               "tisvideobufferfilter", "tisvidebufferfilter");
207           SelectedCam->Pipe.tiscolorize =
208               gst_element_factory_make("tiscolorize", "
                    tiscolorize");
209           SelectedCam->Pipe.queue = gst_element_factory_make("
                queue", "queue");
210           SelectedCam->Pipe.bayer =
211               gst_element_factory_make("bayer2rgb", "bayer");
212           if (!SelectedCam->Pipe.tisvideobuffer ||
213               !SelectedCam->Pipe.tiscolorize || !SelectedCam->
                    Pipe.queue ||
214               !SelectedCam->Pipe.bayer) {
215             throw Exception::MicroscopeException(
216                 EXCEPTION_GSTREAM_ELEM_EXCEPTION,
217                 EXCEPTION_GSTREAM_ELEM_EXCEPTION_NR);
218           }
219         }
220
221         g_object_set(SelectedCam->Pipe.source, "device",
222                      SelectedCam->devString.c_str());
223
224         switch (SelectedCam->SelectedResolution->format) {
225         case PixelFormat::MJPG:
226           SelectedCam->Pipe.caps = gst_caps_new_simple(
227               "video/x-raw-rgb", "width", G_TYPE_INT,
228               SelectedCam->SelectedResolution->Width, "height"
                    , G_TYPE_INT,
229               SelectedCam->SelectedResolution->Height, NULL);
230         case PixelFormat::GREY:
231           SelectedCam->Pipe.caps = gst_caps_new_simple(
232               "video/x-raw-gray", "width", G_TYPE_INT,
233               SelectedCam->SelectedResolution->Width, "height"
                    , G_TYPE_INT,
234               SelectedCam->SelectedResolution->Height, NULL);
235           break;
236         case PixelFormat::YUYV:
237           SelectedCam->Pipe.caps = gst_caps_new_simple(
238               "video/x-raw-gray", "format", G_TYPE_STRING, "(
                    fourcc)UYVY",
```

```
239             "width", G_TYPE_INT, SelectedCam->
                    SelectedResolution->Width,
240             "height", G_TYPE_INT, SelectedCam->
                    SelectedResolution->Height,
241             NULL);
242         default:
243           break;
244         }
245         g_object_set(SelectedCam->Pipe.capsfilter, "caps",
                SelectedCam->Pipe.caps,
246                      NULL);
247         gst_caps_unref(SelectedCam->Pipe.caps);
248         SelectedCam->Pipe.caps = gst_caps_new_simple(
249             "video/x-raw-rgb", "width", G_TYPE_INT,
250             SelectedCam->SelectedResolution->Width, "height",
                    G_TYPE_INT,
251             SelectedCam->SelectedResolution->Height, NULL);
252         g_object_set(SelectedCam->Pipe.convert, "caps",
                SelectedCam->Pipe.caps,
253                      NULL);
254
255         SelectedCam->Pipe.bus = gst_element_get_bus(
                SelectedCam->Pipe.pipeline);
256         g_object_set(SelectedCam->Pipe.sink, "emit-signals",
                TRUE, NULL);
257         g_signal_connect(SelectedCam->Pipe.sink, "new-buffer",
258                          G_CALLBACK(new_buffer), &SelectedCam
                                ->Pipe);
259
260         if (SelectedCam->Name.compare("DFK 24UJ003") == 0) {
261           gst_bin_add_many(GST_BIN(SelectedCam->Pipe.pipeline)
                    ,
262                            SelectedCam->Pipe.source,
                                SelectedCam->Pipe.capsfilter,
263                            SelectedCam->Pipe.tisvideobuffer,
264                            SelectedCam->Pipe.tiscolorize,
                                SelectedCam->Pipe.queue,
265                            SelectedCam->Pipe.bayer,
                                SelectedCam->Pipe.sink, NULL);
266           gst_element_link_many(
267               SelectedCam->Pipe.source, SelectedCam->Pipe.
                      capsfilter,
268               SelectedCam->Pipe.tisvideobuffer, SelectedCam->
                      Pipe.tiscolorize,
269               SelectedCam->Pipe.queue, SelectedCam->Pipe.bayer
                      ,
270               SelectedCam->Pipe.sink, NULL);
271         } else {
272           gst_bin_add_many(
273               GST_BIN(SelectedCam->Pipe.pipeline), SelectedCam
                      ->Pipe.source,
274               SelectedCam->Pipe.capsfilter, SelectedCam->Pipe.
                      colorspace,
275               SelectedCam->Pipe.convert, SelectedCam->Pipe.
                      sink, NULL);
276           gst_element_link_many(
```

```
277             SelectedCam->Pipe.source, SelectedCam->Pipe.
                    capsfilter,
278             SelectedCam->Pipe.colorspace, SelectedCam->Pipe.
                    convert,
279             SelectedCam->Pipe.sink, NULL);
280       }
281       openedUptheCam = true;
282       return true;
283     }
284   }
285   openedUptheCam = false;
286   return false;
287 }
288
289 bool Microscope::openCam(std::string &cam) { return openCam(
      FindCam(cam)); }
290
291 bool Microscope::openCam(int &cam) { return openCam(FindCam(
      cam)); }
292
293 Microscope::Cam_t *Microscope::FindCam(int cam) {
294   for (uint32_t i = 0; i < AvailableCams.size(); i++) {
295     if (cam == AvailableCams[i].ID) {
296       return &AvailableCams[i];
297     }
298   }
299   return nullptr;
300 }
301
302 Microscope::Cam_t *Microscope::FindCam(string cam) {
303   for (uint32_t i = 0; i < AvailableCams.size(); i++) {
304     if (cam.compare(AvailableCams[i].Name) == 0) {
305       return &AvailableCams[i];
306     }
307   }
308   return nullptr;
309 }
310
311 bool Microscope::closeCam(Cam_t *cam) {
312   if (openedUptheCam) {
313     gst_element_set_state(cam->Pipe.pipeline, GST_STATE_NULL
          );
314     gst_object_unref(GST_OBJECT(cam->Pipe.pipeline));
315     openedUptheCam = false;
316   }
317 }
318
319 void Microscope::GetFrame(cv::Mat &dst) {
320   if (!IsOpened()) {
321       openCam(SelectedCam);
322     }
323   QEventLoop loop;
324   loop.connect(this, SIGNAL(imageretrieved()), SLOT(quit()))
        ;
325   gst_element_set_state(SelectedCam->Pipe.pipeline,
        GST_STATE_PLAYING);
```

```
326   loop.exec();
327   dst = lastFrame;
328   closeCam(SelectedCam);
329 }
330
331 void Microscope::on_imageretrieved() { return; }
332
333 void Microscope::GetHDRFrame(cv::Mat &dst, uint32_t noframes
      ) {
334   // create the brightness steps
335   Control_t *brightness = GetControl("Brightness");
336   Control_t *contrast = GetControl("Contrast");
337
338   uint32_t brightnessStep =
339       (brightness->maximum - brightness->minimum) / noframes
          ;
340   int8_t currentBrightness = brightness->current_value;
341   int8_t currentContrast = contrast->current_value;
342   contrast->current_value = contrast->maximum;
343
344   cv::Mat currentImg;
345   // take the shots at different brightness levels
346   for (uint32_t i = 1; i <= noframes; i++) {
347     brightness->current_value = brightness->minimum + (i *
         brightnessStep);
348     GetFrame(currentImg);
349     HDRframes.push_back(currentImg);
350   }
351
352   // Set the brightness and back to the previous used level
353   brightness->current_value = currentBrightness;
354   contrast->current_value = currentContrast;
355
356   // Perform the exposure fusion
357   cv::Mat fusion;
358   cv::Ptr<cv::MergeMertens> merge_mertens = cv::
       createMergeMertens();
359   merge_mertens->process(HDRframes, fusion);
360   fusion *= 255;
361   fusion.convertTo(dst, CV_8UC1);
362 }
363
364 Microscope::Control_t *Microscope::GetControl(const string
      name) {
365   for (Controls_t::iterator it = SelectedCam->Controls.begin
        ();
366         it != SelectedCam->Controls.end(); ++it) {
367     if (name.compare(it->name) == 0) {
368       return &*it;
369     }
370   }
371   return nullptr;
372 }
373
374 void Microscope::SetControl(Control_t *control) {
```

```
375   if ((SelectedCam->fd = open(SelectedCam->devString.c_str()
          , O_RDWR)) == -1) {
376     throw Exception::MicroscopeException(EXCEPTION_NOCAMS,
          EXCEPTION_NOCAMS_NR);
377   }
378
379   struct v4l2_queryctrl queryctrl;
380   struct v4l2_control controlctrl;
381
382   memset(&queryctrl, 0, sizeof(queryctrl));
383   queryctrl.id = control->ID;
384   if (ioctl(SelectedCam->fd, VIDIOC_QUERYCTRL, &queryctrl)
          == -1) {
385     if (errno != EINVAL) {
386       close(SelectedCam->fd);
387       throw Exception::MicroscopeException(EXCEPTION_QUERY,
            EXCEPTION_QUERY_NR);
388     } else {
389       close(SelectedCam->fd);
390       throw Exception::MicroscopeException(
            EXCEPTION_CTRL_NOT_FOUND,
391                                            EXCEPTION_CTRL_NOT_FOUND_NR
                                               );
392     }
393   } else if (queryctrl.flags & V4L2_CTRL_FLAG_DISABLED) {
394     close(SelectedCam->fd);
395     throw Exception::MicroscopeException(
          EXCEPTION_CTRL_NOT_FOUND,
396                                          EXCEPTION_CTRL_NOT_FOUND_NR
                                             );
397   } else {
398     memset(&controlctrl, 0, sizeof(controlctrl));
399     controlctrl.id = control->ID;
400     controlctrl.value = control->current_value;
401
402     if (ioctl(SelectedCam->fd, VIDIOC_S_CTRL, &controlctrl)
            == -1) {
403       // Fails on auto white balance
404       // throw Exception::MicroscopeException(
            EXCEPTION_CTRL_VALUE,
405       //
            EXCEPTION_CTRL_VALUE_NR);
406     }
407   }
408   close(SelectedCam->fd);
409 }
410
411 void Microscope::SendImageRetrieved() { emit imageretrieved
      (); }
412
413 void Microscope::new_buffer(GstElement *sink, CustomData *
      data) {
414   GstBuffer *buffer;
415   g_signal_emit_by_name(sink, "pull-buffer", &buffer);
416   if (buffer) {
417     cv::Mat bufferMat(
```

```
418             data->currentMicroscope->SelectedCam->
                    SelectedResolution->Height,
419             data->currentMicroscope->SelectedCam->
                    SelectedResolution->Width,
420             CV_8UC4, (uchar *)buffer->data);
421         std::vector<cv::Mat> chans;
422         cv::split(bufferMat, chans);
423         chans.erase(chans.begin() + 4);
424         cv::merge(chans, data->currentMicroscope->lastFrame);
425         cv::namedWindow("test");
426         cv::imshow("test", data->currentMicroscope->lastFrame);
427         cv::waitKey(0);
428         data->currentMicroscope->SendImageRetrieved();
429         //      gst_element_set_state(data->currentMicroscope->
                SelectedCam->Pipe.pipeline,
430         //                            GST_STATE_PAUSED);
431         gst_buffer_unref(buffer);
432     }
433 }
434 }
```

Beaglebone Black Class

```
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3   * and only allowed with the written consent of the author (Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  /*! \class BBB
9  The core BeagleBone Black class used for all hardware related classes.
10 Consisting of universal used method, functions and variables. File operations,
11 polling and threading
12 */
13
14 #pragma once
15
16 #define SLOTS \
17   "/sys/devices/platform/bone_capemgr/slots" /*!< Beaglebone capemanager slots file*/
18
19 #include <fstream>
20 #include <sstream>
21 #include <string>
22 #include <sys/stat.h>
23 #include <pthread.h>
24 #include <unistd.h>
25 #include <sys/epoll.h>
26 #include <fcntl.h>
27 #include <regex>
28 #include <stdexcept>
29
30 #include "GPIOReadException.h"
31 #include "FailedToCreateGPIOPollingThreadException.h"
32 #include "ValueOutOfBoundsException.h"
33
34 using namespace std;
35
36 namespace Hardware {
37 typedef int (*CallbackType)(
38     int); /*!< CallbackType used to pass a function to a thread*/
39
40 class BBB {
41 public:
42   int debounceTime; /*!< debounce time for a button in milliseconds*/
43
44   BBB();
45   ~BBB();
```

```
46
47 protected:
48   bool threadRunning;            /*!< used to stop the
       thread*/
49   pthread_t thread;              /*!< The thread*/
50   CallbackType callbackFunction; /*!< the callbakcfunction*/
51
52   bool DirectoryExist(const string &path);
53   bool CapeLoaded(const string &shield);
54
55   string Read(const string &path);
56   void Write(const string &path, const string &value);
57
58   /*! Converts a number to a string
59   \param Number as typename
60   \returns the number as a string
61   */
62   template <typename T> string NumberToString(T Number) {
63     ostringstream ss;
64     ss << Number;
65     return ss.str();
66   };
67
68   /*! Converts a string to a number
69   \param Text the string that needs to be converted
70   \return the number as typename
71   */
72   template <typename T> T StringToNumber(string Text) {
73     stringstream ss(Text);
74     T result;
75     return ss >> result ? result : 0;
76   };
77 };
78 }
```

```
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3   * and only allowed with the written consent of the author (
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4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #include "BBB.h"
9
10 namespace Hardware {
11 /*! Constructor*/
12 BBB::BBB() {
13   threadRunning = false;
14   callbackFunction = NULL;
15   debounceTime = 0;
16   thread = (pthread_t)NULL;
17 }
18
19 /*! De-constructor*/
```

```
20 BBB::~BBB() {}
21
22 /*! Reads the first line from a file
23 \param path constant string pointing towards the file
24 \returns this first line
25 */
26 string BBB::Read(const string &path) {
27   ifstream fs;
28   fs.open(path.c_str());
29   if (!fs.is_open()) {
30     throw Exception::GPIOReadException(("Can't open: " +
         path).c_str());
31   }
32   string input;
33   getline(fs, input);
34   fs.close();
35   return input;
36 }
37
38 /*! Writes a value to a file
39 \param path a constant string pointing towards the file
40 \param value a constant string which should be written in
     the file
41 */
42 void BBB::Write(const string &path, const string &value) {
43   ofstream fs;
44   fs.open(path.c_str());
45   if (!fs.is_open()) {
46     throw Exception::GPIOReadException(("Can't open: " +
         path).c_str());
47   }
48   fs << value;
49   fs.close();
50 }
51
52 /*! Checks if a directory exist
53 \returns true if the directory exists and false if not
54 */
55 bool BBB::DirectoryExist(const string &path) {
56   struct stat st;
57   if (stat((char *)path.c_str(), &st) != 0) {
58     return false;
59   }
60   return true;
61 }
62
63 /*! Checks if a cape is loaded in the file /sys/devices/
     bone_capemgr.9/slots
64 \param shield a const search string which is a (part) of the
      shield name
65 \return true if the search string is found otherwise false
66 */
67 bool BBB::CapeLoaded(const string &shield) {
68   bool shieldFound = false;
69
70   ifstream fs;
```

```
71    fs.open(SLOTS);
72    if (!fs.is_open()) {
73      throw Exception::GPIOReadException("Can't open SLOTS");
74    }
75
76    string line;
77    while (getline(fs, line)) {
78      if (line.find(shield) != string::npos) {
79        shieldFound = true;
80        break;
81      }
82    }
83    fs.close();
84    return shieldFound;
85  }
86  }
```

GPIO Class

```
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4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   * This code is based upon:
7   * Derek Molloy, "Exploring BeagleBone: Tools and Techniques
        for Building
8   * with Embedded Linux", Wiley, 2014, ISBN:9781118935125.
9   * See: www.exploringbeaglebone.com
10  */
11
12 #pragma once
13 #include "BBB.h"
14
15 #define EXPORT_PIN "/sys/class/gpio/export"
16 #define UNEXPORT_PIN "/sys/class/gpio/unexport"
17 #define GPIOS "/sys/class/gpio/gpio"
18 #define DIRECTION "/direction"
19 #define VALUE "/value"
20 #define EDGE "/edge"
21
22 using namespace std;
23
24 namespace Hardware {
25 class GPIO : public BBB {
26 public:
27   enum Direction { Input, Output };
28   enum Value { Low = 0, High = 1 };
29   enum Edge { None, Rising, Falling, Both };
30
31   int number; // Number of the pin
32
33   int WaitForEdge();
34   int WaitForEdge(CallbackType callback);
35   void WaitForEdgeCancel() { this->threadRunning = false; }
36
37   Value GetValue();
38   void SetValue(Value value);
39
40   Direction GetDirection();
41   void SetDirection(Direction direction);
42
43   Edge GetEdge();
44   void SetEdge(Edge edge);
45
46   GPIO(int number);
47   ~GPIO();
48
49 private:
50   string gpiopath;
51   Direction direction;
```

```
52    Edge edge;
53    friend void *threadedPollGPIO(void *value);
54
55    bool isExported(int number, Direction &dir, Edge &edge);
56    bool ExportPin(int number);
57    bool UnexportPin(int number);
58
59    Direction ReadsDirection(const string &gpiopath);
60    void WritesDirection(const string &gpiopath, Direction
          direction);
61
62    Edge ReadsEdge(const string &gpiopath);
63    void WritesEdge(const string &gpiopath, Edge edge);
64
65    Value ReadsValue(const string &gpiopath);
66    void WritesValue(const string &gpiopath, Value value);
67  };
68
69  void *threadedPollGPIO(void *value);
70  }
```

```
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4    * This software is proprietary and confidential
5    * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6    */
7
8   #include "GPIO.h"
9
10  namespace Hardware {
11  GPIO::GPIO(int number) {
12
13    this->number = number;
14    gpiopath = GPIOS + NumberToString<int>(number);
15
16    if (!isExported(number, direction, edge)) {
17      ExportPin(number);
18      direction = ReadsDirection(gpiopath);
19      edge = ReadsEdge(gpiopath);
20    }
21    usleep(250000);
22  }
23
24  GPIO::~GPIO() { UnexportPin(number); }
25
26  int GPIO::WaitForEdge(CallbackType callback) {
27    threadRunning = true;
28    callbackFunction = callback;
29    if (pthread_create(&this->thread, NULL, &threadedPollGPIO,
30                       static_cast<void *>(this))) {
31      threadRunning = false;
32      throw Exception::
             FailedToCreateGPIOPollingThreadException();
```

```
33    }
34    return 0;
35  }
36
37  int GPIO::WaitForEdge() {
38    if (direction == Output) {
39      SetDirection(Input);
40    }
41    int fd, i, epollfd, count = 0;
42    struct epoll_event ev;
43    epollfd = epoll_create(1);
44    if (epollfd == -1) {
45      throw Exception::
            FailedToCreateGPIOPollingThreadException(
46          "GPIO: Failed to create epollfd!");
47    }
48    if ((fd = open((gpiopath + VALUE).c_str(), O_RDONLY |
         O_NONBLOCK)) == -1) {
49      throw Exception::GPIOReadException();
50    }
51
52    // read operation | edge triggered | urgent data
53    ev.events = EPOLLIN | EPOLLET | EPOLLPRI;
54    ev.data.fd = fd;
55
56    if (epoll_ctl(epollfd, EPOLL_CTL_ADD, fd, &ev) == -1) {
57      throw Exception::
            FailedToCreateGPIOPollingThreadException(
58          "GPIO: Failed to add control interface!");
59    }
60
61    while (count <= 1) {
62      i = epoll_wait(epollfd, &ev, 1, -1);
63      if (i == -1) {
64        close(fd);
65        return -1;
66      } else {
67        count++;
68      }
69    }
70    close(fd);
71    return 0;
72  }
73
74  GPIO::Value GPIO::GetValue() { return ReadsValue(gpiopath);
       }
75  void GPIO::SetValue(GPIO::Value value) { WritesValue(
       gpiopath, value); }
76
77  GPIO::Direction GPIO::GetDirection() { return direction; }
78  void GPIO::SetDirection(Direction direction) {
79    this->direction = direction;
80    WritesDirection(gpiopath, direction);
81  }
82
83  GPIO::Edge GPIO::GetEdge() { return edge; }
```

```
84  void GPIO::SetEdge(Edge edge) {
85    this->edge = edge;
86    WritesEdge(gpiopath, edge);
87  }
88
89  bool GPIO::isExported(int number __attribute__((unused)),
       Direction &dir,
90                        Edge &edge) {
91    // Checks if directory exist and therefore is exported
92    if (!DirectoryExist(gpiopath)) {
93      return false;
94    }
95
96    // Reads the data associated with the pin
97    dir = ReadsDirection(gpiopath);
98    edge = ReadsEdge(gpiopath);
99    return true;
100 }
101
102 bool GPIO::ExportPin(int number) {
103   switch (number) {
104   case 7:
105     system("config-pin P9.42 gpio");
106     break;
107   case 116:
108     system("config-pin P9.91 gpio");
109     break;
110   case 112:
111     system("config-pin P9.30 gpio");
112     break;
113   case 115:
114     system("config-pin P9.27 gpio");
115     break;
116   case 14:
117     system("config-pin P9.26 gpio");
118     break;
119   case 15:
120     system("config-pin P9.24 gpio");
121     break;
122   case 49:
123     system("config-pin P9.23 gpio");
124     break;
125   case 2:
126     system("config-pin P9.22 gpio");
127     break;
128   case 3:
129     system("config-pin P9.21 gpio");
130     break;
131   case 4:
132     system("config-pin P9.18 gpio");
133     break;
134   case 5:
135     system("config-pin P9.17 gpio");
136     break;
137   case 51:
138     system("config-pin P9.16 gpio");
```

```
139       break;
140     case 48:
141       system("config-pin P9.15 gpio");
142       break;
143     case 50:
144       system("config-pin P9.14 gpio");
145       break;
146     case 31:
147       system("config-pin P9.13 gpio");
148       break;
149     case 60:
150       system("config-pin P9.12 gpio");
151       break;
152     case 30:
153       system("config-pin P9.11 gpio");
154       break;
155     case 61:
156       system("config-pin P8.26 gpio");
157       break;
158     case 22:
159       system("config-pin P8.19 gpio");
160       break;
161     case 65:
162       system("config-pin P8.18 gpio");
163       break;
164     case 27:
165       system("config-pin P8.17 gpio");
166       break;
167     case 46:
168       system("config-pin P8.16 gpio");
169       break;
170     case 47:
171       system("config-pin P8.15 gpio");
172       break;
173     case 26:
174       system("config-pin P8.14 gpio");
175       break;
176     case 23:
177       system("config-pin P8.13 gpio");
178       break;
179     case 44:
180       system("config-pin P8.12 gpio");
181       break;
182     case 45:
183       system("config-pin P8.11 gpio");
184       break;
185     case 68:
186       system("config-pin P8.10 gpio");
187       break;
188     case 69:
189       system("config-pin P8.09 gpio");
190       break;
191     case 67:
192       system("config-pin P8.08 gpio");
193       break;
194     case 66:
```

```
195       system("config-pin P8.07 gpio");
196       break;
197     }
198     usleep(250000);
199   }
200
201   bool GPIO::UnexportPin(int number) {
202     //Write(UNEXPORT_PIN, NumberToString<int>(number));
203   }
204
205   GPIO::Direction GPIO::ReadsDirection(const string &gpiopath)
          {
206     if (Read(gpiopath + DIRECTION) == "in") {
207       return Input;
208     } else {
209       return Output;
210     }
211   }
212
213   void GPIO::WritesDirection(const string &gpiopath, Direction
          direction) {
214     switch (direction) {
215     case Hardware::GPIO::Input:
216       Write((gpiopath + DIRECTION), "in");
217       break;
218     case Hardware::GPIO::Output:
219       Write((gpiopath + DIRECTION), "out");
220       break;
221     }
222   }
223
224   GPIO::Edge GPIO::ReadsEdge(const string &gpiopath) {
225     string reader = Read(gpiopath + EDGE);
226     if (reader == "none") {
227       return None;
228     } else if (reader == "rising") {
229       return Rising;
230     } else if (reader == "falling") {
231       return Falling;
232     } else {
233       return Both;
234     }
235   }
236
237   void GPIO::WritesEdge(const string &gpiopath, Edge edge) {
238     switch (edge) {
239     case Hardware::GPIO::None:
240       Write((gpiopath + EDGE), "none");
241       break;
242     case Hardware::GPIO::Rising:
243       Write((gpiopath + EDGE), "rising");
244       break;
245     case Hardware::GPIO::Falling:
246       Write((gpiopath + EDGE), "falling");
247       break;
248     case Hardware::GPIO::Both:
```

```
249       Write((gpiopath + EDGE), "both");
250       break;
251     default:
252       break;
253     }
254 }
255
256 GPIO::Value GPIO::ReadsValue(const string &gpiopath) {
257   string path(gpiopath + VALUE);
258   int res = StringToNumber<int>(Read(path));
259   return (Value)res;
260 }
261
262 void GPIO::WritesValue(const string &gpiopath, Value value)
      {
263   Write(gpiopath + VALUE, NumberToString<int>(value));
264 }
265
266 void *threadedPollGPIO(void *value) {
267   GPIO *gpio = static_cast<GPIO *>(value);
268   while (gpio->threadRunning) {
269     gpio->callbackFunction(gpio->WaitForEdge());
270     usleep(gpio->debounceTime * 1000);
271   }
272   return 0;
273 }
274 }
```

PWM Class

```
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6   */
7
8  #pragma once
9  #include "BBB.h"
10 #include <dirent.h>
11
12 #define OCP_PATH "/sys/class/pwm/"
13 #define PWM_CAPE "Override Board Name,00A0,Override Manuf,
       cape-universaln"
14
15 namespace Hardware {
16 class PWM : public BBB {
17 public:
18   enum Pin // Four possible PWM pins
19   { P8_13,
20     P8_19,
21     P9_14,
22     P9_16 };
23   enum Run // Signal generating
24   { On = 1,
25     Off = 0 };
26   enum Polarity // Inverse duty polarity
27   { Normal = 1,
28     Inverted = 0 };
29
30   Pin pin; // Current pin
31
32   uint8_t GetPixelValue() { return pixelvalue; }
33   void SetPixelValue(uint8_t value);
34
35   float GetIntensity() { return intensity; };
36   void SetIntensity(float value);
37
38   int GetPeriod() { return period; };
39   void SetPeriod(int value);
40
41   int GetDuty() { return duty; };
42   void SetDuty(int value);
43   void SetIntensity();
44
45   Run GetRun() { return run; };
46   void SetRun(Run value);
47
48   Polarity GetPolarity() { return polarity; };
49   void SetPolarity(Polarity value);
50
51   PWM(Pin pin);
```

```
52    ~PWM();
53
54  private:
55    int period;          // current period
56    int duty;            // current duty
57    float intensity;     // current intensity
58    uint8_t pixelvalue; // current pixelvalue
59    Run run;             // current run state
60    Polarity polarity;  // current polaity
61
62    string basepath;      // the basepath ocp
63    string dutypath;      // base + duty path
64    string periodpath;    // base + period path
65    string runpath;       // base + run path
66    string polaritypath; // base + polarity path
67
68    void calcIntensity();
69  };
70  }
```

```
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6    */
7
8   #include "PWM.h"
9
10  namespace Hardware {
11  /// <summary>
12  /// Constructeur
13  /// </summary>
14  /// <param name="pin">Pin</param>
15  PWM::PWM(Pin pin) {
16    this->pin = pin;
17
18    // Check if PWM cape is loaded, if not load it
19    if (!CapeLoaded(PWM_CAPE)) {
20      Write(SLOTS, PWM_CAPE);
21    }
22
23    // Init the pin
24    switch (pin) {
25    case Hardware::PWM::P8_13:
26      system("config-pin P8.13 pwm");
27      basepath = OCP_PATH;
28      basepath.append("pwmchip4/pwm1");
29      break;
30    case Hardware::PWM::P8_19:
31      system("config-pin P8.19 pwm");
32      basepath = OCP_PATH;
33      basepath.append("pwmchip4/pwm0");
34      break;
```

```
35    case Hardware::PWM::P9_14:
36      system("config-pin P9.14 pwm");
37      basepath = OCP_PATH;
38      basepath.append("pwmchip2/pwm0");
39      break;
40    case Hardware::PWM::P9_16:
41      system("config-pin P9.16 pwm");
42      basepath.append("pwmchip2/pwm1");
43      break;
44    }
45
46    // Get the working paths
47    dutypath = basepath + "/duty_cycle";
48    periodpath = basepath + "/period";
49    runpath = basepath + "/run";
50    polaritypath = basepath + "/polarity";
51
52    // Give Linux time to setup directory structure;
53    usleep(250000);
54
55    // Read current values
56    period = StringToNumber<int>(Read(periodpath));
57    duty = StringToNumber<int>(Read(dutypath));
58    run = static_cast<Run>(StringToNumber<int>(Read(runpath)))
        ;
59    polarity = static_cast<Polarity>(StringToNumber<int>(Read(
        polaritypath)));
60
61    // calculate the current intensity
62    calcIntensity();
63  }
64
65  PWM::~PWM() {}
66
67  /// <summary>
68  /// Calculate the current intensity
69  /// </summary>
70  void PWM::calcIntensity() {
71    if (polarity == Normal) {
72      if (duty == 0) {
73        intensity = 0.0f;
74      } else {
75        intensity = (float)period / (float)duty;
76      }
77    } else {
78      if (period == 0) {
79        intensity = 0.0f;
80      } else {
81        intensity = (float)duty / (float)period;
82      }
83    }
84  }
85
86  /// <summary>
87  /// Set the intensity level as percentage
88  /// </summary>
```

```
89  /// <param name="value">floating value multipication factor
        </param>
90  void PWM::SetIntensity(float value) {
91    if (polarity == Normal) {
92      SetDuty(static_cast<int>((value * duty) + 0.5));
93    } else {
94      SetPeriod(static_cast<int>((value * period) + 0.5));
95    }
96  }
97
98  /// <summary>
99  /// Set the output as a corresponding uint8_t value
100 /// </summary>
101 /// <param name="value">pixel value 0-255</param>
102 void PWM::SetPixelValue(uint8_t value) {
103   if (period != 255) {
104     SetPeriod(255);
105   }
106   SetDuty(255 - value);
107   pixelvalue = value;
108 }
109
110 /// <summary>
111 /// Set the period of the signal
112 /// </summary>
113 /// <param name="value">period : int</param>
114 void PWM::SetPeriod(int value) {
115   string valstr = NumberToString<int>(value);
116   Write(periodpath, valstr);
117   period = value;
118
119   calcIntensity();
120 }
121
122 /// <summary>
123 /// Set the duty of the signal
124 /// </summary>
125 /// <param name="value">duty : int</param>
126 void PWM::SetDuty(int value) {
127   string valstr = NumberToString<int>(value);
128   Write(dutypath, valstr);
129   duty = value;
130
131   calcIntensity();
132 }
133
134 /// <summary>
135 /// Run the signal
136 /// </summary>
137 /// <param name="value">On or Off</param>
138 void PWM::SetRun(Run value) {
139   int valInt = static_cast<int>(value);
140   string valstr = NumberToString<int>(valInt);
141   Write(runpath, valstr);
142   run = value;
143 }
```

```
144
145 /// <summary>
146 /// Set the polarity
147 /// </summary>
148 /// <param name="value">Normal or Inverted signal</param>
149 void PWM::SetPolarity(Polarity value) {
150   int valInt = static_cast<int>(value);
151   string valstr = NumberToString<int>(valInt);
152   Write(runpath, valstr);
153   polarity = value;
154 }
155 }
```

ADC Class

```
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6   */
7
8  /*! \class ADC
9  Interaction with the beaglebone analogue pins
10 */
11
12 #pragma once
13
14 #include "BBB.h"
15 #include "ADCReadException.h"
16
17 #define ADC0_PATH
       \
18   "/sys/bus/iio/devices/iio:device0/in_voltage0_raw" /*!<
       path to analogue pin \
19                                                      0*/
20 #define ADC1_PATH
       \
21   "/sys/bus/iio/devices/iio:device0/in_voltage1_raw" /*!<
       path to analogue pin \
22                                                      1*/
23 #define ADC2_PATH
       \
24   "/sys/bus/iio/devices/iio:device0/in_voltage2_raw" /*!<
       path to analogue pin \
25                                                      2*/
26 #define ADC3_PATH
       \
27   "/sys/bus/iio/devices/iio:device0/in_voltage3_raw" /*!<
       path to analogue pin \
28                                                      3*/
29 #define ADC4_PATH
       \
30   "/sys/bus/iio/devices/iio:device0/in_voltage4_raw" /*!<
       path to analogue pin \
31                                                      4*/
32 #define ADC5_PATH
       \
33   "/sys/bus/iio/devices/iio:device0/in_voltage5_raw" /*!<
       path to analogue pin \
34                                                      5*/
```

```
35 #define ADC6_PATH
       \
36   "/sys/bus/iio/devices/iio:device0/in_voltage6_raw" /*!<
       path to analogue pin \
37                                                        6*/
38 #define ADC7_PATH
       \
39   "/sys/bus/iio/devices/iio:device0/in_voltage7_raw" /*!<
       path to analogue pin \
40                                                        7*/
41
42 namespace Hardware {
43 class ADC : public BBB {
44 public:
45   /*! Enumerator to indicate the analogue pin*/
46   enum ADCPin {
47     ADC0, /*!< AIN0 pin*/
48     ADC1, /*!< AIN1 pin*/
49     ADC2, /*!< AIN2 pin*/
50     ADC3, /*!< AIN3 pin*/
51     ADC4, /*!< AIN4 pin*/
52     ADC5, /*!< AIN5 pin*/
53     ADC6, /*!< AIN6 pin*/
54     ADC7  /*!< AIN7 pin*/
55   };
56
57   ADCPin Pin; /*!< current pin*/
58
59   ADC(ADCPin pin);
60   ~ADC();
61
62   int GetCurrentValue();
63   float GetIntensity() { return Intensity; }
64   int GetMinIntensity() { return MinIntensity; }
65   int GetMaxIntensity() { return MaxIntensity; }
66
67   void SetMinIntensity();
68   void SetMaxIntensity();
69
70   int WaitForValueChange();
71   int WaitForValueChange(CallbackType callback);
72   void WaitForValueChangeCancel() { this->threadRunning =
       false; }
73
74 private:
75   string adcpath;   /*!< Path to analogue write file*/
76   float Intensity;  /*!< Current intensity expressed as
       percentage*/
77   int MinIntensity; /*!< Voltage level which represent 0
       percentage*/
78   int MaxIntensity; /*!< Voltage level which represent 100
       percentage*/
79
```

```
80    friend void *threadedPollADC(void *value); /*!< friend
          polling function*/
81  };
82
83  void *threadedPollADC(void *value);
84  }
```

```
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6    */
7
8   #include "ADC.h"
9
10  namespace Hardware {
11  /*! Constructor
12  \param pin and ADCPin type indicating which analogue pin to
        use
13  */
14  ADC::ADC(ADCPin pin) {
15    this->Pin = pin;
16    switch (pin) {
17    case Hardware::ADC::ADC0:
18      adcpath = ADC0_PATH;
19      break;
20    case Hardware::ADC::ADC1:
21      adcpath = ADC1_PATH;
22      break;
23    case Hardware::ADC::ADC2:
24      adcpath = ADC2_PATH;
25      break;
26    case Hardware::ADC::ADC3:
27      adcpath = ADC3_PATH;
28      break;
29    case Hardware::ADC::ADC4:
30      adcpath = ADC4_PATH;
31      break;
32    case Hardware::ADC::ADC5:
33      adcpath = ADC5_PATH;
34      break;
35    case Hardware::ADC::ADC6:
36      adcpath = ADC6_PATH;
37      break;
38    case Hardware::ADC::ADC7:
39      adcpath = ADC7_PATH;
40      break;
41    }
42
43    MinIntensity = 0;
44    MaxIntensity = 4096;
45  }
46
```

```
47 /*! De-constructor*/
48 ADC::~ADC() {}
49
50 /*! Reads the current voltage in the pin
51 \return an integer between 0 and 4096
52 */
53 int ADC::GetCurrentValue() {
54   int retVal = StringToNumber<int>(Read(adcpath));
55   Intensity = (float)(retVal - MinIntensity) /
56               (4096 - (MinIntensity + (4096 - MaxIntensity))
                    );
57   return retVal;
58 }
59
60 /*! Set the current voltage at the pin as the minimum
      voltage*/
61 void ADC::SetMinIntensity() {
62   MinIntensity = StringToNumber<int>(Read(adcpath));
63 }
64
65 void ADC::SetMaxIntensity() {
66   MaxIntensity = StringToNumber<int>(Read(adcpath));
67 }
68
69 /*! Threading enabled polling of the analogue pin
70 \param callback the function which should be called when
      polling indicates a
71 change CallbackType
72 \return 0
73 */
74 int ADC::WaitForValueChange(CallbackType callback) {
75   threadRunning = true;
76   callbackFunction = callback;
77   if (pthread_create(&thread, NULL, &threadedPollADC,
78                      static_cast<void *>(this))) {
79     threadRunning = false;
80     throw Exception::
           FailedToCreateGPIOPollingThreadException();
81   }
82   return 0;
83 }
84
85 /*! Polling of the analogue pin
86 \return the current value
87 */
88 int ADC::WaitForValueChange() {
89   int fd, i, epollfd, count = 0;
90   struct epoll_event ev;
91   epollfd = epoll_create(1);
92   if (epollfd == -1) {
93     throw Exception::
          FailedToCreateGPIOPollingThreadException(
94         "GPIO: Failed to create epollfd!");
95   }
96   if ((fd = open(adcpath.c_str(), O_RDONLY | O_NONBLOCK)) ==
        -1) {
```

```
97      throw Exception::ADCReadException();
98    }
99    ev.events = EPOLLIN;
100   ev.data.fd = fd;
101
102   if (epoll_ctl(epollfd, EPOLL_CTL_ADD, fd, &ev) == -1) {
103     throw Exception::
            FailedToCreateGPIOPollingThreadException(
104           "ADC: Failed to add control interface!");
105   }
106
107   while (count <= 1) {
108     i = epoll_wait(epollfd, &ev, 1, -1);
109     if (i == -1) {
110       close(fd);
111       return -1;
112     } else {
113       count++;
114     }
115   }
116   close(fd);
117   return StringToNumber<int>(Read(adcpath));
118 }
119
120 /*! friendly function to start the threading*/
121 void *threadedPollADC(void *value) {
122   ADC *adc = static_cast<ADC *>(value);
123   while (adc->threadRunning) {
124     adc->callbackFunction(adc->WaitForValueChange());
125     usleep(200000);
126   }
127 }
128 }
```

EC12P Class

```
1  /* Copyright (C) Jelle Spijker - All Rights Reserved
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        strictly prohibited
3   * and only allowed with the written consent of the author (
        Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  /*! \class EC12P
9  Interaction with the sparksfun RGB encoder
10 */
11
12 #pragma once
13
14 #include "eqep.h"
15 #include "GPIO.h"
16 #include "FailedToCreateThreadException.h"
17
18 #include <pthread.h>
19
20 using namespace std;
21
22 namespace Hardware {
23 class EC12P {
24 public:
25   EC12P();
26   ~EC12P();
27
28   /*! Enumerator indicating the color of the encoder shaft*/
29   enum Color {
30     Red,      /*!< Red*/
31     Pink,     /*!< Pink*/
32     Blue,     /*!< Blue*/
33     SkyBlue,  /*!< SkyBlue*/
34     Green,    /*!< Green*/
35     Yellow,   /*!< Yellow*/
36     White,    /*!< White*/
37     None      /*!< Off*/
38   };
39
40   void SetPixelColor(Color value);
41   Color GetPixelColor() { return PixelColor; };
42
43   void RainbowLoop(int sleepperiod);
44   void StopRainbowLoop() { threadRunning = false; };
45
46   eQEP Rotary{eQEP2, eQEP::eQEP_Mode_Absolute}; /*!< The
        encoder*/
47   GPIO Button{68};                              /*!< The
        pushbutton*/
48
49 private:
50   Color PixelColor; /*!< Current shaft color*/
```

```
51
52    GPIO R{31}; /*!< Red LED*/
53    GPIO B{48}; /*!< Blue LED*/
54    GPIO G{51}; /*!< Green LED*/
55
56    pthread_t thread;    /*!< the thread*/
57    bool threadRunning; /*!< Bool used to stop the thread*/
58    int sleepperiod;     /*!< Sleep period*/
59    friend void *colorLoop(void *value);
60  };
61  void *colorLoop(void *value);
62  }
```

```
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         strictly prohibited
3    * and only allowed with the written consent of the author (
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4    * This software is proprietary and confidential
5    * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6    */
7
8   #include "EC12P.h"
9
10  namespace Hardware {
11  /*! Constructor*/
12  EC12P::EC12P() {
13    // Init Rotary button
14    Button.SetDirection(GPIO::Input);
15    Button.SetEdge(GPIO::Rising);
16
17    // Init Encoder
18    Rotary.set_period(100000000L);
19
20    // Init Encoder color
21    R.SetDirection(GPIO::Output);
22    B.SetDirection(GPIO::Output);
23    G.SetDirection(GPIO::Output);
24    SetPixelColor(None);
25
26    threadRunning = false;
27  }
28
29  /*! De-constructor*/
30  EC12P::~EC12P() {}
31
32  /*! Set the shaft color
33  \param value as Color enumerator
34  */
35  void EC12P::SetPixelColor(Color value) {
36    switch (value) {
37    case Hardware::EC12P::Red:
38      R.SetValue(GPIO::High);
39      B.SetValue(GPIO::Low);
40      G.SetValue(GPIO::Low);
41      break;
```

```
42    case Hardware::EC12P::Pink:
43      R.SetValue(GPIO::High);
44      B.SetValue(GPIO::High);
45      G.SetValue(GPIO::Low);
46      break;
47    case Hardware::EC12P::Blue:
48      R.SetValue(GPIO::Low);
49      B.SetValue(GPIO::High);
50      G.SetValue(GPIO::Low);
51      break;
52    case Hardware::EC12P::SkyBlue:
53      R.SetValue(GPIO::Low);
54      B.SetValue(GPIO::High);
55      G.SetValue(GPIO::High);
56      break;
57    case Hardware::EC12P::Green:
58      R.SetValue(GPIO::Low);
59      B.SetValue(GPIO::Low);
60      G.SetValue(GPIO::High);
61      break;
62    case Hardware::EC12P::Yellow:
63      R.SetValue(GPIO::High);
64      B.SetValue(GPIO::Low);
65      G.SetValue(GPIO::High);
66      break;
67    case Hardware::EC12P::White:
68      R.SetValue(GPIO::High);
69      B.SetValue(GPIO::High);
70      G.SetValue(GPIO::High);
71      break;
72    case Hardware::EC12P::None:
73      R.SetValue(GPIO::Low);
74      B.SetValue(GPIO::Low);
75      G.SetValue(GPIO::Low);
76      break;
77    }
78    PixelColor = value;
79  }
80
81  /*! Loops through all the colors except of as a thread  */
82  void EC12P::RainbowLoop(int sleepperiod) {
83    this->sleepperiod = sleepperiod;
84    this->threadRunning = true;
85    if (pthread_create(&thread, NULL, colorLoop, this)) {
86      throw Exception::FailedToCreateThreadException();
87    }
88  }
89
90  /*! The thread function that runs trough all the colors*/
91  void *colorLoop(void *value) {
92    int i = 0;
93    EC12P *ec12p = static_cast<EC12P *>(value);
94    EC12P::Color pcolor;
95    while (ec12p->threadRunning) {
96      pcolor = static_cast<EC12P::Color>(i);
97      ec12p->SetPixelColor(pcolor);
```

```
98      usleep(ec12p->sleepperiod);
99      i++;
100     if (i == 6) {
101       i = 0;
102     }
103   }
104   return ec12p;
105 }
106 }
```

eQep Class

```
1  /*
2  * TI eQEP driver interface API
3  *
4  * Copyright (C) 2013 Nathaniel R. Lewis - http://
       nathanielrlewis.com/
5  *
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       /or modify
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       published by
8  * the Free Software Foundation; either version 2 of the
       License, or
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10 *
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       useful,
12 * but WITHOUT ANY WARRANTY; without even the implied
       warranty of
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       the
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15 *
16 * You should have received a copy of the GNU General Public
       License
17 * along with this program; if not, write to the Free
       Software
18 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
19 *
20 *
21 * This code is changed by Jelle Spijker (C) 2014.
22 * Introducing polling with threading.
23 *
24 */
25
26 #pragma once
27
28 #include <iostream>
29 #include <stdint.h>
30 #include <string>
31 #include "BBB.h"
32
33 #define eQEP0 "/sys/devices/ocp.3/48300000.epwmss/48300180.
       eqep"
34 #define eQEP1 "/sys/devices/ocp.3/48302000.epwmss/48302180.
       eqep"
35 #define eQEP2 "/sys/devices/ocp.3/48304000.epwmss/48304180.
       eqep"
36
37 namespace Hardware {
38 // Class which defines an interface to my eQEP driver
39 class eQEP : public BBB {
40   // Base path for the eQEP unit
41   std::string path;
42
```

```
43 public:
44   // Modes of operation for the eQEP hardware
45   typedef enum {
46     // Absolute positioning mode
47     eQEP_Mode_Absolute = 0,
48
49     // Relative positioning mode
50     eQEP_Mode_Relative = 1,
51
52     // Error flag
53     eQEP_Mode_Error = 2,
54   } eQEP_Mode;
55
56   // Default constructor for the eQEP interface driver
57   eQEP(std::string _path, eQEP_Mode _mode);
58
59   // Reset the value of the encoder
60   void set_position(int32_t position);
61
62   // Get the position of the encoder, pass poll as true to
       poll the pin, whereas
63   // passing false reads the immediate value
64   int32_t get_position(bool _poll = true);
65
66   // Thread of the poll
67   int WaitForPositionChange(CallbackType callback);
68   void WaitForPositionChangeCancel() { this->threadRunning =
       false; }
69
70   // Set the polling period
71   void set_period(long long unsigned int period);
72
73   // Get the polling period of the encoder
74   uint64_t get_period();
75
76   // Set the mode of the eQEP hardware
77   void set_mode(eQEP_Mode mode);
78
79   // Get the mode of the eQEP hardware
80   eQEP_Mode get_mode();
81
82 private:
83   friend void *threadedPolleqep(void *value);
84 };
85
86 void *threadedPolleqep(void *value);
87 }
```

```
1 /*
2 * TI eQEP driver interface API
3 *
4 * Copyright (C) 2013 Nathaniel R. Lewis - http://
    nathanielrlewis.com/
5 *
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    /or modify
```

```
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9  * (at your option) any later version.
10 *
11 * This program is distributed in the hope that it will be
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12 * but WITHOUT ANY WARRANTY; without even the implied
       warranty of
13 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See
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14 * GNU General Public License for more details.
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       License
17 * along with this program; if not, write to the Free
       Software
18 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
19 *
20 * This file is modified by Jelle Spijker 2014
21 * Added polling and threading capabilties
22 *
23 */
24
25 // Pull in our eQEP driver definitions
26 #include "eqep.h"
27
28 // Language dependencies
29 #include <cstdint>
30 #include <cstdlib>
31 #include <cstdio>
32
33 // POSIX dependencies
34 #include <unistd.h>
35 #include <fcntl.h>
36 #include <poll.h>
37 #include <sys/types.h>
38 #include <sys/stat.h>
39
40 namespace Hardware {
41 // Constructor for eQEP driver interface object
42 eQEP::eQEP(std::string _path, eQEP::eQEP_Mode _mode) : path(
       _path) {
43   if (_path == eQEP0) {
44     if (!CapeLoaded("bone_eqep0")) {
45       Write(SLOTS, "bone_eqep0");
46     }
47   } else if (_path == eQEP1) {
48     if (!CapeLoaded("bone_eqep1")) {
49       Write(SLOTS, "bone_eqep1");
50     }
51   } else if (_path == eQEP2) {
52     if (!CapeLoaded("bone_eqep2b")) {
53       Write(SLOTS, "bone_eqep2b");
54     }
```

```
55    }
56
57    // Set the mode of the hardware
58    this->set_mode(_mode);
59
60    // Reset the position
61    this->set_position(0);
62  }
63
64  // Set the position of the eQEP hardware
65  void eQEP::set_position(int32_t position) {
66    // Open the file representing the position
67    FILE *fp = fopen((this->path + "/position").c_str(), "w");
68
69    // Check that we opened the file correctly
70    if (fp == NULL) {
71      // Error, break out
72      std::cerr << "[eQEP " << this->path << "] Unable to open
          position for write"
73                << std::endl;
74      return;
75    }
76
77    // Write the desired value to the file
78    fprintf(fp, "%d\n", position);
79
80    // Commit changes
81    fclose(fp);
82  }
83
84  // Set the period of the eQEP hardware
85  void eQEP::set_period(long long unsigned int period) {
86    // Open the file representing the position
87    FILE *fp = fopen((this->path + "/period").c_str(), "w");
88
89    // Check that we opened the file correctly
90    if (fp == NULL) {
91      // Error, break out
92      std::cerr << "[eQEP " << this->path << "] Unable to open
          period for write"
93                << std::endl;
94      return;
95    }
96
97    // Write the desired value to the file
98    fprintf(fp, "%llu\n", period);
99
100   // Commit changes
101   fclose(fp);
102 }
103
104 // Set the mode of the eQEP hardware
105 void eQEP::set_mode(eQEP::eQEP_Mode _mode) {
106   // Open the file representing the position
107   FILE *fp = fopen((this->path + "/mode").c_str(), "w");
108
```

```
109   // Check that we opened the file correctly
110   if (fp == NULL) {
111     // Error, break out
112     std::cerr << "[eQEP " << this->path << "] Unable to open
          mode for write"
113               << std::endl;
114     return;
115   }
116
117   // Write the desired value to the file
118   fprintf(fp, "%u\n", _mode);
119
120   // Commit changes
121   fclose(fp);
122 }
123
124 int eQEP::WaitForPositionChange(CallbackType callback) {
125   threadRunning = true;
126   callbackFunction = callback;
127   if (pthread_create(&this->thread, NULL, &threadedPolleqep,
128                      static_cast<void *>(this))) {
129     threadRunning = false;
130     throw Exception::
         FailedToCreateGPIOPollingThreadException();
131   }
132
133   return 0;
134 }
135
136 // Get the position of the hardware
137 int32_t eQEP::get_position(bool _poll) {
138   // Position temporary variable
139   int32_t position;
140   char dummy;
141   struct pollfd ufd;
142
143   // Do we want to poll?
144   if (_poll) {
145     // Open a connection to the attribute file.
146     if ((ufd.fd = open((this->path + "/position").c_str(),
         O_RDWR)) < 0) {
147       // Error, break out
148       std::cerr << "[eQEP " << this->path
149                 << "] unable to open position for polling"
                      << std::endl;
150       return 0;
151     }
152
153     // Dummy read
154     read(ufd.fd, &dummy, 1);
155
156     // Poll the port
157     ufd.events = (short)EPOLLET;
158     if (poll(&ufd, 1, -1) < 0) {
159       // Error, break out
```

```
160         std::cerr << "[eQEP " << this->path << "] Error
                occurred whilst polling"
161                   << std::endl;
162         close(ufd.fd);
163         return 0;
164       }
165     }
166
167     // Read the position
168     FILE *fp = fopen((this->path + "/position").c_str(), "r");
169
170     // Check that we opened the file correctly
171     if (fp == NULL) {
172       // Error, break out
173       std::cerr << "[eQEP " << this->path << "] Unable to open
              position for read"
174                 << std::endl;
175       close(ufd.fd);
176       return 0;
177     }
178
179     // Write the desired value to the file
180     fscanf(fp, "%d", &position);
181
182     // Commit changes
183     fclose(fp);
184
185     // If we were polling, close the polling file
186     if (_poll) {
187       close(ufd.fd);
188     }
189
190     // Return the position
191     return position;
192   }
193
194   // Get the period of the eQEP hardware
195   uint64_t eQEP::get_period() {
196     // Open the file representing the position
197     FILE *fp = fopen((this->path + "/period").c_str(), "r");
198
199     // Check that we opened the file correctly
200     if (fp == NULL) {
201       // Error, break out
202       std::cerr << "[eQEP " << this->path << "] Unable to open
              period for read"
203                 << std::endl;
204       return 0;
205     }
206
207     // Write the desired value to the file
208     uint64_t period = 0;
209     fscanf(fp, "%llu", &period);
210
211     // Commit changes
212     fclose(fp);
```

```
213
214   // Return the period
215   return period;
216 }
217
218 // Get the mode of the eQEP hardware
219 eQEP::eQEP_Mode eQEP::get_mode() {
220   // Open the file representing the position
221   FILE *fp = fopen((this->path + "/mode").c_str(), "r");
222
223   // Check that we opened the file correctly
224   if (fp == NULL) {
225     // Error, break out
226     std::cerr << "[eQEP " << this->path << "] Unable to open
          mode for read"
227               << std::endl;
228     return eQEP::eQEP_Mode_Error;
229   }
230
231   // Write the desired value to the file
232   eQEP::eQEP_Mode mode;
233   fscanf(fp, "%u", (unsigned int *)&mode);
234
235   // Commit changes
236   fclose(fp);
237
238   // Return the mode
239   return mode;
240 }
241
242 void *threadedPolleqep(void *value) {
243   eQEP *eqep = static_cast<eQEP *>(value);
244   while (eqep->threadRunning) {
245     eqep->callbackFunction(eqep->get_position(true));
246     usleep(eqep->debounceTime * 1000);
247   }
248   return 0;
249 }
250 }
```

SoilCape Class

```
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 */

#pragma once

#include "EC12P.h"
#include "GPIO.h"
#include "PWM.h"
#include "ADC.h"

namespace Hardware {
class SoilCape {
public:
  EC12P RGBEncoder;
  PWM MicroscopeLEDs{PWM::P9_14};
  ADC MicroscopeLDR{ADC::ADC0};

  SoilCape();
  ~SoilCape();
};
}
```

```
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 */

#include "SoilCape.h"

namespace Hardware {
SoilCape::SoilCape() {}

SoilCape::~SoilCape() {}
}
```

USB Class

```
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 */

#pragma once

#include <stdio.h>
#include <unistd.h>
#include <fcntl.h>
#include <errno.h>
#include <sys/ioctl.h>

#include <linux/usbdevice_fs.h>

namespace Hardware {
class USB {
public:
  USB();
  ~USB();
  void ResetUSB();
};
}
```

```
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 * This software is proprietary and confidential
 * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
 */

#include "USB.h"

namespace Hardware {
USB::USB() {}

USB::~USB() {}

void USB::ResetUSB() {
  int fd, rc;

  fd = open("/dev/bus/usb/001/002", O_WRONLY);
  rc = ioctl(fd, USBDEVFS_RESET, 0);
  if (rc < 0) {
    throw - 1;
  }
  close(fd);
}
```

```
25 }
```

General project files

```
#-------------------------------------------------
#
# Project created by QtCreator 2015-06-06T10:49:23
#
#-------------------------------------------------
QT       += core gui concurrent
greaterThan(QT_MAJOR_VERSION, 4): QT += widgets

TARGET = SoilHardware
TEMPLATE = lib
VERSION = 0.9.2

DEFINES += SOILHARDWARE_LIBRARY
QMAKE_CXXFLAGS += -std=c++11 -pthread
unix:!macx: QMAKE_RPATHDIR += $$PWD/../../../build/install/

SOURCES += \
    USB.cpp \
    SoilCape.cpp \
    PWM.cpp \
    Microscope.cpp \
    GPIO.cpp \
    eqep.cpp \
    EC12P.cpp \
    BBB.cpp \
    ADC.cpp

HEADERS += \
    ValueOutOfBoundsException.h \
    USB.h \
    SoilCape.h \
    PWM.h \
    MicroscopeNotFoundException.h \
    Microscope.h \
    Hardware.h \
    GPIOReadException.h \
    GPIO.h \
    FailedToCreateThreadException.h \
    FailedToCreateGPIOPollingThreadException.h \
    eqep.h \
    EC12P.h \
    CouldNotGrabImageException.h \
    BBB.h \
    ADCReadException.h \
    ADC.h

#opencv
LIBS += -L/usr/local/lib -lopencv_core -lopencv_highgui -
   lopencv_photo -lopencv_imgcodecs -lopencv_videoio
INCLUDEPATH += /usr/local/include/opencv
INCLUDEPATH += /usr/local/include

#boost
DEFINES += BOOST_ALL_DYN_LINK
```

```
54 INCLUDEPATH += /usr/include/boost
55 LIBS += -L/usr/lib/x86_64-linux-gnu/ -lboost_filesystem -
      lboost_system
56
57 unix {
58     target.path = $PWD/../../../build/install
59     INSTALLS += target
60 }
61
62 #Gstreamer
63 INCLUDEPATH += /usr/include/gstreamer-0.10
64 INCLUDEPATH += /usr/include/glib-2.0/
65 INCLUDEPATH += /usr/lib/x86_64-linux-gnu/glib-2.0/include/
66 INCLUDEPATH += /usr/include/libxml2/
67 LIBS += `pkg-config --cflags --libs gstreamer-0.10`
```

```
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       Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #pragma once
9
10 #include "ADC.h"
11 #include "EC12P.h"
12 #include "eqep.h"
13 #include "GPIO.h"
14 #include "PWM.h"
15 #include "SoilCape.h"
16 #include "Microscope.h"
17 #include "CouldNotGrabImageException.h"
18 #include "ADCReadException.h"
19 #include "FailedToCreateGPIOPollingThreadException.h"
20 #include "FailedToCreateThreadException.h"
21 #include "GPIOReadException.h"
22 #include "MicroscopeNotFoundException.h"
23 #include "ValueOutOfBoundsException.h"
```

```
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6   */
7
8  #pragma once
9
10 #include <exception>
11 #include <string>
12
```

```
13 using namespace std;
14
15 namespace Hardware {
16 namespace Exception {
17 class ValueOutOfBoundsException : public std::exception {
18 public:
19   ValueOutOfBoundsException(string m = "Value out of bounds!
       ") : msg(m){};
20   ~ValueOutOfBoundsException() _GLIBCXX_USE_NOEXCEPT{};
21   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); };
22
23 private:
24   string msg;
25 };
26 }
27 }
```

```
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6   */
7
8  #pragma once
9  #include <exception>
10 #include <string>
11
12 using namespace std;
13
14 namespace Hardware {
15 namespace Exception {
16 class ADCReadException : public std::exception {
17 public:
18   ADCReadException(string m = "Can't read ADC data!") : msg(
       m){};
19   ~ADCReadException() _GLIBCXX_USE_NOEXCEPT{};
20   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); };
21
22 private:
23   string msg;
24 };
25 }
26 }
```

```
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```

```
 */

#pragma once

#include <exception>
#include <string>

using namespace std;

namespace Hardware {
namespace Exception {
class FailedToCreateGPIOPollingThreadException : public std
    ::exception {
public:
  FailedToCreateGPIOPollingThreadException(
      string m = "Failed to create GPIO polling thread!")
      : msg(m){};
  ~FailedToCreateGPIOPollingThreadException()
      _GLIBCXX_USE_NOEXCEPT{};
  const char *what() const _GLIBCXX_USE_NOEXCEPT { return
      msg.c_str(); };

private:
  string msg;
};
}
}
```

```
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 */

#pragma once

#include <exception>
#include <string>

using namespace std;

namespace Hardware {
namespace Exception {
class FailedToCreateThreadException : public std::exception
    {
public:
  FailedToCreateThreadException(string m = "Couldn't create
      the thread!")
      : msg(m){};
  ~FailedToCreateThreadException() _GLIBCXX_USE_NOEXCEPT{};
  const char *what() const _GLIBCXX_USE_NOEXCEPT { return
      msg.c_str(); };

```

```
24 private:
25   string msg;
26 };
27 }
28 }
```

```
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6   */
7  #define EXCEPTION_OPENCAM "Exception could not open cam!"
8  #define EXCEPTION_OPENCAM_NR 0
9  #define EXCEPTION_NOCAMS "Exception no cam available!"
10 #define EXCEPTION_NOCAMS_NR 1
11 #define EXCEPTION_QUERY "Exception could not query device!"
12 #define EXCEPTION_QUERY_NR 3
13 #define EXCEPTION_FORMAT_RESOLUTION "Exception No supported
       formats and resolutions!"
14 #define EXCEPTION_FORMAT_RESOLUTION_NR 4
15 #define EXCEPTION_CTRL_NOT_FOUND "Control not found!"
16 #define EXCEPTION_CTRL_NOT_FOUND_NR 5
17 #define EXCEPTION_CTRL_VALUE "Control value not set!"
18 #define EXCEPTION_CTRL_VALUE_NR 5
19 #define EXCEPTION_GSTREAM_INIT_EXCEPTION "Gstream could not
       be initialize exception!"
20 #define EXCEPTION_GSTREAM_INIT_EXCEPTION_NR 6
21 #define EXCEPTION_GSTREAM_ELEM_EXCEPTION "Gstream elements
       could not be linked exception!"
22 #define EXCEPTION_GSTREAM_ELEM_EXCEPTION_NR 7
23 #define EXCEPTION_GSTREAM_PLAYSTATE_EXCEPTION "Gstream
       unable to set playstate exception!"
24 #define EXCEPTION_GSTREAM_PLAYSTATE_EXCEPTION_NR 9
25 #define EXCEPTION_GSTREAM_VARIOUS_EXCEPTION_NR 10
26
27 #pragma once
28 #include <exception>
29 #include <string>
30
31 using namespace std;
32
33 namespace Hardware {
34 namespace Exception {
35 class MicroscopeException : public std::exception {
36 public:
37   MicroscopeException(string m = EXCEPTION_OPENCAM,
38                       int n = EXCEPTION_OPENCAM_NR) : msg{m
                            }, nr{n} {  }
39   ~MicroscopeException() _GLIBCXX_USE_NOEXCEPT {}
40   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); }
41   const int *id() const _GLIBCXX_USE_NOEXCEPT { return &nr;
       }
```

```
42
43 private:
44   string msg;
45   int nr;
46 };
47 }
48 }
```

```
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6   */
7
8  #pragma once
9  #include <exception>
10 #include <string>
11
12 using namespace std;
13
14 namespace Hardware {
15 namespace Exception {
16 class CouldNotGrabImageException : public std::exception {
17 public:
18   CouldNotGrabImageException(string m = "Unable to grab the
       next image!")
19     : msg(m){};
20   ~CouldNotGrabImageException() _GLIBCXX_USE_NOEXCEPT{};
21   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); };
22
23 private:
24   string msg;
25 };
26 }
27 }
```

```
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6   */
7
8  #pragma once
9
10 #include <exception>
11 #include <string>
12
13 using namespace std;
14
```

```
15 namespace Hardware {
16 namespace Exception {
17 class GPIOReadException : public std::exception {
18 public:
19   GPIOReadException(string m = "Can't read GPIO data!") :
       msg(m){};
20   ~GPIOReadException() _GLIBCXX_USE_NOEXCEPT{};
21   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); };
22
23 private:
24   string msg;
25 };
26 }
27 }
```

```
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6   */
7
8  #pragma once
9
10 #include <exception>
11 #include <string>
12
13 using namespace std;
14
15 namespace Hardware {
16 namespace Exception {
17 class GPIOReadException : public std::exception {
18 public:
19   GPIOReadException(string m = "Can't read GPIO data!") :
       msg(m){};
20   ~GPIOReadException() _GLIBCXX_USE_NOEXCEPT{};
21   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); };
22
23 private:
24   string msg;
25 };
26 }
27 }
```

J. Vision Library

Image processing Class

```
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6   */
7
8  #pragma once
9  /*! Current class version*/
10 #define IMAGEPROCESSING_VERSION 1
11
12 /*! MACRO which sets the original pointer to the original
       image or a clone of
13  * the earlier processed image */
14 #define CHAIN_PROCESS(chain, O, type)
                                                          \
15    if (chain) {
                                                            \
16      TempImg = ProcessedImg.clone();
                                                                \
17      O = (type *)TempImg.data;
                                                                    \
18    } else {
                                                            \
19      O = (type *)OriginalImg.data;
                                                                \
20    }
```

```
21 /*! MACRO which trows an EmtpyImageException if the matrix
       is empty*/
22 #define EMPTY_CHECK(img)
                                                                \
23   if (img.empty()) {
                                                                \
24     throw Exception::EmtpyImageException();
                                                                \
25   }
26
27 #include <opencv2/core.hpp>
28 #include <opencv2/highgui.hpp>
29 #include <opencv2/imgproc.hpp>
30
31 #include <stdint.h>
32 #include <cmath>
33 #include <vector>
34 #include <string>
35
36 #include <boost/signals2.hpp>
37 #include <boost/bind.hpp>
38
39 #include "EmptyImageException.h"
40 #include "WrongKernelSizeException.h"
41 #include "ChannelMismatchException.h"
42 #include "PixelValueOutOfBoundException.h"
43 #include "VisionDebug.h"
44
45 using namespace cv;
46
47 namespace Vision {
48 class ImageProcessing {
49 public:
50   typedef boost::signals2::signal<void(float, std::string)>
       Progress_t;
51   boost::signals2::connection
52   connect_Progress(const Progress_t::slot_type &subscriber);
53
54 protected:
55   uchar *GetNRow(int nData, int hKsize, int nCols, uint32_t
       totalRows);
56   Mat TempImg;
57
58   Progress_t prog_sig;
59
60 public:
61   ImageProcessing();
62   ~ImageProcessing();
63   Mat OriginalImg;
64   Mat ProcessedImg;
65
66   static void getOrientented(Mat &BW, cv::Point_<double> &
       centroid,
67                              double &theta, double &
                                   eccentricty);
```

```
68    static void RotateImg(Mat &src, Mat &dst, double &theta,
          cv::Point_<double> &Centroid, Rect &ROI);
69
70    double currentProg = 0.;
71    double ProgStep = 0.;
72
73    static std::vector<Mat> extractChannel(const Mat &src);
74
75    /*! Copy a matrix to a new matrix with a LUT mask
76    \param src the source image
77    \param *LUT type T with a LUT to filter out unwanted pixel
          values
78    \param cvType an in where you can pas CV_UC8C1 etc.
79    \return The new matrix
80    */
81    template <typename T1, typename T2>
82    static Mat CopyMat(const Mat &src, T1 *LUT, int cvType) {
83      Mat dst(src.size(), cvType);
84      uint32_t nData = src.rows * src.cols * dst.step[1];
85      if (cvType == 0 || cvType == 8 || cvType == 16 || cvType
            == 24) {
86        for (uint32_t i = 0; i < nData; i += dst.step[1]) {
87          dst.data[i] =
88              static_cast<uint8_t>(LUT[*(T2 *)(src.data + (i *
                  src.step[1]))]);
89        }
90      } else if (cvType == 1 || cvType == 9 || cvType == 17 ||
            cvType == 25) {
91        for (uint32_t i = 0; i < nData; i += src.step[1]) {
92          dst.data[i] =
93              static_cast<int8_t>(LUT[*(T2 *)(src.data + (i *
                  src.step[1]))]);
94        }
95      } else if (cvType == 2 || cvType == 10 || cvType == 18
           || cvType == 26) {
96        for (uint32_t i = 0; i < nData; i += src.step[1]) {
97          dst.data[i] =
98              static_cast<uint16_t>(LUT[*(T2 *)(src.data + (i
                  * src.step[1]))]);
99        }
100     } else if (cvType == 3 || cvType == 11 || cvType == 19
           || cvType == 27) {
101       for (uint32_t i = 0; i < nData; i += src.step[1]) {
102         dst.data[i] =
103             static_cast<int16_t>(LUT[*(T2 *)(src.data + (i *
                  src.step[1]))]);
104       }
105     } else if (cvType == 4 || cvType == 12 || cvType == 20
           || cvType == 28) {
106       for (uint32_t i = 0; i < nData; i += src.step[1]) {
107         dst.data[i] =
108             static_cast<int32_t>(LUT[*(T2 *)(src.data + (i *
                  src.step[1]))]);
109       }
110     }
111     return dst;
```

```
112   }
113
114   /*! Copy a matrix to a new matrix with a mask
115   \param src the source image
116   \param *LUT type T with a LUT to filter out unwanted pixel
          values
117   \param cvType an in where you can pas CV_UC8C1 etc.
118   \return The new matrix
119   */
120   template <typename T1>
121   static Mat CopyMat(const Mat &src, const Mat &mask, int
          cvType) {
122     if (src.size != mask.size) {
123       throw Exception::WrongKernelSizeException(
124           "Mask not the same size as src Exception!");
125     }
126     if (mask.channels() != 1) {
127       throw Exception::WrongKernelSizeException(
128           "Mask has more then 1 channel Exception!");
129     }
130     Mat dst(src.size(), cvType);
131
132     vector<Mat> exSrc = Vision::ImageProcessing::
            extractChannel(src);
133     vector<Mat> exDst;
134
135     int cvBaseType = cvType % 8;
136     for_each(exSrc.begin(), exSrc.end(), [&](const Mat &
            sItem) {
137       Mat dItem(src.size(), cvBaseType);
138       std::transform(sItem.begin<T1>(), sItem.end<T1>(),
              mask.begin<T1>(),
139                      dItem.begin<T1>(),
140                      [](const T1 &s, const T1 &m) -> T1 {
                           return s * m; });
141       exDst.push_back(dItem);
142     });
143
144     merge(exDst, dst);
145
146     return dst;
147   }
148
149   static cv::Mat WhiteBackground(const cv::Mat &src) {
150     cv::Mat dst;
151     cv::floodFill(src, dst, cv::Point(0, 0), cv::Scalar(255,
            255, 255));
152     return dst;
153   }
154
155   template <typename T1>
156   static void ShowDebugImg(cv::Mat img, T1 maxVal, std::
          string windowName,
157                            bool scale = true) {
158     if (img.rows > 0 && img.cols > 0) {
159       cv::Mat tempImg(img.size(), img.type());
```

```
160       if (scale == true) {
161         std::vector<cv::Mat> exSrc = extractChannel(img);
162         std::vector<cv::Mat> exDst;
163         int cvBaseType = img.type() % 8;
164         T1 MatMin = std::numeric_limits<T1>::max();
165         T1 MatMax = std::numeric_limits<T1>::min();
166
167         // Find the global max and min
168         for_each(exSrc.begin(), exSrc.end(), [&](const Mat &
               sItem) {
169           std::for_each(sItem.begin<T1>(), sItem.end<T1>(),
                 [&](const T1 &s) {
170             if (s > MatMax) {
171               MatMax = s;
172             } else if (s < MatMin) {
173               MatMin = s;
174             }
175           });
176         });
177
178         int Range = MatMax - MatMin;
179         if (Range < 1)
180           Range = maxVal;
181
182         // Convert the values
183         for_each(exSrc.begin(), exSrc.end(), [&](const cv::
               Mat &sItem) {
184           Mat dItem(img.size(), cvBaseType);
185           std::transform(sItem.begin<T1>(), sItem.end<T1>(),
                 dItem.begin<T1>(),
186                          [&](const T1 &s) -> T1 {
187                            return (T1)round(((s - MatMin) *
                                 maxVal) / Range);
188                          });
189           exDst.push_back(dItem);
190         });
191
192         merge(exDst, tempImg);
193       } else {
194         tempImg = img;
195       }
196       cv::namedWindow(windowName, cv::WINDOW_NORMAL);
197       cv::imshow(windowName, tempImg);
198       cv::waitKey(0);
199       cv::destroyWindow(windowName);
200     };
201   };
202 };
203 }
```

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```

```
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8   /*! \class ImageProcessing
9   \brief Core class of all the image classes
10  Core class of all the image classes with a few commonly
        shared functions and
11  variables
12  */
13  #include "ImageProcessing.h"
14
15  namespace Vision {
16  /*! Constructor of the core class*/
17  ImageProcessing::ImageProcessing() {}
18
19  /*! De-constructor of the core class*/
20  ImageProcessing::~ImageProcessing() {}
21
22  /*! Create a LUT indicating which iteration variable i is
        the end of an row
23  \param nData an int indicating total pixels
24  \param hKsize int half the size of the kernel, if any. which
        acts as an offset
25  from the border pixels
26  \param nCols int number of columns in a row
27  \return array of uchars where a zero is a middle column and
        a 1 indicates an end
28  of an row minus the offset from half the kernel size
29  */
30  uchar *ImageProcessing::GetNRow(int nData, int hKsize, int
        nCols,
31                                  uint32_t totalRows) {
32    // Create LUT to determine when there is an new row
33    uchar *nRow = new uchar[nData + 1]{};
34    // int i = 0;
35    int shift = nCols - hKsize - 1;
36    for (uint32_t i = 0; i < totalRows; i++) {
37      nRow[(i * nCols) + shift] = 1;
38    }
39    return nRow;
40  }
41
42  std::vector<Mat> ImageProcessing::extractChannel(const Mat &
        src) {
43    vector<Mat> chans;
44    split(src, chans);
45    return chans;
46  }
47
48  void ImageProcessing::getOrientented(cv::Mat &BW, cv::Point_
        <double> &centroid,
49                                       double &theta, double &
                                             eccentricty) {
50    cv::Moments Mu = cv::moments(BW, true);
51
52    centroid.x = Mu.m10 / Mu.m00;
```

```
53    centroid.y = Mu.m01 / Mu.m00;
54
55    theta = 0;
56    double muPrime20 = (Mu.m20 / Mu.m00) - pow(centroid.x, 2);
57    double muPrime02 = (Mu.m02 / Mu.m00) - pow(centroid.y, 2);
58    double diffmuprime2 = muPrime20 - muPrime02;
59    double muPrime11 = (Mu.m11 / Mu.m00) - (centroid.x *
          centroid.y);
60
61    if (diffmuprime2 != 0) {
62      theta = 0.5 * atan((2 * muPrime11) / diffmuprime2);
63    }
64
65    double term1 = (muPrime20 + muPrime02) /2;
66    double term2 = sqrt(4 * pow(muPrime11, 2) + pow(
          diffmuprime2, 2)) / 2;
67    eccentricty = sqrt(1-(term1 - term2)/ (term1 + term2));
68  }
69
70  void ImageProcessing::RotateImg(Mat &src, Mat &dst, double &
        theta,
71                                  cv::Point_<double> &Centroid
                                        , cv::Rect &ROI) {
72    cv::Mat temp;
73    temp.setTo(0);
74    double alpha = cos(theta);
75    double beta = sin(theta);
76    double cx = src.cols / 2;
77    double cy = src.rows / 2;
78    double dx = cx - Centroid.x;
79    double dy = cy - Centroid.y;
80    double rotData[2][3]{{alpha, beta, alpha * dx + beta * dy
          + Centroid.x},
81                         {-beta, alpha, alpha * dy + beta * dx
                                + Centroid.y}};
82    cv::Mat totalrot(2, 3, CV_64FC1, rotData);
83
84    cv::warpAffine(src, temp, totalrot, cv::Size(src.rows *
          2.5, src.cols * 2.5),
85                   INTER_LINEAR);
86    // determine the actual ROI
87    cv::Point minP(0, 0);
88    if (src.channels() == 1) {
89      uchar *O = temp.data;
90      uint32_t nData = temp.rows * temp.cols;
91      minP.x = temp.rows;
92      minP.y = temp.cols;
93      cv::Point maxP(0, 0);
94      int X, Y;
95      for (uint32_t i = 0; i < nData; i++) {
96        if (O[i] != 0) {
97          Y = floor(i / temp.cols);
98          X = (i % temp.cols);
99          if (X < minP.x) {
100           minP.x = X;
101         }
```

```
102           if (Y < minP.y) {
103             minP.y = Y;
104           }
105           if (X > maxP.x) {
106             maxP.x = X;
107           }
108           if (Y > maxP.y) {
109             maxP.y = Y;
110           }
111         }
112       }
113       ROI = cv::Rect(minP, maxP);
114     }
115
116     if (src.channels() > 1) {
117       Centroid.x -= cx;
118       Centroid.y -= cy;
119
120       double xnew = Centroid.x * alpha - Centroid.y * beta;
121       double ynew = Centroid.x * beta - Centroid.y * alpha;
122
123       Centroid.x = xnew + cx + minP.x;
124       Centroid.y = ynew + cy + minP.y;
125     }
126     dst = temp(ROI).clone();
127   }
128
129   boost::signals2::connection
130   ImageProcessing::connect_Progress(const Progress_t::
        slot_type &subscriber) {
131     return prog_sig.connect(subscriber);
132   }
133   }
```

Conversion Class

```
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6   */
7
8  #pragma once
9  #include "ImageProcessing.h"
10 #include "ConversionNotSupportedException.h"
11
12 namespace Vision {
13 class Conversion : public ImageProcessing {
14 public:
15   /*! Enumerator which indicates the colorspace used*/
16   enum ColorSpace {
17     CIE_lab,    /*!< CIE La*b* colorspace */
18     CIE_XYZ,    /*!< CIE XYZ colorspace */
19     RI,         /*!< Redness Index colorspace */
20     RGB,        /*!< RGB colorspace */
21     Intensity, /*!< Grayscale colorspace */
22     None        /*!< none */
23   };
24   ColorSpace OriginalColorSpace;  /*!< The original
       colorspace*/
25   ColorSpace ProcessedColorSpace; /*!< The destination
       colorspace*/
26
27   Conversion();
28   Conversion(const Mat &src);
29   Conversion(const Conversion &rhs);
30
31   ~Conversion();
32
33   Conversion &operator=(Conversion rhs);
34
35   void Convert(ColorSpace convertFrom, ColorSpace convertTo,
36                bool chain = false);
37   void Convert(const Mat &src, Mat &dst, ColorSpace
       convertFrom,
38                ColorSpace convertTo, bool chain = false);
39
40 private:
41   /*!< Conversion matrix used in the conversion between RGB
       and CIE XYZ*/
42   float XYZmat[3][3] = {{0.412453, 0.357580, 0.180423},
43                         {0.212671, 0.715160, 0.072169},
44                         {0.019334, 0.119194, 0.950227}};
45
46   float whitePoint[3] = {
47       0.9504, 1.0000, 1.0889}; /*!< Natural whitepoint in
          XYZ colorspace D65
```

```
48                                    according to Matlab */
49    // float whitePoint[3] = { 0.9642, 1.0000, 0.8251 }; /*!<
          Natural whitepoint
50    // in XYZ colorspace D50 according to Matlab */
51
52    void Lab2RI(float *O, float *P, int nData);
53    void RGB2XYZ(uchar *O, float *P, int nData);
54    void XYZ2Lab(float *O, float *P, int nData);
55    void RGB2Intensity(uchar *O, uchar *P, int nData);
56    inline float f_xyz2lab(float t);
57 };
58 }
```

```
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3   * and only allowed with the written consent of the author (
        Jelle Spijker)
4   * This software is proprietary and confidential
5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  /*! \class Conversion
9  class which converts a cv::Mat image from one colorspace to
       the next colorspace
10 */
11 #include "Conversion.h"
12 namespace Vision {
13 /*! Constructor of the class    */
14 Conversion::Conversion() {
15   OriginalColorSpace = None;
16   ProcessedColorSpace = None;
17 }
18
19 /*! Constructor of the class
20 \param src a cv::Mat object which is the source image
21 */
22 Conversion::Conversion(const Mat &src) {
23   OriginalColorSpace = None;
24   ProcessedColorSpace = None;
25   OriginalImg = src;
26 }
27
28 /*! Copy constructor*/
29 Conversion::Conversion(const Conversion &rhs) {
30   this->OriginalColorSpace = rhs.OriginalColorSpace;
31   this->OriginalImg = rhs.OriginalImg;
32   this->ProcessedColorSpace = rhs.ProcessedColorSpace;
33   this->ProcessedImg = rhs.ProcessedImg;
34   this->TempImg = rhs.TempImg;
35 }
36
37 /*! De-constructor of the class*/
38 Conversion::~Conversion() {}
39
40 /*! Assignment operator*/
```

```
41 Conversion &Conversion::operator=(Conversion rhs) {
42   if (&rhs != this) {
43     this->OriginalColorSpace = rhs.OriginalColorSpace;
44     this->OriginalImg = rhs.OriginalImg;
45     this->ProcessedColorSpace = rhs.ProcessedColorSpace;
46     this->ProcessedImg = rhs.ProcessedImg;
47     this->TempImg = rhs.TempImg;
48   }
49   return *this;
50 }
51
52 /*! Convert the source image from one colorspace to a
       destination colorspace
53 - RGB 2 Intensity
54 - RGB 2 XYZ
55 - RGB 2 Lab
56 - RGB 2 Redness Index
57 - XYZ 2 Lab
58 - XYZ 2 Redness Index
59 - Lab 2 Redness Index
60 \param src a cv::Mat object which is the source image
61 \param dst a cv::Mat object which is the destination image
62 \param convertFrom the starting colorspace
63 \param convertTo the destination colorspace
64 \param chain use the results from the previous operation
       default value = false;
65 */
66 void Conversion::Convert(const Mat &src, Mat &dst,
       ColorSpace convertFrom,
67                          ColorSpace convertTo, bool chain) {
68   OriginalImg = src;
69   Convert(convertFrom, convertTo, chain);
70   dst = ProcessedImg;
71 }
72
73 /*! Convert the source image from one colorspace to a
       destination colorspace
74 posibilities are:
75 - RGB 2 Intensity
76 - RGB 2 XYZ
77 - RGB 2 Lab
78 - RGB 2 Redness Index
79 - XYZ 2 Lab
80 - XYZ 2 Redness Index
81 - Lab 2 Redness Index
82 \param convertFrom the starting colorspace
83 \param convertTo the destination colorspace
84 \param chain use the results from the previous operation
       default value = false;
85 */
86 void Conversion::Convert(ColorSpace convertFrom, ColorSpace
       convertTo,
87                          bool chain) {
88   OriginalColorSpace = convertFrom;
89   ProcessedColorSpace = convertTo;
90
```

```
91    // Exception handling
92    EMPTY_CHECK(OriginalImg);
93    currentProg = 0.;
94    prog_sig(currentProg, "Converting colorspace");
95
96    int nData = OriginalImg.rows * OriginalImg.cols;
97    // uint32_t i, j;
98
99    if (convertFrom == RGB && convertTo == Intensity) // RGB 2
          Intensity
100   {
101     ProcessedImg.create(OriginalImg.size(), CV_8UC1);
102     uchar *P = ProcessedImg.data;
103     uchar *O;
104     CHAIN_PROCESS(chain, O, uchar);
105
106     prog_sig(currentProg, "RGB 2 Intensity conversion");
107     RGB2Intensity(O, P, nData);
108     currentProg += ProgStep;
109     prog_sig(currentProg, "RGB 2 Intensity conversion
          Finished");
110   } else if (convertFrom == RGB && convertTo == CIE_XYZ) //
       RGB 2 XYZ
111   {
112     ProcessedImg.create(OriginalImg.size(), CV_32FC3);
113     float *P = (float *)ProcessedImg.data;
114     uchar *O;
115     CHAIN_PROCESS(chain, O, uchar);
116
117     prog_sig(currentProg, "RGB 2 CIE XYZ conversion");
118     RGB2XYZ(O, P, nData);
119     currentProg += ProgStep;
120     prog_sig(currentProg, "RGB 2 CIE XYZ conversion Finished
          ");
121   } else if (convertFrom == RGB && convertTo == CIE_lab) //
       RGB 2 Lab
122   {
123     ProcessedImg.create(OriginalImg.size(), CV_32FC3);
124     float *P = (float *)ProcessedImg.data;
125     uchar *O;
126     CHAIN_PROCESS(chain, O, uchar);
127
128     prog_sig(currentProg, "RGB 2 CIE XYZ conversion");
129     RGB2XYZ(O, P, nData);
130     currentProg += ProgStep;
131     prog_sig(currentProg, "RGB 2 CIE XYZ conversion Finished
          ");
132     Convert(CIE_XYZ, CIE_lab, true);
133   } else if (convertFrom == RGB && convertTo == RI) // RGB 2
        RI
134   {
135     ProcessedImg.create(OriginalImg.size(), CV_32FC3);
136     float *P = (float *)ProcessedImg.data;
137     uchar *O;
138     CHAIN_PROCESS(chain, O, uchar);
139
```

```
140       prog_sig(currentProg, "RGB 2 CIE XYZ conversion");
141       RGB2XYZ(O, P, nData);
142       currentProg += ProgStep;
143       prog_sig(currentProg, "RGB 2 CIE XYZ conversion Finished
              ");
144       Convert(CIE_XYZ, CIE_lab, true);
145       Convert(CIE_lab, RI, true);
146     } else if (convertFrom == CIE_XYZ && convertTo == CIE_lab)
            // XYZ 2 Lab
147     {
148       ProcessedImg.create(OriginalImg.size(), CV_32FC3);
149       float *P = (float *)ProcessedImg.data;
150       float *O;
151       CHAIN_PROCESS(chain, O, float);
152
153       prog_sig(currentProg, "CIE XYZ 2 CIE La*b* conversion");
154       XYZ2Lab(O, P, nData);
155       currentProg += ProgStep;
156       prog_sig(currentProg, "CIE XYZ 2 CIE La*b* conversion
              Finished");
157     } else if (convertFrom == CIE_XYZ && convertTo == RI) //
            XYZ 2 RI
158     {
159       ProcessedImg.create(OriginalImg.size(), CV_32FC3);
160       float *P = (float *)ProcessedImg.data;
161       float *O;
162       CHAIN_PROCESS(chain, O, float);
163
164       prog_sig(currentProg, "CIE XYZ 2 CIE La*b* conversion");
165       XYZ2Lab(O, P, nData);
166       currentProg += ProgStep;
167       prog_sig(currentProg, "CIE XYZ 2 CIE La*b* conversion
              Finished");
168       Convert(CIE_lab, RI, true);
169     } else if (convertFrom == CIE_lab && convertTo == RI) //
            Lab 2 RI
170     {
171       ProcessedImg.create(OriginalImg.size(), CV_32FC1);
172       float *P = (float *)ProcessedImg.data;
173       float *O;
174       CHAIN_PROCESS(chain, O, float);
175
176       prog_sig(currentProg, "CIE La*b* 2 Redness Index
              conversion");
177       Lab2RI(O, P, nData * 3);
178       currentProg += ProgStep;
179       prog_sig(currentProg, "CIE La*b* 2 Redness Index
              conversion Finsihed");
180     } else {
181       throw Exception::ConversionNotSupportedException();
182     }
183   }
184
185   /*! Conversion from RGB to Intensity
186   \param O a uchar pointer to the source image
187   \param P a uchar pointer to the destination image
```

```
188 \param nData an int indicating the total number of pixels
189 */
190 void Conversion::RGB2Intensity(uchar *O, uchar *P, int nData
    ) {
191   uint32_t i;
192   int j;
193   i = 0;
194   j = 0;
195   while (j < nData) {
196     P[j++] = (*(O + i + 2) * 0.2126 + *(O + i + 1) * 0.7152
        +
197               *(O + i) * 0.0722); // Grey value
198     i += 3;
199   }
200 }
201
202 /*! Conversion from RGB to CIE XYZ
203 \param O a uchar pointer to the source image
204 \param P a uchar pointer to the destination image
205 \param nData an int indicating the total number of pixels
206 */
207 void Conversion::RGB2XYZ(uchar *O, float *P, int nData) {
208   uint32_t endData = nData * OriginalImg.step.buf[1];
209   float R, G, B;
210   for (uint32_t i = 0; i < endData; i += OriginalImg.step.
       buf[1]) {
211     R = static_cast<float>(*(O + i + 2) / 255.0f);
212     B = static_cast<float>(*(O + i + 1) / 255.0f);
213     G = static_cast<float>(*(O + i) / 255.0f);
214     P[i] = (XYZmat[0][0] * R) + (XYZmat[0][1] * B) + (XYZmat
        [0][2] * G); // X
215     P[i + 1] = (XYZmat[1][0] * R) + (XYZmat[1][1] * B) + (
        XYZmat[1][2] * G); // Y
216     P[i + 2] = (XYZmat[2][0] * R) + (XYZmat[2][1] * B) + (
        XYZmat[2][2] * G); // Z
217   }
218 }
219
220 /*! Conversion from CIE XYZ to CIE La*b*
221 \param O a uchar pointer to the source image
222 \param P a uchar pointer to the destination image
223 \param nData an int indicating the total number of pixels
224 */
225 void Conversion::XYZ2Lab(float *O, float *P, int nData) {
226   uint32_t endData = nData * 3;
227   float yy0, xx0, zz0;
228   for (size_t i = 0; i < endData; i += 3) {
229     xx0 = *(O + i) / whitePoint[0];
230     yy0 = *(O + i + 1) / whitePoint[1];
231     zz0 = *(O + i + 2) / whitePoint[2];
232
233     if (yy0 > 0.008856) {
234       P[i] = (116 * pow(yy0, 0.333f)) - 16; // L
235     } else {
236       P[i] = 903.3 * yy0; // L
237     }
```

```
238
239       P[i + 1] = 500 * (f_xyz2lab(xx0) - f_xyz2lab(yy0));
240       P[i + 2] = 200 * (f_xyz2lab(yy0) - f_xyz2lab(zz0));
241     }
242   }
243
244   inline float Conversion::f_xyz2lab(float t) {
245     if (t > 0.008856) {
246       return pow(t, 0.3333333333f);
247     }
248     return 7.787 * t + 0.137931034482759f;
249   }
250
251   /*! Conversion from CIE La*b* to Redness Index
252   \param O a uchar pointer to the source image
253   \param P a uchar pointer to the destination image
254   \param nData an int indicating the total number of pixels
255   */
256   void Conversion::Lab2RI(float *O, float *P, int nData) {
257     uint32_t j = 0;
258     float L, a, b;
259     for (int i = 0; i < nData; i += 3) {
260       L = *(O + i);
261       a = *(O + i + 1);
262       b = *(O + i + 2);
263       P[j++] =
264           (L * (pow((pow(a, 2.0f) + pow(b, 2.0f)), 0.5f) * (
                pow(10, 8.2f)))) /
265           (b * pow(L, 6.0f));
266     }
267   }
268   }
```

Enhance Class

```
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5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #pragma once
9  #define ENHANCE_VERSION 1
10
11 #include "ImageProcessing.h"
12 #include "../SoilMath/SoilMath.h"
13
14 using namespace std;
15 using namespace SoilMath;
16
17 namespace Vision {
18 class Enhance : public ImageProcessing {
19 private:
20   void CalculateSumOfNeighboringPixels(uchar *O, int i, int hKsize, int nCols,
21                                        uint32_t &sum);
22   float CalculateStdOfNeighboringPixels(uchar *O, int i, int hKsize, int nCols,
23                                         int noNeighboursPix, float mean);
24
25 public:
26   /*! Enumerator indicating the requested enhancement operation*/
27   enum EnhanceOperation {
28     _AdaptiveContrastStretch, /*!< custom adaptive contrast stretch operation*/
29     _Blur,                    /*!< Blur operation*/
30     _HistogramEqualization    /*!< Histogram equalization*/
31   };
32
33   Enhance();
34   Enhance(const Mat &src);
35   Enhance(const Mat &src, Mat &dst, uint8_t kernelsize = 9, float factor = 1.0,
36           EnhanceOperation operation = _Blur);
37   Enhance(const Enhance &rhs);
38
39   ~Enhance();
40
41   Enhance &operator=(Enhance rhs);
42
43   void AdaptiveContrastStretch(uint8_t kernelsize, float factor,
44                                bool chain = false);
```

```
45    void AdaptiveContrastStretch(const Mat &src, Mat &dst,
          uint8_t kernelsize,
46                                 float factor);
47
48    void Blur(uint8_t kernelsize, bool chain = false);
49    void Blur(const Mat &src, Mat &dst, uint8_t kernelsize);
50
51    void HistogramEqualization(bool chain = false);
52    void HistogramEqualization(const Mat &src, Mat &dst);
53  };
54  }
```

```
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5    * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6    */
7
8   /*! \class Enhance
9   class which enhances a greyscale cv::Mat image
10  */
11  #include "Enhance.h"
12
13  namespace Vision {
14  /*! Constructor*/
15  Enhance::Enhance() {}
16
17  /*! Constructor
18  \param src cv::Mat source image
19  */
20  Enhance::Enhance(const Mat &src) {
21    OriginalImg = src;
22    ProcessedImg.create(OriginalImg.size(), CV_8UC1);
23  }
24
25  Enhance::Enhance(const Enhance &rhs) {
26    this->OriginalImg = rhs.OriginalImg;
27    this->ProcessedImg = rhs.OriginalImg;
28    this->TempImg = rhs.TempImg;
29  }
30
31  /*! Constructor
32  \param src cv::Mat source image
33  \param dst cv::Mat destination image
34  \param kernelsize an uchar which represent the kernelsize
        should be an uneven
35  number higher than two
36  \param factor float which indicates the amount the effect
        should take place
37  standard value is 1.0 only used in the adaptive contrast
        stretch enhancement
38  \param operation enumerator EnhanceOperation which
        enhancement should be
```

```
39 performed
40 */
41 Enhance::Enhance(const Mat &src, Mat &dst, uchar kernelsize,
       float factor,
42                  EnhanceOperation operation) {
43   OriginalImg = src;
44   ProcessedImg.create(OriginalImg.size(), CV_8UC1);
45   switch (operation) {
46   case Vision::Enhance::_AdaptiveContrastStretch:
47     AdaptiveContrastStretch(kernelsize, factor);
48     break;
49   case Vision::Enhance::_Blur:
50     Blur(kernelsize);
51     break;
52   case Vision::Enhance::_HistogramEqualization:
53     HistogramEqualization();
54     break;
55   }
56   dst = ProcessedImg;
57 }
58
59 /*! Dec-constructor*/
60 Enhance::~Enhance() {}
61
62 Enhance &Enhance::operator=(Enhance rhs) {
63   if (&rhs != this) {
64     this->OriginalImg = rhs.OriginalImg;
65     this->ProcessedImg = rhs.ProcessedImg;
66     this->TempImg = rhs.ProcessedImg;
67   }
68   return *this;
69 }
70
71 /*! Calculate the standard deviation of the neighboring
      pixels
72 \param O uchar pointer to the current pixel of the original
      image
73 \param i current counter
74 \param hKsize half the kernelsize
75 \param nCols total number of columns
76 \param noNeighboursPix total number of neighboring pixels
77 \param mean mean value of the neighboring pixels
78 \return standard deviation
79 */
80 float Enhance::CalculateStdOfNeighboringPixels(uchar *O, int
       i, int hKsize,
81                                                int nCols,
                                                     int
                                                     noNeighboursPix
                                                     ,
82                                                float mean) {
83   uint32_t sum_dev = 0.0;
84   float Std = 0.0;
85   sum_dev = 0.0;
86   Std = 0.0;
87   for (int j = -hKsize; j < hKsize; j++) {
```

```
88      for (int k = -hKsize; k < hKsize; k++) {
89        // sum_dev += pow((O[i + j * nCols + k] - mean), 2);
90        sum_dev += SoilMath::quick_pow2((O[i + j * nCols + k]
              - mean));
91      }
92    }
93    // Std = sqrt(sum_dev / noNeighboursPix);
94    Std = SoilMath::fastPow((static_cast<double>(sum_dev) /
          noNeighboursPix), 2);
95    return Std;
96  }
97
98  /*! Calculate the sum of the neighboring pixels
99  \param O uchar pointer to the current pixel of the original
        image
100 \param i current counter
101 \param hKsize half the kernelsize
102 \param nCols total number of columns
103 \param sum Total sum of the neighboringpixels
104 */
105 void Enhance::CalculateSumOfNeighboringPixels(uchar *O, int
        i, int hKsize,
106                                               int nCols,
                                                      uint32_t &
                                                      sum) {
107   for (int j = -hKsize; j < hKsize; j++) {
108     for (int k = -hKsize; k < hKsize; k++) {
109       sum += O[i + j * nCols + k];
110     }
111   }
112 }
113
114 /*! Homebrew AdaptiveContrastStretch function which
        calculate the mean and
115 standard deviation from the neighboring pixels if the
        current pixel is higher
116 then the mean the value is incremented with an given factor
        multiplied with the
117 standard deviation, and decreased if it's lower then the
        mean.
118 \param src cv::Mat source image
119 \param dst cv::Mat destination image
120 \param kernelsize an uchar which represent the kernelsize
        should be an uneven
121 number higher than two
122 \param factor float which indicates the amount the effect
        should take place
123 standard value is 1.0 only used in the adaptive contrast
        stretch enhancement
124 */
125 void Enhance::AdaptiveContrastStretch(const Mat &src, Mat &
        dst,
126                                       uchar kernelsize,
                                              float factor) {
127   OriginalImg = src;
128   ProcessedImg.create(OriginalImg.size(), CV_8UC1);
```

```
129   AdaptiveContrastStretch(kernelsize, factor);
130   dst = ProcessedImg;
131 }
132
133 /*! Homebrew AdaptiveContrastStretch function which
      calculate the mean and
134 standard deviation from the neighboring pixels if the
      current pixel is higher
135 then the mean the value is incremented with an given factor
      multiplied with the
136 standard deviation, and decreased if it's lower then the
      mean.
137 \param kernelsize an uchar which represent the kernelsize
      should be an uneven
138 number higher than two
139 \param factor float which indicates the amount the effect
      should take place
140 standard value is 1.0 only used in the adaptive contrast
      stretch enhancement
141 \param chain use the results from the previous operation
      default value = false;
142 */
143 void Enhance::AdaptiveContrastStretch(uchar kernelsize,
      float factor,
144                                       bool chain) {
145   // Exception handling
146   EMPTY_CHECK(OriginalImg);
147   if (kernelsize < 3 || (kernelsize % 2) == 0) {
148     throw Exception::WrongKernelSizeException();
149   }
150   CV_Assert(OriginalImg.depth() != sizeof(uchar));
151
152   // Make the pointers to the Data
153   uchar *O;
154   CHAIN_PROCESS(chain, O, uchar);
155   uchar *P = ProcessedImg.data;
156
157   int i = 0;
158   int hKsize = kernelsize / 2;
159   int nCols = OriginalImg.cols;
160   int pStart = (hKsize * nCols) + hKsize + 1;
161
162   int nData = OriginalImg.rows * OriginalImg.cols;
163   int pEnd = nData - pStart;
164   uint32_t noNeighboursPix = kernelsize * kernelsize;
165   uint32_t sum;
166   float mean = 0.0;
167
168   uchar *nRow = GetNRow(nData, hKsize, nCols, OriginalImg.
        rows);
169
170   i = pStart;
171   while (i++ < pEnd) {
172     // Checks if pixel isn't a border pixel and progresses
          to the new row
173     if (nRow[i] == 1) {
```

```
174         i += kernelsize;
175       }
176
177       // Fill the neighboring pixel array
178       sum = 0;
179       mean = 0;
180
181       // Calculate the statistics
182       CalculateSumOfNeighboringPixels(O, i, hKsize, nCols, sum
              );
183       mean = (float)(sum / noNeighboursPix);
184       float Std = CalculateStdOfNeighboringPixels(O, i, hKsize
              , nCols,
185                                                   noNeighboursPix
                                                          , mean);
186
187       // Stretch
188
189       if (O[i] > mean) {
190         // int addValue = O[i] + (int)(round(factor * Std));
191         int addValue = O[i] + static_cast<int>(round(factor *
                Std));
192         if (addValue < 255) {
193           P[i] = addValue;
194         } else {
195           P[i] = 255;
196         }
197       } else if (O[i] < mean) {
198         // int subValue = O[i] - (int)(round(factor * Std));
199         int subValue = O[i] - static_cast<int>(round(factor *
                Std));
200         if (subValue > 0) {
201           P[i] = subValue;
202         } else {
203           P[i] = 0;
204         }
205       } else {
206         P[i] = O[i];
207       }
208     }
209
210     // Stretch the image with an normal histogram equalization
211     HistogramEqualization(true);
212
213     delete[] nRow;
214   }
215
216   /*! Blurs the image with a NxN kernel
217   \param src cv::Mat source image
218   \param dst cv::Mat destination image
219   \param kernelsize an uchar which represent the kernelsize
          should be an uneven
220   number higher than two
221   */
222   void Enhance::Blur(const Mat &src, Mat &dst, uchar
          kernelsize) {
```

```
223   OriginalImg = src;
224   ProcessedImg.create(OriginalImg.size(), CV_8UC1);
225   Blur(kernelsize);
226   dst = ProcessedImg;
227 }
228
229 /*! Blurs the image with a NxN kernel
230 \param kernelsize an uchar which represent the kernelsize
      should be an uneven
231 number higher than two
232 \param chain use the results from the previous operation
      default value = false;
233 */
234 void Enhance::Blur(uchar kernelsize, bool chain) {
235   // Exception handling
236   EMPTY_CHECK(OriginalImg);
237   if (kernelsize < 3 || (kernelsize % 2) == 0) {
238     throw Exception::WrongKernelSizeException();
239   }
240   CV_Assert(OriginalImg.depth() != sizeof(uchar));
241
242   // Make the pointers to the Data
243   uchar *O;
244   CHAIN_PROCESS(chain, O, uchar);
245   uchar *P = ProcessedImg.data;
246
247   int nData = OriginalImg.rows * OriginalImg.cols;
248   int hKsize = kernelsize / 2;
249   int nCols = OriginalImg.cols;
250   int pStart = (hKsize * nCols) + hKsize + 1;
251   int pEnd = nData - pStart;
252   int noNeighboursPix = kernelsize * kernelsize;
253   uint32_t sum;
254
255   int i;
256   uchar *nRow = GetNRow(nData, hKsize, nCols, OriginalImg.
        rows);
257   i = pStart;
258   while (i++ < pEnd) {
259     // Checks if pixel isn't a border pixel and progresses
          to the new row
260     if (nRow[i] == 1) {
261       i += kernelsize;
262     }
263
264     // Calculate the sum of the kernel
265     sum = 0;
266     CalculateSumOfNeighboringPixels(O, i, hKsize, nCols, sum
          );
267
268     P[i] = (uchar)(round(sum / noNeighboursPix));
269   }
270
271   delete[] nRow;
272 }
273
```

```
274 /*! Stretches the image using a histogram
275 \param chain use the results from the previous operation
       default value = false;
276 */
277 void Enhance::HistogramEqualization(bool chain) {
278   // Exception handling
279   EMPTY_CHECK(OriginalImg);
280   CV_Assert(OriginalImg.depth() != sizeof(uchar));
281
282   // Make the pointers to the Data
283   uchar *O;
284   CHAIN_PROCESS(chain, O, uchar);
285   uchar *P = ProcessedImg.data;
286
287   // Calculate the statics of the whole image
288   ucharStat_t imgStats(O, OriginalImg.rows, OriginalImg.cols
         );
289   float sFact;
290   if (imgStats.min != imgStats.max) {
291     sFact = 255.0f / (imgStats.max - imgStats.min);
292   } else {
293     sFact = 1.0f;
294   }
295
296   uint32_t i = 256;
297   uchar LUT_changeValue[256];
298   while (i-- > 0) {
299     LUT_changeValue[i] = (uchar)(((float)(i)*sFact) + 0.5f);
300   }
301
302   O = OriginalImg.data;
303
304   i = OriginalImg.cols * OriginalImg.rows + 1;
305   while (i-- > 0) {
306     *P++ = LUT_changeValue[*O++ - imgStats.min];
307   }
308 }
309 }
```

Morphological filter Class

```
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 */

#pragma once
#define MORPHOLOGICALFILTER_VERSION 1

#include "ImageProcessing.h"

namespace Vision {
class MorphologicalFilter : public ImageProcessing {
public:
  enum FilterType { OPEN, CLOSE, ERODE, DILATE, NONE };

  MorphologicalFilter();
  MorphologicalFilter(FilterType filtertype);
  MorphologicalFilter(const Mat &src, FilterType filtertype = FilterType::NONE);
  MorphologicalFilter(const MorphologicalFilter &rhs);

  ~MorphologicalFilter();

  MorphologicalFilter &operator=(MorphologicalFilter &rhs);

  void Dilation(const Mat &mask, bool chain = false);
  void Erosion(const Mat &mask, bool chain = false);

  void Close(const Mat &mask, bool chain = false);
  void Open(const Mat &mask, bool chain = false);

private:
  void Filter(const Mat &mask, bool chain, uchar startVal, uchar newVal,
              uchar switchVal);
};
}
```

```
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 */

#include "MorphologicalFilter.h"

namespace Vision {
```

```
11 MorphologicalFilter::MorphologicalFilter() {}
12
13 MorphologicalFilter::MorphologicalFilter(FilterType
       filtertype) {
14   switch (filtertype) {
15   case FilterType::OPEN:
16     Open(OriginalImg);
17     break;
18   case FilterType::CLOSE:
19     Close(OriginalImg);
20     break;
21   case FilterType::ERODE:
22     Erosion(OriginalImg);
23     break;
24   case FilterType::DILATE:
25     Dilation(OriginalImg);
26     break;
27   case FilterType::NONE:
28     break;
29   }
30 }
31
32 MorphologicalFilter::MorphologicalFilter(const Mat &src,
33                                          FilterType
                                               filtertype) {
34   OriginalImg = src;
35   ProcessedImg.create(OriginalImg.size(), CV_8UC1);
36   switch (filtertype) {
37   case FilterType::OPEN:
38     Open(OriginalImg);
39     break;
40   case FilterType::CLOSE:
41     Close(OriginalImg);
42     break;
43   case FilterType::ERODE:
44     Erosion(OriginalImg);
45     break;
46   case FilterType::DILATE:
47     Dilation(OriginalImg);
48     break;
49   case FilterType::NONE:
50     break;
51   }
52 }
53
54 MorphologicalFilter::MorphologicalFilter(const
       MorphologicalFilter &rhs) {
55   this->OriginalImg = rhs.OriginalImg;
56   this->ProcessedImg = rhs.ProcessedImg;
57   this->TempImg = rhs.ProcessedImg;
58 }
59
60 MorphologicalFilter::~MorphologicalFilter() {}
61
62 MorphologicalFilter &MorphologicalFilter::operator=(
       MorphologicalFilter &rhs) {
```

```
63    if (&rhs != this) {
64      this->OriginalImg = rhs.OriginalImg;
65      this->ProcessedImg = rhs.ProcessedImg;
66      this->TempImg = rhs.TempImg;
67    }
68    return *this;
69  }
70
71  void MorphologicalFilter::Open(const Mat &mask, bool chain)
       {
72    Erosion(mask, chain);
73    Dilation(mask, true);
74  }
75
76  void MorphologicalFilter::Close(const Mat &mask, bool chain)
       {
77    Dilation(mask, chain);
78    Erosion(mask, true);
79  }
80
81  void MorphologicalFilter::Dilation(const Mat &mask, bool
       chain) {
82    Filter(mask, chain, 0, 1, 1);
83  }
84
85  void MorphologicalFilter::Erosion(const Mat &mask, bool
       chain) {
86    Filter(mask, chain, 1, 0, 0);
87  }
88
89  void MorphologicalFilter::Filter(const Mat &mask, bool chain
       , uchar startVal,
90                                   uchar newVal, uchar
                                        switchVal) {
91    // Exception handling
92    CV_Assert(OriginalImg.depth() != sizeof(uchar));
93    EMPTY_CHECK(OriginalImg);
94    if (mask.cols % 2 == 0 || mask.cols < 3) {
95      throw Exception::WrongKernelSizeException("Wrong
          Kernelsize columns!");
96    }
97    if (mask.rows % 2 == 0 || mask.rows < 3) {
98      throw Exception::WrongKernelSizeException("Wrong
          Kernelsize rows!");
99    }
100
101   uint32_t hKsizeCol = (mask.cols / 2);
102   uint32_t hKsizeRow = (mask.rows / 2);
103
104   // make Pointers
105   Mat workOrigImg(ProcessedImg.rows + mask.rows,
         ProcessedImg.cols + mask.cols,
106                   CV_8UC1);
107   workOrigImg.setTo(0);
108   if (chain) {
109     ProcessedImg.copyTo(workOrigImg(
```

```
110         cv::Rect(hKsizeCol, hKsizeRow, ProcessedImg.cols,
                ProcessedImg.rows)));
111       // workOrigImg(cv::Rect(hKsizeCol, hKsizeRow,
             ProcessedImg.cols,
112       // ProcessedImg.rows)) = ProcessedImg.clone();
113     } else {
114       OriginalImg.copyTo(workOrigImg(
115         cv::Rect(hKsizeCol, hKsizeRow, ProcessedImg.cols,
                ProcessedImg.rows)));
116       // workOrigImg(cv::Rect(hKsizeCol, hKsizeRow,
             ProcessedImg.cols,
117       // ProcessedImg.rows)) = OriginalImg.clone();
118     }
119     uchar *O = workOrigImg.data;
120
121     Mat workProcImg(ProcessedImg.rows + mask.rows,
           ProcessedImg.cols + mask.cols,
122                     CV_8UC1);
123     uchar *P = workProcImg.data;
124
125     // Init the relevant data
126     //uint32_t nData = OriginalImg.cols * OriginalImg.rows;
127     uint32_t nWData = workProcImg.cols * workProcImg.rows;
128     uint32_t nWStart = (hKsizeRow * workProcImg.cols) +
           hKsizeRow;
129     uint32_t nWEnd = nWData - hKsizeCol - hKsizeRow *
           workProcImg.cols - 1;
130     uchar *nRow = GetNRow(nWData, hKsizeCol, workProcImg.cols,
            workProcImg.rows);
131     int MaskPixel = 0, OPixel = 0;
132
133     workProcImg.setTo(0);
134     if (startVal != 0) {
135       workProcImg(cv::Rect(hKsizeCol, hKsizeRow, ProcessedImg.
             cols,
136                            ProcessedImg.rows)).setTo(startVal)
                               ;
137     }
138     SHOW_DEBUG_IMG(workOrigImg, uchar, 255, "workOrigImg
           Filter!", false);
139     SHOW_DEBUG_IMG(mask, uchar, 255, "Filter mask", true);
140
141     for (uint32_t i = nWStart; i < nWEnd; i++) {
142       // Checks if pixel isn't a border pixel and progresses
             to the new row
143       if (nRow[i] == 1) {
144         i += mask.cols;
145       }
146       for (int r = 0; r < mask.rows; r++) {
147         for (int c = 0; c < mask.cols; c++) {
148           MaskPixel = c + r * mask.cols;
149           OPixel = i - hKsizeCol + c + (r - hKsizeRow) *
                workProcImg.cols;
150           if (mask.data[MaskPixel] == 1 && O[OPixel] ==
                switchVal) {
151             P[i] = newVal;
```

```
152             c = mask.cols;
153             r = mask.rows;
154           }
155         }
156       }
157     }
158     delete[] nRow;
159     SHOW_DEBUG_IMG(workProcImg, uchar, 255, "workProcImg
          Filter!", true);
160     ProcessedImg = workProcImg(Rect(hKsizeCol, hKsizeRow,
          ProcessedImg.cols,
161                                     ProcessedImg.rows)).clone
                                        ();
162     SHOW_DEBUG_IMG(ProcessedImg, uchar, 255, "Processed Image
          Filter!", true);
163 }
164 }
```

Segment Class

```
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5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #pragma once
9
10 #include <vector>
11 #include <queue>
12 #include <string>
13 #include <stdint.h>
14 #include <iostream>
15 #include <algorithm>
16 #include <utility>
17
18 #include <boost/range/adaptor/reversed.hpp>
19
20 #include "opencv2/imgproc/imgproc.hpp"
21
22 #include "ImageProcessing.h"
23 #include "MorphologicalFilter.h"
24 #include "../SoilMath/SoilMath.h"
25
26 namespace Vision {
27 class Segment : public ImageProcessing {
28 public:
29   /*! Coordinates for the region of interest*/
30   typedef struct Rect {
31     uint16_t leftX;  /*!< Left X coordinate*/
32     uint16_t leftY;  /*!< Left Y coordinate*/
33     uint16_t rightX; /*!< Right X coordinate*/
34     uint16_t rightY; /*!< Right Y coordinate*/
35     Rect(uint16_t lx, uint16_t ly, uint16_t rx, uint16_t ry)
36         : leftX(lx), leftY(ly), rightX(rx), rightY(ry){}
37   } Rect_t;
38
39   typedef std::vector<Vision::Segment::Rect_t> RectList_t;
40
41   /*! Individual blob*/
42   typedef struct Blob {
43     uint16_t Label; /*!< ID of the blob*/
44     cv::Mat Img;   /*!< BW image of the blob all the pixel
          belonging to the blob
45                       are set to 1 others are 0*/
46     cv::Rect ROI;  /*!< Coordinates for the blob in the
          original picture as a
47                       cv::Rect*/
48     uint32_t Area; /*!< Calculated stats of the blob*/
49     cv::Point_<double> Centroid;
50     double Theta;
```

```
51      Blob(uint16_t label, uint32_t area) : Label(label), Area
           (area){}
52    } Blob_t;
53
54    typedef std::vector<Blob_t> BlobList_t;
55    BlobList_t BlobList; /*!< vector with all the individual
         blobs*/
56
57    /*! Enumerator to indicate what kind of object to extract
         */
58    enum TypeOfObjects {
59      Bright, /*!< Enum value Bright object */
60      Dark    /*!< Enum value Dark object. */
61    };
62
63    /*! Enumerator to indicate how the pixel correlate between
         each other in a
64     * blob*/
65    enum Connected {
66      Four =
67          2, /*!< Enum Four connected, relation between Center
                , North, East, South
68            and West*/
69      Eight =
70          4 /*!< Enum Eight connected, relation between Center
                , North, NorthEast,
71           East, SouthEast, South, SouthWest, West and
              NorthWest */
72    };
73
74    /*!< Enumerator which indicate which Segmentation
         technique should be used */
75    enum SegmentationType {
76      Normal, /*!< Segmentation looking at the intensity of an
           individual pixel */
77      LabNeuralNet, /*!< Segmentation looking at the chromatic
           a* and b* of the
78                       processed pixel and it's surrounding
                            pixels, feeding it in
79                       an Neural Net */
80      GraphMinCut /*!< Segmentation using a graph function and
           the minimum cut */
81    };
82
83    cv::Mat LabelledImg;   /*!< Image with each individual
         blob labeled with a
84                              individual number */
85    uint16_t MaxLabel = 0; /*!< Maximum labels found in the
         labelled image*/
86    uint16_t noOfFilteredBlobs =
87        0; /*!< Total numbers of blobs that where filtered
             beacuse the where
88              smaller than the minBlobArea*/
89
90    ucharStat_t OriginalImgStats; /*!< Statistical data from
         the original image*/
```

```
91    uint8_t ThresholdLevel = 0;    /*!< Current calculated
         threshold level*/
92
93    float sigma = 2;
94    uint32_t thresholdOffset = 4;
95
96    Segment();
97    Segment(const Mat &src);
98    Segment(const Segment &rhs);
99
100   ~Segment();
101
102   Segment &operator=(Segment &rhs);
103
104   void LoadOriginalImg(const Mat &src);
105
106   void ConvertToBW(TypeOfObjects Typeobjects);
107   void ConvertToBW(const Mat &src, Mat &dst, TypeOfObjects
         Typeobjects);
108
109   void GetEdges(bool chain = false, Connected conn = Eight);
110   void GetEdges(const Mat &src, Mat &dst, bool chain = false
         ,
111                 Connected conn = Eight);
112
113   void GetEdgesEroding(bool chain = false);
114
115   void GetBlobList(bool chain = false, Connected conn =
         Eight);
116
117   void Threshold(uchar t, TypeOfObjects Typeobjects);
118
119   void LabelBlobs(bool chain = false, uint16_t minBlobArea =
          25,
120                   Connected conn = Eight);
121
122   void RemoveBorderBlobs(uint32_t border = 1, bool chain =
         false);
123
124   void FillHoles(bool chain = false);
125
126 private:
127   uint8_t GetThresholdLevel(TypeOfObjects TypeObject);
128   void SetBorder(uchar *P, uchar setValue);
129   void FloodFill(uchar *O, uchar *P, uint16_t x, uint16_t y,
          uchar fillValue,
130                  uchar OldValue);
131   void MakeConsecutive(uint16_t *valueArr, uint32_t noElem,
         uint16_t &maxlabel);
132   void MakeConsecutive(uint16_t *valueArr, uint16_t *keyArr,
          uint16_t noElem,
133                        uint16_t &maxlabel);
134   void SortAdjacencyList(std::vector<std::vector<uint16_t>>
         &adj);
135   void ConnectedBlobs(uchar *O, uint16_t *P,
```

```
136                         std::vector<std::vector<uint16_t>> &
                               adj, uint32_t nCols,
137                         uint32_t nRows, Connected conn);
138   void InvertAdjacencyList(std::vector<std::vector<uint16_t
        >> &adj,
139                            std::vector<std::vector<uint16_t
                               >> &adjInv);
140 };
141 }
```

```
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6   */
7
8  /*! \class  Segment
9  \brief Segmentation algorithms
10 With this class, various segmentation routines can be
       applied to a greyscale or
11 black and white source image.
12 */
13 #include "Segment.h"
14
15 namespace Vision {
16 //! Constructor of the Segmentation class
17 Segment::Segment() {}
18
19 //! Constructor of the Segmentation class
20 Segment::Segment(const Mat &src) {
21   OriginalImg = src;
22   ProcessedImg.create(OriginalImg.size(), CV_8UC1);
23   LabelledImg.create(OriginalImg.size(), CV_16UC1);
24 }
25
26 Segment::Segment(const Segment &rhs) {
27   this->BlobList = rhs.BlobList;
28   this->LabelledImg = rhs.LabelledImg;
29   this->MaxLabel = rhs.MaxLabel;
30   this->noOfFilteredBlobs = rhs.noOfFilteredBlobs;
31   this->OriginalImg = rhs.OriginalImg;
32   this->OriginalImgStats = rhs.OriginalImgStats;
33   this->ProcessedImg = rhs.ProcessedImg;
34   this->TempImg = rhs.TempImg;
35   this->ThresholdLevel = rhs.ThresholdLevel;
36 }
37
38 //! De-constructor
39 Segment::~Segment() {}
40
41 Segment &Segment::operator=(Segment &rhs) {
42   if (&rhs != this) {
43     this->BlobList = rhs.BlobList;
```

```
44      this->LabelledImg = rhs.LabelledImg;
45      this->MaxLabel = rhs.MaxLabel;
46      this->noOfFilteredBlobs = rhs.noOfFilteredBlobs;
47      this->OriginalImg = rhs.OriginalImg;
48      this->OriginalImgStats = rhs.OriginalImgStats;
49      this->ProcessedImg = rhs.ProcessedImg;
50      this->TempImg = rhs.TempImg;
51      this->ThresholdLevel = rhs.ThresholdLevel;
52    }
53    return *this;
54  }
55
56  void Segment::LoadOriginalImg(const Mat &src) {
57    OriginalImg = src;
58    ProcessedImg.create(OriginalImg.size(), CV_8UC1);
59    LabelledImg.create(OriginalImg.size(), CV_16UC1);
60  }
61
62  /*! Determine the threshold level by iteration, between two
      distribution,
63  presumably back- and foreground. It works towards the
      average of the two
64  averages and finally sets the threshold with two time the
      standard deviation
65  from the mean of the set object
66  \param TypeObject is an enumerator indicating if the bright
      or the dark pixels
67  are the object and should be set to one
68  \return The threshold level as an uint8_t   */
69  uint8_t Segment::GetThresholdLevel(TypeOfObjects TypeObject)
       {
70    // Exception handling
71    EMPTY_CHECK(OriginalImg);
72    CV_Assert(OriginalImg.depth() != sizeof(uchar));
73
74    // Calculate the statistics of the whole picture
75    ucharStat_t OriginalImgStats(OriginalImg.data, OriginalImg
        .rows,
76                                 OriginalImg.cols);
77
78    // Sets the initial threshold with the mean of the total
        picture
79    pair<uchar, uchar> T;
80    T.first = (uchar)(OriginalImgStats.Mean + 0.5);
81    T.second = 0;
82
83    uchar Rstd = 0;
84    uchar Lstd = 0;
85    uchar Rmean = 0;
86    uchar Lmean = 0;
87
88    // Iterate till optimum Threshold is found between back- &
        foreground
89    while (T.first != T.second) {
90      // Gets an array of the left part of the histogram
91      uint32_t i = T.first;
```

```
92      uint32_t *Left = new uint32_t[i]{};
93      while (i-- > 0) {
94        Left[i] = OriginalImgStats.bins[i];
95      }
96
97      // Gets an array of the right part of the histogram
98      uint32_t rightEnd = 256 - T.first;
99      uint32_t *Right = new uint32_t[rightEnd]{};
100     i = rightEnd;
101     while (i-- > 0) {
102       Right[i] = OriginalImgStats.bins[i + T.first];
103     }
104
105     // Calculate the statistics of both histograms,
106     // taking into account the current threshold
107     ucharStat_t sLeft(Left, 0, T.first);
108     ucharStat_t sRight(Right, T.first, 256);
109
110     // Calculate the new threshold the mean of the means
111     T.second = T.first;
112     T.first = (uchar)(((sLeft.Mean + sRight.Mean) / 2) +
            0.5);
113
114     Rmean = (uchar)(sRight.Mean + 0.5);
115     Lmean = (uchar)(sLeft.Mean + 0.5);
116     Rstd = (uchar)(sRight.Std + 0.5);
117     Lstd = (uchar)(sLeft.Std + 0.5);
118     delete[] Left;
119     delete[] Right;
120   }
121
122   // Assumes the pixel value of the sought object lies
        between 2 sigma
123   int val = 0;
124   switch (TypeObject) {
125   case Bright:
126     val = Rmean - (sigma * Rstd) - thresholdOffset;
127     if (val < 0) {
128       val = 0;
129     } else if (val > 255) {
130       val = 255;
131     }
132     T.first = (uchar)val;
133     break;
134   case Dark:
135     val = Lmean + (sigma * Lstd) + thresholdOffset;
136     if (val < 0) {
137       val = 0;
138     } else if (val > 255) {
139       val = 255;
140     }
141     T.first = (uchar)val;
142     break;
143   }
144
145   return T.first;
```

```
146 }
147
148 /*! Convert a greyscale image to a BW using an automatic
      Threshold
149 \param src is the source image as a cv::Mat
150 \param dst destination image as a cv::Mat
151 \param TypeObject is an enumerator indicating if the bright
      or the dark pixels
152 are the object and should be set to one */
153 void Segment::ConvertToBW(const Mat &src, Mat &dst,
      TypeOfObjects Typeobjects) {
154   OriginalImg = src;
155   ProcessedImg.create(OriginalImg.size(), CV_8UC1);
156   LabelledImg.create(OriginalImg.size(), CV_16UC1);
157   ConvertToBW(Typeobjects);
158   dst = ProcessedImg;
159 }
160
161 /*! Convert a greyscale image to a BW using an automatic
      Threshold
162 \param TypeObject is an enumerator indicating if the bright
      or the dark pixels
163 are the object and should be set to one     */
164 void Segment::ConvertToBW(TypeOfObjects Typeobjects) {
165   // Determine the threshold
166   uchar T = GetThresholdLevel(Typeobjects);
167
168   // Threshold the picture
169   Threshold(T, Typeobjects);
170 }
171
172 /*! Convert a greyscale image to a BW
173 \param t uchar set the value which is the tiping point
174 \param TypeObject is an enumerator indicating if the bright
      or the dark pixels
175 are the object and should be set to one     */
176 void Segment::Threshold(uchar t, TypeOfObjects Typeobjects)
      {
177   // Exception handling
178   EMPTY_CHECK(OriginalImg);
179   CV_Assert(OriginalImg.depth() != sizeof(uchar) ||
180             OriginalImg.depth() != sizeof(uint16_t));
181
182   // Create LUT
183   uchar LUT_newValue[256]{0};
184   if (Typeobjects == Bright) {
185     for (uint32_t i = t; i < 256; i++) {
186       LUT_newValue[i] = 1;
187     }
188   } else {
189     for (uint32_t i = 0; i <= t; i++) {
190       LUT_newValue[i] = 1;
191     }
192   }
193
194   // Create the pointers to the data
```

```
195   uchar *P = ProcessedImg.data;
196   uchar *O = OriginalImg.data;
197
198   // Fills the ProcessedImg with either a 0 or 1
199   for (int i = 0; i < OriginalImg.cols * OriginalImg.rows; i
          ++) {
200     P[i] = LUT_newValue[O[i]];
201   }
202 }
203
204 /*! Set all the border pixels to a set value
205 \param *P uchar pointer to the Mat.data
206 \param setValue uchar the value which is written to the
       border pixels
207 */
208 void Segment::SetBorder(uchar *P, uchar setValue) {
209   // Exception handling
210   EMPTY_CHECK(OriginalImg);
211   CV_Assert(OriginalImg.depth() != sizeof(uchar) ||
212             OriginalImg.depth() != sizeof(uint16_t));
213
214   uint32_t nData = OriginalImg.cols * OriginalImg.rows;
215
216   // Set borderPixels to 2
217   uint32_t i = 0;
218   uint32_t pEnd = OriginalImg.cols + 1;
219
220   // Set the top row to value 2
221   while (i < pEnd) {
222     P[i++] = setValue;
223   }
224
225   // Set the bottom row to value 2
226   i = nData + 1;
227   pEnd = nData - OriginalImg.cols;
228   while (i-- > pEnd) {
229     P[i] = setValue;
230   }
231
232   // Sets the first and the last Column to 2
233   i = 1;
234   pEnd = OriginalImg.rows;
235   while (i < pEnd) {
236     P[(i * OriginalImg.cols) - 1] = setValue;
237     P[(i++ * OriginalImg.cols)] = setValue;
238   }
239 }
240
241 /*! Remove the blobs that are connected to the border
242 \param conn set the pixel connection eight or four
243 \param chain use the results from the previous operation
       default value = false;
244 */
245 void Segment::RemoveBorderBlobs(uint32_t border, bool chain)
        {
246   CV_Assert(OriginalImg.depth() != sizeof(uchar));
```

```
247   EMPTY_CHECK(OriginalImg);
248   // make Pointers
249   uchar *O;
250   CHAIN_PROCESS(chain, O, uchar);
251   if (chain) {
252     ProcessedImg = TempImg.clone();
253   } else {
254     ProcessedImg = OriginalImg.clone();
255   }
256
257   SHOW_DEBUG_IMG(OriginalImg, uchar, 255, "Original Image
          RemoverBorderBlobs!",
258                  true);
259   SHOW_DEBUG_IMG(TempImg, uchar, 255, "Temp Image
          RemoverBorderBlobs!", true);
260
261   uchar *P = ProcessedImg.data;
262   uint32_t cols = ProcessedImg.cols;
263   uint32_t rows = ProcessedImg.rows;
264
265   try {
266     for (uint32_t i = 0; i < border; i++) {
267       for (uint32_t j = 0; j < cols; j++) {
268         if (O[(i * cols) + j] == 1 && P[(i * cols) + j] !=
              2) {
269           cv::floodFill(ProcessedImg, cv::Point(j, i), (
              uchar)2);
270         }
271       }
272     }
273
274     for (uint32_t i = rows - border - 1; i < rows; i++) {
275       for (uint32_t j = 0; j < cols; j++) {
276         if (O[(i * cols) + j] == 1 && P[(i * cols) + j] !=
              2) {
277           cv::floodFill(ProcessedImg, cv::Point(j, i), (
              uchar)2);
278         }
279       }
280     }
281
282     for (uint32_t i = border; i < rows - border; i++) {
283       for (uint32_t j = 0; j < border; j++) {
284         if (O[(i * cols) + j] == 1 && P[(i * cols) + j] !=
              2) {
285           cv::floodFill(ProcessedImg, cv::Point(j, i), (
              uchar)2);
286         }
287         if (O[(i * cols) + (cols - j - 1)] == 1 &&
288             P[(i * cols) + (cols - j - 1)] != 2) {
289           cv::floodFill(ProcessedImg, cv::Point(cols - j -
              1, i), (uchar)2);
290         }
291       }
292     }
293   } catch (cv::Exception &e) {
```

```
294   }
295   SHOW_DEBUG_IMG(ProcessedImg, uchar, 255,
296                  "Processed Image RemoverBorderBlobs before
                       LUT!", true);
297
298   // Change values 2 -> 0
299   uchar LUT_newValue[3]{0, 1, 0};
300   P = ProcessedImg.data;
301   uint32_t nData = rows * cols;
302   for (uint32_t i = 0; i < nData; i++) {
303     P[i] = LUT_newValue[P[i]];
304   }
305
306   SHOW_DEBUG_IMG(ProcessedImg, uchar, 255,
307                  "Processed Image RemoverBorderBlobs!", true
                       );
308 }
309
310 /*! Label all the individual blobs in a BW source image. The
       result are written
311 to the labelledImg as an ushort
312 \param conn set the pixel connection eight or four
313 \param chain use the results from the previous operation
       default value = false;
314 \param minBlobArea minimum area when an artifact is
       considered a blob
315 */
316 void Segment::LabelBlobs(bool chain, uint16_t minBlobArea,
       Connected conn) {
317   // Exception handling
318   CV_Assert(OriginalImg.depth() != sizeof(uchar));
319   EMPTY_CHECK(OriginalImg);
320
321   // make the Pointers to the data
322   uchar *O;
323   if (chain) {
324     TempImg = ProcessedImg.clone();
325     ProcessedImg = cv::Mat(OriginalImg.rows, OriginalImg.
           cols, CV_16UC1);
326     O = (uchar *)TempImg.data;
327   } else {
328     O = (uchar *)OriginalImg.data;
329   }
330   uint16_t *P = (uint16_t *)LabelledImg.data;
331
332   uint32_t nCols = OriginalImg.cols;
333   uint32_t nRows = OriginalImg.rows;
334   uint32_t nData = nCols * nRows;
335
336   vector<vector<uint16_t>> CLdownstream;
337
338   ConnectedBlobs(O, P, CLdownstream, nCols, nRows,
339                  conn); // First loop through the image
340   SortAdjacencyList(
341       CLdownstream); // Sort all the adjacencylists and make
           unique,
```

```
342
343   // identify all the lowest values in the adjacent list
344   uint16_t *valueArr = new uint16_t[CLdownstream.size()];
345   for (int i = CLdownstream.size() - 1; i >= 0; --i) {
346     std::vector<uint16_t *> route;
347     uint16_t minVal = i;
348
349     for (uint32_t j = 0; j < CLdownstream[i].size(); j++) {
350
351       // add the first node to the queue;
352       route.push_back(&CLdownstream[i][j]);
353
354       // itterate till the last node
355       bool lastNodeReached = false;
356       while (!lastNodeReached) {
357         uint32_t nodesVisited = route.size() - 1;
358         if (*route[nodesVisited] < minVal) {
359           minVal = *route[nodesVisited];
360         }
361         route.push_back(&CLdownstream[*route[nodesVisited
              ]][0]);
362         if (route[nodesVisited] == route[nodesVisited + 1])
              {
363           route.pop_back();
364           lastNodeReached = true;
365         }
366       }
367       // Set all values to the lowest value
368       for (uint32_t k = 0; k < route.size(); k++) {
369         *route[k] = minVal;
370       }
371     }
372     valueArr[i] = minVal;
373   }
374
375   // Make numbers consecutive
376   MakeConsecutive(valueArr, CLdownstream.size(), MaxLabel);
377
378   // Second loop through the pixels to give the values a
        final value
379   for_each(P, P + nData, [&](uint16_t &V) { V = valueArr[V];
        });
380   delete[] valueArr;
381 }
382
383 /*! Create a BW image with only edges from a BW image
384 \param src source image as a const cv::Mat
385 \param dst destination image as a cv::Mat
386 \param conn set the pixel connection eight or four
387 \param chain use the results from the previous operation
      default value = false;
388 */
389 void Segment::GetEdges(const Mat &src, Mat &dst, bool chain,
      Connected conn) {
390   OriginalImg = src;
391   GetEdges(chain, conn);
```

```
392   dst = ProcessedImg;
393 }
394
395 /*! Create a BW image with only edges from a BW image
396 \param conn set the pixel connection eight or four
397 \param chain use the results from the previous operation
      default value = false;
398 */
399 void Segment::GetEdges(bool chain, Connected conn) {
400   // Exception handling
401   CV_Assert(OriginalImg.depth() != sizeof(uchar));
402   EMPTY_CHECK(OriginalImg);
403
404   // make Pointers
405   uchar *O;
406   CHAIN_PROCESS(chain, O, uchar);
407   uchar *P = ProcessedImg.data;
408
409   uint32_t nCols = OriginalImg.cols;
410   uint32_t nRows = OriginalImg.rows;
411   uint32_t nData = nCols * nRows;
412   uint32_t pEnd = nData + 1;
413   uint32_t i = 0;
414
415   // Loop through the image and set each pixel which has a
        zero neighbor set it
416   // to two.
417   if (conn == Four) {
418     // Loop through the picture
419     while (i < pEnd) {
420       // If current value = zero processed value = zero
421       if (O[i] == 0) {
422         P[i] = 0;
423       }
424       // If current value = 1 check North West, South and
            East and act
425       // accordingly
426       else if (O[i] == 1) {
427         uchar *nPixels = new uchar[4];
428         nPixels[0] = O[i - 1];
429         nPixels[1] = O[i - nCols];
430         nPixels[2] = O[i + 1];
431         nPixels[3] = O[i + nCols];
432
433         // Sort the neighbors for easier checking
434         SoilMath::Sort::QuickSort<uchar>(nPixels, 4);
435         if (nPixels[0] == 0) {
436           P[i] = 1;
437         } else {
438           P[i] = 0;
439         }
440         delete[] nPixels;
441       } else {
442         throw Exception::PixelValueOutOfBoundException();
443       }
444       i++;
```

```
445       }
446     } else {
447       // Loop through the picture
448       while (i < pEnd) {
449         // If current value = zero processed value = zero
450         if (O[i] == 0) {
451           P[i] = 0;
452         }
453         // If current value = 1 check North West, South and
              East and act
454         // accordingly
455         else if (O[i] == 1) {
456           uchar *nPixels = new uchar[8];
457           nPixels[0] = O[i - 1];
458           nPixels[1] = O[i - nCols];
459           nPixels[2] = O[i - nCols - 1];
460           nPixels[3] = O[i - nCols + 1];
461           nPixels[4] = O[i + 1];
462           nPixels[5] = O[i + nCols + 1];
463           nPixels[6] = O[i + nCols];
464           nPixels[7] = O[i + nCols - 1];
465
466           // Sort the neighbors for easier checking
467           SoilMath::Sort::QuickSort<uchar>(nPixels, 8);
468
469           if (nPixels[0] == 0) {
470             P[i] = 1;
471           } else {
472             P[i] = 0;
473           }
474           delete[] nPixels;
475         } else {
476           throw Exception::PixelValueOutOfBoundException();
477         }
478         i++;
479       }
480     }
481 }
482
483 void Segment::GetEdgesEroding(bool chain) {
484   // Exception handling
485   CV_Assert(OriginalImg.depth() != sizeof(uchar));
486   EMPTY_CHECK(OriginalImg);
487
488   // make Pointers
489   uchar *O;
490   CHAIN_PROCESS(chain, O, uchar);
491   uchar *P = ProcessedImg.data;
492
493   uint32_t nCols = OriginalImg.cols;
494   uint32_t nRows = OriginalImg.rows;
495   uint32_t nData = nCols * nRows;
496
497   // Setup the erosion
498   MorphologicalFilter eroder;
499   if (chain) {
```

```
500       eroder.OriginalImg = TempImg;
501     } else {
502       eroder.OriginalImg = OriginalImg;
503     }
504     // Setup the processed image of the eroder
505     eroder.ProcessedImg.create(OriginalImg.size(), CV_8UC1);
506     eroder.ProcessedImg.setTo(0);
507     // Setup the mask
508     Mat mask(3, 3, CV_8UC1, 1);
509     // Erode the image
510     eroder.Erosion(mask, false);
511
512     // Loop through the image and set the not eroded pixels to
          zero
513     for (uint32_t i = 0; i < nData; i++) {
514       if (O[i] != eroder.ProcessedImg.data[i]) {
515         P[i] = 1;
516       } else {
517         P[i] = 0;
518       }
519     }
520
521     // ProcessedImg = OriginalImg.clone() - eroder.
          ProcessedImg.clone();
522
523     SHOW_DEBUG_IMG(eroder.ProcessedImg, uchar, 255, "Eroded
          img Processed Image!",
524                    true);
525     SHOW_DEBUG_IMG(ProcessedImg, uchar, 255, "GetEdgesEroding
          Processed Image!",
526                    true);
527 }
528
529 /*! Create a BlobList subtracting each individual blob out
       of a Labelled image.
530 If the labelled image is empty build a new one with a BW
       image.
531 \param conn set the pixel connection eight or four
532 \param chain use the results from the previous operation
       default value = false;
533 */
534 void Segment::GetBlobList(bool chain, Connected conn) {
535     // Exception handling
536     CV_Assert(OriginalImg.depth() != sizeof(uchar));
537     EMPTY_CHECK(OriginalImg);
538
539     // If there isn't a labelledImg make one
540     if (MaxLabel < 1) {
541       LabelBlobs(chain, 5, conn);
542     }
543
544     // Make an empty BlobList
545     uint32_t nCols = OriginalImg.cols;
546     uint32_t nRows = OriginalImg.rows;
547     uint32_t nData = nCols * nRows;
548     RectList_t rectList;
```

```
549
550   // Calculate Stats the statistics
551   uint16Stat_t LabelStats((uint16_t *)LabelledImg.data,
          LabelledImg.cols,
552                           LabelledImg.rows, MaxLabel + 1, 0,
                                MaxLabel);
553
554   BlobList.reserve(LabelStats.EndBin);
555   rectList.reserve(LabelStats.EndBin);
556
557   BlobList.push_back(Blob_t(0, 0));
558   rectList.push_back(Rect_t(0, 0, 0, 0));
559
560   for (uint32_t i = 1; i < LabelStats.EndBin; i++) {
561     BlobList.push_back(Blob_t(i, LabelStats.bins[i]));
562     rectList.push_back(Rect_t(nCols, nRows, 0, 0));
563   }
564
565   // make Pointers
566   uint16_t *L = (uint16_t *)LabelledImg.data;
567
568   uint32_t currentX, currentY;
569   // uint16_t leftX, leftY, rightX, rightY;
570   // Loop through the labeled image and extract the Blobs
571   for (uint32_t i = 0; i < nData; i++) {
572     if (L[i] != 0) {
573       /* Determine the current x and y value of the current
             blob and
574       checks if it is min/max */
575       currentY = i / nCols;
576       currentX = i % nCols;
577
578       // Min value
579       if (currentX < rectList[L[i]].leftX) {
580         rectList[L[i]].leftX = currentX;
581       }
582       if (currentY < rectList[L[i]].leftY) {
583         rectList[L[i]].leftY = currentY;
584       }
585
586       // Max value
587       if (currentX > rectList[L[i]].rightX) {
588         rectList[L[i]].rightX = currentX;
589       }
590       if (currentY > rectList[L[i]].rightY) {
591         rectList[L[i]].rightY = currentY;
592       }
593     }
594   }
595
596   // Loop through the BlobList and finalize it
597   uint8_t *LUT_filter = new uint8_t[MaxLabel + 1]{};
598   for (uint32_t i = 1; i <= MaxLabel; i++) {
599     LUT_filter[i] = 1;
600     BlobList[i].ROI.y = rectList[i].leftY;
601     BlobList[i].ROI.x = rectList[i].leftX;
```

```
602       BlobList[i].ROI.height = rectList[i].rightY - rectList[i
              ].leftY + 1;
603       BlobList[i].ROI.width = rectList[i].rightX - rectList[i
              ].leftX + 1;
604       BlobList[i].Img = CopyMat<uint8_t, uint16_t>(
605           LabelledImg(BlobList[i].ROI).clone(), LUT_filter,
                  CV_8UC1);
606       //SHOW_DEBUG_IMG(BlobList[i].Img, uchar, 255, "Blob",
              true);
607       LUT_filter[i] = 0;
608     }
609     delete[] LUT_filter;
610
611     // Remove background blob
612     BlobList.erase(BlobList.begin());
613   }
614
615   void Segment::FillHoles(bool chain) {
616     // Exception handling
617     CV_Assert(OriginalImg.depth() != sizeof(uchar));
618     EMPTY_CHECK(OriginalImg);
619
620     // make Pointers
621     uchar *O;
622     CHAIN_PROCESS(chain, O, uchar);
623     if (chain) {
624       ProcessedImg = TempImg.clone();
625     } else {
626       ProcessedImg = OriginalImg.clone();
627     }
628
629     uchar *P = ProcessedImg.data;
630
631     // Determine the starting point of the floodfill
632     int itt = -1;
633     while (P[++itt] != 0)
634       ;
635     uint16_t row = static_cast<uint16_t>(itt / OriginalImg.
          rows);
636     uint16_t col = static_cast<uint16_t>(itt % OriginalImg.
          rows);
637
638     // Fill the outside
639     try {
640       cv::floodFill(ProcessedImg, cv::Point(col, row), cv::
              Scalar(2));
641     } catch (cv::Exception &e) {
642     }
643
644     // Set the unreached areas to 1 and the outside to 0;
645     uchar LUT_newVal[3] = {1, 1, 0};
646     uint32_t nData = OriginalImg.rows * OriginalImg.cols;
647     uint32_t i = 0;
648     while (i <= nData) {
649       P[i] = LUT_newVal[P[i]];
650       i++;
```

```
651     }
652 }
653
654 /*!
655  * \brief Segment::SortAdjacencyList Sort the the sub
        vectors
656  * \param adj std::vector<std::vector<uint16_t>> &adj
657  */
658 void Segment::SortAdjacencyList(std::vector<std::vector<
      uint16_t>> &adj) {
659   uint32_t j = 0;
660   for_each(adj.begin(), adj.end(), [&](std::vector<uint16_t>
        &L) {
661     std::sort(L.begin(), L.end());
662     std::vector<uint16_t>::iterator it;
663     it = std::unique(L.begin(), L.end());
664     L.resize(std::distance(L.begin(), it));
665     if (L.size() > 1) {
666       for (std::vector<uint16_t>::iterator iter = L.begin();
            iter != L.end();
667            ++iter) {
668         if (*iter == j) {
669           L.erase(iter);
670           break;
671         }
672       }
673     }
674     j++;
675   });
676 }
677
678 /*!
679  * \brief Segment::ConnectedBlobs Connect all the blobs and
        created the
680  * adjacency list
681  * \param O
682  * \param P
683  * \param adj
684  * \param nCols
685  * \param nRows
686  * \param conn
687  */
688 void Segment::ConnectedBlobs(uchar *O, uint16_t *P,
689                              std::vector<std::vector<
                                 uint16_t>> &adj,
690                              uint32_t nCols, uint32_t nRows,
                                   Connected conn) {
691   // Determine the size of the array for beginning and
        endrow and middle of a
692   // row
693   uint32_t noConn[3] = {static_cast<uint32_t>(conn),
694                         (static_cast<uint32_t>(conn) / 2),
695                         (static_cast<uint32_t>(conn) / 2) +
                              1};
696   uint32_t lastConn[3] = {noConn[0] - 1, noConn[1] - 1,
        noConn[2] - 1};
```

```
697   uint32_t nData = nCols * nRows;
698
699   uint16_t currentlbl = 0;
700   vector<uint16_t> zeroVector;
701   zeroVector.push_back(currentlbl);
702   adj.push_back(zeroVector);
703
704   // Determine which borderpixels should be handled
          differently
705   uchar *nRow = new uchar[nData]{};
706   for (uint32_t i = nCols; i < nData; i += nCols) {
707     nRow[i] = 1;
708     nRow[i - 1] = 2;
709   }
710
711   // Set the first pixel
712   if (O[0] == 0) {
713     P[0] = 0;
714   } else if (O[0] == 1) {
715     P[0] = 1;
716   } else {
717     throw Exception::PixelValueOutOfBoundException();
718   }
719
720   // Walk through the toprow and determine if it's a new
          blob or it's connected
721   // with previously determine blob
722   for (uint32_t i = 1; i < nCols; i++) {
723     if (O[i] == 0) {
724       P[i] = 0;
725     } else if (O[i] == 1) {
726       // If West is zero assume this is a new blob
727       if (P[i - 1] == 0) {
728         P[i] = ++currentlbl;
729         vector<uint16_t> cVector;
730         cVector.push_back(currentlbl);
731         adj.push_back(cVector);
732       } else { // set as previous blob
733         P[i] = P[i - 1];
734       }
735     } else { // Value of of bounds
736       throw Exception::PixelValueOutOfBoundException();
737     }
738   }
739
740   // walk through each pixel and determine if it's a new
          blob or it's connected
741   // with previously determine blob
742   for (uint32_t i = OriginalImg.cols; i < nData; i++) {
743     if (O[i] == 0) { // Original pixel = 0
744       P[i] = 0;
745     } else if (O[i] == 1) {
746       // Get an array of Neighboring Pixels
747       uint16_t *nPixels = new uint16_t[noConn[nRow[i]]];
748       if (nRow[i] != 1) {
749         nPixels[0] = P[i - 1];
```

```
750         }
751         uint32_t j = i - nCols - ((nRow[i] == 1) ? 0 : ((conn
               == Four) ? 0 : 1));
752         for_each(nPixels + ((nRow[i] != 1) ? 1 : 0), nPixels +
                noConn[nRow[i]],
753                  [&](uint16_t &N) { N = P[j++]; });
754
755         // Sort the neighbors for easier checking
756         SoilMath::Sort::QuickSort<uint16_t>(nPixels, noConn[
               nRow[i]]);
757
758         // If all are zero assume this is a new blob
759         if (nPixels[lastConn[nRow[i]]] == 0) {
760           P[i] = ++currentlbl;
761           vector<uint16_t> cVector;
762           cVector.push_back(currentlbl);
763           adj.push_back(cVector);
764         } else {
765           /* Sets the processed value to the smallest non-zero
                   value and update
766            * the connectedLabels */
767           for (uint32_t j = 0; j < noConn[nRow[i]]; j++) {
768             if (nPixels[j] > 0) {
769               P[i] = nPixels[j];
770               break;
771             }
772           }
773
774           /* If previous blobs belong to different connected
                  components set the
775            * current processed value to the lowest value and
                   remember that the
776            * other values should be the lowest value*/
777           if (P[i] != nPixels[lastConn[nRow[i]]]) {
778             for (int j = lastConn[nRow[i]]; j >= 0; --j) {
779               if (nPixels[j] <= P[i]) {
780                 break;
781               } else {
782                 adj[nPixels[j]].push_back(P[i]);
783               }
784             }
785           }
786         }
787         delete[] nPixels;
788       } else {
789         throw Exception::PixelValueOutOfBoundException();
790       }
791     }
792     delete[] nRow;
793 }
794
795 /*!
796  * \brief Segment::InvertAdjacencyList invert the
        adjecencylist for upstream
797  * (unused)
798  * \param adj
```

```
799  * \param adjInv
800  */
801 void Segment::InvertAdjacencyList(std::vector<std::vector<
       uint16_t>> &adj,
802                                   std::vector<std::vector<
                                          uint16_t>> &adjInv) {
803   // Build the inverted vector
804   adjInv.resize(adj.size());
805   uint16_t count = 0;
806   for_each(adj.begin(), adj.end(), [&](std::vector<uint16_t>
          &V) {
807     for_each(V.begin(), V.end(),
808              [&](uint16_t &C) { adjInv[C].push_back(count);
                 });
809     count++;
810   });
811 }
812
813 /*!
814  * \brief Segment::MakeConsecutive make the valueArr
          consequative numbers
815  * \param valueArr
816  * \param noElem
817  * \param maxLabel
818  */
819 void Segment::MakeConsecutive(uint16_t *valueArr, uint32_t
       noElem,
820                               uint16_t &maxLabel) {
821   std::vector<std::vector<uint16_t>> conseq;
822   conseq.resize(noElem);
823   for (uint32_t i = 0; i < noElem; i++) {
824     conseq[valueArr[i]].push_back(i);
825   }
826   uint32_t count = 1;
827   for (uint32_t i = 1; i < noElem; i++) {
828     if (conseq[i].size() > 0) {
829       for (uint32_t j = 0; j < conseq[i].size(); j++) {
830         valueArr[conseq[i][j]] = count;
831       }
832       count++;
833     }
834   }
835   maxLabel = count - 1;
836 }
837
838 /*!
839  * \brief Segment::MakeConsecutive probably a fault in this
          function. Don't use
840  * \param valueArr
841  * \param keyArr
842  * \param noElem
843  * \param maxlabel
844  */
845 void Segment::MakeConsecutive(uint16_t *valueArr, uint16_t *
       keyArr,
```

```
846                                 uint16_t noElem, uint16_t &
                                       maxlabel) {
847   SoilMath::Sort::QuickSort<uint16_t>(valueArr, keyArr,
          noElem);
848   uint16_t count = 0;
849   for (uint32_t i = 1; i < noElem; i++) {
850     if (valueArr[i] != valueArr[i - 1]) {
851       count++;
852     }
853     valueArr[i] = count;
854   }
855   SoilMath::Sort::QuickSort<uint16_t>(keyArr, valueArr,
          noElem);
856   delete[] keyArr;
857   maxlabel = count;
858 }
859 }
```

General project files

```
#-------------------------------------------------
#
# Project created by QtCreator 2015-06-06T12:07:42
#
#-------------------------------------------------

QT       += core concurrent
greaterThan(QT_MAJOR_VERSION, 4): QT += widgets
QMAKE_CXXFLAGS += -std=c++11

TARGET = SoilVision
TEMPLATE = lib
VERSION = 0.9.2

DEFINES += SOILVISION_LIBRARY
unix:!macx: QMAKE_RPATHDIR += $$PWD/../../../build/install/

SOURCES += \
    Segment.cpp \
    MorphologicalFilter.cpp \
    ImageProcessing.cpp \
    Enhance.cpp \
    Conversion.cpp

HEADERS += \
    WrongKernelSizeException.h \
    VisionDebug.h \
    Vision.h \
    Segment.h \
    PixelValueOutOfBoundException.h \
    MorphologicalFilter.h \
    ImageProcessing.h \
    Enhance.h \
    EmptyImageException.h \
    ConversionNotSupportedException.h \
    Conversion.h \
    ChannelMismatchException.h

unix {
    target.path = $PWD/../../../build/install
    INSTALLS += target
}

#opencv
LIBS += -L/usr/local/lib -lopencv_core -lopencv_highgui -
   lopencv_imgproc
INCLUDEPATH += /usr/local/include/opencv
INCLUDEPATH += /usr/local/include

#boost
DEFINES += BOOST_ALL_DYN_LINK
INCLUDEPATH += /usr/include/boost

unix:!macx: LIBS += -L$$PWD/../../build/install/ -lSoilMath
```

```
54
55 INCLUDEPATH += $$PWD/../SoilMath
56 DEPENDPATH += $$PWD/../SoilMath
```

```
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5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  /*! Collection header of all the basic Vision headers*/
9
10 #pragma once
11 #include "Conversion.h"
12 #include "Enhance.h"
13 #include "Segment.h"
14 #include "MorphologicalFilter.h"
```

```
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6   */
7
8  #pragma once
9  // Debuging helper macros
10 #ifndef DEBUG
11 //#define DEBUG
12 #endif
13
14 #ifdef DEBUG
15 #include <limits>
16 #include <opencv2/highgui/highgui.hpp>
17 #include <vector>
18 #include "ImageProcessing.h"
19 #ifndef SHOW_DEBUG_IMG
20 #define SHOW_DEBUG_IMG(img, T1, maxVal, windowName, scale)
                          \
21   Vision::ImageProcessing::ShowDebugImg<T1>(img, maxVal,
        windowName, scale)
22 #endif // !SHOW_DEBUG_IMG
23 #else
24 #ifndef SHOW_DEBUG_IMG
25 #define SHOW_DEBUG_IMG(img, T1, maxVal, windowName, scale)
26 #endif // !SHOW_DEBUG_IMG
27 #endif
```

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6   */
7
8   /*! \class ChannelMismatchException
9   Exception class which is thrown when Extracted channel out
        of bounds exception
10  */
11
12  #pragma once
13
14  #include <exception>
15  #include <string>
16
17  using namespace std;
18
19  namespace Vision {
20  namespace Exception {
21  class ChannelMismatchException : public std::exception {
22  public:
23    ChannelMismatchException(
24        string m = "Extracted channel out of bounds exception!
              ")
25        : msg(m){};
26    ~ChannelMismatchException() _GLIBCXX_USE_NOEXCEPT{};
27    const char *what() const _GLIBCXX_USE_NOEXCEPT { return
        msg.c_str(); };
28
29  private:
30    string msg;
31  };
32  }
33  }
```

```
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6   */
7
8   /*! \class ConversionNotSupportedException
9   Exception class which is thrown when an illegal conversion
        is requested.
10  */
11  #pragma once
12
13  #include <exception>
14  #include <string>
15
16  using namespace std;
17
```

```
18 namespace Vision {
19 namespace Exception {
20 class ConversionNotSupportedException : public std::
       exception {
21 public:
22   ConversionNotSupportedException(
23       string m = "Requested conversion is not supported!")
24       : msg(m){};
25   ~ConversionNotSupportedException() _GLIBCXX_USE_NOEXCEPT
       {};
26   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); };
27
28 private:
29   string msg;
30 };
31 }
32 }
```

```
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6   */
7
8  /*! \class EmtpyImageException
9  Exception class which is thrown when operations are about to
       start on a empty
10 image.
11 */
12
13 #pragma once
14
15 #include <exception>
16 #include <string>
17
18 using namespace std;
19
20 namespace Vision {
21 namespace Exception {
22 class EmtpyImageException : public std::exception {
23 public:
24   EmtpyImageException(string m = "Empty Image!") : msg(m){};
25   ~EmtpyImageException() _GLIBCXX_USE_NOEXCEPT{};
26   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); };
27
28 private:
29   string msg;
30 };
31 }
32 }
```

```
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6   */
7
8  /*! \class PixelValueOutOfBoundException
9  Exception class which is thrown when an unexpected pixel
       value has to be
10 computed
11 */
12 #pragma once
13
14 #include <exception>
15 #include <string>
16
17 using namespace std;
18
19 namespace Vision {
20 namespace Exception {
21 class PixelValueOutOfBoundException : public std::exception
       {
22 public:
23   PixelValueOutOfBoundException(string m = "Current pixel
        value out of bounds!")
24       : msg(m){};
25   ~PixelValueOutOfBoundException() _GLIBCXX_USE_NOEXCEPT{};
26   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
        msg.c_str(); };
27
28 private:
29   string msg;
30 };
31 }
32 }
```

```
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6   */
7
8  /*! \class WrongKernelSizeException
9  Exception class which is thrown when a wrong kernelsize is
       requested
10 */
11 #pragma once
12
13 #include <exception>
```

```
14 #include <string>
15
16 using namespace std;
17
18 namespace Vision {
19 namespace Exception {
20 class WrongKernelSizeException : public std::exception {
21 public:
22   WrongKernelSizeException(string m = "Wrong kernel
       dimensions!") : msg(m){};
23   ~WrongKernelSizeException() _GLIBCXX_USE_NOEXCEPT{};
24   const char *what() const _GLIBCXX_USE_NOEXCEPT { return
       msg.c_str(); };
25
26 private:
27   string msg;
28 };
29 }
30 }
```

K. Analyzer Library

Analyzer Class

```
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6   */
7
8  #pragma once
9  #define STARTING_ESTIMATE_PROGRESS 300
10 #ifndef DEBUG
11 //#define DEBUG
12 #endif
13
14 #include <opencv2/core.hpp>
15 #include <opencv2/imgproc.hpp>
16 #include <vector>
17 #include <cmath>
18
19 #include "sample.h"
20 #include "soilsettings.h"
21 #include "soilanalyzerexception.h"
22
23 #include "SoilMath.h"
24
25 #include <QtCore/QObject>
26 #include <QThread>
27 #include <QtConcurrent>
28
29 #include "Vision.h"
```

```
30
31 namespace SoilAnalyzer {
32 class Analyzer : public QObject {
33   Q_OBJECT
34
35 public:
36   bool PredictShape = true;
37   float CurrentSIfactor = 0.0111915;
38   bool SIfactorDet = false;
39   struct Image_t {
40     cv::Mat FrontLight;
41     cv::Mat BackLight;
42     float SIPixelFactor = 0.0111915;
43   }; /*!< */
44
45   typedef std::vector<Image_t> Images_t; /*!< */
46   Images_t *Snapshots = nullptr;         /*!< */
47   SoilSettings *Settings = nullptr;      /*!< */
48
49   Sample *Results; /*!< */
50
51   Analyzer(Images_t *snapshots, Sample *results,
       SoilSettings *settings);
52
53   void Analyse();
54   void Analyse(Images_t *snapshots, Sample *results,
       SoilSettings *settings);
55   float CalibrateSI(float SI, cv::Mat &img);
56
57   uint32_t MaxProgress = STARTING_ESTIMATE_PROGRESS; /*!< */
58
59   SoilMath::NN NeuralNet; /*!< */
60
61 signals:
62   void on_progressUpdate(int value);    /*!< */
63   void on_maxProgressUpdate(int value); /*!< */
64   void on_AnalysisFinished();           /*!< */
65
66 private:
67   uint32_t currentProgress = 0;   /*!< */
68   uint32_t currentParticleID = 0; /*!< */
69   double BinRanges[15]{0.0,  0.038, 0.045, 0.063, 0.075,
       0.09, 0.125, 0.18,
70                        0.25, 0.355, 0.5,   0.71,  1.0,   1.4,
                          2.0};
71
72   SoilMath::FFT fft; /*!< */
73
74   void CalcMaxProgress();
75   void CalcMaxProgressAnalyze();
76   void PrepImages();
77   void GetBW(std::vector<cv::Mat> &images, std::vector<cv::
       Mat> &BWvector);
78   void GetBW(cv::Mat &img, cv::Mat &BW);
79
80   void GetEnhancedInt(Images_t *snapshots,
```

```
81                          std::vector<cv::Mat> &intensityVector)
                               ;
82    void GetEnhancedInt(cv::Mat &img, cv::Mat &intensity);
83
84    void GetParticles(std::vector<cv::Mat> &BW, Images_t *
         snapshots,
85                          Particle::ParticleVector_t &
                               partPopulation);
86    void GetParticlesFromBlobList(Vision::Segment::BlobList_t
         &bloblist,
87                                  Image_t *snapshot,
88                                  Particle::ParticleVector_t &
                                       partPopulation);
89
90    void CleanUpMatVector(std::vector<cv::Mat> &mv);
91    void CleanUpMatVector(Images_t *mv);
92
93    void GetFFD(Particle::ParticleVector_t &particalPopulation
         );
94
95    void GetPrediction(Particle::ParticleVector_t &
         particlePopulation);
96 };
97 }
```

```
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6   */
7
8  #include "analyzer.h"
9
10 namespace SoilAnalyzer {
11
12 /*!
13 *\brief Analyzer::Analyzer
14 *\param snapshots
15 *\param results
16 *\param settings
17 */
18 Analyzer::Analyzer(Images_t *snapshots, Sample *results,
19                    SoilSettings *settings = nullptr) {
20   this->Snapshots = snapshots;
21   this->Results = results;
22   if (settings == nullptr) {
23     Settings = new SoilSettings;
24   } else {
25     this->Settings = settings;
26   }
27   NeuralNet.LoadState(Settings->NNlocation);
28 }
29
```

```
30 /*!
31  * \brief Analyzer::PrepImages
32  */
33 void Analyzer::PrepImages() {
34   if (Snapshots == nullptr || Snapshots->size() == 0) {
35     throw Exception::SoilAnalyzerException(
          EXCEPTION_NO_SNAPSHOTS,
36                                            EXCEPTION_NO_SNAPSHOTS_NR
                                               );
37   }
38
39   std::vector<cv::Mat> intensityVector;
40   GetEnhancedInt(Snapshots, intensityVector);
41
42   std::vector<cv::Mat> BWVector;
43   GetBW(intensityVector, BWVector);
44   CleanUpMatVector(intensityVector);
45
46   GetParticles(BWVector, Snapshots, Results->
        ParticlePopulation);
47
48   CleanUpMatVector(BWVector);
49   CleanUpMatVector(Snapshots);
50
51   Results->isPreparedForAnalysis = true;
52 }
53
54 void Analyzer::Analyse(Images_t *snapshots, Sample *results,
55                        SoilSettings *settings) {
56   Snapshots = snapshots;
57   Results = results;
58   Settings = settings;
59   Analyse();
60 }
61
62 /*!
63  * \brief Analyzer::Analyse
64  */
65 void Analyzer::Analyse() {
66   CalcMaxProgress();
67   if (!Results->isPreparedForAnalysis && !Results->
        IsLoadedFromDisk) {
68     PrepImages();
69   }
70   GetFFD(Results->ParticlePopulation);
71   if (PredictShape && Settings->PredictTheShape) {
72     GetPrediction(Results->ParticlePopulation);
73   }
74
75   Results->Angularity =
76       ucharStat_t(Results->GetAngularityVector()->data(),
77                   Results->GetAngularityVector()->size(), 1,
                        7, 0, true);
78   emit on_progressUpdate(currentProgress++);
79
80   Results->Roundness =
```

```
81        ucharStat_t(Results->GetRoundnessVector()->data(),
82                    Results->GetRoundnessVector()->size(), 1,
                        5, 0, true);
83
84    Results->PSD =
85        SoilMath::PSD(Results->GetPSDVector()->data(),
86                      Results->GetPSDVector()->size(),
                          BinRanges, 15, 14);
87    emit on_progressUpdate(currentProgress++);
88
89    emit on_AnalysisFinished();
90  }
91
92  void Analyzer::CleanUpMatVector(std::vector<Mat> &mv) {
93    for_each(mv.begin(), mv.end(), [](cv::Mat &I) { I.release
          (); });
94    mv.clear();
95  }
96
97  /*!
98   * \brief Analyzer::CleanUpMatVector
99   * \param mv
100  */
101 void Analyzer::CleanUpMatVector(Images_t *mv) {
102   for_each(mv->begin(), mv->end(), [](Image_t &I) {
103     I.BackLight.release();
104     I.FrontLight.release();
105   });
106   mv->clear();
107 }
108
109 /*!
110  * \brief Analyzer::CalcMaxProgress
111  */
112 void Analyzer::CalcMaxProgress() {
113   // Static processing steps
114   MaxProgress += Snapshots->size() * 5;
115
116   // Optional processing steps
117   if (Settings->useBlur) {
118     MaxProgress += Snapshots->size();
119   }
120   if (Settings->useAdaptiveContrast) {
121     MaxProgress += Snapshots->size();
122   }
123   if (Settings->fillHoles) {
124     MaxProgress += Snapshots->size();
125   }
126   if (Settings->ignorePartialBorderParticles) {
127     MaxProgress += Snapshots->size();
128   }
129   if (Settings->morphFilterType != Vision::
          MorphologicalFilter::NONE) {
130     MaxProgress += Snapshots->size();
131   }
132
```

```
133   emit on_maxProgressUpdate(MaxProgress);
134 }
135
136 void Analyzer::CalcMaxProgressAnalyze() {
137   MaxProgress -= STARTING_ESTIMATE_PROGRESS;
138   MaxProgress += Results->ParticlePopulation.size() * 2;
139
140   emit on_maxProgressUpdate(MaxProgress);
141 }
142
143 /*!
144  * \brief Analyzer::GetEnhancedInt
145  * \param snapshots
146  * \param intensityVector
147  */
148 void Analyzer::GetEnhancedInt(Images_t *snapshots,
149                               std::vector<Mat> &
                                    intensityVector) {
150   if (Settings->useBacklightProjection) {
151    for_each(snapshots->begin(), snapshots->end(), [&](
         Image_t &I) {
152       cv::Mat intensity;
153       GetEnhancedInt(I.BackLight, intensity);
154       intensityVector.push_back(intensity);
155     });
156   } else {
157     for_each(snapshots->begin(), snapshots->end(), [&](
          Image_t &I) {
158       cv::Mat intensity;
159       GetEnhancedInt(I.FrontLight, intensity);
160       intensityVector.push_back(intensity);
161     });
162   }
163 }
164
165 /*!
166  * \brief Analyzer::GetEnhancedInt
167  * \param img
168  * \param intensity
169  */
170 void Analyzer::GetEnhancedInt(Mat &img, Mat &intensity) {
171   Vision::Conversion IntConvertor(img.clone());
172   IntConvertor.Convert(Vision::Conversion::RGB, Vision::
         Conversion::Intensity);
173   emit on_progressUpdate(currentProgress++);
174   SHOW_DEBUG_IMG(IntConvertor.ProcessedImg, uchar, 255, "RGB
         2 Int", false);
175
176   if (Settings->useBlur) {
177     Vision::Enhance IntBlur(IntConvertor.ProcessedImg.clone
          ());
178     IntBlur.Blur(Settings->blurKernelSize);
179     emit on_progressUpdate(currentProgress++);
180     uint32_t HBK = Settings->blurKernelSize / 2;
181     uint32_t BK = Settings->blurKernelSize - 1;
182     if (Settings->useAdaptiveContrast) {
```

```
183         Vision::Enhance IntAdaptContrast(
184             IntBlur.ProcessedImg(
185                         cv::Rect(HBK, HBK, IntBlur.
                                ProcessedImg.cols - BK,
186                                     IntBlur.ProcessedImg.rows -
                                        BK)).clone());
187         IntAdaptContrast.AdaptiveContrastStretch(
188             Settings->adaptContrastKernelSize,
189             Settings->adaptContrastKernelFactor);
190         emit on_progressUpdate(currentProgress++);
191         uint32_t HAK = Settings->adaptContrastKernelSize / 2;
192         uint32_t AK = Settings->adaptContrastKernelSize - 1;
193         intensity = IntAdaptContrast.ProcessedImg(
194             cv::Rect(HAK, HAK, IntAdaptContrast.ProcessedImg.
                    cols - AK,
195                      IntAdaptContrast.ProcessedImg.rows - AK))
                         ;
196       } else {
197         intensity = IntBlur.ProcessedImg(
198             cv::Rect(HBK, HBK, IntBlur.ProcessedImg.cols - BK,
199                      IntBlur.ProcessedImg.rows - BK));
200       }
201     } else if (Settings->useAdaptiveContrast) {
202       Vision::Enhance IntAdaptContrast(IntConvertor.
             ProcessedImg.clone());
203       IntAdaptContrast.AdaptiveContrastStretch(
204           Settings->adaptContrastKernelSize, Settings->
                adaptContrastKernelFactor);
205       emit on_progressUpdate(currentProgress++);
206       uint32_t HAK = Settings->adaptContrastKernelSize / 2;
207       uint32_t AK = Settings->adaptContrastKernelSize - 1;
208       intensity = IntAdaptContrast.ProcessedImg(
209           cv::Rect(HAK, HAK, IntAdaptContrast.ProcessedImg.
                  cols - AK,
210                    IntAdaptContrast.ProcessedImg.rows - AK));
211     } else {
212       intensity = IntConvertor.ProcessedImg;
213     }
214     SHOW_DEBUG_IMG(intensity, uchar, 255, "Enhanced Int",
          false);
215 }
216
217 /*!
218  * \brief Analyzer::GetBW
219  * \param images
220  * \param BWvector
221  */
222 void Analyzer::GetBW(std::vector<cv::Mat> &images,
223                      std::vector<cv::Mat> &BWvector) {
224   for_each(images.begin(), images.end(), [&](cv::Mat &I) {
225     cv::Mat BW;
226     GetBW(I, BW);
227     BWvector.push_back(BW);
228   });
229 }
230
```

```
231 /*!
232  * \brief Analyzer::GetBW
233  * \param img
234  * \param BW
235  */
236 void Analyzer::GetBW(cv::Mat &img, cv::Mat &BW) {
237   Vision::Segment SegBL(img.clone());
238   SegBL.sigma = Settings->sigmaFactor;
239   SegBL.thresholdOffset = Settings->thresholdOffsetValue;
240   SegBL.ConvertToBW(Settings->typeOfObjectsSegmented);
241   emit on_progressUpdate(currentProgress++);
242   SHOW_DEBUG_IMG(SegBL.ProcessedImg, uchar, 255, "Segment",
        true);
243
244   cv::Mat BWholes;
245   if (Settings->fillHoles) {
246     Vision::Segment Fillholes(SegBL.ProcessedImg);
247     Fillholes.FillHoles();
248     BWholes = Fillholes.ProcessedImg;
249     emit on_progressUpdate(currentProgress++);
250     SHOW_DEBUG_IMG(BWholes, uchar, 255, "Fillholes", true);
251   } else {
252     BWholes = SegBL.ProcessedImg;
253   }
254
255   cv::Mat BWborder;
256   if (Settings->ignorePartialBorderParticles) {
257     Vision::Segment RemoveBB(BWholes.clone());
258     RemoveBB.RemoveBorderBlobs();
259     BWborder = RemoveBB.ProcessedImg;
260     emit on_progressUpdate(currentProgress++);
261     SHOW_DEBUG_IMG(BWborder, uchar, 255, "RemoveBorderBlobs"
          , true);
262   } else {
263     BWborder = BWholes;
264   }
265
266   if (Settings->morphFilterType != Vision::
        MorphologicalFilter::NONE) {
267     Vision::MorphologicalFilter Morph(BWborder.clone());
268     cv::Mat kernel = cv::Mat::zeros(Settings->filterMaskSize
          ,
269                                     Settings->filterMaskSize
                                          , CV_8UC1);
270     uint32_t hMaskSize = Settings->filterMaskSize / 2;
271     cv::circle(kernel, cv::Point(hMaskSize, hMaskSize),
          hMaskSize + 1, 1, -1);
272     switch (Settings->morphFilterType) {
273     case Vision::MorphologicalFilter::CLOSE:
274       Morph.Close(kernel);
275       break;
276     case Vision::MorphologicalFilter::OPEN:
277       Morph.Open(kernel);
278       break;
279     case Vision::MorphologicalFilter::DILATE:
280       Morph.Dilation(kernel);
```

```
281         break;
282       case Vision::MorphologicalFilter::ERODE:
283         Morph.Erosion(kernel);
284         break;
285       case Vision::MorphologicalFilter::NONE:
286         Morph.ProcessedImg = Morph.OriginalImg;
287         break;
288       }
289       BW = Morph.ProcessedImg;
290       emit on_progressUpdate(currentProgress++);
291       SHOW_DEBUG_IMG(BW, uchar, 255, "Morphological operation"
              , true);
292     } else {
293       BW = BWholes;
294     }
295 }
296
297 /*!
298  * \brief Analyzer::GetParticles
299  * \param BW
300  * \param snapshots
301  * \param partPopulation
302  */
303 void Analyzer::GetParticles(std::vector<Mat> &BW, Images_t *
        snapshots,
304                             Particle::ParticleVector_t &
                                partPopulation) {
305   for (uint32_t i = 0; i < snapshots->size(); i++) {
306     Vision::Segment prepBW(BW[i]);
307     prepBW.GetBlobList();
308     emit on_progressUpdate(currentProgress++);
309     GetParticlesFromBlobList(prepBW.BlobList, &(snapshots->
            at(i)),
310                              partPopulation);
311     emit on_progressUpdate(currentProgress++);
312   }
313 }
314
315 /*!
316  * \brief Analyzer::GetParticlesFromBlobList
317  * \param bloblist
318  * \param snapshot
319  * \param edge
320  * \param partPopulation
321  */
322 void Analyzer::GetParticlesFromBlobList(
323     Vision::Segment::BlobList_t &bloblist, Image_t *snapshot
            ,
324     Particle::ParticleVector_t &partPopulation) {
325   for_each(bloblist.begin(), bloblist.end(), [&](Vision::
          Segment::Blob_t &B) {
326     Particle part;
327     part.ID = currentParticleID++;
328     part.PixelArea = B.Area;
329     Vision::Segment::getOrientented(B.Img, B.Centroid, B.
            Theta,
```

```
330                                         part.Eccentricty);
331     cv::Mat RGB = Vision::Segment::CopyMat<uchar>(snapshot->
            FrontLight(B.ROI),
332                                                   B.Img,
                                                          CV_8UC3
                                                          ).clone
                                                          ();
333     cv::Rect ROI;
334     Vision::Segment::RotateImg(B.Img, part.BW, B.Theta, B.
            Centroid, ROI);
335     Vision::Segment::RotateImg(RGB, part.RGB, B.Theta, B.
            Centroid, ROI);
336     Vision::Segment edgeSeg(part.BW);
337     edgeSeg.GetEdgesEroding();
338     part.Edge = edgeSeg.ProcessedImg.clone();
339     part.SIPixelFactor = snapshot->SIPixelFactor;
340     part.isPreparedForAnalysis = false;
341     part.SetRoundness();
342     partPopulation.push_back(part);
343   });
344 }
345
346 /*!
347  * \brief Analyzer::GetFFD
348  * \param particalPopulation
349  */
350 void Analyzer::GetFFD(Particle::ParticleVector_t &
        particalPopulation) {
351   //for_each(particalPopulation.begin(), particalPopulation.
          end(),  [&](Particle &P) {
352   QtConcurrent::blockingMap<Particle::ParticleVector_t>(
353       particalPopulation, [&](Particle &P) {
354         if (!P.isPreparedForAnalysis) {
355           try {
356             SoilMath::FFT fft;
357             P.FFDescriptors = fft.GetDescriptors(P.Edge);
358             P.isPreparedForAnalysis = true;
359           } catch (SoilMath::Exception::MathException &e) {
360             if (*e.id() == EXCEPTION_NO_CONTOUR_FOUND_NR) {
361               P.isSmall = true;
362             }
363           }
364           emit on_progressUpdate(currentProgress++);
365         }
366       });
367 }
368
369 /*!
370  * \brief Analyzer::GetPrediction
371  * \param particlePopulation
372  */
373 void Analyzer::GetPrediction(Particle::ParticleVector_t &
        particlePopulation) {
374   for_each(particlePopulation.begin(), particlePopulation.
          end(),
375            [&](Particle &P) {
```

```
376               if (P.isPreparedForAnalysis) {
377                 if (!P.isSmall) {
378                   ComplexVect_t usedFFDescr(P.FFDescriptors.
                          begin(),
379                                             P.FFDescriptors.
                                                 begin() +
380                                              NeuralNet.
                                                     GetInputNeurons
                                                     ());
381                   P.Classification = NeuralNet.Predict(
                          usedFFDescr);
382                   P.isAnalysed = true;
383                 }
384               }
385             });
386 }
387
388 float Analyzer::CalibrateSI(float SI, Mat &img) {
389   Vision::Conversion greyConv(img);
390   greyConv.Convert(Vision::Conversion::RGB, Vision::
          Conversion::Intensity);
391   Vision::Segment segment(greyConv.ProcessedImg);
392   segment.ConvertToBW(Vision::Segment::Dark);
393   segment.GetBlobList(true);
394   uint32_t maxCircle = 0;
395   for_each(segment.BlobList.begin(), segment.BlobList.end(),
396             [&](Vision::Segment::Blob_t &B) {
397               if (B.ROI.height > maxCircle) {
398                 maxCircle = B.ROI.height;
399               }
400               if (B.ROI.width > maxCircle) {
401                 maxCircle = B.ROI.width;
402               }
403             });
404   qDebug() << "Maximum circle in pixels: " << maxCircle;
405   CurrentSIfactor = SI / maxCircle;
406   qDebug() << "Current SI factor : " << CurrentSIfactor;
407   return CurrentSIfactor;
408 }
409 }
```

Sample Class

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5   * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6   */
7
8  #pragma once
9
10 #include "stdint.h"
11 #include <vector>
12 #include <string>
13 #include "Stats.h"
14 #include "psd.h"
15 #include "particle.h"
16 #include <fstream>
17 #include <boost/archive/binary_iarchive.hpp>
18 #include <boost/archive/binary_oarchive.hpp>
19 #include <boost/serialization/string.hpp>
20 #include <boost/serialization/version.hpp>
21 #include <boost/serialization/vector.hpp>
22 #include <boost/iostreams/filter/zlib.hpp>
23 #include <boost/iostreams/filtering_streambuf.hpp>
24 #include "zlib.h"
25 #include "soilanalyzertypes.h"
26
27 namespace SoilAnalyzer {
28 class Sample {
29 public:
30   Sample();
31
32   uint32_t ID;          /*!< The sample ID*/
33   std::string Location; /*!< The Location where the sample
       was taken*/
34   double Longtitude = 4.629618299999947;
35   double Latitude = 51.8849149;
36   double Depth = 0;
37   std::string Date = "01-09-2015";
38   std::string Name; /*!< The sample name identifier*/
39
40   Particle::ParticleVector_t
41       ParticlePopulation; /*!< the individual particles of
          the sample*/
42
43   SoilMath::PSD PSD; /*!< The Particle Size Distribution*/
44   ucharStat_t Roundness;
45   ucharStat_t Angularity;
46   floatStat_t RI; /*!< The statistical Redness Index data*/
47
48   void Save(const std::string &filename);
49   void Load(const std::string &filename);
50
```

```
51    Particle::PSDVector_t *GetPSDVector();
52    Particle::ClassVector_t *GetRoundnessVector();
53    Particle::ClassVector_t *GetAngularityVector();
54    Particle::doubleVector_t *GetCIELab_aVector();
55    Particle::doubleVector_t *GetCIELab_bVector();
56
57    bool isPreparedForAnalysis =
58        false; /*!< is the sample ready for analysis, are all
              the particles
59                  extracted*/
60    bool isAnalysed = false; /*!< is the sample analyzed*/
61
62    bool ChangesSinceLastSave = false;
63    bool ParticleChangedStatePSD = false;
64    bool ParticleChangedStateClass = false;
65    bool ParticleChangedStateRoundness = false;
66    bool ParticleChangedStateAngularity = false;
67    bool ColorChange = false;
68
69    bool IsLoadedFromDisk = false;
70
71  private:
72    Particle::PSDVector_t Diameter; /*!< The PSD raw data*/
73    bool PSDGathered = false;       /*!< is the raw data
          gathered*/
74    Particle::ClassVector_t RoundnessVec;
75    bool RoundnessGathered = false;
76    Particle::ClassVector_t AngularityVec;
77    bool AngularityGathered = false;
78    Particle::doubleVector_t CIELab_aVec;
79    bool CIELab_aGathered = false;
80    Particle::doubleVector_t CIELab_bVec;
81    bool CIELab_bGathered = false;
82
83    friend class boost::serialization::access;
84    template <class Archive>
85    void serialize(Archive &ar, const unsigned int version) {
86      ar &ID;
87      ar &Location;
88      ar &Name;
89      ar &ParticlePopulation;
90      ar &Diameter;
91      ar &RoundnessVec;
92      ar &AngularityVec;
93      ar &PSD;
94      ar &Roundness;
95      ar &Angularity;
96      ar &RI;
97      ar &isPreparedForAnalysis;
98      ar &isAnalysed;
99      ar &ChangesSinceLastSave;
100     ar &ParticleChangedStatePSD;
101     ar &ParticleChangedStateClass;
102     ar &ParticleChangedStateAngularity;
103     ar &ParticleChangedStateRoundness;
104     ar &PSDGathered;
```

```
105     ar &RoundnessGathered;
106     ar &AngularityGathered;
107     ar &IsLoadedFromDisk;
108     if (version > 0) {
109       ar &Longtitude;
110       ar &Latitude;
111       ar &Date;
112       ar &Depth;
113       ar &AngularityVec;
114       ar &AngularityGathered;
115       ar &CIELab_aVec;
116       ar &CIELab_aGathered;
117       ar &CIELab_bVec;
118       ar &CIELab_bGathered;
119       ar &ColorChange;
120     } else {
121       Latitude = 51.8849149;
122       Longtitude = 4.629618299999947;
123       Date = "01-10-2015";
124       Depth = 0;
125       CIELab_aVec = Particle::doubleVector_t();
126       CIELab_aGathered = false;
127       CIELab_bVec = Particle::doubleVector_t();
128       CIELab_bGathered = false;
129       ColorChange = false;
130     }
131   }
132 };
133 }
134 BOOST_CLASS_VERSION(SoilAnalyzer::Sample, 1)
```

```
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6   */
7
8  #include "sample.h"
9  #include "particle.h"
10
11 namespace SoilAnalyzer {
12 namespace io = boost::iostreams;
13
14 /*!
15  * \brief Sample::Sample
16  */
17 Sample::Sample() {}
18
19 /*!
20  * \brief Sample::Save
21  * \param filename
22  */
23 void Sample::Save(const std::string &filename) {
```

```
24    std::ofstream ofs(filename.c_str(), std::ios::out | std::
          ios::binary);
25    {
26      io::filtering_streambuf<io::output> out;
27
28      out.push(io::zlib_compressor(io::zlib::best_compression)
          );
29      out.push(ofs);
30      {
31        boost::archive::binary_oarchive oa(out);
32        oa << boost::serialization::make_nvp("Sample", *this);
33      }
34    }
35    ofs.close();
36  }
37
38  /*!
39   * \brief Sample::Load
40   * \param filename
41   */
42  void Sample::Load(const std::string &filename) {
43    std::ifstream ifs(filename.c_str(), std::ios::in | std::
          ios::binary);
44    {
45      io::filtering_streambuf<io::input> in;
46
47      in.push(io::zlib_decompressor());
48      in.push(ifs);
49      {
50        boost::archive::binary_iarchive ia(in);
51        ia >> boost::serialization::make_nvp("Sample", *this);
52      }
53    }
54    ifs.close();
55  }
56
57  /*!
58   * \brief Sample::GetPSDVector
59   * \return
60   */
61  Particle::PSDVector_t *Sample::GetPSDVector() {
62    if (!PSDGathered || ParticleChangedStatePSD) {
63      Diameter.clear();
64      for_each(ParticlePopulation.begin(), ParticlePopulation.
            end(),
65               [&](Particle &P) { Diameter.push_back(P.
                  GetSiDiameter()); });
66      PSDGathered = true;
67      ParticleChangedStatePSD = false;
68    }
69    return &Diameter;
70  }
71
72  Particle::ClassVector_t *Sample::GetAngularityVector() {
73    if (!AngularityGathered || ParticleChangedStateAngularity)
          {
```

```
74      AngularityVec.clear();
75      for_each(ParticlePopulation.begin(), ParticlePopulation.
            end(),
76               [&](Particle &P) { AngularityVec.push_back(P.
                    GetAngularity()); });
77      AngularityGathered = true;
78      ParticleChangedStateAngularity = false;
79    }
80    return &AngularityVec;
81  }
82
83  Particle::ClassVector_t *Sample::GetRoundnessVector() {
84    if (!RoundnessGathered || ParticleChangedStateRoundness) {
85      RoundnessVec.clear();
86      for_each(ParticlePopulation.begin(), ParticlePopulation.
            end(),
87               [&](Particle &P) { RoundnessVec.push_back(P.
                    GetRoundness()); });
88      RoundnessGathered = true;
89      ParticleChangedStateRoundness = false;
90    }
91    return &RoundnessVec;
92  }
93
94  Particle::doubleVector_t *Sample::GetCIELab_aVector() {
95    if (!CIELab_aGathered || ColorChange) {
96      CIELab_aVec.clear();
97      for_each(ParticlePopulation.begin(), ParticlePopulation.
            end(),
98               [&](Particle &P) { CIELab_aVec.push_back(P.
                    getMeanLab().a); });
99      CIELab_aGathered = true;
100   }
101   return &CIELab_aVec;
102 }
103
104 Particle::doubleVector_t *Sample::GetCIELab_bVector() {
105   if (!CIELab_bGathered || ColorChange) {
106     CIELab_bVec.clear();
107     for_each(ParticlePopulation.begin(), ParticlePopulation.
           end(),
108              [&](Particle &P) { CIELab_bVec.push_back(P.
                   getMeanLab().b); });
109     CIELab_bGathered = true;
110   }
111   return &CIELab_bVec;
112 }
113 }
```

Particle Class

```
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6   */
7  #pragma once
8
9  #include <opencv2/core.hpp>
10 #include <stdint.h>
11 #include <vector>
12 #include "SoilMath.h"
13 #include <fstream>
14 #include <boost/archive/binary_iarchive.hpp>
15 #include <boost/archive/binary_oarchive.hpp>
16 #include <boost/serialization/string.hpp>
17 #include <boost/serialization/version.hpp>
18 #include <boost/serialization/vector.hpp>
19 #include <boost/iostreams/filter/zlib.hpp>
20 #include <boost/iostreams/filtering_streambuf.hpp>
21 #include "zlib.h"
22 #include "soilanalyzerexception.h"
23 #include "lab_t_archive.h"
24 #include "soilanalyzertypes.h"
25 #include "Vision.h"
26
27 namespace SoilAnalyzer {
28 class Particle {
29 public:
30   typedef std::vector<Particle>
31       ParticleVector_t; /*!< a vector consisting of
              individual particles*/
32   typedef std::vector<double> PSDVector_t; /*!< a vector
         used in the PSD*/
33   typedef std::vector<uint8_t>
34       ClassVector_t; /*!< a vector used in the
              classification histogram*/
35   typedef std::vector<float> floatVector_t;
36   typedef std::vector<double> doubleVector_t;
37
38   Particle();
39
40   uint32_t ID; /*!< The particle ID*/
41
42   cv::Mat BW;   /*!< The binary image of the particle*/
43   cv::Mat Edge; /*!< The binary edge image of the particle*/
44   cv::Mat RGB;  /*!< The RGB image of the particle*/
45
46   Point_t Centroid = {0, 0};
47   std::vector<Complex_t> FFDescriptors; /*!< The Fast
         Fourier Descriptors
```

```
48                                          describing the
                                               contour in the
49                                          Frequency domain
                                               */
50    Predict_t Classification;             /*!< The
         classification prediction*/
51    double SIPixelFactor = 0.0111915; /*!< The conversion
         factor from pixel to SI*/
52    uint32_t PixelArea = 0;          /*!< The total area of
         the binary image*/
53    double Eccentricty = 1;
54
55    float GetSIVolume();
56    float GetSiDiameter();
57    uint8_t GetRoundness();
58    uint8_t GetAngularity();
59    float GetMeanRI();
60    Lab_t getMeanLab();
61
62    void SetRoundness();
63
64    void Save(const std::string &filename);
65    void Load(const std::string &filename);
66
67    bool isPreparedForAnalysis = false; /*!< is the particle
         ready for analysis*/
68    bool isAnalysed = false;            /*!< is the particle
         analyzed*/
69    bool isSmall = false;
70
71  private:
72    float SIVolume = 0.; /*!< The correspondening SI volume*/
73    float SIDiameter = 0.;
74
75    float meanRI = 0;
76    Lab_t meanLab{0,0,0};
77    cv::Mat LAB;
78
79    void getLabImg();
80
81    friend class boost::serialization::access;
82    template <class Archive>
83    void serialize(Archive &ar, const unsigned int version) {
84
85      ar &ID;
86      ar &BW;
87      ar &Edge;
88      ar &RGB;
89      ar &FFDescriptors;
90      ar &Classification;
91      ar &SIPixelFactor;
92      ar &PixelArea;
93      ar &SIVolume;
94      ar &isPreparedForAnalysis;
95      ar &isAnalysed;
96      if (version > 0) {
```

```
97        ar &isSmall;
98        ar &SIDiameter;
99        ar &Centroid.x;
100       ar &Centroid.y;
101       ar &Eccentricty;
102     } else {
103       isSmall = false;
104       SIDiameter = GetSiDiameter();
105       Centroid.x = 0;
106       Centroid.y = 0;
107       Eccentricty = 1;
108     }
109     if (version > 1) {
110         ar &meanLab;
111         ar &meanRI;
112       }
113     else {
114         meanLab.L = 0;
115         meanLab.a = 0;
116         meanLab.b = 0;
117       }
118   }
119 };
120 }
121 BOOST_CLASS_VERSION(SoilAnalyzer::Particle, 2)
```

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6   */
7
8  #include "particle.h"
9
10 namespace SoilAnalyzer {
11 namespace io = boost::iostreams;
12
13 Particle::Particle() {}
14
15 /*!
16  * \brief Particle::Save
17  * \param filename
18  */
19 void Particle::Save(const std::string &filename) {
20   std::ofstream ofs(filename.c_str(), std::ios::out | std::
       ios::binary);
21   {
22     io::filtering_streambuf<io::output> out;
23
24     out.push(io::zlib_compressor(io::zlib::best_compression)
         );
25     out.push(ofs);
26     {
```

```
27        boost::archive::binary_oarchive oa(out);
28        oa << boost::serialization::make_nvp("Particle", *this
             );
29      }
30    }
31    ofs.close();
32  }
33
34  /*!
35   * \brief Particle::Load
36   * \param filename
37   */
38  void Particle::Load(const std::string &filename) {
39    std::ifstream ifs(filename.c_str(), std::ios::in | std::
        ios::binary);
40    {
41      io::filtering_streambuf<io::input> in;
42
43      in.push(io::zlib_decompressor());
44      in.push(ifs);
45      {
46        boost::archive::binary_iarchive ia(in);
47        ia >> boost::serialization::make_nvp("Particle", *this
             );
48      }
49    }
50    ifs.close();
51  }
52
53  /*!
54   * \brief Particle::GetSIVolume
55   * \return
56   */
57  float Particle::GetSIVolume() {
58    if (SIVolume == 0.) {
59      if (PixelArea == 0) {
60        throw Exception::SoilAnalyzerException(
61            EXCEPTION_PARTICLE_NOT_ANALYZED,
                EXCEPTION_PARTICLE_NOT_ANALYZED_NR);
62      }
63      SIVolume = SoilMath::calcVolume(PixelArea) *
           SIPixelFactor * (Eccentricty/2 + 0.5);
64    }
65    return SIVolume;
66  }
67
68  float Particle::GetSiDiameter() {
69    if (SIDiameter == 0.) {
70      if (PixelArea == 0) {
71        throw Exception::SoilAnalyzerException(
72            EXCEPTION_PARTICLE_NOT_ANALYZED,
                EXCEPTION_PARTICLE_NOT_ANALYZED_NR);
73      }
74      SIDiameter = SoilMath::calcDiameter(PixelArea) *
           SIPixelFactor  * (Eccentricty/2 + 0.5);
75    }
```

```
76    return SIDiameter;
77  }
78
79  uint8_t Particle::GetAngularity() {
80    uint8_t angularity = ((Classification.Category - 1) % 6) +
          1;
81    return angularity;
82  }
83
84  uint8_t Particle::GetRoundness() {
85    uint8_t roundness = ((Classification.Category - 1) / 6) +
        1;
86    return roundness;
87  }
88
89  void Particle::SetRoundness() {
90    uint8_t ang = GetAngularity() - 1;
91    Classification.Category +=
92        ang + (static_cast<uint8_t>(floor(Eccentricty / 0.33))
              * 6);
93    Classification.ManualSet = true;
94  }
95
96  Lab_t Particle::getMeanLab() {
97    if (BW.empty() || RGB.empty()) {
98      throw SoilAnalyzer::Exception::SoilAnalyzerException(
99          EXCEPTION_NO_IMAGES_PRESENT,
                EXCEPTION_NO_IMAGES_PRESENT_NR);
100   }
101   if (meanLab.L == 0 && meanLab.a == 0 && meanLab.b == 0) {
102     // convert to Lab
103     if (LAB.empty()) {
104       getLabImg();
105     }
106     std::vector<cv::Mat> LABvect = Vision::Conversion::
          extractChannel(LAB);
107     std::vector<float> labvect;
108     for_each(LABvect.begin(), LABvect.end(), [&](cv::Mat &I)
          {
109       floatStat_t labStat((float *)I.data, I.rows, I.cols, (
            uchar *)BW.data, 1,
110                           0, true);
111       labvect.push_back(labStat.Mean);
112     });
113     meanLab.L = labvect[0];
114     meanLab.a = labvect[1];
115     meanLab.b = labvect[2];
116   }
117   return meanLab;
118 }
119
120 float Particle::GetMeanRI() {
121   if (BW.empty() || RGB.empty()) {
122     throw SoilAnalyzer::Exception::SoilAnalyzerException(
123         EXCEPTION_NO_IMAGES_PRESENT,
              EXCEPTION_NO_IMAGES_PRESENT_NR);
```

```
124   }
125   if (meanRI == 0) {
126     if (LAB.empty()) {
127       getLabImg();
128     }
129     Vision::Conversion convertor(LAB);
130     convertor.Convert(Vision::Conversion::CIE_lab, Vision::
          Conversion::RI);
131     floatStat_t RIstat((float *)convertor.ProcessedImg.data,
          LAB.rows, LAB.cols,
132                        (uchar *)BW.data, 1, 0, true);
133     meanRI = RIstat.Mean;
134   }
135   return meanRI;
136 }
137
138 void Particle::getLabImg() {
139   Vision::Conversion convertor(RGB);
140   convertor.Convert(Vision::Conversion::RGB, Vision::
        Conversion::CIE_lab);
141   LAB = convertor.ProcessedImg.clone();
142 }
143 }
```

Settings Class

```
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6   */
7
8  #pragma once
9
10 #include <string>
11 #include <fstream>
12 #include <boost/archive/xml_iarchive.hpp>
13 #include <boost/archive/xml_oarchive.hpp>
14 #include <boost/serialization/version.hpp>
15 #include "../SoilVision/Vision.h"
16
17 namespace SoilAnalyzer {
18 /*!
19  * \brief The SoilSettings class
20  * \details A class with which the used settings can easily transfered to setup
21  * the Sample class in one go. This class is also used in the GUI. and has a
22  * possibility to saved to disk as a serialized object
23  */
24 class SoilSettings {
25 public:
26   SoilSettings();
27
28   /*!
29    * \brief SaveSettings a function to save the settings to disk
30    * \param filename a string with the filename
31    */
32   void SaveSettings(std::string filename);
33
34   /*!
35    * \brief LoadSettings a function to load the settings from disk
36    * \param filename a string with the filename
37    */
38   void LoadSettings(std::string filename);
39
40   bool useAdaptiveContrast =
41       false; /**< Should adaptive contrast stretch be used default is true*/
42   uint32_t adaptContrastKernelSize =
43       9; /**< The size of the adaptive contrast kernelsize*/
44   float adaptContrastKernelFactor = 1.; /**< the factor with which to multiply
45                                          the effect of the adaptive
```

```
                                                    contrast
46                                                 stretch*/
47
48      bool useBlur = false; /**< Should the mediaan blur be used
            during analsyis*/
49      uint32_t blurKernelSize = 5; /**< the median blurkernel*/
50
51      Vision::Segment::TypeOfObjects typeOfObjectsSegmented =
52          Vision::Segment::Dark; /**< Which type of object
               should be segmented*/
53      bool ignorePartialBorderParticles =
54          true; /**< Indication of partial border particles
               should be used*/
55      bool fillHoles = true; /**< should the holes be filled*/
56      float sigmaFactor = 2; /**< The sigma factor or the
           bandwidth indicating which
57                                pixel intensity values count
                                     belong to an object*/
58      int thresholdOffsetValue = 0; /**< an tweaking offset
           value*/
59
60      Vision::MorphologicalFilter::FilterType morphFilterType =
61          Vision::MorphologicalFilter::OPEN; /**< Indicating
               which type of
62                                                 morhpological
                                                      filter should
                                                       be
63                                                 used*/
64      uint32_t filterMaskSize = 5;             /**< the filter
           mask*/
65
66      uint32_t HDRframes =
67          5; /**< The number of frames which should be used for
               the HDR image*/
68      float lightLevel = 0.5; /**< The light level of the
           environmental case*/
69      bool encInv = false;    /**< invert the values gained form
            the encoder*/
70      bool enableRainbow =
71          true; /**< run a rainbow loop on the RGB encoder
               during analysis*/
72      bool useBacklightProjection = true;           /*!< use
           Projection*/
73      bool useHDR = false;                          /*!< use HDR
           */
74      std::string defaultWebcam = "USB Microscope"; /*!< The
           defaultWebcam string*/
75      int Brightness_front = 0;  /*!< cam brightness setting
           front light*/
76      int Brightness_proj = -10; /*!< cam brightness setting
           projected light*/
77      int Contrast_front = 36;   /*!< cam contrast setting front
            light*/
78      int Contrast_proj = 36;    /*!< cam contrast setting
           projected light*/
```

```
79    int Saturation_front = 64; /*!< cam saturation setting
          front light*/
80    int Saturation_proj = 0;   /*!< cam saturation setting
          projected light*/
81    int Hue_front = 0;         /*!< cam hue setting front
          light*/
82    int Hue_proj = -40;        /*!< cam hue setting projected
          light*/
83    int Gamma_front = 100;     /*!< cam gamma setting front
          light*/
84    int Gamma_proj = 200;      /*!< cam gamma setting
          projected light*/
85    int PowerLineFrequency_front =
86        1; /*!< cam powerline freq setting front light*/
87    int PowerLineFrequency_proj =
88        1;                     /*!< cam powerline freq setting
              projected light*/
89    int Sharpness_front = 12; /*!< cam sharpness setting front
          light*/
90    int Sharpness_proj = 25;  /*!< cam sharpness setting
          projected light*/
91    int BackLightCompensation_front =
92        1; /*!< cam backlight compensation setting front light
              */
93    int BackLightCompensation_proj =
94        1; /*!< cam backlight compensation setting projected
              light*/
95    std::string NNlocation = "NeuralNet/Default.NN";
96    bool useCUDA = false; /*!< CUDA enabled*/
97    int selectedResolution = 0;
98    std::string SampleFolder = "~/Samples";
99    std::string SettingsFolder = "Settings";
100   std::string NNFolder = "NeuralNet";
101   std::string StandardSentTo = "j.spijker@ihcmerwede.com";
102   std::string StandardPrinter = "PDF printer";
103   uint32_t StandardNumberOfShots = 10;
104   bool PredictTheShape = true;
105   bool Revolution = true;
106 private:
107   friend class boost::serialization::access;
108   template <class Archive>
109   void serialize(Archive &ar, const unsigned int version) {
110     if (version >= 0) {
111       ar &BOOST_SERIALIZATION_NVP(useAdaptiveContrast);
112       ar &BOOST_SERIALIZATION_NVP(adaptContrastKernelFactor)
              ;
113       ar &BOOST_SERIALIZATION_NVP(adaptContrastKernelSize);
114       ar &BOOST_SERIALIZATION_NVP(useBlur);
115       ar &BOOST_SERIALIZATION_NVP(blurKernelSize);
116       ar &BOOST_SERIALIZATION_NVP(typeOfObjectsSegmented);
117       ar &BOOST_SERIALIZATION_NVP(
              ignorePartialBorderParticles);
118       ar &BOOST_SERIALIZATION_NVP(fillHoles);
119       ar &BOOST_SERIALIZATION_NVP(sigmaFactor);
120       ar &BOOST_SERIALIZATION_NVP(morphFilterType);
121       ar &BOOST_SERIALIZATION_NVP(filterMaskSize);
```

```
122         ar &BOOST_SERIALIZATION_NVP(thresholdOffsetValue);
123         ar &BOOST_SERIALIZATION_NVP(HDRframes);
124         ar &BOOST_SERIALIZATION_NVP(lightLevel);
125         ar &BOOST_SERIALIZATION_NVP(encInv);
126         ar &BOOST_SERIALIZATION_NVP(enableRainbow);
127         ar &BOOST_SERIALIZATION_NVP(useBacklightProjection);
128         ar &BOOST_SERIALIZATION_NVP(useHDR);
129         ar &BOOST_SERIALIZATION_NVP(defaultWebcam);
130         ar &BOOST_SERIALIZATION_NVP(Brightness_front);
131         ar &BOOST_SERIALIZATION_NVP(Brightness_proj);
132         ar &BOOST_SERIALIZATION_NVP(Contrast_front);
133         ar &BOOST_SERIALIZATION_NVP(Contrast_proj);
134         ar &BOOST_SERIALIZATION_NVP(Saturation_front);
135         ar &BOOST_SERIALIZATION_NVP(Saturation_proj);
136         ar &BOOST_SERIALIZATION_NVP(Hue_front);
137         ar &BOOST_SERIALIZATION_NVP(Hue_proj);
138         ar &BOOST_SERIALIZATION_NVP(Gamma_front);
139         ar &BOOST_SERIALIZATION_NVP(Gamma_proj);
140         ar &BOOST_SERIALIZATION_NVP(PowerLineFrequency_front);
141         ar &BOOST_SERIALIZATION_NVP(PowerLineFrequency_proj);
142         ar &BOOST_SERIALIZATION_NVP(Sharpness_front);
143         ar &BOOST_SERIALIZATION_NVP(Sharpness_proj);
144         ar &BOOST_SERIALIZATION_NVP(
                BackLightCompensation_front);
145         ar &BOOST_SERIALIZATION_NVP(BackLightCompensation_proj
                );
146         ar &BOOST_SERIALIZATION_NVP(NNlocation);
147         ar &BOOST_SERIALIZATION_NVP(useCUDA);
148         ar &BOOST_SERIALIZATION_NVP(selectedResolution);
149         ar &BOOST_SERIALIZATION_NVP(SampleFolder);
150         ar &BOOST_SERIALIZATION_NVP(SettingsFolder);
151         ar &BOOST_SERIALIZATION_NVP(NNFolder);
152         ar &BOOST_SERIALIZATION_NVP(StandardSentTo);
153         ar &BOOST_SERIALIZATION_NVP(StandardPrinter);
154         ar &BOOST_SERIALIZATION_NVP(StandardNumberOfShots);
155         ar &BOOST_SERIALIZATION_NVP(PredictTheShape);
156         ar &BOOST_SERIALIZATION_NVP(Revolution);
157     }
158   }
159 };
160 }
161 BOOST_CLASS_VERSION(SoilAnalyzer::SoilSettings, 0)
```

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6   */
7
8  #include "soilsettings.h"
9
10 namespace SoilAnalyzer {
11 SoilSettings::SoilSettings() {}
```

```
12
13 void SoilSettings::LoadSettings(string filename) {
14   std::ifstream ifs(filename.c_str());
15   boost::archive::xml_iarchive ia(ifs);
16   ia >> boost::serialization::make_nvp("SoilSettings", *this
       );
17 }
18
19 void SoilSettings::SaveSettings(string filename) {
20   std::ofstream ofs(filename.c_str());
21   boost::archive::xml_oarchive oa(ofs);
22   oa << boost::serialization::make_nvp("SoilSettings", *this
       );
23 }
24 }
```

General project files

```
#-------------------------------------------------
#
# Project created by QtCreator 2015-08-08T18:57:27
#
#-------------------------------------------------

QT       += core gui concurrent
QMAKE_CXXFLAGS += -std=c++11

greaterThan(QT_MAJOR_VERSION, 4): QT += widgets
@
CONFIG(release, debug|release):DEFINES += QT_NO_DEBUG_OUTPUT
@

TARGET = SoilAnalyzer
TEMPLATE = lib
VERSION = 0.9.96

DEFINES += SOILANALYZER_LIBRARY

SOURCES += \
    soilsettings.cpp \
    sample.cpp \
    particle.cpp \
    analyzer.cpp

HEADERS +=\
    soilsettings.h \
    sample.h \
    particle.h \
    analyzer.h \
    soilanalyzerexception.h \
    soilanalyzer.h \
    lab_t_archive.h \
    soilanalyzertypes.h

#opencv
LIBS += -L/usr/local/lib -lopencv_core -lopencv_highgui
INCLUDEPATH += /usr/local/include/opencv
INCLUDEPATH += /usr/local/include

#boost
DEFINES += BOOST_ALL_DYN_LINK
INCLUDEPATH += /usr/include/boost
LIBS += -L/usr/lib/x86_64-linux-gnu/ -lboost_serialization -
   lboost_iostreams

#Zlib
LIBS += -L/usr/local/lib -lz
INCLUDEPATH += /usr/local/include

unix:!macx: LIBS += -L$$PWD/../../build/install/ -lSoilMath
INCLUDEPATH += $$PWD/../SoilMath
DEPENDPATH += $$PWD/../SoilMath
```

```
54
55 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
      lSoilVision
56 INCLUDEPATH += $$PWD/../SoilVision
57 DEPENDPATH += $$PWD/../SoilVision
58
59 #MainLib
60
61 target.path = $PWD/../../../build/install
62 INSTALLS += target
```

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6   */
7
8  #pragma once
9
10 #include <boost/archive/binary_iarchive.hpp>
11 #include <boost/archive/binary_oarchive.hpp>
12 #include <boost/serialization/access.hpp>
13 #include "soilanalyzertypes.h"
14
15 namespace boost {
16 namespace serialization {
17 /*!
18  * \brief serialize Serialize the openCV mat to disk
19  */
20 template <class Archive>
21 inline void serialize(Archive &ar, SoilAnalyzer::Lab_t &P,
      const unsigned int version __attribute__((unused))) {
22   ar &P.L;
23   ar &P.a;
24   ar &P.b;
25 }
26 }
27 }
```

```
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6   */
7  #define EXCEPTION_PARTICLE_NOT_ANALYZED "Particle not
      analyzed Exception!"
8  #define EXCEPTION_PARTICLE_NOT_ANALYZED_NR 0
9  #define EXCEPTION_NO_SNAPSHOTS "No snapshots Exception!"
10 #define EXCEPTION_NO_SNAPSHOTS_NR 1
```
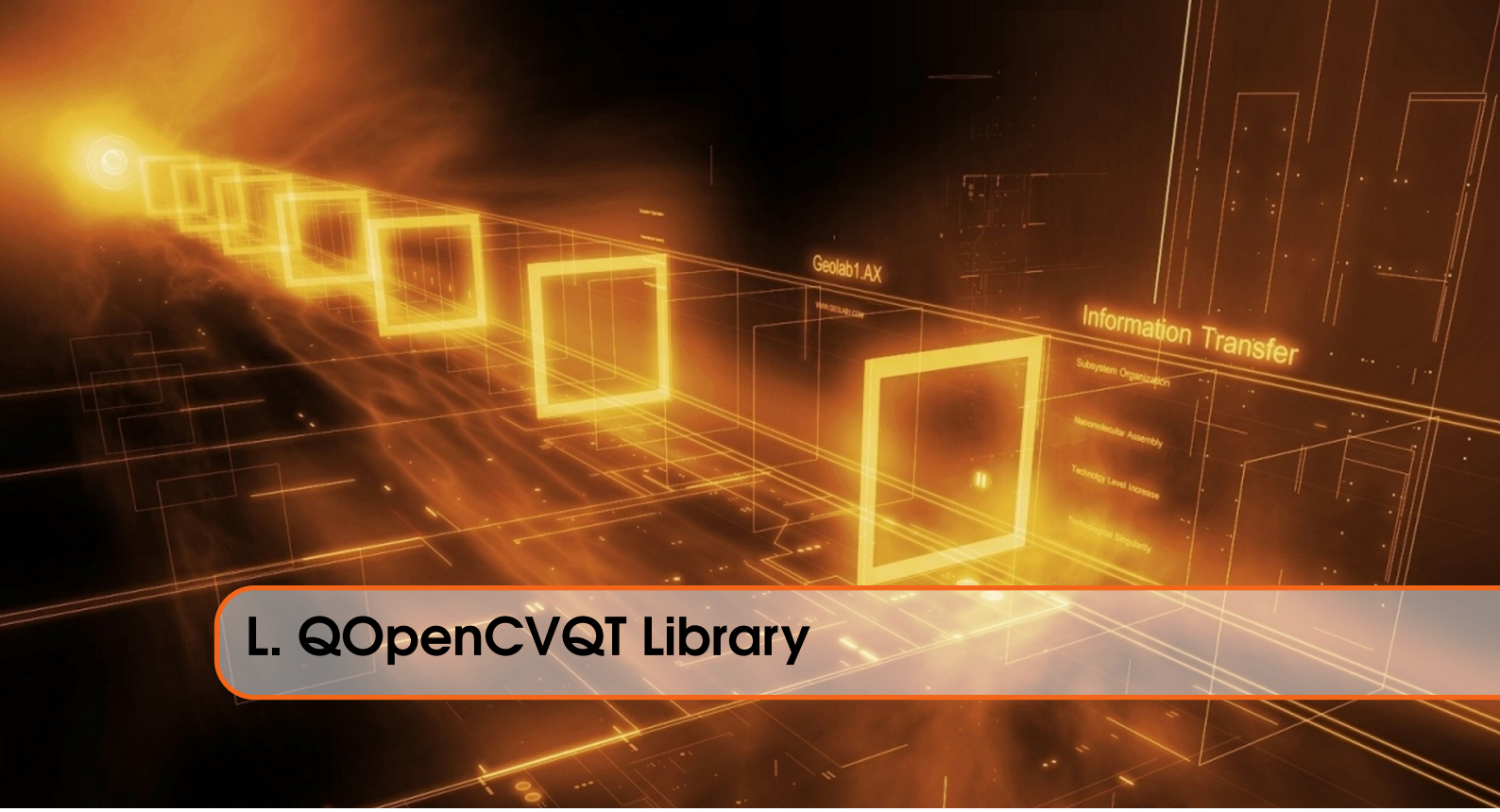

```
11 #define EXCEPTION_NO_IMAGES_PRESENT "No images to analyse
       exception!"
12 #define EXCEPTION_NO_IMAGES_PRESENT_NR 2
13
14 #pragma once
15 #include <exception>
16 #include <string>
17
18 namespace SoilAnalyzer {
19   namespace Exception {
20     class SoilAnalyzerException : public std::exception {
21     public:
22       SoilAnalyzerException(std::string m =
             EXCEPTION_PARTICLE_NOT_ANALYZED,
23                             int n =
                                 EXCEPTION_PARTICLE_NOT_ANALYZED_NR
                                 ) : msg(m), nr(n) { }
24       ~SoilAnalyzerException() _GLIBCXX_USE_NOEXCEPT {}
25       const char *what() const _GLIBCXX_USE_NOEXCEPT {
             return msg.c_str(); }
26       const int *id() const _GLIBCXX_USE_NOEXCEPT { return &
             nr; }
27
28     private:
29       std::string msg;
30       int nr;
31     };
32   }
33 }
```

```
1  #ifndef SOILANALYZERTYPES
2  #define SOILANALYZERTYPES
3
4  namespace SoilAnalyzer {
5    struct Point_t {
6      double x;
7      double y;
8    };
9
10   struct Lab_t {
11     float L;
12     float a;
13     float b;
14   };
15 }
16 #endif // SOILANALYZERTYPES
```



L. QOpenCVQT Library

```
#-------------------------------------------------
#
# Project created by QtCreator 2015-08-08T08:11:34
#
#-------------------------------------------------

TARGET = QOpenCVQT
TEMPLATE = lib

QT += gui

DEFINES += QOPENCVQT_LIBRARY
VERSION = 1.1.0
CONFIG += shared

SOURCES += qopencvqt.cpp

HEADERS += qopencvqt.h

#opencv
LIBS += -L/usr/local/lib -lopencv_core
INCLUDEPATH += /usr/local/include/opencv
INCLUDEPATH += /usr/local/include

#MainLib
unix {
    target.path = $PWD/../../../build/install
    INSTALLS += target
}
```

```
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```

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6   */
7
8   #ifndef QOPENCVQT_H
9   #define QOPENCVQT_H
10
11  #include <QImage>
12  #include <opencv2/core.hpp>
13  #include <opencv2/imgproc.hpp>
14  #include <vector>
15
16  class QOpenCVQT
17  {
18  public:
19    QOpenCVQT();
20    static cv::Mat WhiteBackground(const cv::Mat &src) {
21      cv::Mat dst;
22      cv::floodFill(src, dst, cv::Point(1,1), cv::Scalar_<
          uchar>(255,255,255));
23      return dst;
24    }
25
26    static QImage Mat2QImage(const cv::Mat &src) {
27      QImage dest;
28      if (src.channels() == 1) {
29        cv::Mat destRGB;
30        std::vector<cv::Mat> grayRGB(3, src);
31        cv::merge(grayRGB, destRGB);
32        dest = QImage((uchar *)destRGB.data, destRGB.cols,
            destRGB.rows,
33                      destRGB.step, QImage::Format_RGB888);
34      } else {
35        dest = QImage((uchar *)src.data, src.cols, src.rows,
            src.step,
36                      QImage::Format_RGB888);
37        dest = dest.rgbSwapped();
38      }
39      return dest;
40    }
41  };
42
43  #endif // QOPENCVQT_H
```

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6   */
```
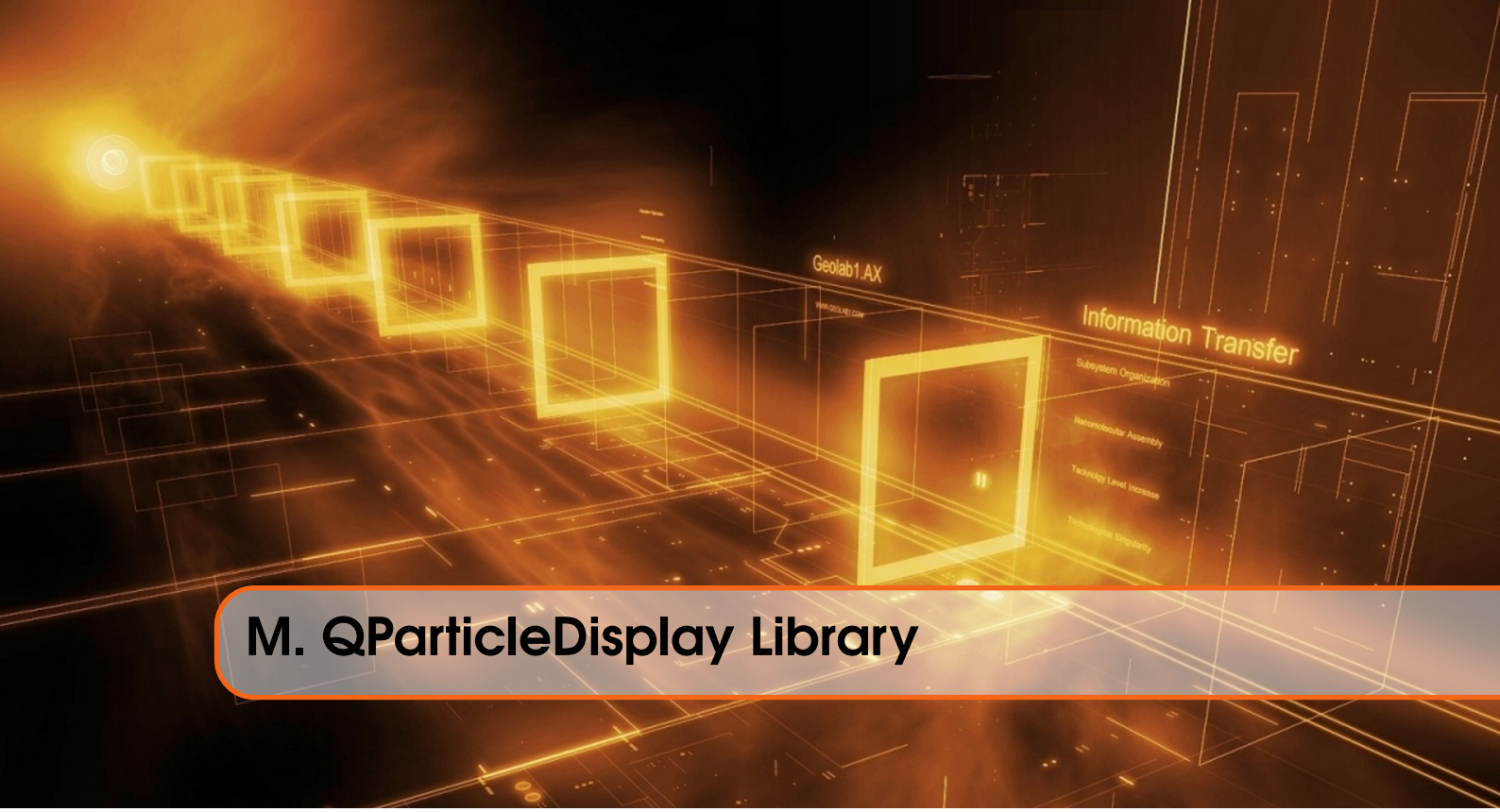

```
7
8  #include "qopencvqt.h"
9
10
11 QOpenCVQT::QOpenCVQT()
12 {
13 }
```



M. QParticleDisplay Library

```
#-------------------------------------------------
#
# Project created by QtCreator 2015-08-07T22:02:49
#
#-------------------------------------------------

QT       += core gui concurrent
QMAKE_CXXFLAGS += -std=c++11

greaterThan(QT_MAJOR_VERSION, 4): QT += widgets

TARGET = QParticleDisplay
TEMPLATE = lib
CONFIG += shared
VERSION = 1.3.25

SOURCES += qparticledisplay.cpp

HEADERS  += qparticledisplay.h

FORMS    += qparticledisplay.ui

unix:!macx: LIBS += -L$$PWD/../../build/install/ -
    lpictureflow-qt

INCLUDEPATH += $$PWD/../pictureflow-qt
DEPENDPATH += $$PWD/../pictureflow-qt

#MainLib
unix {
    target.path = $PWD/../../../build/install
    INSTALLS += target
```

```
32 }
33
34 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
       lSoilAnalyzer
35
36 INCLUDEPATH += $$PWD/../SoilAnalyzer
37 DEPENDPATH += $$PWD/../SoilAnalyzer
38
39 unix:!macx: LIBS += -L$$PWD/../../build/install/ -lSoilMath
40
41 INCLUDEPATH += $$PWD/../SoilMath
42 DEPENDPATH += $$PWD/../SoilMath
43
44 unix:!macx: LIBS += -L$$PWD/../../build/install/ -lQOpenCVQT
45
46 INCLUDEPATH += $$PWD/../QOpenCVQT
47 DEPENDPATH += $$PWD/../QOpenCVQT
48
49 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
       lSoilVision
50 INCLUDEPATH += $$PWD/../SoilVision
51 DEPENDPATH += $$PWD/../SoilVision
```

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6   */
7
8  #pragma once
9  #include <QWidget>
10 #include <QImage>
11 #include <qopencvqt.h>
12 #include <QColor>
13 #include <QWheelEvent>
14
15 #include "soilanalyzer.h"
16
17 namespace Ui {
18   class QParticleDisplay;
19 }
20
21 class QParticleDisplay : public QWidget
22 {
23   Q_OBJECT
24
25 public:
26   explicit QParticleDisplay(QWidget *parent = 0);
27   ~QParticleDisplay();
28   void SetSample(SoilAnalyzer::Sample *sample);
29   SoilAnalyzer::Particle *SelectedParticle;
30   void wheelEvent( QWheelEvent * event );
31   void next();
```

```
32
33 signals:
34   void particleChanged(int newValue);
35   void shapeClassificationChanged(int newValue);
36   void particleDeleted();
37
38 public slots:
39   void setSelectedParticle(int newValue);
40
41 private slots:
42   void on_selectedParticleChangedWidget(int value);
43   void on_selectedParticleChangedSlider(int value);
44   void on_pushButton_delete_clicked();
45
46 private:
47   Ui::QParticleDisplay *ui;
48   SoilAnalyzer::Sample *Sample;
49   QVector<QImage> images;
50   QImage ConvertParticleToQImage(SoilAnalyzer::Particle *
       particle);
51   bool dontDoIt = false;
52 };
```

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6   */
7
8  #include "qparticledisplay.h"
9  #include "ui_qparticledisplay.h"
10
11 QParticleDisplay::QParticleDisplay(QWidget *parent)
12     : QWidget(parent), ui(new Ui::QParticleDisplay) {
13   ui->setupUi(this);
14   ui->widget->setBackgroundColor(QColor("white"));
15   ui->widget->setSlideSize(QSize(230, 230));
16   connect(ui->widget, SIGNAL(centerIndexChanged(int)), this,
17           SLOT(on_selectedParticleChangedWidget(int)));
18   connect(ui->horizontalSlider, SIGNAL(valueChanged(int)),
       this,
19           SLOT(on_selectedParticleChangedSlider(int)));
20 }
21
22 QParticleDisplay::~QParticleDisplay() {
23   for (uint32_t i = 0; i < ui->widget->slideCount(); i++) {
24     ui->widget->removeSlide(0);
25   }
26   delete ui->widget;
27   delete ui;
28 }
29
30 void QParticleDisplay::setSelectedParticle(int newValue) {
```
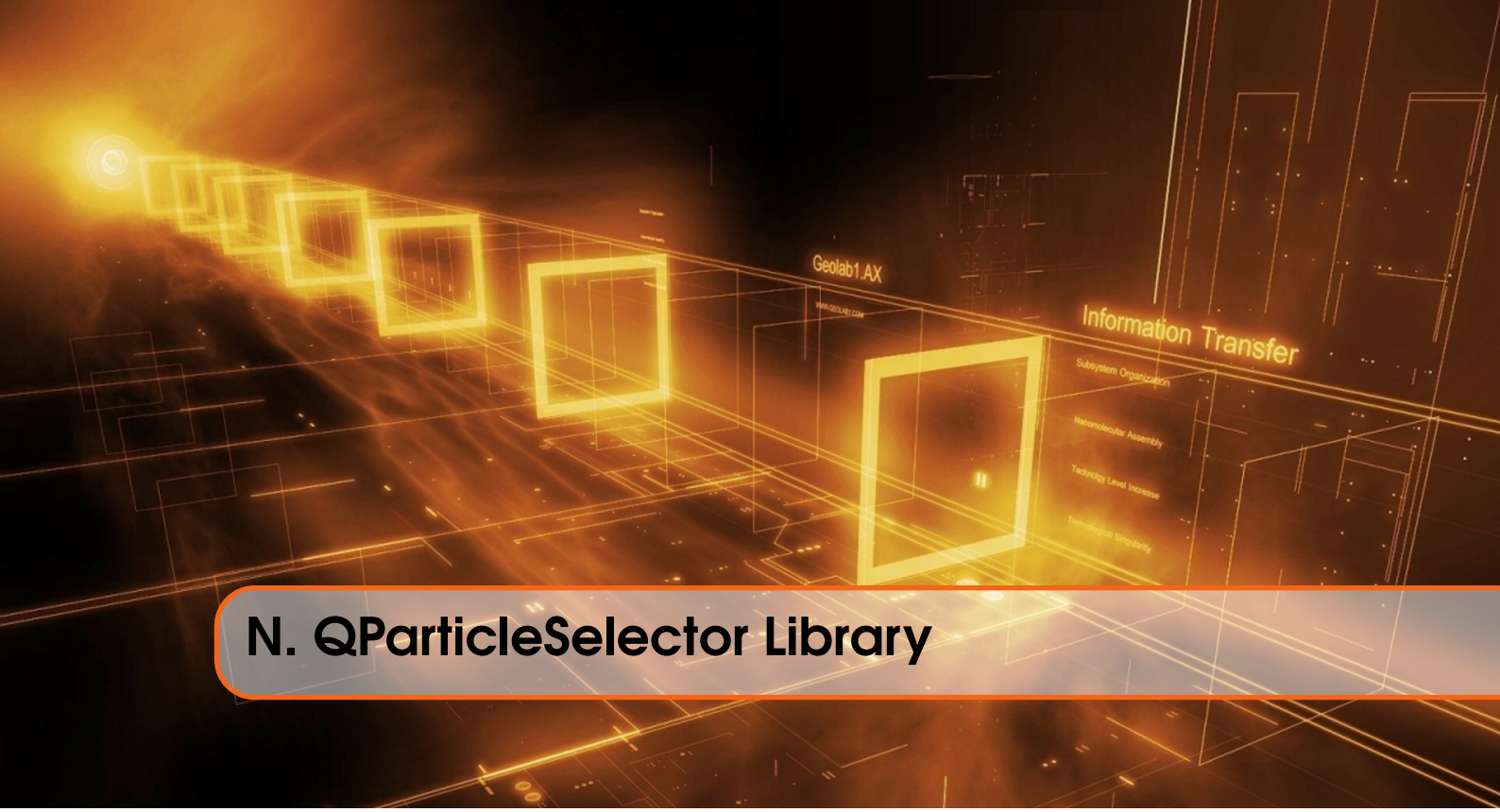

```
31    ui->widget->setCenterIndex(newValue);
32    ui->horizontalSlider->setValue(newValue);
33  }
34
35  void QParticleDisplay::SetSample(SoilAnalyzer::Sample *
        sample) {
36    this->Sample = sample;
37    images.clear();
38    ui->widget->clear();
39    ui->horizontalSlider->setMaximum(this->Sample->
          ParticlePopulation.size() - 1);
40    for (uint32_t i = 0; i < this->Sample->ParticlePopulation.
          size(); i++) {
41      images.push_back(
42          ConvertParticleToQImage(&Sample->ParticlePopulation.
              at(i)));
43      ui->widget->addSlide(images[images.size() - 1]);
44    }
45    SelectedParticle = &Sample->ParticlePopulation[ui->widget
          ->centerIndex()];
46    on_selectedParticleChangedSlider(0);
47  }
48
49  QImage
50  QParticleDisplay::ConvertParticleToQImage(SoilAnalyzer::
        Particle *particle) {
51    QImage dst(particle->BW.cols + 10, particle->BW.rows + 10,
52               QImage::Format_RGB32);
53    uint32_t nData = particle->BW.cols * particle->BW.rows;
54    uint32_t sData = ((dst.width() - 1) * 5) + 5;
55    uchar *QDst = dst.bits();
56    uchar *CVBW = particle->BW.data;
57    uchar *CVRGB = particle->RGB.data;
58    for (uint32_t i = 0; i < sData; i++) {
59      *(QDst++) = 255;
60      *(QDst++) = 255;
61      *(QDst++) = 255;
62      *(QDst++) = 0;
63    }
64    for (uint32_t i = 0; i < nData; i++) {
65      if ((i % particle->BW.cols) == 0) {
66        for (uint32_t j = 0; j < 10; j++) {
67          *(QDst++) = 255;
68          *(QDst++) = 255;
69          *(QDst++) = 255;
70          *(QDst++) = 0;
71        }
72      }
73      if (CVBW[i]) {
74        *(QDst++) = *(CVRGB);
75        *(QDst++) = *(CVRGB + 1);
76        *(QDst++) = *(CVRGB + 2);
77        *(QDst++) = 0;
78        CVRGB += 3;
79      } else {
80        *(QDst++) = 255;
```

```
81          *(QDst++) = 255;
82          *(QDst++) = 255;
83          *(QDst++) = 0;
84          CVRGB += 3;
85        }
86      }
87      for (uint32_t i = 0; i < sData; i++) {
88        *(QDst++) = 255;
89        *(QDst++) = 255;
90        *(QDst++) = 255;
91        *(QDst++) = 0;
92      }
93      return dst;
94    }
95
96    void QParticleDisplay::on_pushButton_delete_clicked() {
97      Sample->ParticlePopulation.erase(Sample->
            ParticlePopulation.begin() +
98                                       ui->widget->centerIndex()
                                           );
99      ui->widget->removeSlide(ui->widget->centerIndex());
100     ui->horizontalSlider->setMaximum(this->Sample->
            ParticlePopulation.size() - 1);
101     Sample->ParticleChangedStatePSD = true;
102     Sample->ParticleChangedStateAngularity = true;
103     Sample->ParticleChangedStateRoundness = true;
104     Sample->ChangesSinceLastSave = true;
105     Sample->ColorChange = true;
106     SelectedParticle = &Sample->ParticlePopulation[ui->widget
            ->centerIndex()];
107     emit particleDeleted();
108   }
109
110   void QParticleDisplay::on_selectedParticleChangedWidget(int
        value) {
111     if (!dontDoIt) {
112       dontDoIt = true;
113       ui->horizontalSlider->setValue(value);
114       SelectedParticle = &Sample->ParticlePopulation[ui->
            widget->centerIndex()];
115       QString volume;
116       volume.sprintf("%+06.2f", SelectedParticle->
            GetSiDiameter());
117       ui->label_Volume->setText(volume);
118       emit particleChanged(value);
119       emit shapeClassificationChanged(SelectedParticle->
            Classification.Category);
120       dontDoIt = false;
121     }
122   }
123
124   void QParticleDisplay::on_selectedParticleChangedSlider(int
        value) {
125     if (!dontDoIt) {
126       dontDoIt = true;
127       ui->widget->setCenterIndex(value);
```

```
128       SelectedParticle = &Sample->ParticlePopulation[ui->
              widget->centerIndex()];
129       QString volume;
130       volume.sprintf("%+06.2f", SelectedParticle->
              GetSiDiameter());
131       ui->label_Volume->setText(volume);
132       emit particleChanged(value);
133       emit shapeClassificationChanged(SelectedParticle->
              Classification.Category);
134       dontDoIt = false;
135     }
136   }
137
138   void QParticleDisplay::wheelEvent(QWheelEvent *event) {
139     int i = ui->widget->centerIndex();
140     i -= event->delta() / 120;
141     if (i < 0) {
142       i = ui->widget->slideCount() - abs(i) - 1;
143     } else if (i >= ui->widget->slideCount()) {
144       i = 0;
145     }
146     ui->widget->setCenterIndex(i);
147     on_selectedParticleChangedWidget(i);
148   }
149
150   void QParticleDisplay::next() {
151     int i = ui->widget->centerIndex();
152     i++;
153     if (i < 0) {
154       i = ui->widget->slideCount() - abs(i) - 1;
155     } else if (i >= ui->widget->slideCount()) {
156       i = 0;
157     }
158     ui->widget->setCenterIndex(i);
159     on_selectedParticleChangedWidget(i);
160   }
```



N. QParticleSelector Library

```
1  #-------------------------------------------------
2  #
3  # Project created by QtCreator 2015-08-07T18:56:27
4  #
5  #-------------------------------------------------
6
7  QT       += core gui
8  QMAKE_CXXFLAGS += -std=c++11
9
10 greaterThan(QT_MAJOR_VERSION, 4): QT += widgets
11
12 TARGET = QParticleSelector
13 TEMPLATE = lib
14 CONFIG += shared
15 VERSION = 0.1.11
16
17 SOURCES += qparticleselector.cpp
18
19 HEADERS  += qparticleselector.h
20
21 FORMS    += qparticleselector.ui
22
23 RESOURCES += \
24     qparticleselector.qrc
25
26 #MainLib
27 unix {
28     target.path = $PWD/../../../build/install
29     INSTALLS += target
30 }
31
32 unix:!macx: LIBS += -L$$PWD/../../build/install/ -lSoilMath
```

```
33
34 INCLUDEPATH += $$PWD/../SoilMath
35 DEPENDPATH += $$PWD/../SoilMath
```

```
1  #ifndef QPARTICLESELECTOR_H
2  #define QPARTICLESELECTOR_H
3
4  #include <QWidget>
5  #include <QPushButton>
6
7  namespace Ui {
8    class QParticleSelector;
9  }
10
11 class QParticleSelector : public QWidget
12 {
13   Q_OBJECT
14
15 public:
16   explicit QParticleSelector(QWidget *parent = 0);
17   ~QParticleSelector();
18
19   void setDisabled(bool value, int currentClass = 1);
20
21 signals:
22   void valueChanged(int newValue);
23
24 public slots:
25   void setValue(int newValue);
26
27 private slots:
28   void on_pb_1_clicked(bool checked);
29
30   void on_pb_2_clicked(bool checked);
31
32   void on_pb_3_clicked(bool checked);
33
34   void on_pb_4_clicked(bool checked);
35
36   void on_pb_5_clicked(bool checked);
37
38   void on_pb_6_clicked(bool checked);
39
40   void on_pb_7_clicked(bool checked);
41
42   void on_pb_8_clicked(bool checked);
43
44   void on_pb_9_clicked(bool checked);
45
46   void on_pb_10_clicked(bool checked);
47
48   void on_pb_11_clicked(bool checked);
49
50   void on_pb_12_clicked(bool checked);
51
52   void on_pb_13_clicked(bool checked);
```

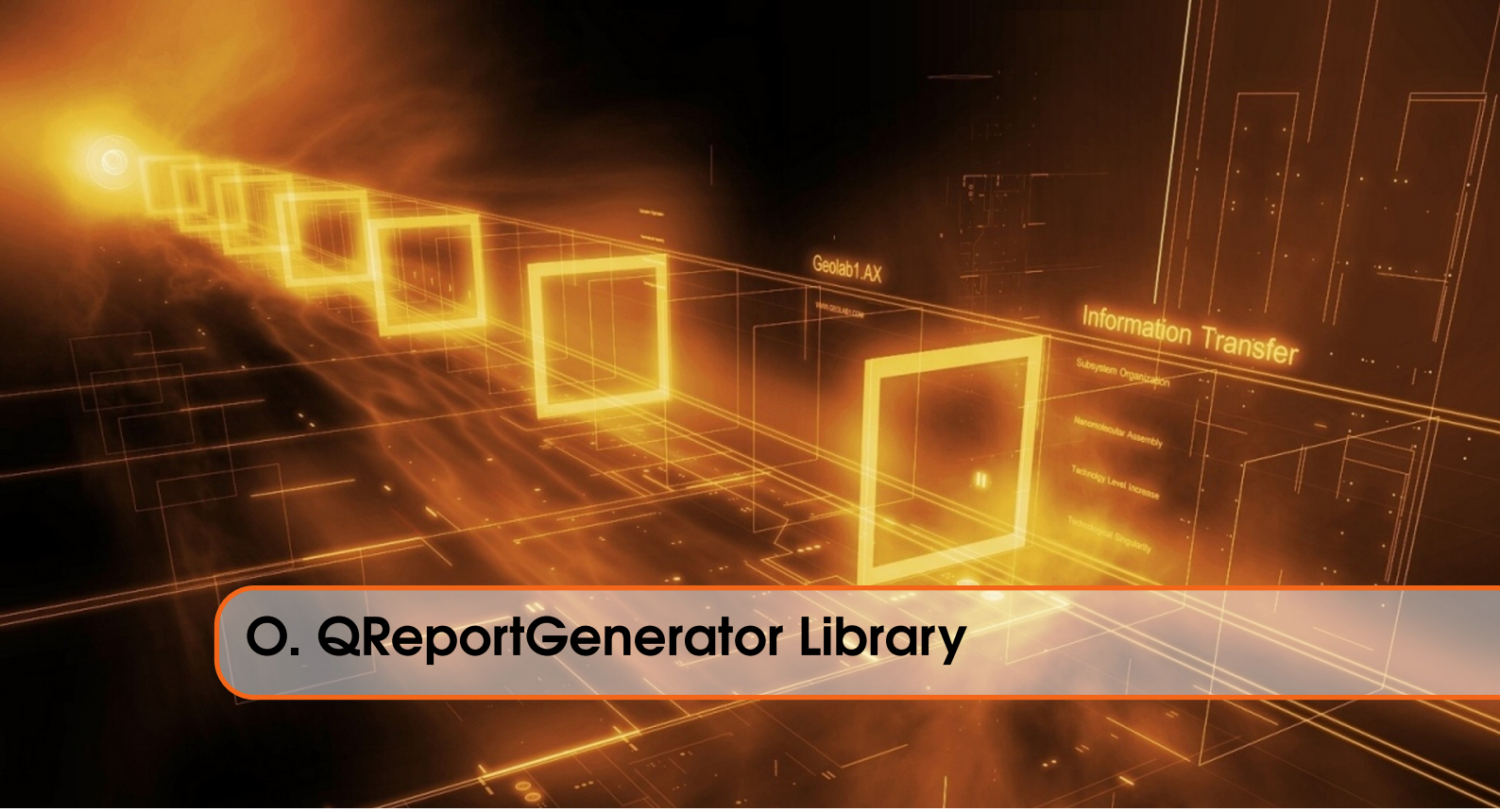
```
53
54    void on_pb_14_clicked(bool checked);
55
56    void on_pb_15_clicked(bool checked);
57
58    void on_pb_16_clicked(bool checked);
59
60    void on_pb_17_clicked(bool checked);
61
62    void on_pb_18_clicked(bool checked);
63
64  private:
65    QVector<QPushButton *> btns;
66    Ui::QParticleSelector *ui;
67  };
68
69  #endif // QPARTICLESELECTOR_H
```

```
1   #include "qparticleselector.h"
2   #include "ui_qparticleselector.h"
3
4   QParticleSelector::QParticleSelector(QWidget *parent)
5       : QWidget(parent), ui(new Ui::QParticleSelector) {
6     ui->setupUi(this);
7     btns.push_back(ui->pb_1);
8     btns.push_back(ui->pb_2);
9     btns.push_back(ui->pb_3);
10    btns.push_back(ui->pb_4);
11    btns.push_back(ui->pb_5);
12    btns.push_back(ui->pb_6);
13    btns.push_back(ui->pb_7);
14    btns.push_back(ui->pb_8);
15    btns.push_back(ui->pb_9);
16    btns.push_back(ui->pb_10);
17    btns.push_back(ui->pb_11);
18    btns.push_back(ui->pb_12);
19    btns.push_back(ui->pb_13);
20    btns.push_back(ui->pb_14);
21    btns.push_back(ui->pb_15);
22    btns.push_back(ui->pb_16);
23    btns.push_back(ui->pb_17);
24    btns.push_back(ui->pb_18);
25  }
26
27  QParticleSelector::~QParticleSelector() {
28    for (auto b : btns) {
29      delete b;
30    }
31    btns.clear();
32    delete ui;
33  }
34
35  void QParticleSelector::setValue(int newValue) {
36    btns[newValue - 1]->setChecked(true);
37  }
38
```

```
39 void QParticleSelector::setDisabled(bool value, int
       currentClass) {
40   for (auto b : btns) {
41     b->setDisabled(value);
42   }
43   if (currentClass > 18 || currentClass < 1) {
44     btns[0]->setChecked(true);
45   } else {
46     btns[currentClass - 1]->setChecked(true);
47   }
48 }
49
50 void QParticleSelector::on_pb_1_clicked(bool checked) {
51   if (checked) {
52     emit valueChanged(1);
53   }
54 }
55
56 void QParticleSelector::on_pb_2_clicked(bool checked) {
57   if (checked) {
58     emit valueChanged(2);
59   }
60 }
61
62 void QParticleSelector::on_pb_3_clicked(bool checked) {
63   if (checked) {
64     emit valueChanged(3);
65   }
66 }
67
68 void QParticleSelector::on_pb_4_clicked(bool checked) {
69   if (checked) {
70     emit valueChanged(4);
71   }
72 }
73
74 void QParticleSelector::on_pb_5_clicked(bool checked) {
75   if (checked) {
76     emit valueChanged(5);
77   }
78 }
79
80 void QParticleSelector::on_pb_6_clicked(bool checked) {
81   if (checked) {
82     emit valueChanged(6);
83   }
84 }
85
86 void QParticleSelector::on_pb_7_clicked(bool checked) {
87   if (checked) {
88     emit valueChanged(7);
89   }
90 }
91
92 void QParticleSelector::on_pb_8_clicked(bool checked) {
93   if (checked) {
```

```
94      emit valueChanged(8);
95    }
96  }
97
98  void QParticleSelector::on_pb_9_clicked(bool checked) {
99    if (checked) {
100     emit valueChanged(9);
101   }
102 }
103
104 void QParticleSelector::on_pb_10_clicked(bool checked) {
105   if (checked) {
106     emit valueChanged(10);
107   }
108 }
109
110 void QParticleSelector::on_pb_11_clicked(bool checked) {
111   if (checked) {
112     emit valueChanged(11);
113   }
114 }
115
116 void QParticleSelector::on_pb_12_clicked(bool checked) {
117   if (checked) {
118     emit valueChanged(12);
119   }
120 }
121
122 void QParticleSelector::on_pb_13_clicked(bool checked) {
123   if (checked) {
124     emit valueChanged(13);
125   }
126 }
127
128 void QParticleSelector::on_pb_14_clicked(bool checked) {
129   if (checked) {
130     emit valueChanged(14);
131   }
132 }
133
134 void QParticleSelector::on_pb_15_clicked(bool checked) {
135   if (checked) {
136     emit valueChanged(15);
137   }
138 }
139
140 void QParticleSelector::on_pb_16_clicked(bool checked) {
141   if (checked) {
142     emit valueChanged(16);
143   }
144 }
145
146 void QParticleSelector::on_pb_17_clicked(bool checked) {
147   if (checked) {
148     emit valueChanged(17);
149   }
```

```
150 }
151
152 void QParticleSelector::on_pb_18_clicked(bool checked) {
153   if (checked) {
154     emit valueChanged(18);
155   }
156 }
```



0. QReportGenerator Library

```
1  #-------------------------------------------------
2  #
3  # Project created by QtCreator 2015-08-20T08:46:42
4  #
5  #-------------------------------------------------
6
7  QT       += core gui concurrent network
8  QMAKE_CXXFLAGS += -std=c++11
9
10 greaterThan(QT_MAJOR_VERSION, 4): QT += widgets printsupport
       multimedia multimediawidgets
11
12 @
13 CONFIG(release, debug|release):DEFINES += QT_NO_DEBUG_OUTPUT
14 @
15
16 unix:!macx: QMAKE_RPATHDIR += $$PWD/../../../build/install/
17
18 TARGET = QReportGenerator
19 TEMPLATE = lib
20 CONFIG += shared
21 VERSION = 0.1.00
22
23 SOURCES += \
24     qreportgenerator.cpp \
25     ../qcustomplot/examples/text-document-integration/
          qcpdocumentobject.cpp
26
27 HEADERS  += \
28     qreportgenerator.h \
29     ../qcustomplot/examples/text-document-integration/
          qcpdocumentobject.h
```

```
30
31 FORMS    += \
32     qreportgenerator.ui
33
34 #MainLib
35 unix {
36     target.path = $PWD/../../../build/install
37     INSTALLS += target
38 }
39
40 unix:!macx: LIBS += -L$$PWD/../../build/install/ -lSoilMath
41 INCLUDEPATH += $$PWD/../SoilMath
42 DEPENDPATH += $$PWD/../SoilMath
43
44 DEFINES += QCUSTOMPLOT_USE_LIBRARY
45 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
      lqcustomplot
46
47 INCLUDEPATH += $$PWD/../qcustomplot
48 DEPENDPATH += $$PWD/../qcustomplot
49
50 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
      lSoilAnalyzer
51 INCLUDEPATH += $$PWD/../SoilAnalyzer
52 DEPENDPATH += $$PWD/../SoilAnalyzer
53
54 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
      lSoilVision
55 INCLUDEPATH += $$PWD/../SoilVision
56 DEPENDPATH += $$PWD/../SoilVision
57
58 RESOURCES += \
59     qreportresources.qrc \
60     ../VSA/vsa_resources.qrc
61
62 #maps
63 Mapstarget.path += $${OUT_PWD}/Maps
64 Mapstarget.files += $${PWD}/Maps/*
65 INSTALLS += Mapstarget
66 bMapstarget.path += $${PWD}/../../build/install/Maps
67 bMapstarget.files += $${PWD}/Maps/*
68 INSTALLS += bMapstarget
```

```
1  #ifndef QREPORTGENERATOR_H
2  #define QREPORTGENERATOR_H
3
4  #include <QMainWindow>
5  #include <QTextDocument>
6  #include <QDebug>
7  #include <QTextBlockFormat>
8  #include <QTextCharFormat>
9  #include <QTextBlock>
10 #include <QNetworkAccessManager>
11 #include <QNetworkReply>
12 #include <QTextDocumentWriter>
13 #include <QPrinter>
```

```
14
15 #include "soilanalyzer.h"
16 #include "SoilMath.h"
17
18 #include <qcustomplot.h>
19 #include "../qcustomplot/examples/text-document-integration/
       qcpdocumentobject.h"
20
21 namespace Ui {
22   class QReportGenerator;
23 }
24
25 class QReportGenerator : public QMainWindow
26 {
27   Q_OBJECT
28
29 public:
30   QTextDocument *Report = nullptr;
31   SoilAnalyzer::Sample *Sample = nullptr;
32   SoilAnalyzer::SoilSettings *Settings = nullptr;
33   QCustomPlot *PSD = nullptr;
34   QCustomPlot *Roundness = nullptr;
35   QCustomPlot *Angularity = nullptr;
36
37   explicit QReportGenerator(QWidget *parent = 0,
         SoilAnalyzer::Sample *sample = nullptr, SoilAnalyzer::
         SoilSettings *settings = nullptr, QCustomPlot *psd =
         nullptr, QCustomPlot *roundness = nullptr, QCustomPlot
         *angularity = nullptr);
38   ~QReportGenerator();
39
40 private slots:
41   void on_locationImageDownloaded(QNetworkReply *reply);
42
43   void on_actionSave_triggered();
44
45   void on_actionExport_to_PDF_triggered();
46
47 private:
48   Ui::QReportGenerator *ui;
49   QCustomPlot *CIElabPlot = nullptr;
50
51   void getLocationMap(double &latitude, double &longtitude);
52   void SetupCIElabPLot();
53
54   QImage *mapLocation = nullptr;
55
56   QTextCursor rCurs;
57
58   // Layout formats
59   QTextBlockFormat TitleFormat;
60   QTextBlockFormat HeaderFormat;
61   QTextBlockFormat GeneralFormat;
62   QTextBlockFormat ImageGraphFormat;
63
64   QTextCharFormat TitleTextFormat;
```

```
65    QTextCharFormat HeaderTextFormat;
66    QTextCharFormat GtxtFormat;
67    QTextCharFormat GFieldtxtFormat;
68
69    QTextListFormat GeneralSampleList;
70    QTextTableFormat GeneralTextTableFormat;
71
72
73    QFont TitleFont;
74    QFont HeaderFont;
75    QFont GeneralFont;
76    QFont FieldFont;
77  };
78
79  #endif // QREPORTGENERATOR_H
```

```
1   #include "qreportgenerator.h"
2   #include "ui_qreportgenerator.h"
3
4   QReportGenerator::QReportGenerator(QWidget *parent,
5                                      SoilAnalyzer::Sample *
                                           sample,
6                                      SoilAnalyzer::
                                           SoilSettings *settings
                                           ,
7                                      QCustomPlot *psd,
                                           QCustomPlot *roundness
                                           ,
8                                      QCustomPlot *angularity)
9       : QMainWindow(parent), ui(new Ui::QReportGenerator) {
10    ui->setupUi(this);
11    if (settings == nullptr) {
12      settings = new SoilAnalyzer::SoilSettings;
13    }
14    this->Settings = settings;
15    if (sample == nullptr) {
16      sample = new SoilAnalyzer::Sample;
17    }
18    this->Sample = sample;
19
20    if (psd == nullptr) {
21      psd = new QCustomPlot;
22    }
23    this->PSD = psd;
24
25    if (roundness == nullptr) {
26      roundness = new QCustomPlot;
27    }
28    this->Roundness = roundness;
29
30    if (angularity == nullptr) {
31      angularity = new QCustomPlot;
32    }
33    this->Angularity = angularity;
34
35    Report = new QTextDocument(ui->textEdit);
```

```
36    ui->textEdit->setDocument(Report);
37    rCurs = QTextCursor(Report);
38
39    // Setup the layout
40    TitleFormat.setAlignment(Qt::AlignCenter);
41    TitleFont.setBold(true);
42    TitleFont.setPointSize(36);
43    TitleTextFormat.setFont(TitleFont);
44
45    HeaderFormat.setAlignment(Qt::AlignCenter);
46    HeaderFormat.setPageBreakPolicy(QTextFormat::
         PageBreak_AlwaysBefore);
47    HeaderFormat.setTopMargin(40);
48    HeaderFormat.setBottomMargin(10);
49    HeaderFont.setBold(true);
50    HeaderFont.setPointSize(18);
51    HeaderTextFormat.setFont(HeaderFont);
52
53    ImageGraphFormat.setAlignment(Qt::AlignCenter);
54    ImageGraphFormat.setTopMargin(10);
55    ImageGraphFormat.setBottomMargin(10);
56
57    GeneralFormat.setAlignment(Qt::AlignLeft);
58
59    GeneralFont.setPointSize(12);
60    GeneralFont.setBold(false);
61    GtxtFormat.setFont(GeneralFont);
62
63    FieldFont.setBold(true);
64    GFieldtxtFormat.setFont(FieldFont);
65
66    GeneralSampleList.setStyle(QTextListFormat::ListDisc);
67
68    GeneralTextTableFormat.setHeaderRowCount(1);
69    GeneralTextTableFormat.setBorderStyle(QTextFrameFormat::
         BorderStyle_None);
70    GeneralTextTableFormat.setWidth(
71        QTextLength(QTextLength::PercentageLength, 90));
72    GeneralTextTableFormat.setAlignment(Qt::AlignCenter);
73
74    // Setup the Title
75    rCurs.setBlockFormat(TitleFormat);
76    rCurs.insertText("Soil Report", TitleTextFormat);
77    rCurs.insertBlock();
78
79    // Setup the general Text
80    rCurs.insertBlock(ImageGraphFormat);
81    QTextTable *mainTable = rCurs.insertTable(5, 2,
         GeneralTextTableFormat);
82    rCurs = mainTable->cellAt(0, 0).firstCursorPosition();
83    rCurs.insertText("Sample name:", GFieldtxtFormat);
84    rCurs.movePosition(QTextCursor::NextCell);
85    rCurs.insertText(QString::fromStdString(Sample->Name),
         GtxtFormat);
86    rCurs.movePosition(QTextCursor::NextCell);
87
```

```
88    rCurs.insertText("Sample ID:", GFieldtxtFormat);
89    rCurs.movePosition(QTextCursor::NextCell);
90    rCurs.insertText(QString::number(Sample->ID), GtxtFormat);
91    rCurs.movePosition(QTextCursor::NextCell);
92
93    rCurs.insertText("Date:", GFieldtxtFormat);
94    rCurs.movePosition(QTextCursor::NextCell);
95    rCurs.insertText(QString::fromStdString(Sample->Date),
          GtxtFormat);
96    rCurs.movePosition(QTextCursor::NextCell);
97
98    rCurs.insertText("Location:", GFieldtxtFormat);
99    rCurs.movePosition(QTextCursor::NextCell);
100   rCurs.insertText(QString::number(Sample->Latitude),
          GtxtFormat);
101   rCurs.insertText(", ", GtxtFormat);
102   rCurs.insertText(QString::number(Sample->Longtitude),
          GtxtFormat);
103   rCurs.movePosition(QTextCursor::NextCell);
104
105   rCurs.insertText("Sample depth:", GFieldtxtFormat);
106   rCurs.movePosition(QTextCursor::NextCell);
107   rCurs.insertText(QString::number(Sample->Depth),
          GtxtFormat);
108   rCurs.insertText(" [m]", GtxtFormat);
109   rCurs.movePosition(QTextCursor::NextBlock);
110   rCurs.insertBlock();
111
112   // Insert the Google map
113   getLocationMap(Sample->Latitude, Sample->Longtitude);
114
115   // Setup the QCustomplot handler
116   QCPDocumentObject *plotObjectHandler = new
          QCPDocumentObject(this);
117   ui->textEdit->document()->documentLayout()->
          registerHandler(
118        QCPDocumentObject::PlotTextFormat, plotObjectHandler);
119
120   // Setup the Textdata for the PSD
121   rCurs.insertBlock(HeaderFormat, HeaderTextFormat);
122   rCurs.insertText("Particle Size Distribution");
123
124   rCurs.insertBlock(ImageGraphFormat);
125   QTextTable *PSDdescr = rCurs.insertTable(6, 2,
          GeneralTextTableFormat);
126   rCurs = PSDdescr->cellAt(0, 0).firstCursorPosition();
127   rCurs.insertText("No of particles:", GFieldtxtFormat);
128   rCurs.movePosition(QTextCursor::NextCell);
129   rCurs.insertText(QString::number(Sample->PSD.n),
          GtxtFormat);
130   rCurs.movePosition(QTextCursor::NextCell);
131
132   rCurs.insertText("Mean: ", GFieldtxtFormat);
133   rCurs.movePosition(QTextCursor::NextCell);
134   rCurs.insertText(QString::number(Sample->PSD.Mean),
          GtxtFormat);
```

```
135     rCurs.movePosition(QTextCursor::NextCell);
136
137     rCurs.insertText("Minimum: ", GFieldtxtFormat);
138     rCurs.movePosition(QTextCursor::NextCell);
139     rCurs.insertText(QString::number(Sample->PSD.min),
            GtxtFormat);
140     rCurs.movePosition(QTextCursor::NextCell);
141
142     rCurs.insertText("Maximum: ", GFieldtxtFormat);
143     rCurs.movePosition(QTextCursor::NextCell);
144     rCurs.insertText(QString::number(Sample->PSD.max),
            GtxtFormat);
145     rCurs.movePosition(QTextCursor::NextCell);
146
147     rCurs.insertText("Range: ", GFieldtxtFormat);
148     rCurs.movePosition(QTextCursor::NextCell);
149     rCurs.insertText(QString::number(Sample->PSD.Range),
            GtxtFormat);
150     rCurs.movePosition(QTextCursor::NextCell);
151
152     rCurs.insertText("Standard deviation: ", GFieldtxtFormat);
153     rCurs.movePosition(QTextCursor::NextCell);
154     rCurs.insertText(QString::number(Sample->PSD.Std),
            GtxtFormat);
155     rCurs.movePosition(QTextCursor::NextBlock);
156
157     // Setup the PSD
158     rCurs.insertBlock(ImageGraphFormat);
159     rCurs.insertText(QString(QChar::ObjectReplacementCharacter
            ),
160                      QCPDocumentObject::generatePlotFormat(PSD
                             , 600, 350));
161
162     rCurs.insertBlock(ImageGraphFormat);
163     QTextTable *PSDdata = rCurs.insertTable(16, 3,
            GeneralTextTableFormat);
164     rCurs.insertText("Mesh Size [mm]", GFieldtxtFormat);
165     rCurs.movePosition(QTextCursor::NextCell);
166     rCurs.insertText("Cummulatief [%]", GFieldtxtFormat);
167     rCurs.movePosition(QTextCursor::NextCell);
168     rCurs.insertText("Retained [-]", GFieldtxtFormat);
169     rCurs.movePosition(QTextCursor::NextCell);
170     rCurs.insertText("2", GFieldtxtFormat);
171     rCurs.movePosition(QTextCursor::NextCell);
172     rCurs.insertText(QString::number(Sample->PSD.CFD[14]),
            GtxtFormat);
173     rCurs.movePosition(QTextCursor::NextCell);
174     rCurs.insertText(QString::number(Sample->PSD.bins[14]),
            GtxtFormat);
175     rCurs.movePosition(QTextCursor::NextCell);
176     rCurs.insertText("1.4", GFieldtxtFormat);
177     rCurs.movePosition(QTextCursor::NextCell);
178     rCurs.insertText(QString::number(Sample->PSD.CFD[13]),
            GtxtFormat);
179     rCurs.movePosition(QTextCursor::NextCell);
```

```
180     rCurs.insertText(QString::number(Sample->PSD.bins[13]),
            GtxtFormat);
181     rCurs.movePosition(QTextCursor::NextCell);
182     rCurs.insertText("1", GFieldtxtFormat);
183     rCurs.movePosition(QTextCursor::NextCell);
184     rCurs.insertText(QString::number(Sample->PSD.CFD[12]),
            GtxtFormat);
185     rCurs.movePosition(QTextCursor::NextCell);
186     rCurs.insertText(QString::number(Sample->PSD.bins[12]),
            GtxtFormat);
187     rCurs.movePosition(QTextCursor::NextCell);
188     rCurs.insertText("0.71", GFieldtxtFormat);
189     rCurs.movePosition(QTextCursor::NextCell);
190     rCurs.insertText(QString::number(Sample->PSD.CFD[11]),
            GtxtFormat);
191     rCurs.movePosition(QTextCursor::NextCell);
192     rCurs.insertText(QString::number(Sample->PSD.bins[11]),
            GtxtFormat);
193     rCurs.movePosition(QTextCursor::NextCell);
194     rCurs.insertText("0.5", GFieldtxtFormat);
195     rCurs.movePosition(QTextCursor::NextCell);
196     rCurs.insertText(QString::number(Sample->PSD.CFD[10]),
            GtxtFormat);
197     rCurs.movePosition(QTextCursor::NextCell);
198     rCurs.insertText(QString::number(Sample->PSD.bins[10]),
            GtxtFormat);
199     rCurs.movePosition(QTextCursor::NextCell);
200     rCurs.insertText("0.355", GFieldtxtFormat);
201     rCurs.movePosition(QTextCursor::NextCell);
202     rCurs.insertText(QString::number(Sample->PSD.CFD[9]),
            GtxtFormat);
203     rCurs.movePosition(QTextCursor::NextCell);
204     rCurs.insertText(QString::number(Sample->PSD.bins[9]),
            GtxtFormat);
205     rCurs.movePosition(QTextCursor::NextCell);
206     rCurs.insertText("0.25", GFieldtxtFormat);
207     rCurs.movePosition(QTextCursor::NextCell);
208     rCurs.insertText(QString::number(Sample->PSD.CFD[8]),
            GtxtFormat);
209     rCurs.movePosition(QTextCursor::NextCell);
210     rCurs.insertText(QString::number(Sample->PSD.bins[8]),
            GtxtFormat);
211     rCurs.movePosition(QTextCursor::NextCell);
212     rCurs.insertText("0.18", GFieldtxtFormat);
213     rCurs.movePosition(QTextCursor::NextCell);
214     rCurs.insertText(QString::number(Sample->PSD.CFD[7]),
            GtxtFormat);
215     rCurs.movePosition(QTextCursor::NextCell);
216     rCurs.insertText(QString::number(Sample->PSD.bins[7]),
            GtxtFormat);
217     rCurs.movePosition(QTextCursor::NextCell);
218     rCurs.insertText("0.125", GFieldtxtFormat);
219     rCurs.movePosition(QTextCursor::NextCell);
220     rCurs.insertText(QString::number(Sample->PSD.CFD[6]),
            GtxtFormat);
221     rCurs.movePosition(QTextCursor::NextCell);
```

```
222     rCurs.insertText(QString::number(Sample->PSD.bins[6]),
            GtxtFormat);
223     rCurs.movePosition(QTextCursor::NextCell);
224     rCurs.insertText("0.09", GFieldtxtFormat);
225     rCurs.movePosition(QTextCursor::NextCell);
226     rCurs.insertText(QString::number(Sample->PSD.CFD[5]),
            GtxtFormat);
227     rCurs.movePosition(QTextCursor::NextCell);
228     rCurs.insertText(QString::number(Sample->PSD.bins[5]),
            GtxtFormat);
229     rCurs.movePosition(QTextCursor::NextCell);
230     rCurs.insertText("0.075", GFieldtxtFormat);
231     rCurs.movePosition(QTextCursor::NextCell);
232     rCurs.insertText(QString::number(Sample->PSD.CFD[4]),
            GtxtFormat);
233     rCurs.movePosition(QTextCursor::NextCell);
234     rCurs.insertText(QString::number(Sample->PSD.bins[4]),
            GtxtFormat);
235     rCurs.movePosition(QTextCursor::NextCell);
236     rCurs.insertText("0.063", GFieldtxtFormat);
237     rCurs.movePosition(QTextCursor::NextCell);
238     rCurs.insertText(QString::number(Sample->PSD.CFD[3]),
            GtxtFormat);
239     rCurs.movePosition(QTextCursor::NextCell);
240     rCurs.insertText(QString::number(Sample->PSD.bins[3]),
            GtxtFormat);
241     rCurs.movePosition(QTextCursor::NextCell);
242     rCurs.insertText("0.045", GFieldtxtFormat);
243     rCurs.movePosition(QTextCursor::NextCell);
244     rCurs.insertText(QString::number(Sample->PSD.CFD[2]),
            GtxtFormat);
245     rCurs.movePosition(QTextCursor::NextCell);
246     rCurs.insertText(QString::number(Sample->PSD.bins[2]),
            GtxtFormat);
247     rCurs.movePosition(QTextCursor::NextCell);
248     rCurs.insertText("0.038", GFieldtxtFormat);
249     rCurs.movePosition(QTextCursor::NextCell);
250     rCurs.insertText(QString::number(Sample->PSD.CFD[1]),
            GtxtFormat);
251     rCurs.movePosition(QTextCursor::NextCell);
252     rCurs.insertText(QString::number(Sample->PSD.bins[1]),
            GtxtFormat);
253     rCurs.movePosition(QTextCursor::NextCell);
254     rCurs.insertText("0", GFieldtxtFormat);
255     rCurs.movePosition(QTextCursor::NextCell);
256     rCurs.insertText(QString::number(Sample->PSD.CFD[0]),
            GtxtFormat);
257     rCurs.movePosition(QTextCursor::NextCell);
258     rCurs.insertText(QString::number(Sample->PSD.bins[0]),
            GtxtFormat);
259     rCurs.movePosition(QTextCursor::NextBlock);
260
261     // Setup the Textdata for the Roundness
262     rCurs.insertBlock(HeaderFormat, HeaderTextFormat);
263     rCurs.insertText("Sphericity Classification");
264
```

```
265     rCurs.insertBlock(ImageGraphFormat);
266     QTextTable *Rounddescr = rCurs.insertTable(6, 2,
            GeneralTextTableFormat);
267     rCurs = Rounddescr->cellAt(0, 0).firstCursorPosition();
268     rCurs.insertText("No of particles:", GFieldtxtFormat);
269     rCurs.movePosition(QTextCursor::NextCell);
270     rCurs.insertText(QString::number(Sample->Roundness.n),
            GtxtFormat);
271     rCurs.movePosition(QTextCursor::NextCell);
272
273     rCurs.insertText("Mean: ", GFieldtxtFormat);
274     rCurs.movePosition(QTextCursor::NextCell);
275     rCurs.insertText(QString::number(Sample->Roundness.Mean),
            GtxtFormat);
276     rCurs.movePosition(QTextCursor::NextCell);
277
278     rCurs.insertText("Minimum: ", GFieldtxtFormat);
279     rCurs.movePosition(QTextCursor::NextCell);
280     rCurs.insertText(QString::number(Sample->Roundness.min),
            GtxtFormat);
281     rCurs.movePosition(QTextCursor::NextCell);
282
283     rCurs.insertText("Maximum: ", GFieldtxtFormat);
284     rCurs.movePosition(QTextCursor::NextCell);
285     rCurs.insertText(QString::number(Sample->Roundness.max),
            GtxtFormat);
286     rCurs.movePosition(QTextCursor::NextCell);
287
288     rCurs.insertText("Range: ", GFieldtxtFormat);
289     rCurs.movePosition(QTextCursor::NextCell);
290     rCurs.insertText(QString::number(Sample->Roundness.Range),
             GtxtFormat);
291     rCurs.movePosition(QTextCursor::NextCell);
292
293     rCurs.insertText("Standard deviation: ", GFieldtxtFormat);
294     rCurs.movePosition(QTextCursor::NextCell);
295     rCurs.insertText(QString::number(Sample->Roundness.Std),
            GtxtFormat);
296     rCurs.movePosition(QTextCursor::NextBlock);
297
298     // Setup the Roundness Graph
299     rCurs.insertBlock(ImageGraphFormat);
300     rCurs.insertText(QString(QChar::ObjectReplacementCharacter
            ),
301                      QCPDocumentObject::generatePlotFormat(
                            Roundness, 600, 400));
302
303     // Setup the Textdata for the Roundness
304     rCurs.insertBlock(HeaderFormat, HeaderTextFormat);
305     rCurs.insertText("Angularity Classification");
306
307     rCurs.insertBlock(ImageGraphFormat);
308     QTextTable *Angularitydescr = rCurs.insertTable(6, 2,
            GeneralTextTableFormat);
309     rCurs = Angularitydescr->cellAt(0, 0).firstCursorPosition
            ();
```

```
310     rCurs.insertText("No of particles:", GFieldtxtFormat);
311     rCurs.movePosition(QTextCursor::NextCell);
312     rCurs.insertText(QString::number(Sample->Angularity.n),
            GtxtFormat);
313     rCurs.movePosition(QTextCursor::NextCell);
314
315     rCurs.insertText("Mean: ", GFieldtxtFormat);
316     rCurs.movePosition(QTextCursor::NextCell);
317     rCurs.insertText(QString::number(Sample->Angularity.Mean),
             GtxtFormat);
318     rCurs.movePosition(QTextCursor::NextCell);
319
320     rCurs.insertText("Minimum: ", GFieldtxtFormat);
321     rCurs.movePosition(QTextCursor::NextCell);
322     rCurs.insertText(QString::number(Sample->Angularity.min),
            GtxtFormat);
323     rCurs.movePosition(QTextCursor::NextCell);
324
325     rCurs.insertText("Maximum: ", GFieldtxtFormat);
326     rCurs.movePosition(QTextCursor::NextCell);
327     rCurs.insertText(QString::number(Sample->Angularity.max),
            GtxtFormat);
328     rCurs.movePosition(QTextCursor::NextCell);
329
330     rCurs.insertText("Range: ", GFieldtxtFormat);
331     rCurs.movePosition(QTextCursor::NextCell);
332     rCurs.insertText(QString::number(Sample->Angularity.Range)
            , GtxtFormat);
333     rCurs.movePosition(QTextCursor::NextCell);
334
335     rCurs.insertText("Standard deviation: ", GFieldtxtFormat);
336     rCurs.movePosition(QTextCursor::NextCell);
337     rCurs.insertText(QString::number(Sample->Angularity.Std),
            GtxtFormat);
338     rCurs.movePosition(QTextCursor::NextBlock);
339
340     // Setup the Roundness Graph
341     rCurs.insertBlock(ImageGraphFormat);
342     rCurs.insertText(QString(QChar::ObjectReplacementCharacter
            ),
343                      QCPDocumentObject::generatePlotFormat(
                            Angularity, 600, 400));
344
345     // Setup the CIE La*b* graph
346     // Setup the Textdata for the Roundness
347     rCurs.insertBlock(HeaderFormat, HeaderTextFormat);
348     rCurs.insertText("CIE La*b*");
349
350     SetupCIElabPLot();
351     rCurs.insertBlock(ImageGraphFormat);
352     rCurs.insertText(QString(QChar::ObjectReplacementCharacter
            ),
353                      QCPDocumentObject::generatePlotFormat(
                            CIElabPlot, 600, 400));
354
355 }
```

```
356
357 void QReportGenerator::getLocationMap(double &latitude,
       double &longtitude) {
358   QNetworkAccessManager *manager = new QNetworkAccessManager
        ;
359   connect(manager, SIGNAL(finished(QNetworkReply *)), this,
360           SLOT(on_locationImageDownloaded(QNetworkReply *)))
                ;
361   QString locationURL("http://maps.googleapis.com/maps/api/
        staticmap?center=");
362   locationURL.append(QString::number(latitude));
363   locationURL.append(",");
364   locationURL.append(QString::number(longtitude));
365   locationURL.append("&zoom=17&size=600x750&maptype=hybrid&&
        format=png&visual_"
366                      "refresh=true&markers=size:mid%7Ccolor
                           :0xff0000%7Clabel:S%"
367                      "7C");
368   locationURL.append(QString::number(latitude));
369   locationURL.append(",");
370   locationURL.append(QString::number(longtitude));
371   qDebug() << locationURL;
372   QUrl googleStaticMapUrl(locationURL);
373   manager->get(QNetworkRequest(googleStaticMapUrl));
374 }
375
376 void QReportGenerator::on_locationImageDownloaded(
       QNetworkReply *reply) {
377   if (mapLocation == nullptr) {
378     mapLocation = new QImage;
379   }
380   mapLocation->loadFromData(reply->readAll());
381
382   if (mapLocation->isNull()) {
383     mapLocation->load("Maps/SampleLocation.png");
384   }
385
386   QTextBlock location = Report->findBlockByNumber(15);
387   QTextCursor insertMap(location);
388   insertMap.setBlockFormat(ImageGraphFormat);
389   insertMap.insertImage(*mapLocation);
390   insertMap.insertBlock();
391   insertMap.insertHtml("<br>");
392 }
393
394 QReportGenerator::~QReportGenerator()
395 {
396   delete CIElabPlot;
397   delete mapLocation;
398   delete ui;
399 }
400
401 void QReportGenerator::on_actionSave_triggered() {
402   QString fn = QFileDialog::getSaveFileName(
403       this, tr("Save Report"), QString::fromStdString(
           Settings->SampleFolder),
```

```
404         tr("Report (*.odf)"));
405     if (!fn.isEmpty()) {
406       if (!fn.contains(tr(".odf"))) {
407         fn.append(tr(".odf"));
408       }
409       QTextDocumentWriter m_write;
410       m_write.setFileName(fn);
411       m_write.setFormat("odf");
412       m_write.write(Report);
413     }
414 }
415
416 void QReportGenerator::on_actionExport_to_PDF_triggered() {
417     QString fn = QFileDialog::getSaveFileName(
418         this, tr("Save Report"), QString::fromStdString(
                Settings->SampleFolder),
419         tr("Report (*.pdf)"));
420     if (!fn.isEmpty()) {
421       if (!fn.contains(tr(".pdf"))) {
422         fn.append(tr(".pdf"));
423       }
424       QPrinter printer;
425       printer.setOutputFormat(QPrinter::PdfFormat);
426       printer.setOutputFileName(fn);
427       Report->print(&printer);
428     }
429 }
430
431 void QReportGenerator::SetupCIElabPLot() {
432     if (CIElabPlot == nullptr) {
433         CIElabPlot = new QCustomPlot();
434       }
435
436     QPen binPen;
437     binPen.setColor((QColor("blue")));
438     binPen.setStyle(Qt::SolidLine);
439     binPen.setWidthF(1);
440
441     // Setup the CIElabplot plot
442     QCPPlotTitle *CIEtitle = new QCPPlotTitle(CIElabPlot);
443     CIEtitle->setText("mean CIE Lab - a* vs. b*");
444     CIEtitle->setFont(QFont("sans", 8, QFont::Bold));
445     CIElabPlot->plotLayout()->insertRow(0);
446     CIElabPlot->plotLayout()->addElement(0, 0, CIEtitle);
447
448     CIElabPlot->addGraph(CIElabPlot->xAxis, CIElabPlot->yAxis)
          ;
449     CIElabPlot->graph(0)
450         ->setScatterStyle(QCPScatterStyle(QCPScatterStyle::
              ssCircle, 8));
451     CIElabPlot->graph(0)->setPen(binPen);
452     CIElabPlot->graph(0)->setName("a* vs. b*");
453     CIElabPlot->graph(0)->setData(*Sample->GetCIELab_bVector()
          , *Sample->GetCIELab_aVector());
454     CIElabPlot->graph(0)->setScatterStyle(QCPScatterStyle::
          ssCross);
```

```
455     CIElabPlot->graph(0)->setLineStyle(QCPGraph::lsNone);
456
457     CIElabPlot->xAxis->setLabel("mean chromatic b*");
458     CIElabPlot->xAxis->setTickLabelFont(QFont("sans", 8, QFont
            ::Normal));
459     CIElabPlot->xAxis->setScaleType(QCPAxis::stLinear);
460     CIElabPlot->xAxis->setRange(-128,128);
461
462     CIElabPlot->yAxis->setLabel("mean chromatic a*");
463     CIElabPlot->yAxis->setTickLabelFont(QFont("sans", 8, QFont
            ::Normal));
464     CIElabPlot->yAxis->setScaleType(QCPAxis::stLinear);
465     CIElabPlot->yAxis->setRange(-128,128);
466     CIElabPlot->replot();
467
468 }
```

P. Vision Soil Analyzer Program

General project files

```
#-------------------------------------------------
#
# Project created by QtCreator 2015-08-07T16:50:24
#
#
#-------------------------------------------------

QT       += core gui concurrent
QMAKE_CXXFLAGS += -std=c++11

greaterThan(QT_MAJOR_VERSION, 4): QT += widgets printsupport
    multimedia multimediawidgets

TARGET = VSA
TEMPLATE = app
VERSION = 0.9.7

unix:!macx: QMAKE_RPATHDIR += $$PWD/../../../build/install/

@
CONFIG(release, debug|release):DEFINES += QT_NO_DEBUG_OUTPUT
@

SOURCES += main.cpp\
        vsamainwindow.cpp \
    dialogsettings.cpp \
    dialognn.cpp

HEADERS  += vsamainwindow.h \
    dialogsettings.h \
    dialognn.h
```

```
31
32 FORMS    += vsamainwindow.ui \
33     dialogsettings.ui \
34     dialognn.ui
35
36 #opencv
37 LIBS += -L/usr/local/lib -lopencv_core -lopencv_highgui -
      lopencv_imgcodecs
38 INCLUDEPATH += /usr/local/include/opencv
39 INCLUDEPATH += /usr/local/include
40
41 #boost
42 DEFINES += BOOST_ALL_DYN_LINK
43 INCLUDEPATH += /usr/include/boost
44 LIBS += -L/usr/lib/x86_64-linux-gnu/ -lboost_filesystem -
      lboost_serialization -lboost_system -lboost_iostreams
45
46 #Gstreamer
47 INCLUDEPATH += /usr/include/gstreamer-0.10
48 INCLUDEPATH += /usr/include/glib-2.0/
49 INCLUDEPATH += /usr/lib/x86_64-linux-gnu/glib-2.0/include/
50 INCLUDEPATH += /usr/include/libxml2/
51 LIBS += `pkg-config --cflags --libs gstreamer-0.10`
52
53 #SoilMath lib
54 unix:!macx: LIBS += -L$$PWD/../../build/install/ -lSoilMath
55 INCLUDEPATH += $$PWD/../SoilMath
56 DEPENDPATH += $$PWD/../SoilMath
57
58 #SoilHardware lib
59 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
      lSoilHardware
60 INCLUDEPATH += $$PWD/../SoilHardware
61 DEPENDPATH += $$PWD/../SoilHardware
62
63 #SoilVision lib
64 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
      lSoilVision
65 INCLUDEPATH += $$PWD/../SoilVision
66 DEPENDPATH += $$PWD/../SoilVision
67
68 #QCustomplot lib
69 DEFINES += QCUSTOMPLOT_USE_LIBRARY
70 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
      lqcustomplot
71 INCLUDEPATH += $$PWD/../qcustomplot
72 DEPENDPATH += $$PWD/../qcustomplot
73
74 #QParticleSelector
75 unix:!macx: LIBS += -L$$PWD/../../build/install/ -
      lQParticleSelector
76 INCLUDEPATH += $$PWD/../QParticleSelector
77 DEPENDPATH += $$PWD/../QParticleSelector
78
79 #QParticleDisplay
```

```
80  unix:!macx: LIBS += -L$$PWD/../../build/install/ -
        lQParticleDisplay
81  INCLUDEPATH += $$PWD/../QParticleDisplay
82  DEPENDPATH += $$PWD/../QParticleDisplay
83
84  #QOpenCVQT
85  unix:!macx: LIBS += -L$$PWD/../../build/install/ -lQOpenCVQT
86  INCLUDEPATH += $$PWD/../QOpenCVQT
87  DEPENDPATH += $$PWD/../QOpenCVQT
88
89  #QSoilAnalyzer
90  unix:!macx: LIBS += -L$$PWD/../../build/install/ -
        lSoilAnalyzer
91  INCLUDEPATH += $$PWD/../SoilAnalyzer
92  DEPENDPATH += $$PWD/../SoilAnalyzer
93
94  #QReportGenerator
95  unix:!macx: LIBS += -L$$PWD/../../build/install/ -
        lQReportGenerator
96  INCLUDEPATH += $$PWD/../QReportGenerator
97  DEPENDPATH += $$PWD/../QReportGenerator
98
99  #NeuralNetFiles
100 NNtarget.path += $${OUT_PWD}/NeuralNet
101 NNtarget.files += $${PWD}/NeuralNet/*.NN
102 INSTALLS += NNtarget
103 bNNtarget.path += $${PWD}/../../build/install/NeuralNet
104 bNNtarget.files += $${PWD}/NeuralNet/*.NN
105 INSTALLS += bNNtarget
106
107 #SettingFiles
108 INItarget.path += $${OUT_PWD}/Settings
109 INItarget.files += $${PWD}/Settings/*.ini
110 INSTALLS += INItarget
111 bINItarget.path += $$PWD/../../build/install/Settings
112 bINItarget.files += $$PWD/Settings/*.ini
113 INSTALLS += bINItarget
114
115 #SoilSamples
116 IMGtarget.path += $${OUT_PWD}/SoilSamples
117 IMGtarget.files += $${PWD}/SoilSamples/*.VSA
118 INSTALLS += IMGtarget
119 bIMGtarget.path += $${PWD}/../../build/install/SoilSamples
120 bIMGtarget.files += $${PWD}/SoilSamples/*.VSA
121 INSTALLS += bIMGtarget
122
123 #Images
124 Imgtarget.path += $${OUT_PWD}/Images
125 Imgtarget.files += $${PWD}/Images/*
126 INSTALLS += Imgtarget
127 bImgtarget.path += $${PWD}/../../build/install/Images
128 bImgtarget.files += $${PWD}/Images/*
129 INSTALLS += bImgtarget
130
131 #TestedSample
132 TestedSamplesTarget.path += $${OUT_PWD}/TestedSamples
```

```
133 TestedSamplesTarget.files += $${PWD}/TestedSamples/*
134 INSTALLS += Imgtarget
135 bTestedSamplesTarget.path += $${PWD}/../../build/install/
    TestedSamples
136 bTestedSamplesTarget.files += $${PWD}/TestedSamples/*
137 INSTALLS += bImgtarget
138
139 RESOURCES += \
140     vsa_resources.qrc
141
142 #MainProg
143 unix {
144     target.path = $PWD/../../../build/install
145     INSTALLS += target
146 }
147
148 DISTFILES += \
149     Settings/Default.ini \
150     NeuralNet/Default.NN \
151     Settings/User.ini \
152     SoilSamples/Eurogrit_B3_01__Cat.VSA \
153     SoilSamples/Gran_K1_0.5_2.5__01_Cat.VSA \
154     TestedSamples/Filterzand_0.2_1.6.csv \
155     TestedSamples/Magro_dol.csv \
156     TestedSamples/Gran_K1.csv \
157     TestedSamples/GL70.csv \
158     TestedSamples/Gannet_20_40.csv \
159     TestedSamples/Eurogrit.csv \
160     TestedSamples/0.8_1.25.csv
```

```
1  #include "vsamainwindow.h"
2  #include <QApplication>
3
4  int main(int argc, char *argv[])
5  {
6    QApplication a(argc, argv);
7    VSAMainWindow w;
8    w.show();
9
10   return a.exec();
11 }
```

Main window Class

```
#ifndef VSAMAINWINDOW_H
#define VSAMAINWINDOW_H

#include <QDebug>
#include <QMainWindow>
#include <QErrorMessage>
#include <QMessageBox>
#include <QProgressBar>
#include <QBrush>

#include <stdint.h>

#include <qcustomplot.h>

#include "soilanalyzer.h"
#include "Hardware.h"

#include "dialognn.h"
#include "dialogsettings.h"
#include "qparticleselector.h"
#include "qreportgenerator.h"

namespace Ui {
class VSAMainWindow;
}

class VSAMainWindow : public QMainWindow {
  Q_OBJECT

public:
  explicit VSAMainWindow(QWidget *parent = 0);
  ~VSAMainWindow();

private slots:
  void on_actionSettings_triggered();

  void on_analyzer_finished();

  void on_actionNeuralNet_triggered();

  void on_actionNewSample_triggered();

  void on_actionSaveSample_triggered();

  void on_actionLoadSample_triggered();

  void on_actionUseLearning_toggled(bool arg1);

  void on_actionCalibrate_triggered();

  void on_Classification_changed(int newValue);

  void on_particle_deleted();

```

```
55    void on_actionAutomatic_Shape_Pediction_triggered(bool
          checked);
56
57    void on_reset_graph(QMouseEvent * e);
58
59    void on_actionReport_Generator_triggered();
60
61    void on_particleChanged(int newPart);
62
63    void on_PSD_contextMenuRequest(QPoint point);
64
65    void on_compare_against();
66
67    void on_restore_PSD();
68
69  private:
70    Ui::VSAMainWindow *ui;
71    DialogSettings *settingsWindow = nullptr;
72    DialogNN *nnWindow = nullptr;
73    QProgressBar *Progress;
74    QErrorMessage *CamError = nullptr;
75    QMessageBox *SaveMeMessage = nullptr;
76    QMessageBox *BacklightMessage = nullptr;
77    QMessageBox *ShakeItBabyMessage = nullptr;
78    QReportGenerator *ReportGenWindow = nullptr;
79
80    SoilAnalyzer::SoilSettings *Settings = nullptr;
81    Hardware::Microscope *Microscope = nullptr;
82    SoilAnalyzer::Sample *Sample = nullptr;
83    SoilAnalyzer::Analyzer *Analyzer = nullptr;
84    SoilAnalyzer::Analyzer::Images_t *Images = nullptr;
85    QCPBars *RoundnessBars = nullptr;
86    QCPBars *AngularityBars = nullptr;
87    std::vector<double> PSDTicks = {0.0,  0.038, 0.045, 0.063,
          0.075,
88                                    0.09, 0.125, 0.18,  0.25,
                                          0.355,
89                                    0.5,  0.71,  1.0,   1.4,
                                          2.0};
90    QVector<QString> RoundnessCat = {"High", "Medium", "Low"};
91    std::vector<double> RoundnessTicks = {1, 2, 3};
92    QVector<QString> AngularityCat = {"Very Angular", "Angular
          ", "Sub Angular",
93                                      "Sub Rounded",  "Rounded
                                            ", "Well Rounded"};
94    std::vector<double> AngularityTicks = {1, 2, 3, 4, 5, 6};
95
96    bool ParticleDisplayerFilled = false;
97
98    void SetPSDgraph();
99    void setRoundnessHistogram();
100   void setAngularityHistogram();
101   void setAmpgraph();
102   void TakeSnapShots();
103 };
104
```

```
105 #endif // VSAMAINWINDOW_H
```

```
1  #include "vsamainwindow.h"
2  #include "ui_vsamainwindow.h"
3
4  VSAMainWindow::VSAMainWindow(QWidget *parent)
5      : QMainWindow(parent), ui(new Ui::VSAMainWindow) {
6    ui->setupUi(this);
7
8    // Load the usersettings
9    Settings = new SoilAnalyzer::SoilSettings;
10   Settings->LoadSettings("Settings/Default.ini");
11
12   // Set the message windows
13   CamError = new QErrorMessage(this);
14   SaveMeMessage = new QMessageBox(this);
15   SaveMeMessage->setText(tr("Sample is not saved, Save
         sample?"));
16   SaveMeMessage->addButton(QMessageBox::Abort);
17   SaveMeMessage->addButton(QMessageBox::Close);
18
19   BacklightMessage = new QMessageBox(this);
20   BacklightMessage->setText("Turn off Frontlight! Turn on
         Backlight!");
21   ShakeItBabyMessage = new QMessageBox(this);
22
23   // Load the Microscope
24   Microscope = new Hardware::Microscope;
25   try {
26     Microscope->FindCam(Settings->defaultWebcam)->
           SelectedResolution =
27         &Microscope->FindCam(Settings->defaultWebcam)
28             ->Resolutions[Settings->selectedResolution];
29   } catch (exception &e) {
30     Microscope->FindCam(0)->SelectedResolution =
31         &Microscope->FindCam(0)->Resolutions[Settings->
               selectedResolution];
32   }
33   try {
34     if (!Microscope->openCam(Settings->defaultWebcam)) {
35       int defaultCam = 0;
36       Microscope->openCam(defaultCam);
37       Settings->defaultWebcam = Microscope->SelectedCam->
             Name;
38     }
39   } catch (Hardware::Exception::MicroscopeException &e) {
40     if (*e.id() == EXCEPTION_OPENCAM_NR) {
41       try {
42         int defaultCam = 0;
43         Microscope->openCam(defaultCam);
44         Settings->defaultWebcam = Microscope->SelectedCam->
               Name;
45       } catch (Hardware::Exception::MicroscopeException &e)
             {
46         if (*e.id() == EXCEPTION_NOCAMS_NR) {
47           CamError->showMessage(
```

```
48                tr("No cams found! Connect the cam and set the
                      default"));
49              settingsWindow = new DialogSettings(this, Settings
                    , Microscope);
50            }
51          }
52        }
53    }
54
55    // Setup the sample
56    Sample = new SoilAnalyzer::Sample;
57    Images = new SoilAnalyzer::Analyzer::Images_t;
58    Analyzer = new SoilAnalyzer::Analyzer(Images, Sample,
         Settings);
59
60    // Setup the setting Window
61    if (settingsWindow == nullptr) {
62      settingsWindow =
63          new DialogSettings(this, Settings, Microscope, &
              Analyzer->NeuralNet);
64    }
65
66    // Setup the NN window
67    if (nnWindow == nullptr) {
68      nnWindow =
69          new DialogNN(this, &Analyzer->NeuralNet, Settings,
              settingsWindow);
70    }
71
72    // Setup the progresbar and connect it to the Analyzer
73    Progress = new QProgressBar(ui->statusBar);
74    Progress->setMaximum(Analyzer->MaxProgress);
75    Progress->setValue(0);
76    Progress->setAlignment(Qt::AlignLeft);
77    Progress->setMinimumSize(750, 19);
78    ui->statusBar->addWidget(Progress);
79    connect(Analyzer, SIGNAL(on_progressUpdate(int)), Progress
         ,
80            SLOT(setValue(int)));
81    connect(Analyzer, SIGNAL(on_progressUpdate(int)), Progress
         ,
82            SLOT(setMaximum(int)));
83    connect(Analyzer, SIGNAL(on_AnalysisFinished()), this,
84            SLOT(on_analyzer_finished()));
85    // Setup the plot linestyles;
86    QPen pdfPen;
87    pdfPen.setColor(QColor("gray"));
88    pdfPen.setStyle(Qt::DashDotDotLine);
89    pdfPen.setWidthF(1);
90
91    QPen meanPen;
92    meanPen.setColor(QColor("darkBlue"));
93    meanPen.setStyle(Qt::DashLine);
94    meanPen.setWidthF(1);
95
96    QPen binPen;
```

```
97    binPen.setColor((QColor("blue")));
98    binPen.setStyle(Qt::SolidLine);
99    binPen.setWidthF(2);
100
101   // Setup the PSD plot
102   QCPPlotTitle *PSDtitle = new QCPPlotTitle(ui->Qplot_PSD);
103   PSDtitle->setText("Particle Size Distribution");
104   PSDtitle->setFont(QFont("sans", 8, QFont::Bold));
105   ui->Qplot_PSD->plotLayout()->insertRow(0);
106   ui->Qplot_PSD->plotLayout()->addElement(0, 0, PSDtitle);
107
108   ui->Qplot_PSD->addGraph(ui->Qplot_PSD->xAxis, ui->
          Qplot_PSD->yAxis);
109   ui->Qplot_PSD->graph(0)
110       ->setScatterStyle(QCPScatterStyle(QCPScatterStyle::
              ssCircle, 8));
111   ui->Qplot_PSD->graph(0)->setPen(binPen);
112   ui->Qplot_PSD->graph(0)->setName("Particle Size
          Distribution");
113   ui->Qplot_PSD->graph(0)->addToLegend();
114
115   ui->Qplot_PSD->xAxis->setLabel("Particle size [mm]");
116   ui->Qplot_PSD->xAxis->setRange(0.01, 10);
117   ui->Qplot_PSD->xAxis->setAutoTicks(false);
118   ui->Qplot_PSD->xAxis->setTickVector(QVector<double>::
          fromStdVector(PSDTicks));
119   ui->Qplot_PSD->xAxis->setTickLabelRotation(30);
120   ui->Qplot_PSD->xAxis->setTickLabelFont(QFont("sans", 8,
          QFont::Normal));
121   ui->Qplot_PSD->xAxis->setScaleType(QCPAxis::stLogarithmic)
          ;
122
123   QFont legendfont;
124   legendfont.setPointSize(10);
125   ui->Qplot_PSD->legend->setFont(legendfont);
126   ui->Qplot_PSD->legend->setSelectedFont(legendfont);
127   ui->Qplot_PSD->legend->setVisible(true);
128   ui->Qplot_PSD->axisRect()->insetLayout()->
          setInsetAlignment(
129       0, Qt::AlignTop | Qt::AlignLeft);
130
131   ui->Qplot_PSD->yAxis->setLabel("Percentage [%]");
132   ui->Qplot_PSD->yAxis->setRange(0, 100);
133   ui->Qplot_PSD->setInteractions(QCP::iRangeDrag | QCP::
          iRangeZoom);
134   ui->Qplot_PSD->yAxis->grid()->setSubGridVisible(true);
135
136   connect(ui->Qplot_PSD, SIGNAL(mouseDoubleClick(QMouseEvent
          *)), this,
137           SLOT(on_reset_graph(QMouseEvent *)));
138   ui->Qplot_PSD->setContextMenuPolicy(Qt::CustomContextMenu)
          ;
139   connect(ui->Qplot_PSD, SIGNAL(customContextMenuRequested(
          QPoint)), this,
140           SLOT(on_PSD_contextMenuRequest(QPoint)));
141
```

```
142   // Setup the Roundness plot
143   QCPPlotTitle *Roundnesstitle = new QCPPlotTitle(ui->
          QPlot_Roudness);
144   Roundnesstitle->setText("Sphericity Histogram");
145   Roundnesstitle->setFont(QFont("sans", 8, QFont::Bold));
146   ui->QPlot_Roudness->plotLayout()->insertRow(0);
147   ui->QPlot_Roudness->plotLayout()->addElement(0, 0,
          Roundnesstitle);
148
149   ui->QPlot_Roudness->addGraph(ui->QPlot_Roudness->xAxis,
150                                ui->QPlot_Roudness->yAxis2);
151   ui->QPlot_Roudness->addGraph(ui->QPlot_Roudness->xAxis,
152                                ui->QPlot_Roudness->yAxis2);
153   ui->QPlot_Roudness->graph(0)->setPen(pdfPen);
154   ui->QPlot_Roudness->graph(1)->setPen(meanPen);
155
156   RoundnessBars =
157       new QCPBars(ui->QPlot_Roudness->xAxis, ui->
              QPlot_Roudness->yAxis);
158   ui->QPlot_Roudness->addPlottable(RoundnessBars);
159   RoundnessBars->setPen(binPen);
160
161   ui->QPlot_Roudness->xAxis->setAutoTicks(false);
162   ui->QPlot_Roudness->xAxis->setAutoTickLabels(false);
163   ui->QPlot_Roudness->xAxis->setTickVector(
164       QVector<double>::fromStdVector(RoundnessTicks));
165   ui->QPlot_Roudness->xAxis->setTickVectorLabels(
          RoundnessCat);
166   ui->QPlot_Roudness->xAxis->setTickLabelRotation(30);
167   ui->QPlot_Roudness->xAxis->setSubTickCount(0);
168   ui->QPlot_Roudness->xAxis->setTickLength(0, 4);
169   ui->QPlot_Roudness->xAxis->grid()->setVisible(true);
170   ui->QPlot_Roudness->xAxis->setRange(0, 4);
171   ui->QPlot_Roudness->xAxis->setLabel("Count [-]");
172   ui->QPlot_Roudness->xAxis->setLabelFont(QFont("sans", 8,
          QFont::Bold));
173   ui->QPlot_Roudness->xAxis->setTickLabelFont(QFont("sans",
          8, QFont::Normal));
174   ui->QPlot_Roudness->xAxis->setPadding(25);
175   ui->QPlot_Roudness->yAxis->setLabel("Sphericity [-]");
176   ui->QPlot_Roudness->yAxis->setLabelFont(QFont("sans", 8,
          QFont::Bold));
177
178   // Setup the angularity plot
179   QCPPlotTitle *Angularitytitle = new QCPPlotTitle(ui->
          QPlot_Angularity);
180   Angularitytitle->setText("Angularity Histogram");
181   Angularitytitle->setFont(QFont("sans", 8, QFont::Bold));
182   ui->QPlot_Angularity->plotLayout()->insertRow(0);
183   ui->QPlot_Angularity->plotLayout()->addElement(0, 0,
          Angularitytitle);
184
185   ui->QPlot_Angularity->addGraph(ui->QPlot_Angularity->xAxis
          ,
186                                  ui->QPlot_Angularity->
                                       yAxis2);
```

```
187     ui->QPlot_Angularity->addGraph(ui->QPlot_Angularity->xAxis
            ,
188                                    ui->QPlot_Angularity->
                                           yAxis2);
189     AngularityBars =
190         new QCPBars(ui->QPlot_Angularity->xAxis, ui->
                QPlot_Angularity->yAxis);
191     ui->QPlot_Angularity->addPlottable(AngularityBars);
192     AngularityBars->setPen(binPen);
193
194     ui->QPlot_Angularity->xAxis->setAutoTicks(false);
195     ui->QPlot_Angularity->xAxis->setAutoTickLabels(false);
196     ui->QPlot_Angularity->xAxis->setTickVector(
197         QVector<double>::fromStdVector(AngularityTicks));
198     ui->QPlot_Angularity->xAxis->setTickVectorLabels(
            AngularityCat);
199     ui->QPlot_Angularity->xAxis->setTickLabelRotation(30);
200     ui->QPlot_Angularity->xAxis->setSubTickCount(0);
201     ui->QPlot_Angularity->xAxis->setTickLength(0, 4);
202     ui->QPlot_Angularity->xAxis->grid()->setVisible(true);
203     ui->QPlot_Angularity->xAxis->setRange(0, 7);
204     ui->QPlot_Angularity->xAxis->setLabel("Count [-]");
205     ui->QPlot_Angularity->xAxis->setLabelFont(QFont("sans", 8,
            QFont::Bold));
206     ui->QPlot_Angularity->xAxis->setTickLabelFont(
207         QFont("sans", 8, QFont::Normal));
208     ui->QPlot_Angularity->yAxis->setLabel("Sphericity [-]");
209     ui->QPlot_Angularity->yAxis->setLabelFont(QFont("sans", 8,
            QFont::Bold));
210     ui->QPlot_Angularity->graph(0)->setPen(pdfPen);
211     ui->QPlot_Angularity->graph(1)->setPen(meanPen);
212
213     // Setup the Amplitude diagram
214     QCPPlotTitle *Amptitle = new QCPPlotTitle(ui->QPlot_Amp);
215     Amptitle->setText("Fast Fourier Amplitude for the current
            particle");
216     Amptitle->setFont(QFont("sans", 8, QFont::Bold));
217     ui->QPlot_Amp->plotLayout()->insertRow(0);
218     ui->QPlot_Amp->plotLayout()->addElement(0, 0, Amptitle);
219
220     ui->QPlot_Amp->addGraph(ui->QPlot_Amp->xAxis, ui->
            QPlot_Amp->yAxis);
221
222     ui->QPlot_Amp->xAxis->setTickLabelRotation(30);
223     ui->QPlot_Amp->xAxis->setSubTickCount(0);
224     ui->QPlot_Amp->xAxis->setTickLength(0, 4);
225     ui->QPlot_Amp->xAxis->grid()->setVisible(true);
226     ui->QPlot_Amp->xAxis->setRange(0, 512);
227     ui->QPlot_Amp->xAxis->setLabel("Frequency [-]");
228     ui->QPlot_Amp->xAxis->setLabelFont(QFont("sans", 8, QFont
            ::Bold));
229     ui->QPlot_Amp->xAxis->setTickLabelFont(QFont("sans", 8,
            QFont::Normal));
230     ui->QPlot_Amp->yAxis->setLabel("Amplitude [-]");
231     ui->QPlot_Amp->yAxis->setLabelFont(QFont("sans", 8, QFont
            ::Bold));
```

```
232   ui->QPlot_Amp->yAxis->setScaleType(QCPAxis::stLogarithmic)
          ;
233   ui->QPlot_Amp->graph()->setPen(binPen);
234   ui->QPlot_Amp->graph()->setLineStyle(QCPGraph::lsLine);
235   ui->QPlot_Amp->graph()->setBrush(QBrush(QColor
          (50,50,200,40)));
236
237   // Connect the Particle display and Selector
238   connect(ui->widget_ParticleSelector, SIGNAL(valueChanged(
          int)), this,
239           SLOT(on_Classification_changed(int)));
240   connect(ui->widget_ParticleDisplay, SIGNAL(
          shapeClassificationChanged(int)),
241           ui->widget_ParticleSelector, SLOT(setValue(int)));
242   connect(ui->widget_ParticleDisplay, SIGNAL(particleDeleted
          ()), this,
243           SLOT(on_particle_deleted()));
244   connect(ui->widget_ParticleDisplay, SIGNAL(particleChanged
          (int)), this,
245           SLOT(on_particleChanged(int)));
246
247   // Setup the bar
248   ui->actionUseLearning->setChecked(Settings->
          PredictTheShape);
249
250   // Setup the widgets
251   ui->widget_ParticleSelector->setDisabled(true);
252 }
253
254 VSAMainWindow::~VSAMainWindow() {
255   delete Settings;
256   delete Microscope;
257   delete Analyzer;
258   delete Sample;
259   delete Images;
260
261   delete settingsWindow;
262   delete nnWindow;
263   delete CamError;
264   delete SaveMeMessage;
265   delete BacklightMessage;
266   delete ShakeItBabyMessage;
267   delete ui;
268 }
269
270 void VSAMainWindow::on_actionSettings_triggered() {
271   settingsWindow->openTab(0);
272   settingsWindow->show();
273 }
274
275 void VSAMainWindow::on_analyzer_finished() {
276   if (!ParticleDisplayerFilled && Sample->ParticlePopulation
          .size() > 0) {
277     ui->widget_ParticleDisplay->SetSample(Sample);
278   }
279   SetPSDgraph();
```

```
280   setRoundnessHistogram();
281   setAngularityHistogram();
282   ParticleDisplayerFilled = true;
283 }
284
285 void VSAMainWindow::SetPSDgraph() {
286   std::vector<double> stdPSDvalue(Sample->PSD.CFD, Sample->
          PSD.CFD + 15);
287   ui->Qplot_PSD->graph(0)->setData(PSDTicks, stdPSDvalue);
288   ui->Qplot_PSD->replot();
289 }
290
291 void VSAMainWindow::setRoundnessHistogram() {
292   // Setup the Histogram bins
293   std::vector<double> stdValues(Sample->Roundness.bins + 1,
294                                 Sample->Roundness.bins + 4);
295
296   ui->QPlot_Roudness->yAxis->setRange(
297       0, static_cast<double>(Sample->Roundness.
             HighestFrequency()));
298   RoundnessBars->setData(RoundnessTicks, stdValues);
299
300   // Setup the Prediction Density Function
301   std::vector<double> stdPDFkey, stdPDFvalues;
302   Sample->Roundness.GetPDFfunction(stdPDFkey, stdPDFvalues,
          0.2, 0, 4);
303   ui->QPlot_Roudness->graph(0)->setData(stdPDFkey,
          stdPDFvalues);
304   ui->QPlot_Roudness->yAxis2->setRange(0, Sample->Roundness.
          HighestPDF);
305
306   // Setup the mean Vector
307   QVector<double> meanKey(2, static_cast<double>(Sample->
          Roundness.Mean));
308   QVector<double> meanValue(2);
309   meanValue[0] = 0;
310   meanValue[1] = Sample->Roundness.HighestPDF;
311   ui->QPlot_Roudness->graph(1)->setData(meanKey, meanValue);
312   ui->QPlot_Roudness->replot();
313 }
314
315 void VSAMainWindow::setAngularityHistogram() {
316   // Setup the Histogram bins
317   std::vector<double> stdValues(Sample->Angularity.bins + 1,
318                                 Sample->Angularity.bins + 7)
                                      ;
319
320   ui->QPlot_Angularity->yAxis->setRange(
321       0, static_cast<double>(Sample->Angularity.
             HighestFrequency()));
322   AngularityBars->setData(AngularityTicks, stdValues);
323
324   // Setup the Prediction Density Function
325   std::vector<double> stdPDFkey, stdPDFvalues;
326   Sample->Angularity.GetPDFfunction(stdPDFkey, stdPDFvalues,
          0.2, 0, 7);
```

```
327   ui->QPlot_Angularity->graph(0)->setData(stdPDFkey,
          stdPDFvalues);
328   ui->QPlot_Angularity->yAxis2->setRange(0, Sample->
          Angularity.HighestPDF);
329
330   // Setup the mean Vector
331   QVector<double> meanKey(2, static_cast<double>(Sample->
          Angularity.Mean));
332   QVector<double> meanValue(2);
333   meanValue[0] = 0;
334   meanValue[1] = Sample->Angularity.HighestPDF;
335   ui->QPlot_Angularity->graph(1)->setData(meanKey, meanValue
          );
336   ui->QPlot_Angularity->replot();
337 }
338
339 void VSAMainWindow::setAmpgraph() {
340   ui->QPlot_Amp->graph(0)->clearData();
341   ComplexVect_t *comp =
342       &ui->widget_ParticleDisplay->SelectedParticle->
              FFDescriptors;
343   uint32_t count = (comp->size() > 64) ? 64 : comp->size();
344   for (uint32_t i = 0; i < count; i++) {
345     ui->QPlot_Amp->graph(0)->addData(i, abs(comp->at(i)));
346   }
347   ui->QPlot_Amp->rescaleAxes();
348   ui->QPlot_Amp->replot();
349 }
350
351 void VSAMainWindow::on_particleChanged(int newPart) {
      setAmpgraph(); }
352
353 void VSAMainWindow::on_actionNeuralNet_triggered() {
354   if (nnWindow != nullptr) {
355     nnWindow =
356         new DialogNN(this, &Analyzer->NeuralNet, Settings,
                settingsWindow);
357   }
358   nnWindow->show();
359 }
360
361 void VSAMainWindow::on_actionNewSample_triggered() {
362   if (Sample->ChangesSinceLastSave) {
363     if (SaveMeMessage->exec() == QMessageBox::Abort) {
364       return;
365     }
366   }
367   delete Sample;
368   Sample = nullptr;
369   delete Images;
370   Images = nullptr;
371   Sample = new SoilAnalyzer::Sample;
372   Images = new SoilAnalyzer::Analyzer::Images_t;
373   TakeSnapShots();
374   try {
375     Analyzer->Analyse(Images, Sample, Settings);
```

```
376   } catch (SoilAnalyzer::Exception::SoilAnalyzerException &e
          ) {
377     if (*e.id() == EXCEPTION_NO_SNAPSHOTS_NR) {
378       CamError->showMessage(
379           "No images acquired! Check you microscope settings
              ");
380       return;
381     }
382   }
383   Sample->ChangesSinceLastSave = true;
384   if (Sample->ParticlePopulation.size() > 0) {
385     ui->widget_ParticleSelector->setDisabled(
386         false,
387         ui->widget_ParticleDisplay->SelectedParticle->
              Classification.Category);
388   }
389 }
390
391 void VSAMainWindow::TakeSnapShots() {
392   Analyzer->SIfactorDet = true; // remeber to remove
393   if (!Analyzer->SIfactorDet) {
394     QMessageBox *DetSIFactor = new QMessageBox(this);
395     DetSIFactor->setText("Put calibration Disc under the
          microscope");
396     DetSIFactor->exec();
397     on_actionCalibrate_triggered();
398     DetSIFactor->setText("Place sample under the microscope"
          );
399     DetSIFactor->exec();
400   }
401   if (Settings->useBacklightProjection && !Settings->useHDR)
          {
402     for (uint32_t i = 0; i < Settings->StandardNumberOfShots
          ; i++) {
403       SoilAnalyzer::Analyzer::Image_t newShot;
404       newShot.SIPixelFactor = Analyzer->CurrentSIfactor;
405       Microscope->GetFrame(newShot.FrontLight);
406       BacklightMessage->exec();
407       Microscope->GetFrame(newShot.BackLight);
408       Images->push_back(newShot);
409       QString ShakeMsg = "Shake it baby! ";
410       int number = Settings->StandardNumberOfShots - i;
411       ShakeMsg.append(QString::number(number));
412       ShakeMsg.append(" to go!");
413       ShakeItBabyMessage->setText(ShakeMsg);
414       ShakeItBabyMessage->exec();
415     }
416   } else if (Settings->useBacklightProjection && Settings->
          useHDR) {
417     for (uint32_t i = 0; i < Settings->StandardNumberOfShots
          ; i++) {
418       SoilAnalyzer::Analyzer::Image_t newShot;
419       newShot.SIPixelFactor = Analyzer->CurrentSIfactor;
420       Microscope->GetHDRFrame(newShot.FrontLight, Settings->
              HDRframes);
421       BacklightMessage->exec();
```

```
422         Microscope->GetFrame(newShot.BackLight);
423         Images->push_back(newShot);
424         QString ShakeMsg = "Shake it baby! ";
425         int number = Settings->StandardNumberOfShots - i - 1;
426         ShakeMsg.append(QString::number(number));
427         ShakeMsg.append(" to go!");
428         ShakeItBabyMessage->setText(ShakeMsg);
429         ShakeItBabyMessage->exec();
430       }
431     } else if (!Settings->useBacklightProjection && Settings->
          useHDR) {
432       for (uint32_t i = 0; i < Settings->StandardNumberOfShots
            ; i++) {
433         SoilAnalyzer::Analyzer::Image_t newShot;
434         newShot.SIPixelFactor = Analyzer->CurrentSIfactor;
435         Microscope->GetHDRFrame(newShot.FrontLight, Settings->
              HDRframes);
436         Images->push_back(newShot);
437         QString ShakeMsg = "Shake it baby! ";
438         int number = Settings->StandardNumberOfShots - i - 1;
439         ShakeMsg.append(QString::number(number));
440         ShakeMsg.append(" to go!");
441         ShakeItBabyMessage->setText(ShakeMsg);
442         ShakeItBabyMessage->exec();
443       }
444     } else if (!Settings->useBacklightProjection && !Settings
          ->useHDR) {
445       for (uint32_t i = 0; i < Settings->StandardNumberOfShots
            ; i++) {
446         SoilAnalyzer::Analyzer::Image_t newShot;
447         newShot.SIPixelFactor = Analyzer->CurrentSIfactor;
448         Microscope->GetFrame(newShot.FrontLight);
449         Images->push_back(newShot);
450         QString ShakeMsg = "Shake it baby! ";
451         int number = Settings->StandardNumberOfShots - i - 1;
452         ShakeMsg.append(QString::number(number));
453         ShakeMsg.append(" to go!");
454         ShakeItBabyMessage->setText(ShakeMsg);
455         ShakeItBabyMessage->exec();
456       }
457     }
458 }
459
460 void VSAMainWindow::on_actionSaveSample_triggered() {
461   QString fn = QFileDialog::getSaveFileName(
462       this, tr("Save Sample"), QString::fromStdString(
              Settings->SampleFolder),
463       tr("Sample (*.VSA)"));
464   if (!fn.isEmpty()) {
465     if (!fn.contains(tr(".VSA"))) {
466       fn.append(tr(".VSA"));
467     }
468     Sample->IsLoadedFromDisk = true;
469     Sample->ChangesSinceLastSave = false;
470     Sample->Save(fn.toStdString());
471     qDebug() << "Saving finished";
```

```
472   }
473 }
474
475 void VSAMainWindow::on_actionLoadSample_triggered() {
476   if (Sample->ChangesSinceLastSave) {
477     if (SaveMeMessage->exec() == QMessageBox::Abort) {
478       return;
479     }
480   }
481
482   QString fn = QFileDialog::getOpenFileName(
483       this, tr("Open Sample"), QString::fromStdString(
              Settings->SampleFolder),
484       tr("Sample (*.VSA)"));
485   if (!fn.isEmpty()) {
486     if (!fn.contains(tr(".VSA"))) {
487       fn.append(tr(".VSA"));
488     }
489     delete Sample;
490     Sample = nullptr;
491     delete Images;
492     Images = nullptr;
493     Sample = new SoilAnalyzer::Sample;
494     Images = new SoilAnalyzer::Analyzer::Images_t;
495     try {
496       Sample->Load(fn.toStdString());
497     } catch (boost::archive::archive_exception &e) {
498       // qDebug() << *e.what();
499     }
500     ParticleDisplayerFilled = false;
501     Sample->Angularity.Data = Sample->GetAngularityVector()
          ->data();
502     Sample->Roundness.Data = Sample->GetRoundnessVector()->
          data();
503     Sample->PSD.Data = Sample->GetPSDVector()->data();
504     Analyzer->Results = Sample;
505     on_analyzer_finished();
506     ui->widget_ParticleSelector->setDisabled(
507         false,
508         ui->widget_ParticleDisplay->SelectedParticle->
              Classification.Category);
509   }
510 }
511
512 void VSAMainWindow::on_actionUseLearning_toggled(bool arg1)
      {
513   Analyzer->PredictShape = !arg1;
514 }
515
516 void VSAMainWindow::on_actionCalibrate_triggered() {
517   cv::Mat calib;
518   Microscope->GetFrame(calib);
519   Analyzer->CalibrateSI(16.25, calib);
520 }
521
```

```
522 void VSAMainWindow::on_Classification_changed(int newValue)
    {
523   uint8_t *Cat =
524       &ui->widget_ParticleDisplay->SelectedParticle->
          Classification.Category;
525   if ((*Cat - 1) % 6 != (newValue - 1) % 6) {
526     Sample->ParticleChangedStateAngularity = true;
527   }
528   if ((*Cat - 1) / 6 != (newValue - 1) / 6) {
529     Sample->ParticleChangedStateRoundness = true;
530   }
531   ui->widget_ParticleDisplay->SelectedParticle->
        Classification.Category =
532       newValue;
533   ui->widget_ParticleDisplay->SelectedParticle->
        Classification.ManualSet = true;
534   Sample->ChangesSinceLastSave = true;
535   Analyzer->Analyse();
536   ui->widget_ParticleDisplay->next();
537 }
538
539 void VSAMainWindow::on_particle_deleted() { Analyzer->
    Analyse(); }
540
541 void VSAMainWindow::
    on_actionAutomatic_Shape_Pediction_triggered(bool checked
    ) {
542   Settings->PredictTheShape = checked;
543 }
544
545 void VSAMainWindow::on_reset_graph(QMouseEvent *e) {
546   ui->Qplot_PSD->xAxis->setRange(0, 10);
547   ui->Qplot_PSD->yAxis->setRange(0, 100);
548   ui->Qplot_PSD->setInteractions(QCP::iRangeDrag | QCP::
        iRangeZoom);
549   ui->Qplot_PSD->replot();
550 }
551
552 void VSAMainWindow::on_actionReport_Generator_triggered() {
553   if (ReportGenWindow == nullptr) {
554     ReportGenWindow =
555         new QReportGenerator(this, Sample, Settings, ui->
            Qplot_PSD,
556                              ui->QPlot_Roudness, ui->
                                 QPlot_Angularity);
557   }
558   ReportGenWindow->show();
559 }
560
561 void VSAMainWindow::on_PSD_contextMenuRequest(QPoint point)
    {
562   QMenu *menu = new QMenu(this);
563   menu->setAttribute(Qt::WA_DeleteOnClose);
564
565   menu->addAction("Compare against...", this, SLOT(
        on_compare_against()));
```

```
566   menu->addAction("Restore", this, SLOT(on_restore_PSD()));
567   menu->popup(ui->Qplot_PSD->mapToGlobal(point));
568 }
569
570 void VSAMainWindow::on_compare_against() {
571   QString fn = QFileDialog::getOpenFileName(
572       this, tr("Open CSV"), QString::fromStdString(Settings
          ->SampleFolder),
573       tr("Comma Seperated Value (*.csv)"));
574   if (!fn.isEmpty()) {
575     if (!fn.contains(tr(".csv"))) {
576       fn.append(tr(".csv"));
577     }
578
579     if (ui->Qplot_PSD->graphCount() > 1) {
580       ui->Qplot_PSD->legend->removeItem(1);
581       ui->Qplot_PSD->removeGraph(1);
582     }
583
584     QStringList rows;
585     QStringList cellValues;
586
587     QFile f(fn);
588     if (f.open(QIODevice::ReadOnly)) {
589       QString data;
590       data = f.readAll();
591       rows = data.split('\n');
592       f.close();
593       for (uint32_t i = 0; i < rows.size(); i++) {
594         QStringList cols = rows[i].split(',');
595         for (uint32_t j = 0; j < cols.size(); j++) {
596           cellValues.append(cols[j]);
597         }
598       }
599       cellValues.removeLast();
600
601       std::vector<double> compValues(15);
602       for (uint32_t i = 0; i < cellValues.size(); i += 4) {
603         bool conversionSucces = false;
604         double binValue = cellValues[i].toDouble(&
             conversionSucces);
605         qDebug() << cellValues[i + 3];
606         if (conversionSucces) {
607           for (uint32_t j = 0; j < 15; j++) {
608             if (binValue == PSDTicks[j]) {
609               compValues[j] = cellValues[i + 3].toDouble();
610             }
611           }
612         }
613       }
614       ui->Qplot_PSD->addGraph(ui->Qplot_PSD->xAxis, ui->
           Qplot_PSD->yAxis);
615       ui->Qplot_PSD->graph(1)->setData(PSDTicks, compValues)
           ;
616       QPen compPen;
617       compPen.setColor(QColor("darkBlue"));
```

```
618         compPen.setStyle(Qt::DashLine);
619         compPen.setWidthF(1);
620         ui->Qplot_PSD->graph(1)->setPen(compPen);
621         ui->Qplot_PSD->graph(1)->setName("Compared Particle
                Size Distribution");
622         ui->Qplot_PSD->graph(1)->addToLegend();
623         ui->Qplot_PSD->replot();
624       }
625     }
626 }
627
628 void VSAMainWindow::on_restore_PSD() {
629   if (ui->Qplot_PSD->graphCount() > 1) {
630     ui->Qplot_PSD->legend->removeItem(1);
631     ui->Qplot_PSD->removeGraph(1);
632   }
633   on_reset_graph(nullptr);
634 }
```

Dialog window Class

```
1  #ifndef DIALOGSETTINGS_H
2  #define DIALOGSETTINGS_H
3
4  #include <QDialog>
5  #include <soilsettings.h>
6  #include <QFileDialog>
7  #include <QString>
8  #include <QDir>
9  #include <QSlider>
10 #include "Hardware.h"
11
12 namespace Ui {
13 class DialogSettings;
14 }
15
16 class DialogSettings : public QDialog {
17   Q_OBJECT
18
19 public:
20   SoilAnalyzer::SoilSettings *Settings = nullptr;
21   explicit DialogSettings(QWidget *parent = 0,
22                           SoilAnalyzer::SoilSettings *
                                settings = nullptr,
23                           Hardware::Microscope *microscope =
                                nullptr,
24                           SoilMath::NN *nn = nullptr, bool
                                openNN = false);
25   ~DialogSettings();
26
27   void openTab(int newValue);
28 private slots:
29
30   void on_pushButton_RestoreDefault_clicked();
31
32   void on_pushButton_Open_clicked();
33
34   void on_pushButton_Save_clicked();
35
36   void on_checkBox_Backlight_clicked(bool checked);
37
38   void on_comboBox_Microscopes_currentIndexChanged(const
        QString &arg1);
39
40   void on_comboBox_Resolution_currentIndexChanged(int index)
        ;
41
42   void on_checkBox_useHDR_clicked(bool checked);
43
44   void on_spinBox_NoFrames_editingFinished();
45
46   void on_doubleSpinBox_LightLevel_editingFinished();
47
48   void on_checkBox_useRainbow_clicked(bool checked);
49
```

```
50    void on_checkBox_InvertEncoder_clicked(bool checked);
51
52    void on_checkBox_useCUDA_clicked(bool checked);
53
54    void on_horizontalSlider_BrightFront_valueChanged(int
          value);
55
56    void on_horizontalSlider_ContrastFront_valueChanged(int
          value);
57
58    void on_horizontalSlider_SaturationFront_valueChanged(int
          value);
59
60    void on_horizontalSlider_HueFront_valueChanged(int value);
61
62    void on_horizontalSlider_SharpnessFront_valueChanged(int
          value);
63
64    void on_horizontalSlider_BrightProj_valueChanged(int value
          );
65
66    void on_horizontalSlider_ContrastProj_valueChanged(int
          value);
67
68    void on_horizontalSlider_SaturationProj_valueChanged(int
          value);
69
70    void on_horizontalSlider_HueProj_valueChanged(int value);
71
72    void on_horizontalSlider_SharpnessProj_valueChanged(int
          value);
73
74    void on_cb_use_adaptContrast_3_clicked(bool checked);
75
76    void on_cb_useBlur_3_clicked(bool checked);
77
78    void on_rb_useDark_3_toggled(bool checked);
79
80    void on_cb_ignoreBorder_3_clicked(bool checked);
81
82    void on_cb_fillHoles_3_clicked(bool checked);
83
84    void on_sb_sigmaFactor_3_editingFinished();
85
86    void on_rb_useOpen_3_clicked(bool checked);
87
88    void on_rb_useClose_3_clicked(bool checked);
89
90    void on_rb_useErode_3_clicked(bool checked);
91
92    void on_rb_useDilate_3_clicked(bool checked);
93
94    void on_sb_morphMask_3_editingFinished();
95
96    void on_spinBox_MaxGen_editingFinished();
97
```

```
98    void on_spinBox_PopSize_editingFinished();
99
100   void on_doubleSpinBox_MutationRate_editingFinished();
101
102   void on_spinBox_Elitisme_editingFinished();
103
104   void on_doubleSpinBox_endError_editingFinished();
105
106   void on_doubleSpinBox_maxWeight_editingFinished();
107
108   void on_doubleSpinBox_MinWeight_editingFinished();
109
110   void on_doubleSpinBox_Beta_editingFinished();
111
112   void on_spinBox_InputNeurons_editingFinished();
113
114   void on_spinBox_HiddenNeurons_editingFinished();
115
116   void on_spinBox_OutputNeurons_editingFinished();
117
118   void on_pushButton_selectSampleFolder_clicked();
119
120   void on_pushButton_SelectSettingFolder_clicked();
121
122   void on_pushButton_SelectNNFolder_clicked();
123
124   void on_pushButton_SelectNN_clicked();
125
126   void on_spinBox_NoShots_editingFinished();
127
128   void on_checkBox_PredictShape_clicked(bool checked);
129
130   void on_checkBox_revolt_clicked(bool checked);
131
132 private:
133   Ui::DialogSettings *ui;
134   Hardware::Microscope *Microscope;
135   SoilMath::NN *NN;
136   bool initfase = true;
137   void SetCamControl(Hardware::Microscope::Cam_t *
        selectedCam,
138                      QSlider *Brightness, QSlider *Contrast,
139                      QSlider *Saturation, QSlider *Hue,
                           QSlider *Sharpness);
140 };
141
142 #endif // DIALOGSETTINGS_H
```

```
1  #include "dialogsettings.h"
2  #include "ui_dialogsettings.h"
3  #include <opencv2/core.hpp>
4
5  DialogSettings::DialogSettings(QWidget *parent,
6                                 SoilAnalyzer::SoilSettings *
                                      settings,
```

```
7                                   Hardware::Microscope *
                                       microscope,
8                                   SoilMath::NN *nn, bool openNN
                                       )
9     : QDialog(parent), ui(new Ui::DialogSettings) {
10  ui->setupUi(this);
11  if (settings == nullptr) {
12    settings = new SoilAnalyzer::SoilSettings;
13  }
14  Settings = settings;
15  if (microscope == nullptr) {
16    microscope = new Hardware::Microscope;
17  }
18  if (nn == nullptr) {
19    nn = new SoilMath::NN;
20  }
21
22  // Setup the Hardware tab
23  Microscope = microscope;
24  QStringList Cams;
25  for (uint32_t i = 0; i < Microscope->AvailableCams.size();
        i++) {
26    Cams << Microscope->AvailableCams[i].Name.c_str();
27  }
28  ui->comboBox_Microscopes->addItems(Cams);
29  ui->comboBox_Microscopes->setCurrentIndex(Microscope->
       SelectedCam->ID);
30
31  QStringList Resolutions;
32  for (uint32_t i = 0; i < Microscope->SelectedCam->
       Resolutions.size(); i++) {
33    Resolutions << Microscope->SelectedCam->Resolutions[i].
         to_string().c_str();
34  }
35  ui->comboBox_Resolution->addItems(Resolutions);
36  ui->comboBox_Resolution->setCurrentIndex(
37      Microscope->SelectedCam->SelectedResolution->ID);
38
39  ui->spinBox_NoShots->setValue(Settings->
       StandardNumberOfShots);
40
41  ui->spinBox_NoFrames->setValue(Settings->HDRframes);
42  ui->spinBox_NoFrames->setDisabled(true);
43  ui->label_nf->setDisabled(true);
44
45  ui->checkBox_Backlight->setChecked(Settings->
       useBacklightProjection);
46  ui->tabWidget_Hardware->setTabEnabled(2, Settings->
       useBacklightProjection);
47
48  ui->checkBox_InvertEncoder->setChecked(Settings->encInv);
49  ui->checkBox_useCUDA->setChecked(Settings->useCUDA);
50
51  Settings->useCUDA = false;
52  ui->checkBox_useCUDA->setDisabled(true);
53
```

```
54    ui->checkBox_useHDR->setChecked(Settings->useHDR);
55    ui->checkBox_useRainbow->setChecked(Settings->
          enableRainbow);
56
57    // Get system info
58    struct utsname unameData;
59    uname(&unameData);
60
61    ui->label_machinename->setText(tr(unameData.machine));
62    ui->label_nodename->setText(tr(unameData.nodename));
63    ui->label_releasename->setText(tr(unameData.release));
64    ui->label_systemname->setText(tr(unameData.sysname));
65    ui->label_versioname->setText(tr(unameData.version));
66    if (Microscope->RunEnv == Hardware::Microscope::X64) {
67      ui->checkBox_useRainbow->setDisabled(true);
68      ui->checkBox_InvertEncoder->setDisabled(true);
69      ui->doubleSpinBox_LightLevel->setDisabled(true);
70      ui->label_ll->setDisabled(true);
71    }
72
73    SetCamControl(
74        Microscope->SelectedCam, ui->
              horizontalSlider_BrightFront,
75        ui->horizontalSlider_ContrastFront, ui->
              horizontalSlider_SaturationFront,
76        ui->horizontalSlider_HueFront, ui->
              horizontalSlider_SharpnessFront);
77    ui->horizontalSlider_BrightFront->setValue(Settings->
          Brightness_front);
78    ui->horizontalSlider_ContrastFront->setValue(Settings->
          Contrast_front);
79    ui->horizontalSlider_HueFront->setValue(Settings->
          Hue_front);
80    ui->horizontalSlider_SaturationFront->setValue(Settings->
          Saturation_front);
81    ui->horizontalSlider_SharpnessFront->setValue(Settings->
          Sharpness_front);
82
83    SetCamControl(
84        Microscope->SelectedCam, ui->
              horizontalSlider_BrightProj,
85        ui->horizontalSlider_ContrastProj, ui->
              horizontalSlider_SaturationProj,
86        ui->horizontalSlider_HueProj, ui->
              horizontalSlider_SharpnessProj);
87    ui->horizontalSlider_BrightProj->setValue(Settings->
          Brightness_proj);
88    ui->horizontalSlider_ContrastProj->setValue(Settings->
          Contrast_proj);
89    ui->horizontalSlider_HueProj->setValue(Settings->Hue_proj)
          ;
90    ui->horizontalSlider_SaturationProj->setValue(Settings->
          Saturation_proj);
91    ui->horizontalSlider_SharpnessProj->setValue(Settings->
          Sharpness_proj);
92
```

```
93    // Setup the Vision tab
94    ui->cb_fillHoles_3->setChecked(Settings->fillHoles);
95    ui->cb_ignoreBorder_3->setChecked(Settings->
          ignorePartialBorderParticles);
96    ui->cb_useBlur_3->setChecked(Settings->useBlur);
97    if (!Settings->useBlur) {
98      ui->sb_blurMask_3->setEnabled(false);
99    }
100   ui->cb_use_adaptContrast_3->setChecked(Settings->
          useAdaptiveContrast);
101   if (!Settings->useAdaptiveContrast) {
102     ui->sb_adaptContrastFactor_3->setEnabled(false);
103     ui->sb_adaptContrKernel_3->setEnabled(false);
104   }
105   switch (Settings->typeOfObjectsSegmented) {
106   case Vision::Segment::Bright:
107     ui->rb_useDark_3->setChecked(false);
108     ui->rb_useLight_3->setChecked(true);
109     break;
110   case Vision::Segment::Dark:
111     ui->rb_useDark_3->setChecked(true);
112     ui->rb_useLight_3->setChecked(false);
113     break;
114   }
115   switch (Settings->morphFilterType) {
116   case Vision::MorphologicalFilter::CLOSE:
117     ui->rb_useClose_3->setChecked(true);
118     ui->rb_useDilate_3->setChecked(false);
119     ui->rb_useErode_3->setChecked(false);
120     ui->rb_useOpen_3->setChecked(false);
121     break;
122   case Vision::MorphologicalFilter::OPEN:
123     ui->rb_useClose_3->setChecked(false);
124     ui->rb_useDilate_3->setChecked(false);
125     ui->rb_useErode_3->setChecked(false);
126     ui->rb_useOpen_3->setChecked(true);
127     break;
128   case Vision::MorphologicalFilter::ERODE:
129     ui->rb_useClose_3->setChecked(false);
130     ui->rb_useDilate_3->setChecked(false);
131     ui->rb_useErode_3->setChecked(true);
132     ui->rb_useOpen_3->setChecked(false);
133     break;
134   case Vision::MorphologicalFilter::DILATE:
135     ui->rb_useClose_3->setChecked(false);
136     ui->rb_useDilate_3->setChecked(true);
137     ui->rb_useErode_3->setChecked(false);
138     ui->rb_useOpen_3->setChecked(false);
139     break;
140   }
141
142   ui->sb_adaptContrastFactor_3->setValue(Settings->
          adaptContrastKernelFactor);
143   ui->sb_adaptContrKernel_3->setValue(Settings->
          adaptContrastKernelSize);
144   ui->sb_blurMask_3->setValue(Settings->blurKernelSize);
```

```
145     ui->sb_morphMask_3->setValue(Settings->filterMaskSize);
146     ui->sb_sigmaFactor_3->setValue(Settings->sigmaFactor);
147
148     // Setup the neural Network tab
149     NN = nn;
150     QPixmap NNpix("Images/feedforwardnetwork2.png");
151     ui->label_NNimage->setPixmap(NNpix);
152     ui->label_NNimage->setScaledContents(true);
153
154     ui->spinBox_InputNeurons->setValue(NN->GetInputNeurons());
155     ui->spinBox_HiddenNeurons->setValue(NN->GetHiddenNeurons()
          );
156     ui->spinBox_OutputNeurons->setValue(NN->GetOutputNeurons()
          );
157     ui->spinBox_Elitisme->setValue(NN->ElitismeUsedByGA);
158     ui->spinBox_MaxGen->setValue(NN->MaxGenUsedByGA);
159     ui->spinBox_PopSize->setValue(NN->PopulationSizeUsedByGA);
160     ui->doubleSpinBox_endError->setValue(NN->EndErrorUsedByGA)
          ;
161     ui->doubleSpinBox_MutationRate->setValue(NN->
          MutationrateUsedByGA);
162     ui->doubleSpinBox_Beta->setValue(NN->GetBeta());
163     ui->doubleSpinBox_maxWeight->setValue(NN->
          MaxWeightUsedByGA);
164     ui->doubleSpinBox_MinWeight->setValue(NN->
          MinWeightUSedByGa);
165     ui->checkBox_PredictShape->setChecked(Settings->
          PredictTheShape);
166     ui->checkBox_revolt->setChecked(Settings->Revolution);
167
168     // Setup the preference tab
169     ui->lineEdit_NeuralNetFolder->setText(
170         QString::fromStdString(Settings->NNFolder));
171     ui->lineEdit_Printer->setText(
172         QString::fromStdString(Settings->StandardPrinter));
173     ui->lineEdit_Samplefolder->setText(
174         QString::fromStdString(Settings->SampleFolder));
175     ui->lineEdit_SendTo->setText(
176         (QString::fromStdString(Settings->StandardSentTo)));
177     ui->lineEdit_SettingFolder->setText(
178         QString::fromStdString(Settings->SettingsFolder));
179     ui->lineEdit__NeuralNet->setText(
180         QString::fromStdString(Settings->NNlocation));
181
182     if (openNN) {
183       ui->tabWidget->setCurrentIndex(3);
184     }
185     initfase = false;
186 }
187
188 DialogSettings::~DialogSettings() { delete ui; }
189
190 void DialogSettings::openTab(int newValue) {
191     if (newValue > ui->tabWidget->count()) {
192       ui->tabWidget->setCurrentIndex(newValue);
193     }
```

```
194 }
195
196 void DialogSettings::on_pushButton_RestoreDefault_clicked()
    {
197   Settings->LoadSettings("Settings/Default.ini");
198 }
199
200 void DialogSettings::on_pushButton_Open_clicked() {
201   QString fn = QFileDialog::getOpenFileName(
202       this, tr("Open Settings"), QDir::homePath(), tr("
          Settings (*.ini)"));
203   if (!fn.isEmpty()) {
204     if (!fn.contains(tr(".ini"))) {
205       fn.append(tr(".ini"));
206     }
207     Settings->LoadSettings(fn.toStdString());
208   }
209 }
210
211 void DialogSettings::on_pushButton_Save_clicked() {
212   QString fn = QFileDialog::getSaveFileName(
213       this, tr("Save Settings"), QDir::homePath(), tr("
          Settings (*.ini)"));
214   if (!fn.isEmpty()) {
215     if (!fn.contains(tr(".ini"))) {
216       fn.append(tr(".ini"));
217     }
218     Settings->SaveSettings(fn.toStdString());
219   }
220 }
221
222 void DialogSettings::on_checkBox_Backlight_clicked(bool
    checked) {
223   ui->tabWidget_Hardware->setTabEnabled(2, checked);
224   Settings->useBacklightProjection = checked;
225 }
226
227 void DialogSettings::
    on_comboBox_Microscopes_currentIndexChanged(
228     const QString &arg1) {
229
230   if (!initfase) {
231     std::string selectedCam = arg1.toStdString();
232     Microscope->openCam(selectedCam);
233     Settings->defaultWebcam = selectedCam;
234
235     ui->comboBox_Resolution->clear();
236     QStringList Resolutions;
237     for (uint32_t i = 0; i < Microscope->SelectedCam->
        Resolutions.size(); i++) {
238       Resolutions
239           << Microscope->SelectedCam->Resolutions[i].
              to_string().c_str();
240     }
241     ui->comboBox_Resolution->addItems(Resolutions);
242     ui->comboBox_Resolution->setCurrentIndex(
```

```
243         Microscope->SelectedCam->SelectedResolution->ID);
244   }
245 }
246
247 void DialogSettings::
      on_comboBox_Resolution_currentIndexChanged(int index) {
248   if (!initfase) {
249     Microscope->SelectedCam->SelectedResolution =
250         &Microscope->SelectedCam->Resolutions[index];
251     Microscope->openCam(Microscope->SelectedCam);
252     Settings->selectedResolution = index;
253   }
254 }
255
256 void DialogSettings::on_checkBox_useHDR_clicked(bool checked
      ) {
257   ui->spinBox_NoFrames->setDisabled(!checked);
258   ui->label_nf->setDisabled(!checked);
259   Settings->useHDR = checked;
260 }
261
262 void DialogSettings::SetCamControl(Hardware::Microscope::
      Cam_t *selectedCam,
263                                    QSlider *Brightness,
                                         QSlider *Contrast,
264                                    QSlider *Saturation,
                                         QSlider *Hue,
265                                    QSlider *Sharpness) {
266   for (uint32_t i = 0; i < selectedCam->Controls.size(); i
        ++) {
267     if (selectedCam->Controls[i].name.compare("Brightness")
          == 0) {
268       Brightness->setMinimum(selectedCam->Controls[i].
            minimum);
269       Brightness->setMaximum(selectedCam->Controls[i].
            maximum);
270     } else if (selectedCam->Controls[i].name.compare("
          Contrast") == 0) {
271       Contrast->setMinimum(selectedCam->Controls[i].minimum)
            ;
272       Contrast->setMaximum(selectedCam->Controls[i].maximum)
            ;
273     } else if (selectedCam->Controls[i].name.compare("
          Saturation") == 0) {
274       Saturation->setMinimum(selectedCam->Controls[i].
            minimum);
275       Saturation->setMaximum(selectedCam->Controls[i].
            maximum);
276     } else if (selectedCam->Controls[i].name.compare("Hue")
          == 0) {
277       Hue->setMinimum(selectedCam->Controls[i].minimum);
278       Hue->setMaximum(selectedCam->Controls[i].maximum);
279     } else if (selectedCam->Controls[i].name.compare("
          Sharpness") == 0) {
280       Sharpness->setMinimum(selectedCam->Controls[i].minimum
            );
```

```
281         Sharpness->setMaximum(selectedCam->Controls[i].maximum
                );
282       }
283     }
284 }
285
286 void DialogSettings::on_spinBox_NoFrames_editingFinished() {
287   Settings->HDRframes = ui->spinBox_NoFrames->value();
288 }
289
290 void DialogSettings::
        on_doubleSpinBox_LightLevel_editingFinished() {
291   Settings->lightLevel =
292       static_cast<float>(ui->doubleSpinBox_LightLevel->value
              ());
293 }
294
295 void DialogSettings::on_checkBox_useRainbow_clicked(bool
        checked) {
296   Settings->enableRainbow = checked;
297 }
298
299 void DialogSettings::on_checkBox_InvertEncoder_clicked(bool
        checked) {
300   Settings->encInv = checked;
301 }
302
303 void DialogSettings::on_checkBox_useCUDA_clicked(bool
        checked) {
304   Settings->useCUDA = checked;
305 }
306
307 void DialogSettings::
        on_horizontalSlider_BrightFront_valueChanged(int value) {
308   if (!initfase) {
309     Settings->Brightness_front = value;
310   }
311 }
312
313 void DialogSettings::
        on_horizontalSlider_ContrastFront_valueChanged(int value)
         {
314   if (!initfase) {
315     Settings->Contrast_front = value;
316   }
317 }
318
319 void DialogSettings::
        on_horizontalSlider_SaturationFront_valueChanged(
320     int value) {
321   if (!initfase) {
322     Settings->Saturation_front = value;
323   }
324 }
325
```

```
326 void DialogSettings::
        on_horizontalSlider_HueFront_valueChanged(int value) {
327   if (!initfase) {
328     Settings->Hue_front = value;
329   }
330 }
331
332 void DialogSettings::
        on_horizontalSlider_SharpnessFront_valueChanged(
333     int value) {
334   if (!initfase) {
335     Settings->Sharpness_front = value;
336   }
337 }
338
339 void DialogSettings::
        on_horizontalSlider_BrightProj_valueChanged(int value) {
340   if (!initfase) {
341     Settings->Brightness_proj = value;
342   }
343 }
344
345 void DialogSettings::
        on_horizontalSlider_ContrastProj_valueChanged(int value)
        {
346   if (!initfase) {
347     Settings->Contrast_proj = value;
348   }
349 }
350
351 void DialogSettings::
        on_horizontalSlider_SaturationProj_valueChanged(
352     int value) {
353   if (!initfase) {
354     Settings->Saturation_proj = value;
355   }
356 }
357
358 void DialogSettings::
        on_horizontalSlider_HueProj_valueChanged(int value) {
359   if (!initfase) {
360     Settings->Hue_proj = value;
361   }
362 }
363
364 void DialogSettings::
        on_horizontalSlider_SharpnessProj_valueChanged(int value)
        {
365   if (!initfase) {
366     Settings->Sharpness_proj = value;
367   }
368 }
369
370 void DialogSettings::on_cb_use_adaptContrast_3_clicked(bool
        checked) {
371   Settings->useAdaptiveContrast = checked;
```

```
372   ui->sb_adaptContrastFactor_3->setDisabled(!checked);
373   ui->sb_adaptContrKernel_3->setDisabled(!checked);
374 }
375
376 void DialogSettings::on_cb_useBlur_3_clicked(bool checked) {
377   Settings->useBlur = checked;
378   ui->sb_blurMask_3->setDisabled(!checked);
379 }
380
381 void DialogSettings::on_rb_useDark_3_toggled(bool checked) {
382   if (checked) {
383     Settings->typeOfObjectsSegmented = Vision::Segment::Dark
          ;
384   } else {
385     Settings->typeOfObjectsSegmented = Vision::Segment::
          Bright;
386   }
387 }
388
389 void DialogSettings::on_cb_ignoreBorder_3_clicked(bool
      checked) {
390   Settings->ignorePartialBorderParticles = checked;
391 }
392
393 void DialogSettings::on_cb_fillHoles_3_clicked(bool checked)
       {
394   Settings->fillHoles = checked;
395 }
396
397 void DialogSettings::on_sb_sigmaFactor_3_editingFinished() {
398   Settings->sigmaFactor = ui->sb_sigmaFactor_3->value();
399 }
400
401 void DialogSettings::on_rb_useOpen_3_clicked(bool checked) {
402   Settings->morphFilterType = Vision::MorphologicalFilter::
        OPEN;
403 }
404
405 void DialogSettings::on_rb_useClose_3_clicked(bool checked)
      {
406   Settings->morphFilterType = Vision::MorphologicalFilter::
        CLOSE;
407 }
408
409 void DialogSettings::on_rb_useErode_3_clicked(bool checked)
      {
410   Settings->morphFilterType = Vision::MorphologicalFilter::
        ERODE;
411 }
412
413 void DialogSettings::on_rb_useDilate_3_clicked(bool checked)
       {
414   Settings->morphFilterType = Vision::MorphologicalFilter::
        DILATE;
415 }
416
```

```
417 void DialogSettings::on_sb_morphMask_3_editingFinished() {
418   Settings->filterMaskSize = ui->sb_morphMask_3->value();
419 }
420
421 void DialogSettings::on_spinBox_MaxGen_editingFinished() {
422   NN->MaxGenUsedByGA = ui->spinBox_MaxGen->value();
423 }
424
425 void DialogSettings::on_spinBox_PopSize_editingFinished() {
426   NN->PopulationSizeUsedByGA = ui->spinBox_PopSize->value();
427 }
428
429 void DialogSettings::
       on_doubleSpinBox_MutationRate_editingFinished() {
430   NN->MutationrateUsedByGA = ui->doubleSpinBox_MutationRate
        ->value();
431 }
432
433 void DialogSettings::on_spinBox_Elitisme_editingFinished() {
434   NN->ElitismeUsedByGA = ui->spinBox_Elitisme->value();
435 }
436
437 void DialogSettings::
       on_doubleSpinBox_endError_editingFinished() {
438   NN->EndErrorUsedByGA = ui->doubleSpinBox_endError->value()
        ;
439 }
440
441 void DialogSettings::
       on_doubleSpinBox_maxWeight_editingFinished() {
442   NN->MaxWeightUsedByGA = ui->doubleSpinBox_maxWeight->value
        ();
443 }
444
445 void DialogSettings::
       on_doubleSpinBox_MinWeight_editingFinished() {
446   NN->MinWeightUSedByGa = ui->doubleSpinBox_MinWeight->value
        ();
447 }
448
449 void DialogSettings::on_doubleSpinBox_Beta_editingFinished()
       {
450   NN->SetBeta(ui->doubleSpinBox_Beta->value());
451 }
452
453 void DialogSettings::on_spinBox_InputNeurons_editingFinished
       () {
454   NN->SetInputNeurons(ui->spinBox_InputNeurons->value());
455 }
456
457 void DialogSettings::
       on_spinBox_HiddenNeurons_editingFinished() {
458   NN->SetHiddenNeurons(ui->spinBox_HiddenNeurons->value());
459 }
460
```

```
461 void DialogSettings::
        on_spinBox_OutputNeurons_editingFinished() {
462   NN->SetOutputNeurons(ui->spinBox_OutputNeurons->value());
463 }
464
465 void DialogSettings::
        on_pushButton_selectSampleFolder_clicked() {
466   QString fn = QFileDialog::getExistingDirectory(
467       this, tr("Select the Sample Directory"),
468       QString::fromStdString(Settings->SampleFolder),
469       QFileDialog::ShowDirsOnly | QFileDialog::
              DontResolveSymlinks);
470   if (!fn.isEmpty()) {
471     ui->lineEdit_Samplefolder->setText(fn);
472     Settings->SampleFolder = fn.toStdString();
473   }
474 }
475
476 void DialogSettings::
        on_pushButton_SelectSettingFolder_clicked() {
477   QString fn = QFileDialog::getExistingDirectory(
478       this, tr("Select the Setting Directory"),
479       QString::fromStdString(Settings->SettingsFolder),
480       QFileDialog::ShowDirsOnly | QFileDialog::
              DontResolveSymlinks);
481   if (!fn.isEmpty()) {
482     ui->lineEdit_SettingFolder->setText(fn);
483     Settings->SettingsFolder = fn.toStdString();
484   }
485 }
486
487 void DialogSettings::on_pushButton_SelectNNFolder_clicked()
        {
488   QString fn = QFileDialog::getExistingDirectory(
489       this, tr("Select the NeuralNet Directory"),
490       QString::fromStdString(Settings->NNFolder),
491       QFileDialog::ShowDirsOnly | QFileDialog::
              DontResolveSymlinks);
492   if (!fn.isEmpty()) {
493     ui->lineEdit_NeuralNetFolder->setText(fn);
494     Settings->NNFolder = fn.toStdString();
495   }
496 }
497
498 void DialogSettings::on_pushButton_SelectNN_clicked() {
499   QString fn =
500       QFileDialog::getOpenFileName(this, tr("Select the
              standard Neural Net"),
501                                    QDir::homePath(), tr("
                                       NeuralNet (*.NN)"));
502   if (!fn.isEmpty()) {
503     if (!fn.contains(tr(".NN"))) {
504       fn.append(tr(".NN"));
505     }
506     Settings->NNlocation = fn.toStdString();
507     ui->lineEdit__NeuralNet->setText(fn);
```

```
508   }
509 }
510
511 void DialogSettings::on_spinBox_NoShots_editingFinished() {
512   Settings->StandardNumberOfShots = ui->spinBox_NoShots->
          value();
513 }
514
515 void DialogSettings::on_checkBox_PredictShape_clicked(bool
       checked) {
516   Settings->PredictTheShape = checked;
517 }
518
519 void DialogSettings::on_checkBox_revolt_clicked(bool checked
       )
520 {
521     Settings->Revolution = checked;
522 }
```

Dialog Neural Network Class

```
#ifndef DIALOGNN_H
#define DIALOGNN_H

#include <QDialog>
#include "SoilMath.h"
#include "soilanalyzer.h"
#include "dialogsettings.h"
#include <qcustomplot.h>
#include <QDebug>

namespace Ui {
  class DialogNN;
}

class DialogNN : public QDialog
{
  Q_OBJECT

public:
  explicit DialogNN(QWidget *parent = 0, SoilMath::NN *
      neuralnet = nullptr, SoilAnalyzer::SoilSettings *
      settings = nullptr, DialogSettings *settingWindow =
      nullptr);
  ~DialogNN();

private slots:

  void on_pushButton_Settings_clicked();

  void on_learnErrorUpdate(double newError);

  void on_pushButton_SelectSamples_clicked();

  void on_pushButton_Learn_clicked();

  void on_pushButton_SaveNN_clicked();

  void on_pushButton_OpenNN_clicked();

  void on_actionAbort_triggered();

private:
  Ui::DialogNN *ui;
  DialogSettings *SettingsWindow = nullptr;
  SoilMath::NN *NeuralNet = nullptr;
  SoilAnalyzer::SoilSettings *Settings = nullptr;

  void setupErrorGraph();
  void makeLearnVectors(InputLearnVector_t &input,
      OutputLearnVector_t &output);

  QVector<double> currentError;
  QVector<double> errorTicks;
  double currentGeneration = 0;
```

```
51    QStringList fn;
52  };
53
54  #endif // DIALOGNN_H
```

```
1   #include "dialognn.h"
2   #include "ui_dialognn.h"
3
4   DialogNN::DialogNN(QWidget *parent, SoilMath::NN *neuralnet,
5                      SoilAnalyzer::SoilSettings *settings,
6                      DialogSettings *settingsWindow)
7       : QDialog(parent), ui(new Ui::DialogNN) {
8     ui->setupUi(this);
9
10    if (neuralnet == nullptr) {
11      neuralnet = new SoilMath::NN;
12    }
13    NeuralNet = neuralnet;
14    if (settings == nullptr) {
15      settings = new SoilAnalyzer::SoilSettings;
16    }
17    Settings = settings;
18    if (settingsWindow == nullptr) {
19      settingsWindow = new DialogSettings;
20    }
21    SettingsWindow = settingsWindow;
22
23    // Setup the Qplots
24    ui->widget_NNError->addGraph();
25    ui->widget_NNError->addGraph();
26
27    ui->widget_NNError->xAxis->setLabel("Generation [-]");
28    ui->widget_NNError->yAxis->setLabel("Error [%]");
29    QCPPlotTitle *widget_NNErrorTitle = new QCPPlotTitle(ui->
          widget_NNError);
30    widget_NNErrorTitle->setText("Learning error");
31    widget_NNErrorTitle->setFont(QFont("sans", 10, QFont::Bold
          ));
32    ui->widget_NNError->plotLayout()->insertRow(0);
33    ui->widget_NNError->plotLayout()->addElement(0, 0,
          widget_NNErrorTitle);
34
35    setupErrorGraph();
36
37    // Connect the NN learn error
38    connect(NeuralNet, SIGNAL(learnErrorUpdate(double)), this,
39            SLOT(on_learnErrorUpdate(double)));
40  }
41
42  DialogNN::~DialogNN() { delete ui; }
43
44  void DialogNN::on_pushButton_Settings_clicked() {
45    SettingsWindow->openTab(2);
46    SettingsWindow->show();
47    setupErrorGraph();
48  }
```

```
49
50 void DialogNN::on_learnErrorUpdate(double newError) {
51   ui->widget_NNError->graph(0)->addData(currentGeneration,
       newError);
52   currentGeneration += 1;
53   ui->widget_NNError->yAxis->rescale();
54   //ui->widget_NNError->yAxis->setRange(0, 20);
55   ui->widget_NNError->replot();
56 }
57
58 void DialogNN::setupErrorGraph() {
59   errorTicks.clear();
60   for (uint32_t i = 0; i < NeuralNet->MaxGenUsedByGA; i++) {
61     errorTicks.push_back(i);
62   }
63   ui->widget_NNError->xAxis->setRange(0, NeuralNet->
       MaxGenUsedByGA);
64   QVector<double> endErrorValue(2, NeuralNet->
       EndErrorUsedByGA);
65   QVector<double> endErrorKey(2, 0);
66   endErrorKey[1] = NeuralNet->MaxGenUsedByGA;
67   ui->widget_NNError->graph(1)->setData(endErrorKey,
       endErrorValue);
68   ui->widget_NNError->xAxis->setAutoTicks(false);
69   ui->widget_NNError->xAxis->setTickVector(errorTicks);
70   ui->widget_NNError->xAxis->setTickLabels(false);
71   //ui->widget_NNError->yAxis->setScaleType(QCPAxis::
       stLogarithmic);
72   ui->widget_NNError->replot();
73 }
74
75 void DialogNN::on_pushButton_SelectSamples_clicked() {
76   fn = QFileDialog::getOpenFileNames(
77        this, tr("Open Samples"), QString::fromStdString(
           Settings->SampleFolder),
78        tr("Samples (*.VSA)"));
79   for_each(fn.begin(), fn.end(), [](QString &f) {
80     if (!f.contains(tr(".VSA"))) {
81       f.append(tr(".VSA"));
82     }
83   });
84 }
85
86 void DialogNN::on_pushButton_Learn_clicked() {
87   if (fn.size() < 1) {
88     return;
89   }
90   InputLearnVector_t InputVec;
91   OutputLearnVector_t OutputVec;
92   makeLearnVectors(InputVec, OutputVec);
93   NeuralNet->Learn(InputVec, OutputVec, NeuralNet->
       GetInputNeurons());
94   setupErrorGraph();
95 }
96
97 void DialogNN::makeLearnVectors(InputLearnVector_t &input,
```

```
98                                      OutputLearnVector_t &output)
                                            {
99    for (uint32_t i = 0; i < fn.size(); i++) {
100     SoilAnalyzer::Sample sample;
101     sample.Load(fn[i].toStdString());
102     for_each(sample.ParticlePopulation.begin(), sample.
          ParticlePopulation.end(),
103           [&](SoilAnalyzer::Particle &P) {
104             if (P.FFDescriptors.size() >= NeuralNet->
                  GetInputNeurons()) {
105               ComplexVect_t ffdesc;
106               for (uint32_t j = 0; j < NeuralNet->
                    GetInputNeurons(); j++) {
107                 ffdesc.push_back(P.FFDescriptors[j]);
108               }
109               input.push_back(ffdesc);
110               Predict_t predict = P.Classification;
111               predict.OutputNeurons = SoilMath::
                    makeOutput(P.GetAngularity(), NeuralNet
                    ->GetOutputNeurons());
112               output.push_back(predict);
113             }
114           });
115   }
116 }
117
118 void DialogNN::on_pushButton_SaveNN_clicked() {
119   QString fn = QFileDialog::getSaveFileName(
120       this, tr("Save NeuralNet"), QString::fromStdString(
            Settings->NNFolder),
121       tr("NeuralNet (*.NN)"));
122   if (!fn.isEmpty()) {
123     if (!fn.contains(tr(".NN"))) {
124       fn.append(tr(".NN"));
125     }
126     NeuralNet->SaveState(fn.toStdString());
127   }
128 }
129
130 void DialogNN::on_pushButton_OpenNN_clicked() {
131   QString fn = QFileDialog::getOpenFileName(
132       this, tr("Open NeuralNet"),
133       QString::fromStdString(Settings->SampleFolder), tr("
          NeuralNet (*.NN)"));
134   if (!fn.isEmpty()) {
135     if (!fn.contains(tr(".NN"))) {
136       fn.append(tr(".NN"));
137     }
138     if (NeuralNet != nullptr) {
139       delete NeuralNet;
140     }
141     NeuralNet->LoadState(fn.toStdString());
142     connect(NeuralNet, SIGNAL(learnErrorUpdate(double)),
          this,
143           SLOT(on_learnErrorUpdate(double)));
144   }
```

```
145 }
146
147 void DialogNN::on_actionAbort_triggered()
148 {
149     NeuralNet->EndErrorUsedByGA = ui->widget_NNError->graph
        (0)->data()->lastKey();
150 }
```

Q. Reference manual

Vision Soil Analyzer

1.0.0

Generated by Doxygen 1.8.9.1

Mon Oct 5 2015 21:06:41

Contents

1 Namespace Index

1.1 Namespace List

Here is a list of all namespaces with brief descriptions:

2 Hierarchical Index

2.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

3 Class Index

3.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

4 File Index

4.1 File List

Here is a list of all files with brief descriptions:

5 Namespace Documentation

5.1 boost Namespace Reference

Namespaces

- serialization

5.2 boost::serialization Namespace Reference

Functions

- template<class Archive >
  void serialize (Archive &ar, cv::Mat &m, const unsigned int version __attribute__((unused)))
  serialize Serialize the openCV mat to disk
- template<class Archive >
  void serialize (Archive &ar, Predict_t &P, const unsigned int version __attribute__((unused)))
  serialize Serialize the openCV mat to disk
- template<class Archive >
  void serialize (Archive &ar, SoilAnalyzer::Lab_t &P, const unsigned int version __attribute__((unused)))
  serialize Serialize the openCV mat to disk

5.2.1 Function Documentation

5.2.1.1 template<class Archive > void boost::serialization::serialize (Archive & *ar,* SoilAnalyzer::Lab_t & *P,* const unsigned int version *__attribute__(unused)*) [inline]

serialize Serialize the openCV mat to disk

Definition at line 21 of file lab_t_archive.h.

References SoilAnalyzer::Lab_t::a, SoilAnalyzer::Lab_t::b, and SoilAnalyzer::Lab_t::L.

5.2.1.2 template<class Archive > void boost::serialization::serialize (Archive & *ar,* cv::Mat & *m,* const unsigned int version *__attribute__(unused)*) [inline]

serialize Serialize the openCV mat to disk

Definition at line 24 of file Mat_archive.h.

5.2.1.3 template<class Archive > void boost::serialization::serialize (Archive & *ar*, Predict_t & *P*, const unsigned int version *__attribute__(unused)*) [inline]

serialize Serialize the openCV mat to disk

Definition at line 25 of file predict_t_archive.h.

References Predict_struct::Accuracy, Predict_struct::Category, Predict_struct::OutputNeurons, and Predict_struct::RealValue.

5.3 Hardware Namespace Reference

Namespaces

- Exception

Classes

- class ADC
- class BBB
- class EC12P
- class eQEP
- class GPIO
- class Microscope
- class PWM
- class SoilCape
- class USB

Typedefs

- typedef int(∗ CallbackType) (int)

Functions

- void ∗ threadedPollADC (void ∗value)
- void ∗ colorLoop (void ∗value)
- void ∗ threadedPolleqep (void ∗value)
- void ∗ threadedPollGPIO (void ∗value)

5.3.1 Typedef Documentation

5.3.1.1 typedef int(∗ Hardware::CallbackType) (int)

CallbackType used to pass a function to a thread

Definition at line 37 of file BBB.h.

5.3.2 Function Documentation

5.3.2.1 void ∗ Hardware::colorLoop (void ∗ *value*)

The thread function that runs trough all the colors

Definition at line 91 of file EC12P.cpp.

References Hardware::EC12P::SetPixelColor(), Hardware::EC12P::sleepperiod, and Hardware::EC12P::threadRunning.

Here is the call graph for this function:

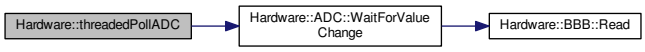
5.3.2.2 void * Hardware::threadedPollADC (void * *value*)

friendly function to start the threading

Definition at line 121 of file ADC.cpp.

References Hardware::BBB::callbackFunction, Hardware::BBB::threadRunning, and Hardware::ADC::WaitForValueChange().

Here is the call graph for this function:

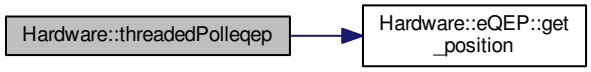


5.3.2.3 void * Hardware::threadedPolleqep (void * *value*)

Definition at line 242 of file eqep.cpp.

References Hardware::BBB::callbackFunction, Hardware::BBB::debounceTime, Hardware::eQEP::get_position(), and Hardware::BBB::threadRunning.

Here is the call graph for this function:

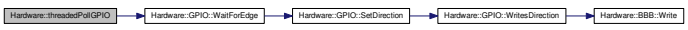


5.3.2.4 void * Hardware::threadedPollGPIO (void * *value*)

Definition at line 266 of file GPIO.cpp.

References Hardware::BBB::callbackFunction, Hardware::BBB::debounceTime, Hardware::BBB::threadRunning, and Hardware::GPIO::WaitForEdge().

Here is the call graph for this function:



5.4 Hardware::Exception Namespace Reference

Classes

- class ADCReadException
- class CouldNotGrabImageException
- class FailedToCreateGPIOPollingThreadException
- class FailedToCreateThreadException
- class GPIOReadException
- class MicroscopeException
- class ValueOutOfBoundsException

5.5 SoilAnalyzer Namespace Reference

Namespaces

- Exception

Classes

- class Analyzer
- struct Lab_t
- class Particle
- struct Point_t
- class Sample
- class SoilSettings

  The SoilSettings class.

5.6 SoilAnalyzer::Exception Namespace Reference

Classes

- class SoilAnalyzerException

5.7 SoilMath Namespace Reference

Genetic Algorithmes used for optimization problems.

Namespaces

- Exception

Classes

- class FFT

  Fast Fourier Transform class.
- class GA
- class NN

  The Neural Network class.
- class PSD
- class Sort

  The Sort template class.
- class Stats

  Stats class.

Functions

- uint16_t MinNotZero (uint16_t a, uint16_t b)
- uint16_t Max (uint16_t a, uint16_t b)
- uint16_t Max (uint16_t a, uint16_t b, uint16_t c, uint16_t d)
- uint16_t Min (uint16_t a, uint16_t b)
- uint16_t Min (uint16_t a, uint16_t b, uint16_t c, uint16_t d)
- static double quick_pow10 (int n)
- static double fastPow (double a, double b)
- static double quick_pow2 (int n)
- static long float2intRound (double d)
- static float calcVolume (float A)

  calcVolume according to ISO 9276-6
- static std::vector< float > makeOutput (uint8_t value, uint32_t noNeurons)
- static float calcDiameter (float A)

  calcDiameter according to ISO 9276-6

5.7.1 Detailed Description

Genetic Algorithmes used for optimization problems.

Use this class for optimization problems. It's currently optimized for Neural Network optimzation

5.7.2 Function Documentation

5.7.2.1 static float SoilMath::calcDiameter (float *A*) [inline], [static]

calcDiameter according to ISO 9276-6

Parameters

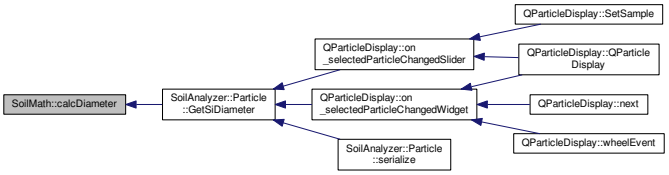
A	

Returns

Definition at line 115 of file CommonOperations.h.

Referenced by SoilAnalyzer::Particle::GetSiDiameter().

Here is the caller graph for this function:



5.7.2.2 static float SoilMath::calcVolume (float *A*) [inline], [static]

calcVolume according to ISO 9276-6

Parameters

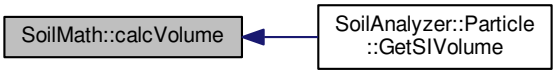
A	

Returns

Definition at line 100 of file CommonOperations.h.

Referenced by SoilAnalyzer::Particle::GetSIVolume().

Here is the caller graph for this function:

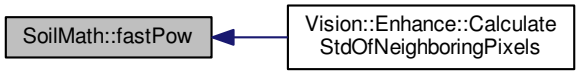


5.7.2.3 static double SoilMath::fastPow (double *a*, double *b*) [inline], [static]

Definition at line 49 of file CommonOperations.h.

Referenced by Vision::Enhance::CalculateStdOfNeighboringPixels().

Here is the caller graph for this function:



5.7.2.4 static long SoilMath::float2intRound (double *d*) [inline], [static]

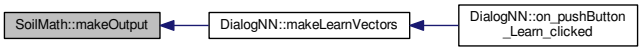
Definition at line 90 of file CommonOperations.h.

5.7.2.5 static std::vector<float> SoilMath::makeOutput (uint8_t *value*, uint32_t *noNeurons*) [inline], [static]

Definition at line 104 of file CommonOperations.h.

Referenced by DialogNN::makeLearnVectors().

Here is the caller graph for this function:



5.7.2.6 uint16_t SoilMath::Max (uint16_t *a*, uint16_t *b*) [inline]

Definition at line 25 of file CommonOperations.h.

Referenced by Max().

Here is the caller graph for this function:

5.7.2.7 uint16_t SoilMath::Max (uint16_t *a*, uint16_t *b*, uint16_t *c*, uint16_t *d*) [inline]

Definition at line 27 of file CommonOperations.h.

References Max().

Here is the call graph for this function:

5.7.2.8 uint16_t SoilMath::Min (uint16_t *a*, uint16_t *b*) [inline]

Definition at line 31 of file CommonOperations.h.

Referenced by Min().

Here is the caller graph for this function:

5.7.2.9 uint16_t SoilMath::Min (uint16_t *a*, uint16_t *b*, uint16_t *c*, uint16_t *d*) [inline]

Definition at line 33 of file CommonOperations.h.

References Min().

Here is the call graph for this function:

5.7.2.10 uint16_t SoilMath::MinNotZero (uint16_t *a*, uint16_t *b*) [inline]

Definition at line 17 of file CommonOperations.h.

5.7.2.11 static double SoilMath::quick_pow10 (int *n*) [inline], [static]

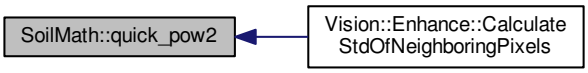
Definition at line 37 of file CommonOperations.h.

5.7.2.12 static double SoilMath::quick_pow2 (int *n*) [inline], [static]

Definition at line 59 of file CommonOperations.h.

Referenced by Vision::Enhance::CalculateStdOfNeighboringPixels().

Here is the caller graph for this function:



5.8 SoilMath::Exception Namespace Reference

Classes

- class MathException

5.9 Ui Namespace Reference

5.10 Vision Namespace Reference

Namespaces

- Exception

Classes

- class Conversion
- class Enhance
- class ImageProcessing
- class MorphologicalFilter
- class Segment

5.11 Vision::Exception Namespace Reference

Classes

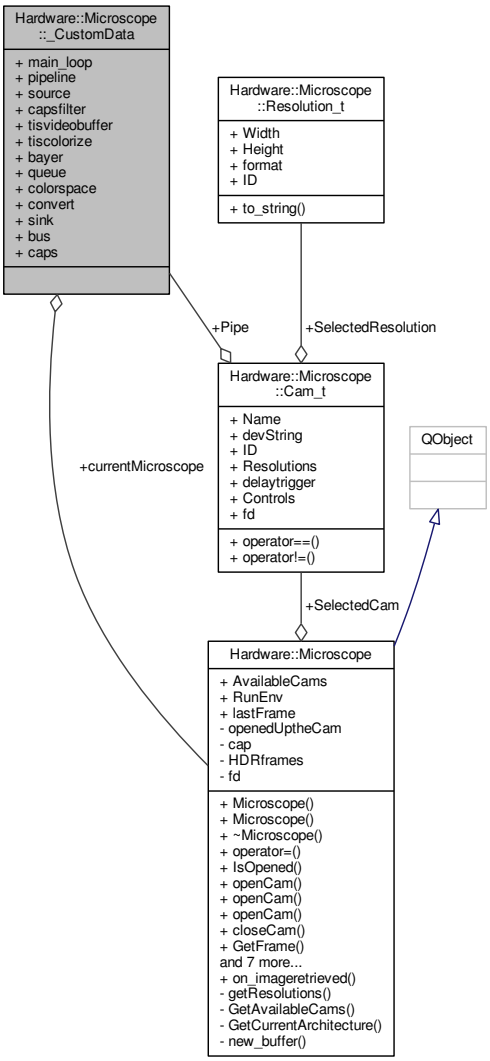
- class ChannelMismatchException
- class ConversionNotSupportedException
- class EmtpyImageException
- class PixelValueOutOfBoundException
- class WrongKernelSizeException

6 Class Documentation

6.1 Hardware::Microscope::_CustomData Struct Reference

`#include <Microscope.h>`

Collaboration diagram for Hardware::Microscope::_CustomData:



Public Attributes

- GMainLoop * main_loop
- GstElement * pipeline
- GstElement * source
- GstElement * capsfilter
- GstElement * tisvideobuffer
- GstElement * tiscolorize
- GstElement * bayer
- GstElement * queue
- GstElement * colorspace
- GstElement * convert
- GstElement * sink
- GstBus * bus
- GstCaps * caps
- Hardware::Microscope * currentMicroscope

6.1.1 Detailed Description

Definition at line 105 of file Microscope.h.

6.1.2 Member Data Documentation

6.1.2.1 GstElement* Hardware::Microscope::_CustomData::bayer

Definition at line 112 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.2 GstBus* Hardware::Microscope::_CustomData::bus

Definition at line 117 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.3 GstCaps* Hardware::Microscope::_CustomData::caps

Definition at line 118 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.4 GstElement* Hardware::Microscope::_CustomData::capsfilter

Definition at line 109 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.5 GstElement* Hardware::Microscope::_CustomData::colorspace

Definition at line 114 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.6 GstElement* Hardware::Microscope::_CustomData::convert

Definition at line 115 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.7 Hardware::Microscope* Hardware::Microscope::_CustomData::currentMicroscope

Definition at line 119 of file Microscope.h.

Referenced by Hardware::Microscope::new_buffer(), and Hardware::Microscope::openCam().

6.1.2.8 GMainLoop* Hardware::Microscope::_CustomData::main_loop

Definition at line 106 of file Microscope.h.

6.1.2.9 GstElement* Hardware::Microscope::_CustomData::pipeline

Definition at line 107 of file Microscope.h.

Referenced by Hardware::Microscope::closeCam(), Hardware::Microscope::GetFrame(), and Hardware::Microscope::openCam().

6.1.2.10 GstElement* Hardware::Microscope::_CustomData::queue

Definition at line 113 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.11 GstElement* Hardware::Microscope::_CustomData::sink

Definition at line 116 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.12 GstElement* Hardware::Microscope::_CustomData::source

Definition at line 108 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.13 GstElement* Hardware::Microscope::_CustomData::tiscolorize

Definition at line 111 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

6.1.2.14 GstElement* Hardware::Microscope::_CustomData::tisvideobuffer

Definition at line 110 of file Microscope.h.

Referenced by Hardware::Microscope::openCam().

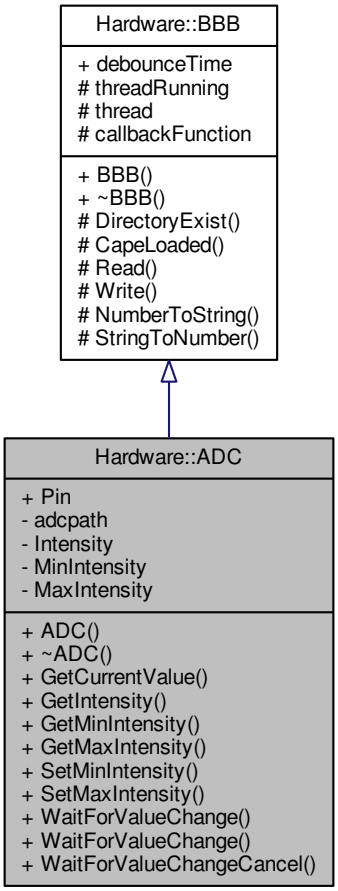
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/Microscope.h

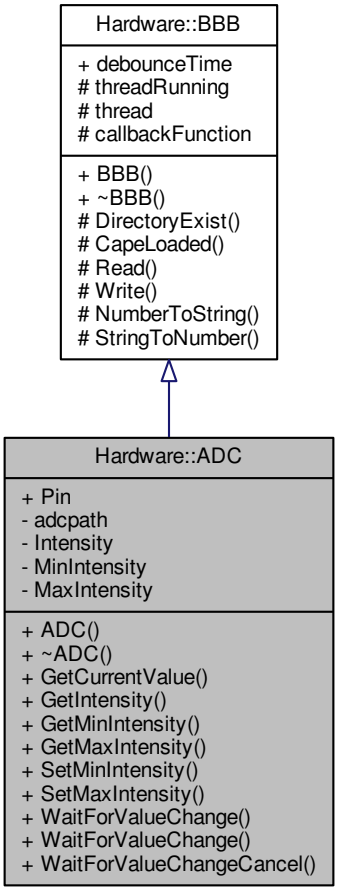
6.2 Hardware::ADC Class Reference

`#include <ADC.h>`

Inheritance diagram for Hardware::ADC:



Collaboration diagram for Hardware::ADC:



Public Types

- enum ADCPin {
  ADC0, ADC1, ADC2, ADC3,
  ADC4, ADC5, ADC6, ADC7 }

Public Member Functions

- ADC (ADCPin pin)
- ~ADC ()
- int GetCurrentValue ()
- float GetIntensity ()
- int GetMinIntensity ()
- int GetMaxIntensity ()
- void SetMinIntensity ()
- void SetMaxIntensity ()
- int WaitForValueChange ()
- int WaitForValueChange (CallbackType callback)
- void WaitForValueChangeCancel ()

Public Attributes

- ADCPin Pin

Private Attributes

- string adcpath
- float Intensity
- int MinIntensity
- int MaxIntensity

Friends

- void * threadedPollADC (void *value)

Additional Inherited Members

6.2.1 Detailed Description

Definition at line 51 of file ADC.h.

6.2.2 Member Enumeration Documentation

6.2.2.1 enum Hardware::ADC::ADCPin

Enumerator to indicate the analogue pin

Enumerator

ADC0 AIN0 pin

ADC1 AIN1 pin

ADC2 AIN2 pin

ADC3 AIN3 pin

ADC4 AIN4 pin

ADC5 AIN5 pin

ADC6 AIN6 pin

ADC7 AIN7 pin

Definition at line 54 of file ADC.h.

6.2.3 Constructor & Destructor Documentation

6.2.3.1 ADC::ADC (ADCPin *pin*)

Constructor

Parameters

pin	and ADCPin type indicating which analogue pin to use

Definition at line 14 of file ADC.cpp.

References ADC0, ADC0_PATH, ADC1, ADC1_PATH, ADC2, ADC2_PATH, ADC3, ADC3_PATH, ADC4, ADC4_PATH, ADC5, ADC5_PATH, ADC6, ADC6_PATH, ADC7, ADC7_PATH, adcpath, MaxIntensity, MinIntensity, and Pin.

6.2.3.2 ADC::~ADC ( )

De-constructor

Definition at line 48 of file ADC.cpp.

6.2.4 Member Function Documentation

6.2.4.1 int ADC::GetCurrentValue ( )

Reads the current voltage in the pin

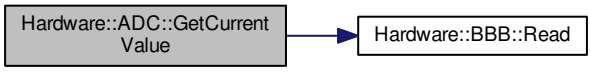
Returns

an integer between 0 and 4096

Definition at line 53 of file ADC.cpp.

References adcpath, Intensity, MaxIntensity, MinIntensity, and Hardware::BBB::Read().

Here is the call graph for this function:



6.2.4.2 float Hardware::ADC::GetIntensity ( ) [inline]

Definition at line 71 of file ADC.h.

6.2.4.3 int Hardware::ADC::GetMaxIntensity ( ) [inline]

Definition at line 73 of file ADC.h.

6.2.4.4 int Hardware::ADC::GetMinIntensity ( ) [inline]

Definition at line 72 of file ADC.h.

6.2.4.5 void ADC::SetMaxIntensity ( )

Definition at line 65 of file ADC.cpp.

References adcpath, MaxIntensity, and Hardware::BBB::Read().

Here is the call graph for this function:

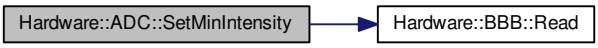
6.2.4.6 void ADC::SetMinIntensity ( )

Set the current voltage at the pin as the minimum voltage

Definition at line 61 of file ADC.cpp.

References adcpath, MinIntensity, and Hardware::BBB::Read().

Here is the call graph for this function:



6.2.4.7 int ADC::WaitForValueChange ( )

Polling of the analogue pin

Returns

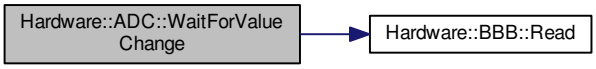
the current value

Definition at line 88 of file ADC.cpp.

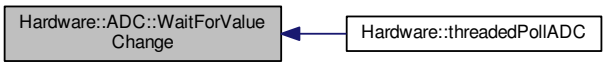
References adcpath, and Hardware::BBB::Read().

Referenced by Hardware::threadedPollADC().

Here is the call graph for this function:



Here is the caller graph for this function:



6.2.4.8 int ADC::WaitForValueChange (CallbackType *callback*)

Threading enabled polling of the analogue pin

Parameters

callback	the function which should be called when polling indicates a change CallbackType

Returns

0

Definition at line 74 of file ADC.cpp.

References Hardware::BBB::callbackFunction, Hardware::BBB::thread, threadedPollADC, and Hardware::BBB::threadRunning.

6.2.4.9 void Hardware::ADC::WaitForValueChangeCancel ( ) [inline]

Definition at line 80 of file ADC.h.

6.2.5 Friends And Related Function Documentation

6.2.5.1 void* threadedPollADC (void * *value*) [friend]

friend polling function

friendly function to start the threading

Definition at line 121 of file ADC.cpp.

Referenced by WaitForValueChange().

6.2.6 Member Data Documentation

6.2.6.1 string Hardware::ADC::adcpath [private]

Path to analogue write file

Definition at line 83 of file ADC.h.

Referenced by ADC(), GetCurrentValue(), SetMaxIntensity(), SetMinIntensity(), and WaitForValueChange().

6.2.6.2 float Hardware::ADC::Intensity [private]

Current intensity expressed as percentage

Definition at line 84 of file ADC.h.

Referenced by GetCurrentValue().

6.2.6.3 int Hardware::ADC::MaxIntensity [private]

Voltage level which represent 100 percentage

Definition at line 86 of file ADC.h.

Referenced by ADC(), GetCurrentValue(), and SetMaxIntensity().

6.2.6.4 int Hardware::ADC::MinIntensity [private]

Voltage level which represent 0 percentage

Definition at line 85 of file ADC.h.

Referenced by ADC(), GetCurrentValue(), and SetMinIntensity().

6.2.6.5 ADCPin Hardware::ADC::Pin

current pin

Definition at line 65 of file ADC.h.

Referenced by ADC().

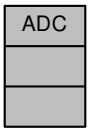
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/ADC.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/ADC.cpp

6.3 ADC Class Reference

```
#include <ADC.h>
```

Collaboration diagram for ADC:



6.3.1 Detailed Description

Interaction with the beaglebone analogue pins

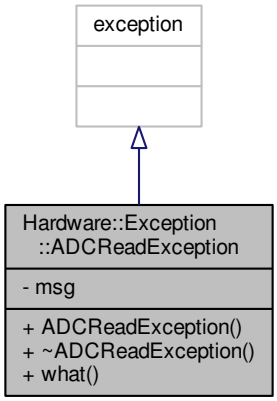
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/ADC.h

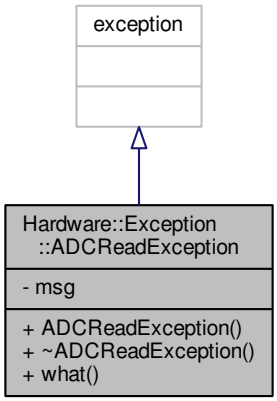
6.4 Hardware::Exception::ADCReadException Class Reference

`#include <ADCReadException.h>`

Inheritance diagram for Hardware::Exception::ADCReadException:



Collaboration diagram for Hardware::Exception::ADCReadException:



Public Member Functions

- ADCReadException (string m="Can't read ADC data!")
- ~ADCReadException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.4.1 Detailed Description

Definition at line 16 of file ADCReadException.h.

6.4.2 Constructor & Destructor Documentation

6.4.2.1 Hardware::Exception::ADCReadException::ADCReadException (string *m* = "Can't read ADC data!") [inline]

Definition at line 18 of file ADCReadException.h.

6.4.2.2 Hardware::Exception::ADCReadException::~ADCReadException ( ) [inline]

Definition at line 19 of file ADCReadException.h.

6.4.3 Member Function Documentation

6.4.3.1 const char* Hardware::Exception::ADCReadException::what ( ) const [inline]

Definition at line 20 of file ADCReadException.h.

6.4.4 Member Data Documentation

6.4.4.1 string Hardware::Exception::ADCReadException::msg [private]

Definition at line 20 of file ADCReadException.h.

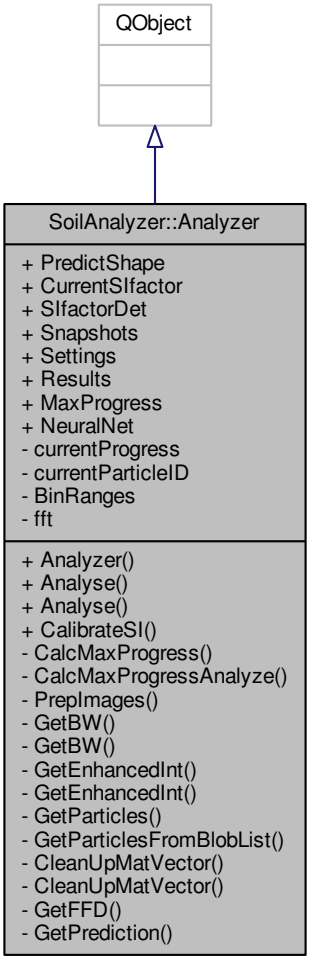
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/ADCReadException.h

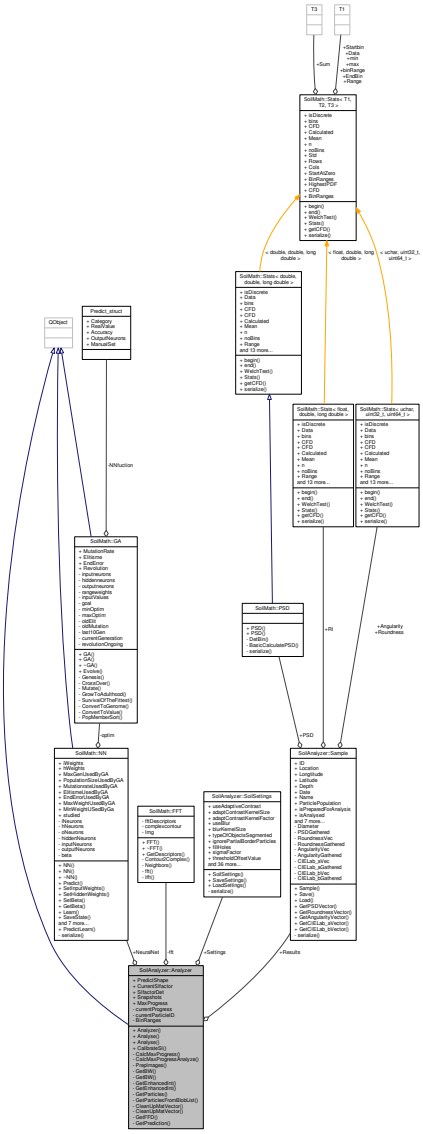
6.5 SoilAnalyzer::Analyzer Class Reference

`#include <analyzer.h>`

Inheritance diagram for SoilAnalyzer::Analyzer:



Collaboration diagram for SoilAnalyzer::Analyzer:



Classes

- struct Image_t

Public Types

- typedef std::vector< Image_t > Images_t

Signals

- void on_progressUpdate (int value)
- void on_maxProgressUpdate (int value)
- void on_AnalysisFinished ()

Public Member Functions

- Analyzer (Images_t *snapshots, Sample *results, SoilSettings *settings)
  Analyzer::Analyzer.
- void Analyse ()
  Analyzer::Analyse.
- void Analyse (Images_t *snapshots, Sample *results, SoilSettings *settings)
- float CalibrateSI (float SI, cv::Mat &img)

Public Attributes

- bool PredictShape = true
- float CurrentSIfactor = 0.0111915
- bool SIfactorDet = false
- Images_t * Snapshots = nullptr
- SoilSettings * Settings = nullptr
- Sample * Results
- uint32_t MaxProgress = STARTING_ESTIMATE_PROGRESS
- SoilMath::NN NeuralNet

Private Member Functions

- void CalcMaxProgress ()
  Analyzer::CalcMaxProgress.
- void CalcMaxProgressAnalyze ()
- void PrepImages ()
  Analyzer::PrepImages.
- void GetBW (std::vector< cv::Mat > &images, std::vector< cv::Mat > &BWvector)
  Analyzer::GetBW.
- void GetBW (cv::Mat &img, cv::Mat &BW)
  Analyzer::GetBW.
- void GetEnhancedInt (Images_t *snapshots, std::vector< cv::Mat > &intensityVector)
- void GetEnhancedInt (cv::Mat &img, cv::Mat &intensity)
- void GetParticles (std::vector< cv::Mat > &BW, Images_t *snapshots, Particle::ParticleVector_t &partPopulation)
  Analyzer::GetParticles.
- void GetParticlesFromBlobList (Vision::Segment::BlobList_t &bloblist, Image_t *snapshot, Particle::ParticleVector_t &partPopulation)
  Analyzer::GetParticlesFromBlobList.
- void CleanUpMatVector (std::vector< cv::Mat > &mv)
- void CleanUpMatVector (Images_t *mv)
  Analyzer::CleanUpMatVector.
- void GetFFD (Particle::ParticleVector_t &particalPopulation)
  Analyzer::GetFFD.
- void GetPrediction (Particle::ParticleVector_t &particlePopulation)
  Analyzer::GetPrediction.

Private Attributes

- uint32_t currentProgress = 0
- uint32_t currentParticleID = 0
- double BinRanges [15]
- SoilMath::FFT fft

6.5.1 Detailed Description

Definition at line 32 of file analyzer.h.

6.5.2 Member Typedef Documentation

6.5.2.1 typedef std::vector<Image_t> SoilAnalyzer::Analyzer::Images_t

Definition at line 45 of file analyzer.h.

6.5.3 Constructor & Destructor Documentation

6.5.3.1 SoilAnalyzer::Analyzer::Analyzer (Images_t * *snapshots*, Sample * *results*, SoilSettings * *settings* = nullptr)

Analyzer::Analyzer.

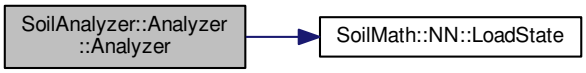
Parameters

snapshots	
results	
settings	

Definition at line 18 of file analyzer.cpp.

References SoilMath::NN::LoadState(), NeuralNet, SoilAnalyzer::SoilSettings::NNlocation, Results, Settings, and Snapshots.

Here is the call graph for this function:



6.5.4 Member Function Documentation

6.5.4.1 void SoilAnalyzer::Analyzer::Analyse ( )

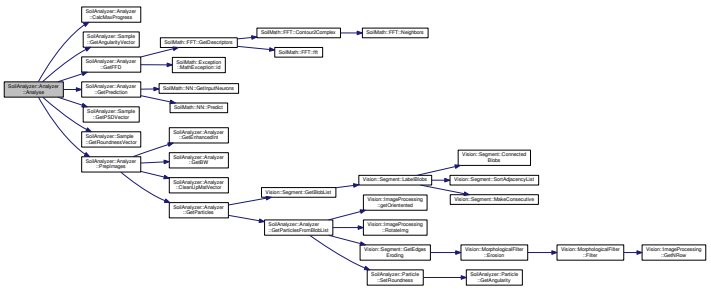
Analyzer::Analyse.

Definition at line 65 of file analyzer.cpp.

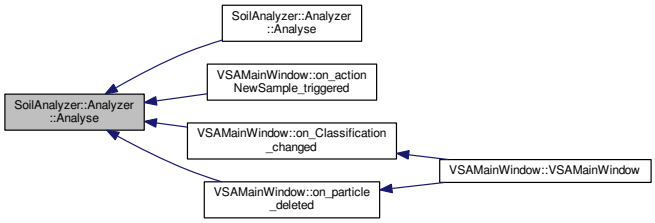
References SoilAnalyzer::Sample::Angularity, BinRanges, CalcMaxProgress(), currentProgress, SoilAnalyzer::Sample::GetAngularityVector(), GetFFD(), GetPrediction(), SoilAnalyzer::Sample::GetPSDVector(), SoilAnalyzer::Sample::GetRoundnessVector(), SoilAnalyzer::Sample::IsLoadedFromDisk, SoilAnalyzer::Sample::isPreparedForAnalysis, on_AnalysisFinished(), on_progressUpdate(), SoilAnalyzer::Sample::ParticlePopulation, PredictShape, SoilAnalyzer::SoilSettings::PredictTheShape, PrepImages(), SoilAnalyzer::Sample::PSD, Results, SoilAnalyzer::Sample::Roundness, and Settings.

Referenced by Analyse(), VSAMainWindow::on_actionNewSample_triggered(), VSAMainWindow::on_Classification_changed(), and VSAMainWindow::on_particle_deleted().

Here is the call graph for this function:



Here is the caller graph for this function:

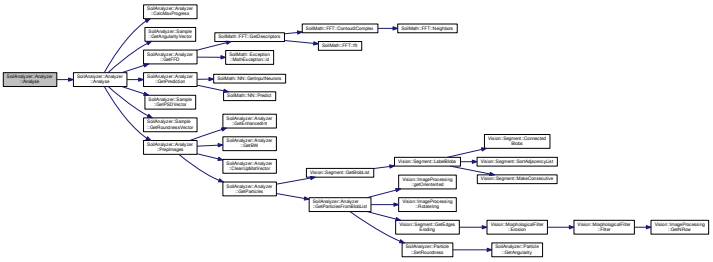


6.5.4.2 void SoilAnalyzer::Analyzer::Analyse (Images_t * *snapshots,* Sample * *results,* SoilSettings * *settings*)

Definition at line 54 of file analyzer.cpp.

References Analyse(), Results, Settings, and Snapshots.

Here is the call graph for this function:



6.5.4.3 void SoilAnalyzer::Analyzer::CalcMaxProgress ( ) [private]

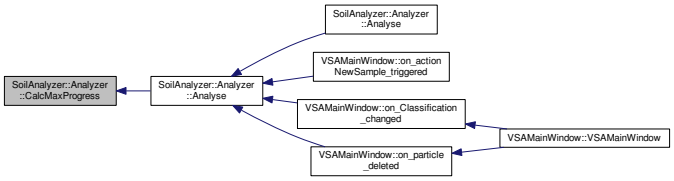
Analyzer::CalcMaxProgress.

Definition at line 112 of file analyzer.cpp.

References SoilAnalyzer::SoilSettings::fillHoles, SoilAnalyzer::SoilSettings::ignorePartialBorderParticles, MaxProgress, SoilAnalyzer::SoilSettings::morphFilterType, Vision::MorphologicalFilter::NONE, on_maxProgressUpdate(), Settings, Snapshots, SoilAnalyzer::SoilSettings::useAdaptiveContrast, and SoilAnalyzer::SoilSettings::useBlur.

Referenced by Analyse().

Here is the caller graph for this function:



6.5.4.4 void SoilAnalyzer::Analyzer::CalcMaxProgressAnalyze ( ) [private]

Definition at line 136 of file analyzer.cpp.

References MaxProgress, on_maxProgressUpdate(), SoilAnalyzer::Sample::ParticlePopulation, Results, and STARTING_ESTIMATE_PROGRESS.

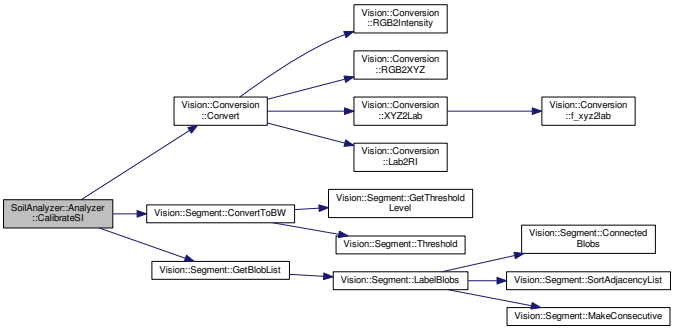
6.5.4.5 float SoilAnalyzer::Analyzer::CalibrateSI (float *SI*, cv::Mat & *img*)

Definition at line 388 of file analyzer.cpp.

References Vision::Segment::BlobList, Vision::Conversion::Convert(), Vision::Segment::ConvertToBW(), CurrentSIfactor, Vision::Segment::Dark, Vision::Segment::GetBlobList(), Vision::Conversion::Intensity, Vision::ImageProcessing::ProcessedImg, and Vision::Conversion::RGB.

Referenced by VSAMainWindow::on_actionCalibrate_triggered().

Here is the call graph for this function:

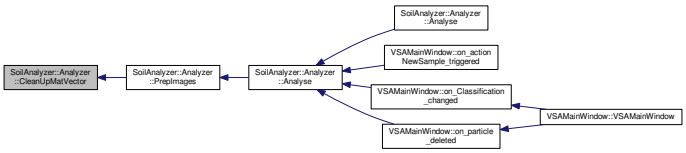


Here is the caller graph for this function:

6.5.4.6 void SoilAnalyzer::Analyzer::CleanUpMatVector (std::vector< cv::Mat > & *mv*) [private]

Referenced by PrepImages().

Here is the caller graph for this function:



6.5.4.7 void SoilAnalyzer::Analyzer::CleanUpMatVector (Images_t * *mv*) [private]

Analyzer::CleanUpMatVector.

Parameters

mv	

Definition at line 101 of file analyzer.cpp.

6.5.4.8 void SoilAnalyzer::Analyzer::GetBW (std::vector< cv::Mat > & *images*, std::vector< cv::Mat > & *BWvector*) [private]

Analyzer::GetBW.

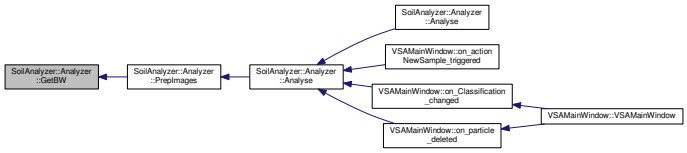
Parameters

images	
BWvector	

Definition at line 222 of file analyzer.cpp.

Referenced by PrepImages().

Here is the caller graph for this function:



6.5.4.9 void SoilAnalyzer::Analyzer::GetBW (cv::Mat & *img*, cv::Mat & *BW*) [private]

Analyzer::GetBW.

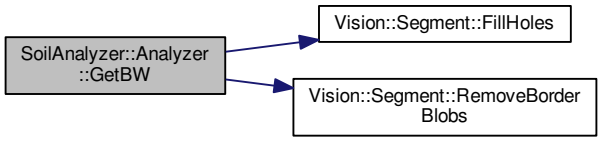
Parameters

img	
BW	

Definition at line 236 of file analyzer.cpp.

References Vision::MorphologicalFilter::CLOSE, currentProgress, Vision::MorphologicalFilter::DILATE, Vision::MorphologicalFilter::EROD↩ E, SoilAnalyzer::SoilSettings::fillHoles, Vision::Segment::FillHoles(), SoilAnalyzer::SoilSettings::filterMaskSize, SoilAnalyzer::SoilSettings↩ ::ignorePartialBorderParticles, SoilAnalyzer::SoilSettings::morphFilterType, Vision::MorphologicalFilter::NONE, on_progressUpdate(), Vision::↩ MorphologicalFilter::OPEN, Vision::ImageProcessing::ProcessedImg, Vision::Segment::RemoveBorderBlobs(), Settings, SHOW_DEBUG_IMG, Vision::Segment::sigma, SoilAnalyzer::SoilSettings::sigmaFactor, SoilAnalyzer::SoilSettings::thresholdOffsetValue, and SoilAnalyzer::Soil↩ Settings::typeOfObjectsSegmented.

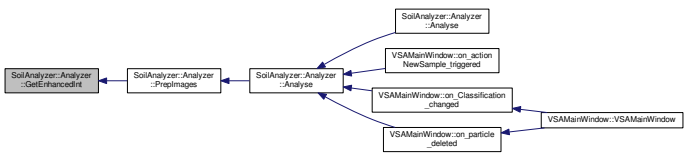
Here is the call graph for this function:



6.5.4.10 void SoilAnalyzer::Analyzer::GetEnhancedInt (Images_t * *snapshots*, std::vector< cv::Mat > & *intensityVector*) [private]

Referenced by PrepImages().

Here is the caller graph for this function:



6.5.4.11 void SoilAnalyzer::Analyzer::GetEnhancedInt (cv::Mat & *img*, cv::Mat & *intensity*) [private]

6.5.4.12 void SoilAnalyzer::Analyzer::GetFFD (Particle::ParticleVector_t & *particalPopulation*) [private]

Analyzer::GetFFD.

Parameters

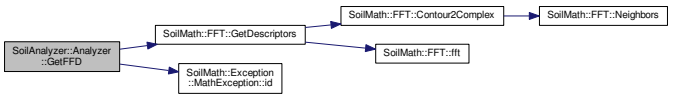
particalPopulation	

Definition at line 350 of file analyzer.cpp.

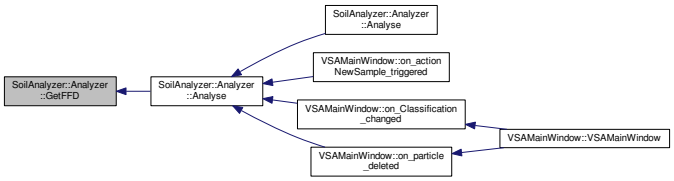
References currentProgress, EXCEPTION_NO_CONTOUR_FOUND_NR, fft, SoilMath::FFT::GetDescriptors(), SoilMath::Exception::Math↩Exception::id(), and on_progressUpdate().

Referenced by Analyse().

Here is the call graph for this function:



Here is the caller graph for this function:



6.5.4.13 void SoilAnalyzer::Analyzer::GetParticles (std::vector< cv::Mat > & *BW*, Images_t * *snapshots*, Particle::ParticleVector_t & *partPopulation*) [private]

Analyzer::GetParticles.

Parameters

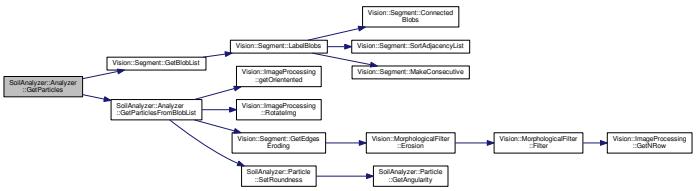
BW	
snapshots	
partPopulation	

Definition at line 303 of file analyzer.cpp.

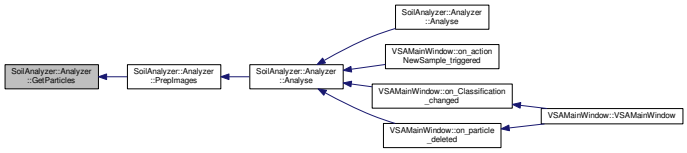
References Vision::Segment::BlobList, currentProgress, Vision::Segment::GetBlobList(), GetParticlesFromBlobList(), and on_progressUpdate().

Referenced by PrepImages().

Here is the call graph for this function:



Here is the caller graph for this function:



6.5.4.14 void SoilAnalyzer::Analyzer::GetParticlesFromBlobList (Vision::Segment::BlobList_t & *bloblist*, Image_t * *snapshot*, Particle::ParticleVector_t & *partPopulation*) [private]

Analyzer::GetParticlesFromBlobList.

Parameters

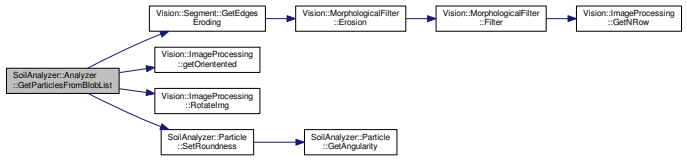
bloblist	
snapshot	
edge	
partPopulation	

Definition at line 322 of file analyzer.cpp.

References SoilAnalyzer::Particle::BW, currentParticleID, SoilAnalyzer::Particle::Eccentricty, SoilAnalyzer::Particle::Edge, SoilAnalyzer::↩ Analyzer::Image_t::FrontLight, Vision::Segment::GetEdgesEroding(), Vision::ImageProcessing::getOrientented(), SoilAnalyzer::Particle::ID, SoilAnalyzer::Particle::isPreparedForAnalysis, SoilAnalyzer::Particle::PixelArea, Vision::ImageProcessing::ProcessedImg, SoilAnalyzer::↩ Particle::RGB, Vision::ImageProcessing::RotateImg(), SoilAnalyzer::Particle::SetRoundness(), SoilAnalyzer::Analyzer::Image_t::SIPixelFactor, and SoilAnalyzer::Particle::SIPixelFactor.

Referenced by GetParticles().

Here is the call graph for this function:



Here is the caller graph for this function:

6.5.4.15 void SoilAnalyzer::Analyzer::GetPrediction (Particle::ParticleVector_t & *particlePopulation*) [private]

Analyzer::GetPrediction.

Parameters

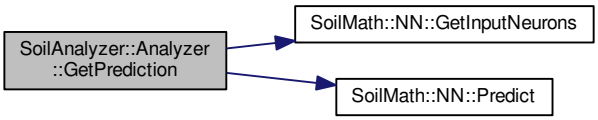
particlePopulation	

Definition at line 373 of file analyzer.cpp.

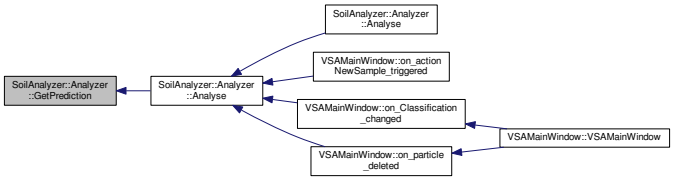
References SoilMath::NN::GetInputNeurons(), NeuralNet, and SoilMath::NN::Predict().

Referenced by Analyse().

Here is the call graph for this function:



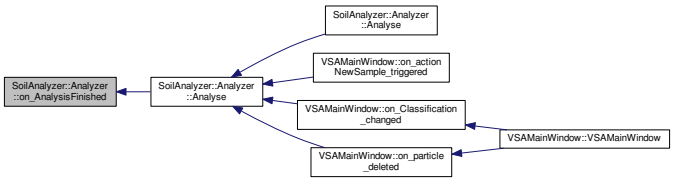
Here is the caller graph for this function:



6.5.4.16 void SoilAnalyzer::Analyzer::on_AnalysisFinished ( ) [signal]

Referenced by Analyse().

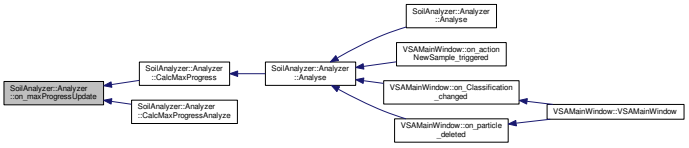
Here is the caller graph for this function:



6.5.4.17 void SoilAnalyzer::Analyzer::on_maxProgressUpdate (int *value*) [signal]

Referenced by CalcMaxProgress(), and CalcMaxProgressAnalyze().

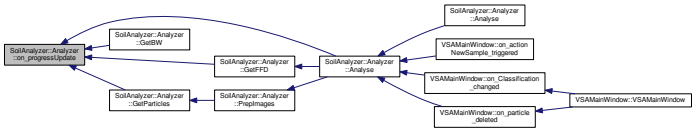
Here is the caller graph for this function:



6.5.4.18 void SoilAnalyzer::Analyzer::on_progressUpdate (int *value*) [signal]

Referenced by Analyse(), GetBW(), GetFFD(), and GetParticles().

Here is the caller graph for this function:



6.5.4.19 void SoilAnalyzer::Analyzer::PrepImages ( ) [private]

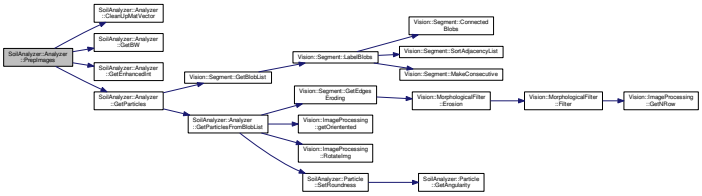
Analyzer::PrepImages.

Definition at line 33 of file analyzer.cpp.

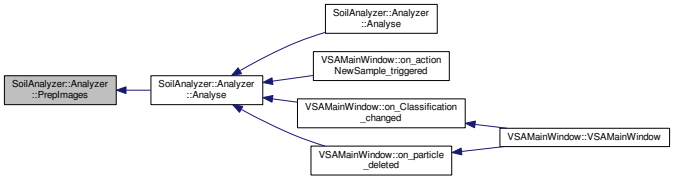
References CleanUpMatVector(), EXCEPTION_NO_SNAPSHOTS, EXCEPTION_NO_SNAPSHOTS_NR, GetBW(), GetEnhancedInt(), GetParticles(), SoilAnalyzer::Sample::isPreparedForAnalysis, SoilAnalyzer::Sample::ParticlePopulation, Results, and Snapshots.

Referenced by Analyse().

Here is the call graph for this function:



Here is the caller graph for this function:



6.5.5 Member Data Documentation

6.5.5.1 double SoilAnalyzer::Analyzer::BinRanges[15] [private]

Initial value:

```
{0.0,  0.038, 0.045, 0.063, 0.075, 0.09, 0.125, 0.18,
                     0.25, 0.355, 0.5,   0.71,  1.0,   1.4,  2.0}
```

Definition at line 69 of file analyzer.h.

Referenced by Analyse().

6.5.5.2 uint32_t SoilAnalyzer::Analyzer::currentParticleID = 0 [private]

Definition at line 68 of file analyzer.h.

Referenced by GetParticlesFromBlobList().

6.5.5.3 uint32_t SoilAnalyzer::Analyzer::currentProgress = 0 [private]

Definition at line 67 of file analyzer.h.

Referenced by Analyse(), GetBW(), GetFFD(), and GetParticles().

6.5.5.4 float SoilAnalyzer::Analyzer::CurrentSIfactor = 0.0111915

Definition at line 37 of file analyzer.h.

Referenced by CalibrateSI(), and VSAMainWindow::TakeSnapShots().

6.5.5.5 SoilMath::FFT SoilAnalyzer::Analyzer::fft [private]

Definition at line 72 of file analyzer.h.

Referenced by GetFFD().

6.5.5.6 uint32_t SoilAnalyzer::Analyzer::MaxProgress = STARTING_ESTIMATE_PROGRESS

Definition at line 57 of file analyzer.h.

Referenced by CalcMaxProgress(), CalcMaxProgressAnalyze(), and VSAMainWindow::VSAMainWindow().

6.5.5.7 SoilMath::NN SoilAnalyzer::Analyzer::NeuralNet

Definition at line 59 of file analyzer.h.

Referenced by Analyzer(), GetPrediction(), VSAMainWindow::on_actionNeuralNet_triggered(), and VSAMainWindow::VSAMainWindow().

6.5.5.8 bool SoilAnalyzer::Analyzer::PredictShape = true

Definition at line 36 of file analyzer.h.

Referenced by Analyse(), and VSAMainWindow::on_actionUseLearning_toggled().

6.5.5.9 Sample* SoilAnalyzer::Analyzer::Results

Definition at line 49 of file analyzer.h.

Referenced by Analyse(), Analyzer(), CalcMaxProgressAnalyze(), VSAMainWindow::on_actionLoadSample_triggered(), and PrepImages().

6.5.5.10 SoilSettings* SoilAnalyzer::Analyzer::Settings = nullptr

Definition at line 47 of file analyzer.h.

Referenced by Analyse(), Analyzer(), CalcMaxProgress(), and GetBW().

6.5.5.11 bool SoilAnalyzer::Analyzer::SIfactorDet = false

Definition at line 38 of file analyzer.h.

Referenced by VSAMainWindow::TakeSnapShots().

6.5.5.12 Images_t* SoilAnalyzer::Analyzer::Snapshots = nullptr

Definition at line 46 of file analyzer.h.

Referenced by Analyse(), Analyzer(), CalcMaxProgress(), and PrepImages().

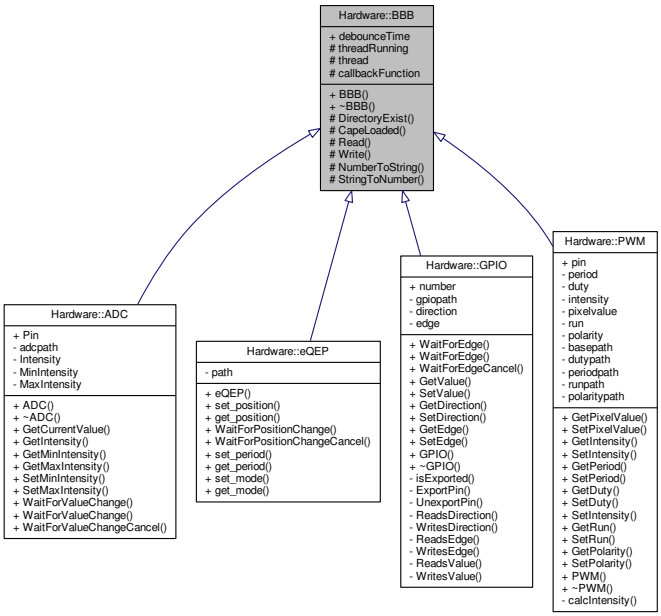
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/analyzer.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/analyzer.cpp

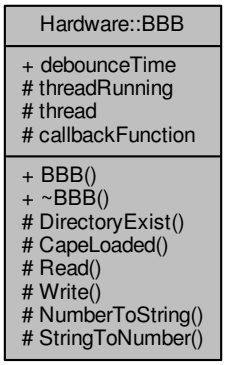
6.6 Hardware::BBB Class Reference

```
#include <BBB.h>
```

Inheritance diagram for Hardware::BBB:



Collaboration diagram for Hardware::BBB:



Public Member Functions

- BBB ()
- ~BBB ()

Public Attributes

- int debounceTime

Protected Member Functions

- bool DirectoryExist (const string &path)
- bool CapeLoaded (const string &shield)
- string Read (const string &path)
- void Write (const string &path, const string &value)
- template<typename T >
  string NumberToString (T Number)
- template<typename T >
  T StringToNumber (string Text)

Protected Attributes

- bool threadRunning
- pthread_t thread
- CallbackType callbackFunction

6.6.1 Detailed Description

Definition at line 40 of file BBB.h.

6.6.2 Constructor & Destructor Documentation

6.6.2.1 BBB::BBB ( )

Constructor

Definition at line 12 of file BBB.cpp.

References callbackFunction, debounceTime, thread, and threadRunning.

6.6.2.2 BBB::~BBB ( )

De-constructor

Definition at line 20 of file BBB.cpp.

6.6.3 Member Function Documentation

6.6.3.1 bool BBB::CapeLoaded (const string & *shield*) [protected]

Checks if a cape is loaded in the file /sys/devices/bone_capemgr.9/slots

Parameters

shield	a const search string which is a (part) of the shield name

Returns

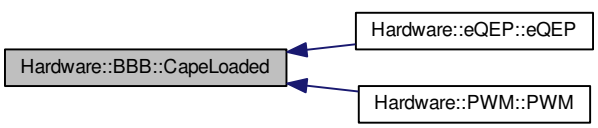
true if the search string is found otherwise false

Definition at line 67 of file BBB.cpp.

References SLOTS.

Referenced by Hardware::eQEP::eQEP(), and Hardware::PWM::PWM().

Here is the caller graph for this function:



6.6.3.2 bool BBB::DirectoryExist (const string & *path*) [protected]

Checks if a directory exist

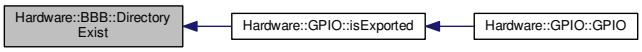
Returns

true if the directory exists and false if not

Definition at line 55 of file BBB.cpp.

Referenced by Hardware::GPIO::isExported().

Here is the caller graph for this function:



6.6.3.3 template<typename T > string Hardware::BBB::NumberToString (T *Number*) [inline], [protected]

Converts a number to a string

Parameters

Number	as typename

Returns

the number as a string

Definition at line 62 of file BBB.h.

6.6.3.4 string BBB::Read (const string & *path*) [protected]

Reads the first line from a file

Parameters

path	constant string pointing towards the file

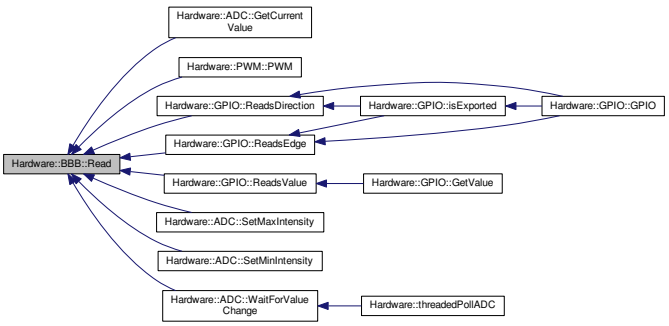
Returns

this first line

Definition at line 26 of file BBB.cpp.

Referenced by Hardware::ADC::GetCurrentValue(), Hardware::PWM::PWM(), Hardware::GPIO::ReadsDirection(), Hardware::GPIO::ReadsEdge(), Hardware::GPIO::ReadsValue(), Hardware::ADC::SetMaxIntensity(), Hardware::ADC::SetMinIntensity(), and Hardware::ADC::WaitForValueChange().

Here is the caller graph for this function:



6.6.3.5 template<typename T > T Hardware::BBB::StringToNumber (string *Text*) [inline], [protected]

Converts a string to a number

Parameters

Text	the string that needs to be converted

Returns

the number as typename

Definition at line 72 of file BBB.h.

6.6.3.6 void BBB::Write (const string & *path*, const string & *value*) [protected]

Writes a value to a file

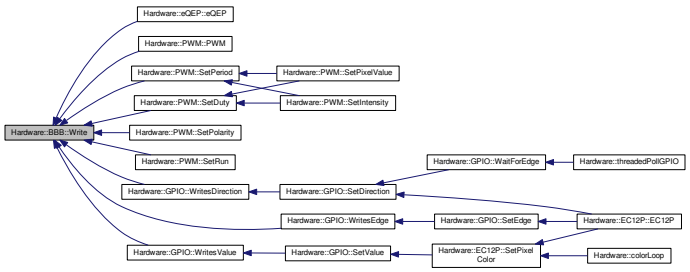
Parameters

path	a constant string pointing towards the file
value	a constant string which should be written in the file

Definition at line 42 of file BBB.cpp.

Referenced by Hardware::eQEP::eQEP(), Hardware::PWM::PWM(), Hardware::PWM::SetDuty(), Hardware::PWM::SetPeriod(), Hardware::PWM::SetPolarity(), Hardware::PWM::SetRun(), Hardware::GPIO::WritesDirection(), Hardware::GPIO::WritesEdge(), and Hardware::GPIO::WritesValue().

Here is the caller graph for this function:



6.6.4 Member Data Documentation

6.6.4.1 CallbackType Hardware::BBB::callbackFunction [protected]

the callbakcfunction

Definition at line 50 of file BBB.h.

Referenced by BBB(), Hardware::threadedPollADC(), Hardware::threadedPolleqep(), Hardware::threadedPollGPIO(), Hardware::GPIO::WaitForEdge(), Hardware::eQEP::WaitForPositionChange(), and Hardware::ADC::WaitForValueChange().

6.6.4.2 int Hardware::BBB::debounceTime

debounce time for a button in milliseconds

Definition at line 42 of file BBB.h.

Referenced by BBB(), Hardware::threadedPolleqep(), and Hardware::threadedPollGPIO().

6.6.4.3 pthread_t Hardware::BBB::thread [protected]

The thread

Definition at line 49 of file BBB.h.

Referenced by BBB(), Hardware::GPIO::WaitForEdge(), Hardware::eQEP::WaitForPositionChange(), and Hardware::ADC::WaitForValueChange().

6.6.4.4 bool Hardware::BBB::threadRunning [protected]

used to stop the thread

Definition at line 48 of file BBB.h.

Referenced by BBB(), Hardware::threadedPollADC(), Hardware::threadedPolleqep(), Hardware::threadedPollGPIO(), Hardware::GPIO::WaitForEdge(), Hardware::eQEP::WaitForPositionChange(), Hardware::eQEP::WaitForPositionChangeCancel(), and Hardware::ADC::WaitForValueChange().

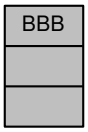
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/BBB.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/BBB.cpp

6.7 BBB Class Reference

`#include <BBB.h>`

Collaboration diagram for BBB:



6.7.1 Detailed Description

The core BeagleBone Black class used for all hardware related classes. Consisting of universal used method, functions and variables. File operations, polling and threading

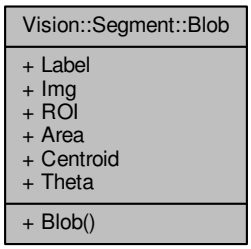
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/BBB.h

6.8 Vision::Segment::Blob Struct Reference

`#include <Segment.h>`

Collaboration diagram for Vision::Segment::Blob:



Public Member Functions

- Blob (uint16_t label, uint32_t area)

Public Attributes

- uint16_t Label
- cv::Mat Img
- cv::Rect ROI
- uint32_t Area
- cv::Point_< double > Centroid
- double Theta

6.8.1 Detailed Description

Individual blob

Definition at line 42 of file Segment.h.

6.8.2 Constructor & Destructor Documentation

6.8.2.1 Vision::Segment::Blob::Blob (uint16_t *label*, uint32_t *area*) [inline]

Definition at line 51 of file Segment.h.

6.8.3 Member Data Documentation

6.8.3.1 uint32_t Vision::Segment::Blob::Area

Calculated stats of the blob

Definition at line 48 of file Segment.h.

6.8.3.2 cv::Point_<double> Vision::Segment::Blob::Centroid

Definition at line 49 of file Segment.h.

6.8.3.3 cv::Mat Vision::Segment::Blob::Img

BW image of the blob all the pixel belonging to the blob are set to 1 others are 0

Definition at line 44 of file Segment.h.

6.8.3.4 uint16_t Vision::Segment::Blob::Label

ID of the blob

Definition at line 43 of file Segment.h.

6.8.3.5 cv::Rect Vision::Segment::Blob::ROI

Coordinates for the blob in the original picture as a cv::Rect

Definition at line 46 of file Segment.h.

6.8.3.6 double Vision::Segment::Blob::Theta

Definition at line 50 of file Segment.h.

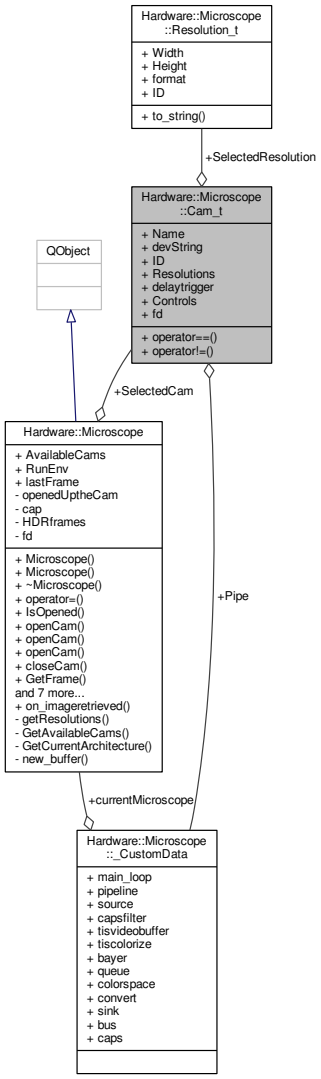
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Segment.h

6.9 Hardware::Microscope::Cam_t Struct Reference

`#include <Microscope.h>`

Collaboration diagram for Hardware::Microscope::Cam_t:



Public Member Functions

- bool operator== (Cam_t const &rhs)
- bool operator!= (Cam_t const &rhs)

Public Attributes

- std::string Name
- std::string devString
- uint32_t ID
- std::vector< Resolution_t > Resolutions
- uint32_t delaytrigger = 1
- Resolution_t * SelectedResolution = nullptr
- Controls_t Controls
- CustomData Pipe
- int fd

6.9.1 Detailed Description

Definition at line 122 of file Microscope.h.

6.9.2 Member Function Documentation

6.9.2.1 bool Hardware::Microscope::Cam_t::operator!= (Cam_t const & *rhs*) [inline]

Definition at line 139 of file Microscope.h.

References ID, and Name.

6.9.2.2 bool Hardware::Microscope::Cam_t::operator== (Cam_t const & *rhs*) [inline]

Definition at line 132 of file Microscope.h.

References ID, and Name.

6.9.3 Member Data Documentation

6.9.3.1 Controls_t Hardware::Microscope::Cam_t::Controls

Definition at line 129 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), Hardware::Microscope::GetControl(), Hardware::Microscope::openCam(), and DialogSettings::SetCamControl().

6.9.3.2 uint32_t Hardware::Microscope::Cam_t::delaytrigger = 1

Definition at line 127 of file Microscope.h.

6.9.3.3 std::string Hardware::Microscope::Cam_t::devString

Definition at line 124 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), Hardware::Microscope::openCam(), and Hardware::Microscope::SetControl().

6.9.3.4 int Hardware::Microscope::Cam_t::fd

Definition at line 131 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), Hardware::Microscope::getResolutions(), and Hardware::Microscope::SetControl().

6.9.3.5 uint32_t Hardware::Microscope::Cam_t::ID

Definition at line 125 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), operator!=(), and operator==().

6.9.3.6 std::string Hardware::Microscope::Cam_t::Name

Definition at line 123 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), Hardware::Microscope::openCam(), operator!=(), and operator==().

6.9.3.7 CustomData Hardware::Microscope::Cam_t::Pipe

Definition at line 130 of file Microscope.h.

Referenced by Hardware::Microscope::closeCam(), Hardware::Microscope::GetFrame(), and Hardware::Microscope::openCam().

6.9.3.8 std::vector<Resolution_t> Hardware::Microscope::Cam_t::Resolutions

Definition at line 126 of file Microscope.h.

Referenced by Hardware::Microscope::getResolutions().

6.9.3.9 Resolution_t* Hardware::Microscope::Cam_t::SelectedResolution = nullptr

Definition at line 128 of file Microscope.h.

Referenced by Hardware::Microscope::new_buffer(), and Hardware::Microscope::openCam().

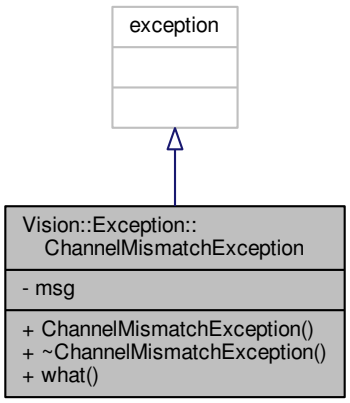
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/Microscope.h

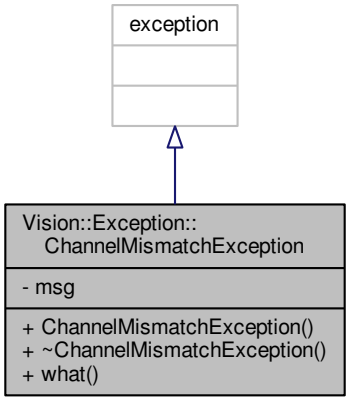
6.10 Vision::Exception::ChannelMismatchException Class Reference

`#include <ChannelMismatchException.h>`

Inheritance diagram for Vision::Exception::ChannelMismatchException:



Collaboration diagram for Vision::Exception::ChannelMismatchException:



Public Member Functions

- ChannelMismatchException (string m="Extracted channel out of bounds exception!")
- ~ChannelMismatchException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.10.1 Detailed Description

Definition at line 21 of file ChannelMismatchException.h.

6.10.2 Constructor & Destructor Documentation

6.10.2.1 Vision::Exception::ChannelMismatchException::ChannelMismatchException (string *m* = "Extracted channel out of bounds exception!") [inline]

Definition at line 23 of file ChannelMismatchException.h.

6.10.2.2 Vision::Exception::ChannelMismatchException::~ChannelMismatchException ( ) [inline]

Definition at line 26 of file ChannelMismatchException.h.

6.10.3 Member Function Documentation

6.10.3.1 const char* Vision::Exception::ChannelMismatchException::what ( ) const [inline]

Definition at line 27 of file ChannelMismatchException.h.

6.10.4 Member Data Documentation

6.10.4.1 string Vision::Exception::ChannelMismatchException::msg [private]

Definition at line 27 of file ChannelMismatchException.h.

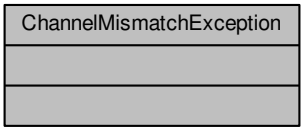
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/ChannelMismatchException.h

6.11 ChannelMismatchException Class Reference

`#include <ChannelMismatchException.h>`

Collaboration diagram for ChannelMismatchException:



6.11.1 Detailed Description

Exception class which is thrown when Extracted channel out of bounds exception

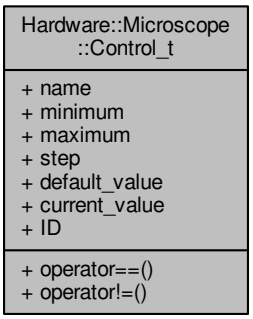
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/ChannelMismatchException.h

6.12 Hardware::Microscope::Control_t Struct Reference

`#include <Microscope.h>`

Collaboration diagram for Hardware::Microscope::Control_t:



Public Member Functions

- bool operator== (Control_t &rhs)
- bool operator!= (Control_t &rhs)

Public Attributes

- std::string name
- int minimum
- int maximum
- int step
- int default_value
- int current_value
- uint32_t ID = V4L2_CID_BASE

6.12.1 Detailed Description

Definition at line 79 of file Microscope.h.

6.12.2 Member Function Documentation

6.12.2.1 bool Hardware::Microscope::Control_t::operator!= (Control_t & *rhs*) [inline]

Definition at line 94 of file Microscope.h.

References name.

6.12.2.2 bool Hardware::Microscope::Control_t::operator== (Control_t & *rhs*) [inline]

Definition at line 87 of file Microscope.h.

References name.

6.12.3 Member Data Documentation

6.12.3.1 int Hardware::Microscope::Control_t::current_value

Definition at line 85 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), Hardware::Microscope::GetHDRFrame(), and Hardware::Microscope::SetControl().

6.12.3.2 int Hardware::Microscope::Control_t::default_value

Definition at line 84 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams().

6.12.3.3 uint32_t Hardware::Microscope::Control_t::ID = V4L2_CID_BASE

Definition at line 86 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), and Hardware::Microscope::SetControl().

6.12.3.4 int Hardware::Microscope::Control_t::maximum

Definition at line 82 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), and Hardware::Microscope::GetHDRFrame().

6.12.3.5 int Hardware::Microscope::Control_t::minimum

Definition at line 81 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), and Hardware::Microscope::GetHDRFrame().

6.12.3.6 std::string Hardware::Microscope::Control_t::name

Definition at line 80 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams(), operator!=(), and operator==().

6.12.3.7 int Hardware::Microscope::Control_t::step

Definition at line 83 of file Microscope.h.

Referenced by Hardware::Microscope::GetAvailableCams().

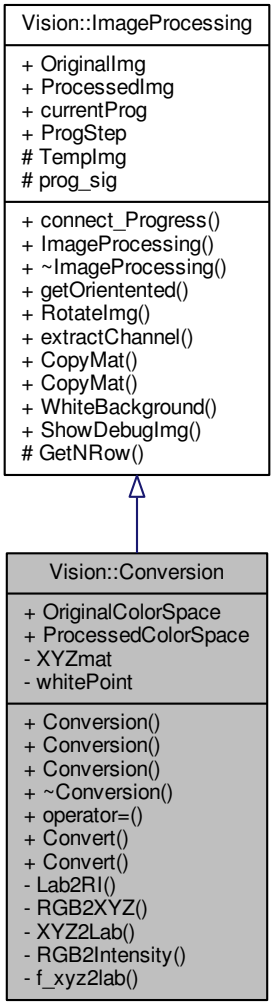
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/Microscope.h

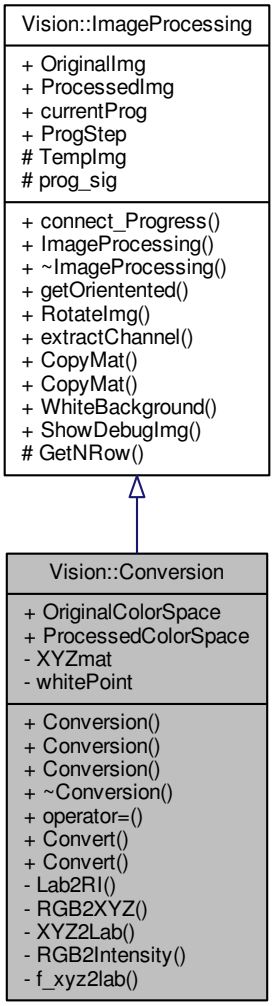
6.13 Vision::Conversion Class Reference

```
#include <Conversion.h>
```

Inheritance diagram for Vision::Conversion:



Collaboration diagram for Vision::Conversion:



Public Types

- enum ColorSpace {
  CIE_lab, CIE_XYZ, RI, RGB,
  Intensity, None }

Public Member Functions

- Conversion ()
- Conversion (const Mat &src)
- Conversion (const Conversion &rhs)
- ~Conversion ()
- Conversion & operator= (Conversion rhs)
- void Convert (ColorSpace convertFrom, ColorSpace convertTo, bool chain=false)
- void Convert (const Mat &src, Mat &dst, ColorSpace convertFrom, ColorSpace convertTo, bool chain=false)

Public Attributes

- ColorSpace OriginalColorSpace
- ColorSpace ProcessedColorSpace

Private Member Functions

- void Lab2RI (float ∗O, float ∗P, int nData)
- void RGB2XYZ (uchar ∗O, float ∗P, int nData)
- void XYZ2Lab (float ∗O, float ∗P, int nData)
- void RGB2Intensity (uchar ∗O, uchar ∗P, int nData)
- float f_xyz2lab (float t)

Private Attributes

- float XYZmat [3][3]
- float whitePoint [3]

Additional Inherited Members

6.13.1 Detailed Description

Definition at line 13 of file Conversion.h.

6.13.2 Member Enumeration Documentation

6.13.2.1 enum Vision::Conversion::ColorSpace

Enumerator which indicates the colorspace used

Enumerator

CIE_lab CIE La∗b∗ colorspace

CIE_XYZ CIE XYZ colorspace

RI Redness Index colorspace

RGB RGB colorspace

Intensity Grayscale colorspace

None none

Definition at line 16 of file Conversion.h.

6.13.3 Constructor & Destructor Documentation

6.13.3.1 Conversion::Conversion ( )

Constructor of the class

Definition at line 14 of file Conversion.cpp.

References None, OriginalColorSpace, and ProcessedColorSpace.

6.13.3.2 Conversion::Conversion (const Mat & *src*)

Constructor of the class

Parameters

src	a cv::Mat object which is the source image

Definition at line 22 of file Conversion.cpp.

References None, OriginalColorSpace, Vision::ImageProcessing::OriginalImg, and ProcessedColorSpace.

6.13.3.3 Conversion::Conversion (const Conversion & *rhs*)

Copy constructor

Definition at line 29 of file Conversion.cpp.

References OriginalColorSpace, Vision::ImageProcessing::OriginalImg, ProcessedColorSpace, Vision::ImageProcessing::ProcessedImg, and Vision::ImageProcessing::TempImg.

6.13.3.4 Conversion::~Conversion ( )

De-constructor of the class

Definition at line 38 of file Conversion.cpp.

6.13.4 Member Function Documentation

6.13.4.1 void Conversion::Convert (ColorSpace *convertFrom*, ColorSpace *convertTo*, bool *chain* = `false`)

Convert the source image from one colorspace to a destination colorspace posibilities are:

- RGB 2 Intensity
- RGB 2 XYZ
- RGB 2 Lab
- RGB 2 Redness Index
- XYZ 2 Lab
- XYZ 2 Redness Index
- Lab 2 Redness Index

Parameters

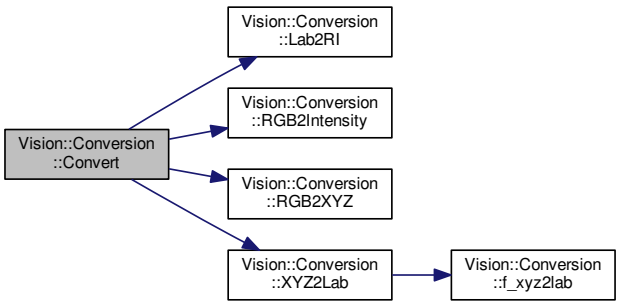
convertFrom	the starting colorspace
convertTo	the destination colorspace
chain	use the results from the previous operation default value = false;

Definition at line 86 of file Conversion.cpp.

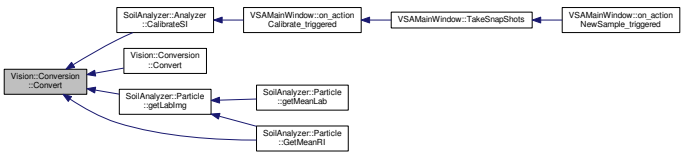
References CHAIN_PROCESS, CIE_lab, CIE_XYZ, Vision::ImageProcessing::currentProg, EMPTY_CHECK, Intensity, Lab2RI(), OriginalColorSpace, Vision::ImageProcessing::OriginalImg, ProcessedColorSpace, Vision::ImageProcessing::ProcessedImg, Vision::ImageProcessing::prog_sig, Vision::ImageProcessing::ProgStep, RGB, RGB2Intensity(), RGB2XYZ(), RI, and XYZ2Lab().

Referenced by SoilAnalyzer::Analyzer::CalibrateSI(), Convert(), SoilAnalyzer::Particle::getLabImg(), and SoilAnalyzer::Particle::GetMeanRI().

Here is the call graph for this function:



Here is the caller graph for this function:



6.13.4.2 void Conversion::Convert (const Mat & *src*, Mat & *dst*, ColorSpace *convertFrom*, ColorSpace *convertTo*, bool *chain* = `false`)

Convert the source image from one colorspace to a destination colorspace

- RGB 2 Intensity
- RGB 2 XYZ
- RGB 2 Lab
- RGB 2 Redness Index
- XYZ 2 Lab
- XYZ 2 Redness Index
- Lab 2 Redness Index

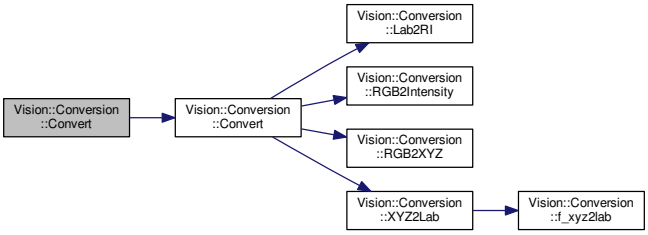
Parameters

src	a cv::Mat object which is the source image
dst	a cv::Mat object which is the destination image
convertFrom	the starting colorspace
convertTo	the destination colorspace
chain	use the results from the previous operation default value = false;

Definition at line 66 of file Conversion.cpp.

References Convert(), Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

Here is the call graph for this function:

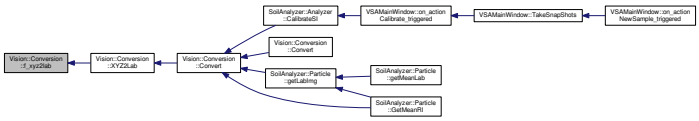


6.13.4.3 float Conversion::f_xyz2lab (float *t*) `[inline]`, `[private]`

Definition at line 244 of file Conversion.cpp.

Referenced by XYZ2Lab().

Here is the caller graph for this function:



6.13.4.4 void Conversion::Lab2RI (float * *O*, float * *P*, int *nData*) [private]

Conversion from CIE La*b* to Redness Index

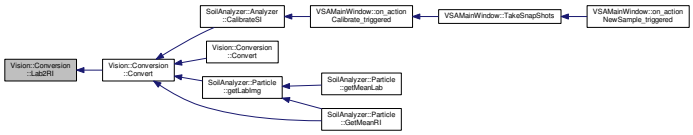
Parameters

O	a uchar pointer to the source image
P	a uchar pointer to the destination image
nData	an int indicating the total number of pixels

Definition at line 256 of file Conversion.cpp.

Referenced by Convert().

Here is the caller graph for this function:



6.13.4.5 Conversion & Conversion::operator= (Conversion *rhs*)

Assignment operator

Definition at line 41 of file Conversion.cpp.

References OriginalColorSpace, Vision::ImageProcessing::OriginalImg, ProcessedColorSpace, Vision::ImageProcessing::ProcessedImg, and Vision::ImageProcessing::TempImg.

6.13.4.6 void Conversion::RGB2Intensity (uchar * *O*, uchar * *P*, int *nData*) [private]

Conversion from RGB to Intensity

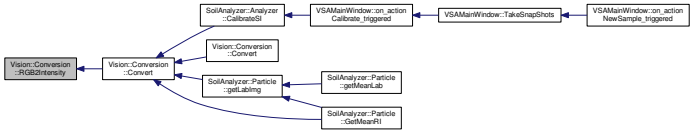
Parameters

O	a uchar pointer to the source image
P	a uchar pointer to the destination image
nData	an int indicating the total number of pixels

Definition at line 190 of file Conversion.cpp.

Referenced by Convert().

Here is the caller graph for this function:



6.13.4.7 void Conversion::RGB2XYZ (uchar * *O*, float * *P*, int *nData*) [private]

Conversion from RGB to CIE XYZ

Parameters

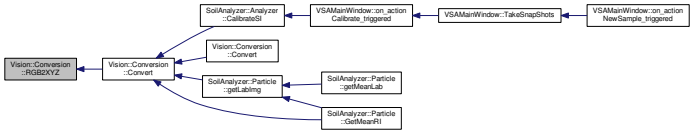
O	a uchar pointer to the source image
P	a uchar pointer to the destination image
nData	an int indicating the total number of pixels

Definition at line 207 of file Conversion.cpp.

References Vision::ImageProcessing::OriginalImg, and XYZmat.

Referenced by Convert().

Here is the caller graph for this function:



6.13.4.8 void Conversion::XYZ2Lab (float * *O*, float * *P*, int *nData*) [private]

Conversion from CIE XYZ to CIE La*b*

Parameters

O	a uchar pointer to the source image
P	a uchar pointer to the destination image
nData	an int indicating the total number of pixels

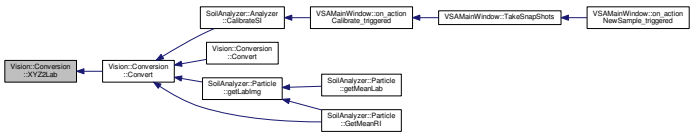
Definition at line 225 of file Conversion.cpp.

References f_xyz2lab(), and whitePoint.

Referenced by Convert().

Here is the call graph for this function:

Here is the caller graph for this function:



6.13.5 Member Data Documentation

6.13.5.1 ColorSpace Vision::Conversion::OriginalColorSpace

The original colorspace

Definition at line 24 of file Conversion.h.

Referenced by Conversion(), Convert(), and operator=().

6.13.5.2 ColorSpace Vision::Conversion::ProcessedColorSpace

The destination colorspace

Definition at line 25 of file Conversion.h.

Referenced by Conversion(), Convert(), and operator=().

6.13.5.3 float Vision::Conversion::whitePoint[3] [private]

Initial value:

```
= {
      0.9504, 1.0000, 1.0889}
```

Natural whitepoint in XYZ colorspace D65 according to Matlab

Definition at line 46 of file Conversion.h.

Referenced by XYZ2Lab().

6.13.5.4 float Vision::Conversion::XYZmat[3][3] [private]

Initial value:

```
= {{0.412453, 0.357580, 0.180423},
                        {0.212671, 0.715160, 0.072169},
                        {0.019334, 0.119194, 0.950227}}
```

< Conversion matrix used in the conversion between RGB and CIE XYZ

Definition at line 42 of file Conversion.h.

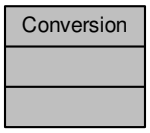
Referenced by RGB2XYZ().

The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Conversion.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Conversion.cpp

6.14 Conversion Class Reference

Collaboration diagram for Conversion:



6.14.1 Detailed Description

class which converts a cv::Mat image from one colorspace to the next colorspace

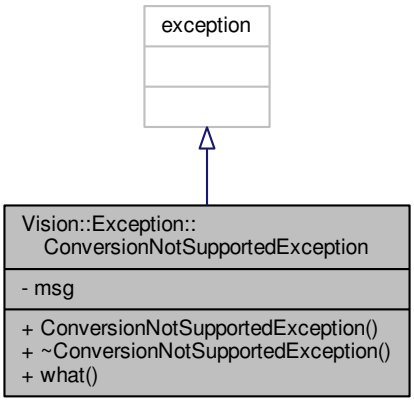
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Conversion.cpp

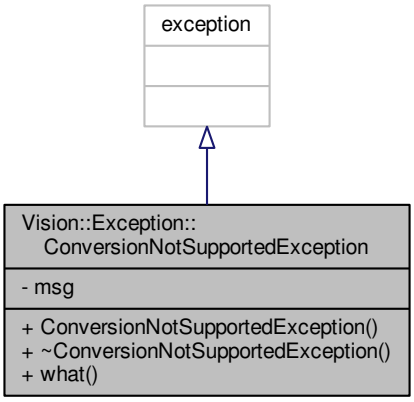
6.15 Vision::Exception::ConversionNotSupportedException Class Reference

```
#include <ConversionNotSupportedException.h>
```

Inheritance diagram for Vision::Exception::ConversionNotSupportedException:



Collaboration diagram for Vision::Exception::ConversionNotSupportedException:



Public Member Functions

- ConversionNotSupportedException (string m="Requested conversion is not supported!")
- ~ConversionNotSupportedException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.15.1 Detailed Description

Definition at line 20 of file ConversionNotSupportedException.h.

6.15.2 Constructor & Destructor Documentation

6.15.2.1 Vision::Exception::ConversionNotSupportedException::ConversionNotSupportedException (string *m* = "Requested conversion is not supported!") [inline]

Definition at line 22 of file ConversionNotSupportedException.h.

6.15.2.2 Vision::Exception::ConversionNotSupportedException::~ConversionNotSupportedException ( ) [inline]

Definition at line 25 of file ConversionNotSupportedException.h.

6.15.3 Member Function Documentation

6.15.3.1 const char* Vision::Exception::ConversionNotSupportedException::what ( ) const [inline]

Definition at line 26 of file ConversionNotSupportedException.h.

6.15.4 Member Data Documentation

6.15.4.1 string Vision::Exception::ConversionNotSupportedException::msg [private]

Definition at line 26 of file ConversionNotSupportedException.h.

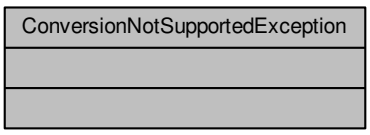
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/ConversionNotSupportedException.h

6.16 ConversionNotSupportedException Class Reference

`#include <ConversionNotSupportedException.h>`

Collaboration diagram for ConversionNotSupportedException:



6.16.1 Detailed Description

Exception class which is thrown when an illegal conversion is requested.

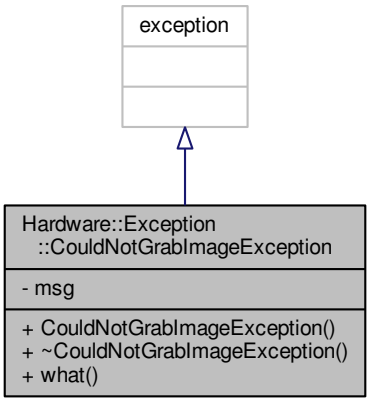
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/ConversionNotSupportedException.h

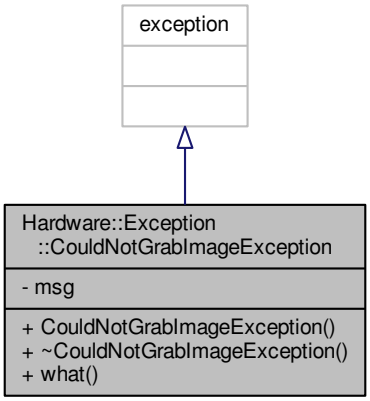
6.17 Hardware::Exception::CouldNotGrabImageException Class Reference

`#include <CouldNotGrabImageException.h>`

Inheritance diagram for Hardware::Exception::CouldNotGrabImageException:



Collaboration diagram for Hardware::Exception::CouldNotGrabImageException:



Public Member Functions

- CouldNotGrabImageException (string m="Unable to grab the next image!")
- ~CouldNotGrabImageException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.17.1 Detailed Description

Definition at line 16 of file CouldNotGrabImageException.h.

6.17.2 Constructor & Destructor Documentation

6.17.2.1 Hardware::Exception::CouldNotGrabImageException::CouldNotGrabImageException (string *m* = "Unable to grab the next image!") [inline]

Definition at line 18 of file CouldNotGrabImageException.h.

6.17.2.2 Hardware::Exception::CouldNotGrabImageException::~CouldNotGrabImageException ( ) [inline]

Definition at line 20 of file CouldNotGrabImageException.h.

6.17.3 Member Function Documentation

6.17.3.1 const char* Hardware::Exception::CouldNotGrabImageException::what ( ) const [inline]

Definition at line 21 of file CouldNotGrabImageException.h.

6.17.4 Member Data Documentation

6.17.4.1 string Hardware::Exception::CouldNotGrabImageException::msg [private]

Definition at line 21 of file CouldNotGrabImageException.h.

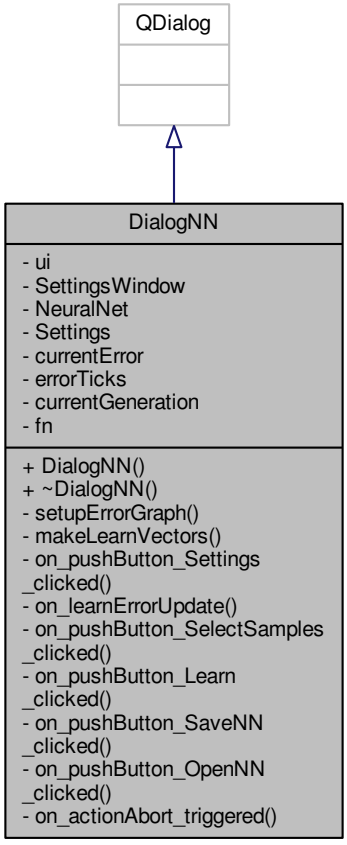
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/CouldNotGrabImageException.h

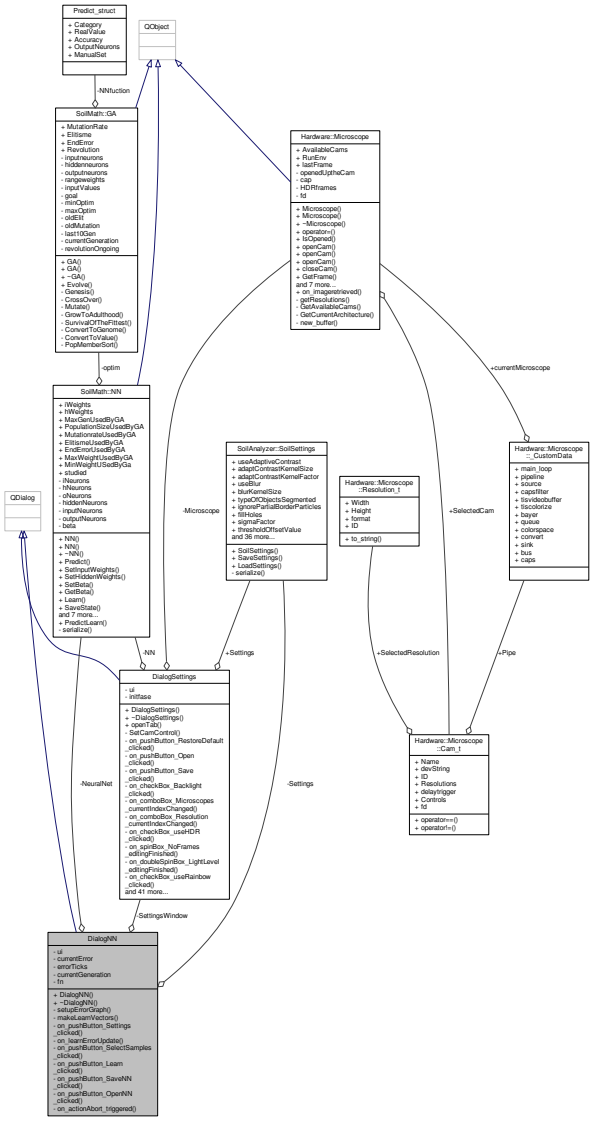
6.18 DialogNN Class Reference

`#include <dialognn.h>`

Inheritance diagram for DialogNN:



Collaboration diagram for DialogNN:



Public Member Functions

- DialogNN (QWidget *parent=0, SoilMath::NN *neuralnet=nullptr, SoilAnalyzer::SoilSettings *settings=nullptr, DialogSettings *setting↩ Window=nullptr)
- ~DialogNN ()

Private Slots

- void on_pushButton_Settings_clicked ()
- void on_learnErrorUpdate (double newError)
- void on_pushButton_SelectSamples_clicked ()
- void on_pushButton_Learn_clicked ()
- void on_pushButton_SaveNN_clicked ()
- void on_pushButton_OpenNN_clicked ()
- void on_actionAbort_triggered ()

Private Member Functions

- void setupErrorGraph ()
- void makeLearnVectors (InputLearnVector_t &input, OutputLearnVector_t &output)

Private Attributes

- Ui::DialogNN * ui
- DialogSettings * SettingsWindow = nullptr
- SoilMath::NN * NeuralNet = nullptr
- SoilAnalyzer::SoilSettings * Settings = nullptr
- QVector< double > currentError
- QVector< double > errorTicks
- double currentGeneration = 0
- QStringList fn

6.18.1 Detailed Description

Definition at line 15 of file dialognn.h.

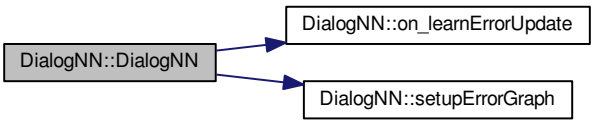
6.18.2 Constructor & Destructor Documentation

6.18.2.1 DialogNN::DialogNN (QWidget * *parent* = 0, SoilMath::NN * *neuralnet* = nullptr, SoilAnalyzer::SoilSettings * *settings* = nullptr, DialogSettings * *settingWindow* = nullptr) [explicit]

Definition at line 4 of file dialognn.cpp.

References NeuralNet, on_learnErrorUpdate(), Settings, SettingsWindow, setupErrorGraph(), and ui.

Here is the call graph for this function:



6.18.2.2 DialogNN::~DialogNN ( )

Definition at line 42 of file dialognn.cpp.

References ui.

6.18.3 Member Function Documentation

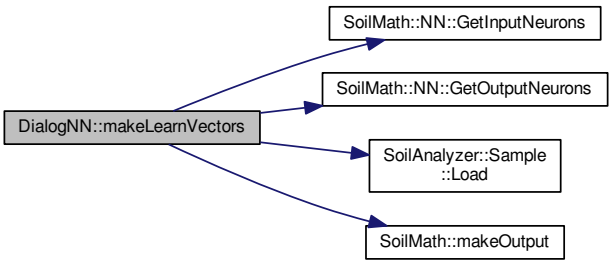
6.18.3.1 void DialogNN::makeLearnVectors (InputLearnVector_t & *input*, OutputLearnVector_t & *output*) [private]

Definition at line 97 of file dialognn.cpp.

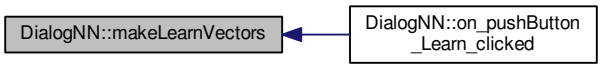
References fn, SoilMath::NN::GetInputNeurons(), SoilMath::NN::GetOutputNeurons(), SoilAnalyzer::Sample::Load(), SoilMath::makeOutput(), NeuralNet, Predict_struct::OutputNeurons, and SoilAnalyzer::Sample::ParticlePopulation.

Referenced by on_pushButton_Learn_clicked().

Here is the call graph for this function:



Here is the caller graph for this function:



6.18.3.2 void DialogNN::on_actionAbort_triggered ( ) [private], [slot]

Definition at line 147 of file dialognn.cpp.

References SoilMath::NN::EndErrorUsedByGA, NeuralNet, and ui.

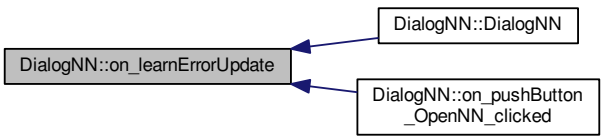
6.18.3.3 void DialogNN::on_learnErrorUpdate (double *newError*) [private], [slot]

Definition at line 50 of file dialognn.cpp.

References currentGeneration, and ui.

Referenced by DialogNN(), and on_pushButton_OpenNN_clicked().

Here is the caller graph for this function:

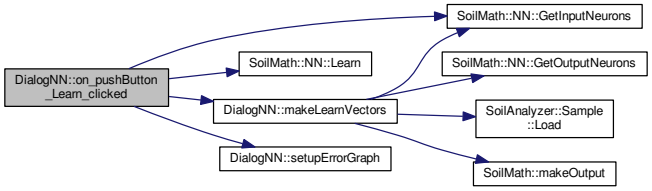


6.18.3.4 void DialogNN::on_pushButton_Learn_clicked ( ) [private], [slot]

Definition at line 86 of file dialognn.cpp.

References fn, SoilMath::NN::GetInputNeurons(), SoilMath::NN::Learn(), makeLearnVectors(), NeuralNet, and setupErrorGraph().

Here is the call graph for this function:

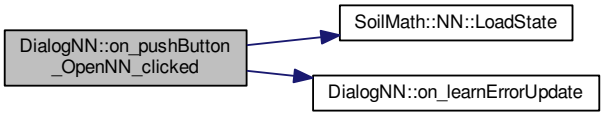


6.18.3.5 void DialogNN::on_pushButton_OpenNN_clicked ( ) [private], [slot]

Definition at line 130 of file dialognn.cpp.

References fn, SoilMath::NN::LoadState(), NeuralNet, on_learnErrorUpdate(), SoilAnalyzer::SoilSettings::SampleFolder, and Settings.

Here is the call graph for this function:

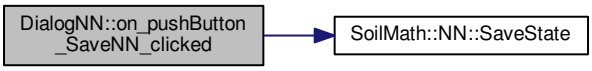


6.18.3.6 void DialogNN::on_pushButton_SaveNN_clicked ( ) [private], [slot]

Definition at line 118 of file dialognn.cpp.

References fn, NeuralNet, SoilAnalyzer::SoilSettings::NNFolder, SoilMath::NN::SaveState(), and Settings.

Here is the call graph for this function:



6.18.3.7 void DialogNN::on_pushButton_SelectSamples_clicked ( ) [private], [slot]

Definition at line 75 of file dialognn.cpp.

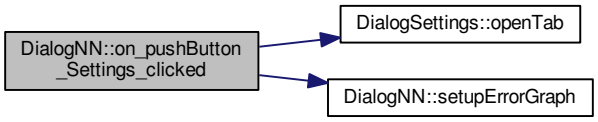
References fn, SoilAnalyzer::SoilSettings::SampleFolder, and Settings.

6.18.3.8 void DialogNN::on_pushButton_Settings_clicked ( ) [private], [slot]

Definition at line 44 of file dialognn.cpp.

References DialogSettings::openTab(), SettingsWindow, and setupErrorGraph().

Here is the call graph for this function:



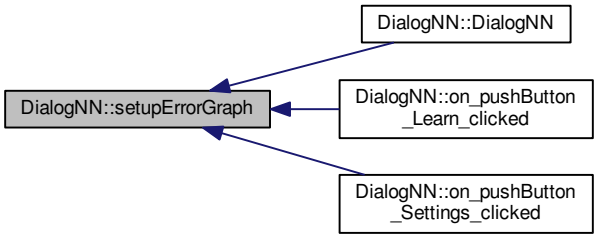
6.18.3.9 void DialogNN::setupErrorGraph ( ) [private]

Definition at line 58 of file dialognn.cpp.

References SoilMath::NN::EndErrorUsedByGA, errorTicks, SoilMath::NN::MaxGenUsedByGA, NeuralNet, and ui.

Referenced by DialogNN(), on_pushButton_Learn_clicked(), and on_pushButton_Settings_clicked().

Here is the caller graph for this function:



6.18.4 Member Data Documentation

6.18.4.1 QVector<double> DialogNN::currentError [private]

Definition at line 48 of file dialognn.h.

6.18.4.2 double DialogNN::currentGeneration = 0 [private]

Definition at line 50 of file dialognn.h.

Referenced by on_learnErrorUpdate().

6.18.4.3 QVector<double> DialogNN::errorTicks [private]

Definition at line 49 of file dialognn.h.

Referenced by setupErrorGraph().

6.18.4.4 QStringList DialogNN::fn [private]

Definition at line 51 of file dialognn.h.

Referenced by makeLearnVectors(), on_pushButton_Learn_clicked(), on_pushButton_OpenNN_clicked(), on_pushButton_SaveNN_clicked(), and on_pushButton_SelectSamples_clicked().

6.18.4.5 SoilMath::NN* DialogNN::NeuralNet = nullptr [private]

Definition at line 42 of file dialognn.h.

Referenced by DialogNN(), makeLearnVectors(), on_actionAbort_triggered(), on_pushButton_Learn_clicked(), on_pushButton_OpenNN_↩ clicked(), on_pushButton_SaveNN_clicked(), and setupErrorGraph().

6.18.4.6 SoilAnalyzer::SoilSettings* DialogNN::Settings = nullptr [private]

Definition at line 43 of file dialognn.h.

Referenced by DialogNN(), on_pushButton_OpenNN_clicked(), on_pushButton_SaveNN_clicked(), and on_pushButton_SelectSamples_↩ clicked().

6.18.4.7 DialogSettings* DialogNN::SettingsWindow = nullptr [private]

Definition at line 41 of file dialognn.h.

Referenced by DialogNN(), and on_pushButton_Settings_clicked().

6.18.4.8 Ui::DialogNN* DialogNN::ui [private]

Definition at line 40 of file dialognn.h.

Referenced by DialogNN(), on_actionAbort_triggered(), on_learnErrorUpdate(), setupErrorGraph(), and ~DialogNN().

The documentation for this class was generated from the following files:

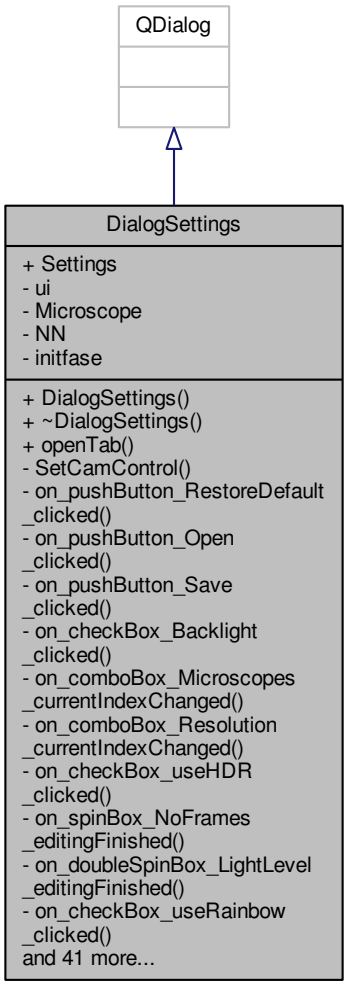
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/VSA/dialognn.h

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/VSA/dialognn.cpp

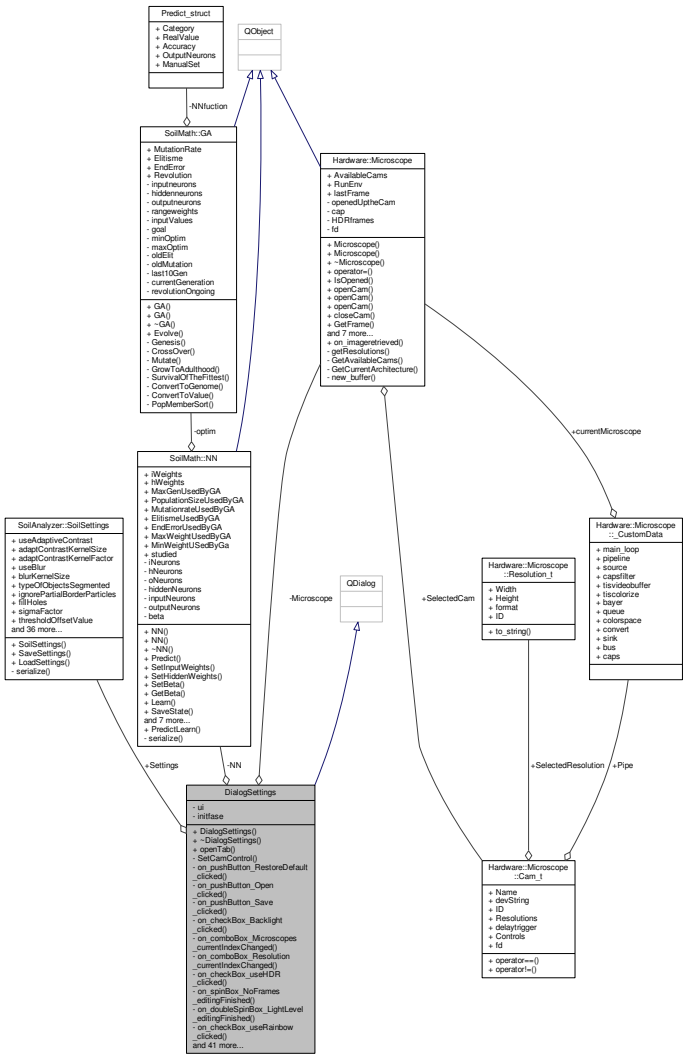
6.19 DialogSettings Class Reference

```
#include <dialogsettings.h>
```

Inheritance diagram for DialogSettings:



Collaboration diagram for DialogSettings:



Public Member Functions

- DialogSettings (QWidget *parent=0, SoilAnalyzer::SoilSettings *settings=nullptr, Hardware::Microscope *microscope=nullptr, SoilMath::NN *nn=nullptr, bool openNN=false)
- ~DialogSettings ()
- void openTab (int newValue)

Public Attributes

- SoilAnalyzer::SoilSettings * Settings = nullptr

Private Slots

- void on_pushButton_RestoreDefault_clicked ()
- void on_pushButton_Open_clicked ()
- void on_pushButton_Save_clicked ()
- void on_checkBox_Backlight_clicked (bool checked)
- void on_comboBox_Microscopes_currentIndexChanged (const QString &arg1)

- void on_comboBox_Resolution_currentIndexChanged (int index)
- void on_checkBox_useHDR_clicked (bool checked)
- void on_spinBox_NoFrames_editingFinished ()
- void on_doubleSpinBox_LightLevel_editingFinished ()
- void on_checkBox_useRainbow_clicked (bool checked)
- void on_checkBox_InvertEncoder_clicked (bool checked)
- void on_checkBox_useCUDA_clicked (bool checked)
- void on_horizontalSlider_BrightFront_valueChanged (int value)
- void on_horizontalSlider_ContrastFront_valueChanged (int value)
- void on_horizontalSlider_SaturationFront_valueChanged (int value)
- void on_horizontalSlider_HueFront_valueChanged (int value)
- void on_horizontalSlider_SharpnessFront_valueChanged (int value)
- void on_horizontalSlider_BrightProj_valueChanged (int value)
- void on_horizontalSlider_ContrastProj_valueChanged (int value)
- void on_horizontalSlider_SaturationProj_valueChanged (int value)
- void on_horizontalSlider_HueProj_valueChanged (int value)
- void on_horizontalSlider_SharpnessProj_valueChanged (int value)
- void on_cb_use_adaptContrast_3_clicked (bool checked)
- void on_cb_useBlur_3_clicked (bool checked)
- void on_rb_useDark_3_toggled (bool checked)
- void on_cb_ignoreBorder_3_clicked (bool checked)
- void on_cb_fillHoles_3_clicked (bool checked)
- void on_sb_sigmaFactor_3_editingFinished ()
- void on_rb_useOpen_3_clicked (bool checked)
- void on_rb_useClose_3_clicked (bool checked)
- void on_rb_useErode_3_clicked (bool checked)
- void on_rb_useDilate_3_clicked (bool checked)
- void on_sb_morphMask_3_editingFinished ()
- void on_spinBox_MaxGen_editingFinished ()
- void on_spinBox_PopSize_editingFinished ()
- void on_doubleSpinBox_MutationRate_editingFinished ()
- void on_spinBox_Elitisme_editingFinished ()
- void on_doubleSpinBox_endError_editingFinished ()
- void on_doubleSpinBox_maxWeight_editingFinished ()
- void on_doubleSpinBox_MinWeight_editingFinished ()
- void on_doubleSpinBox_Beta_editingFinished ()
- void on_spinBox_InputNeurons_editingFinished ()
- void on_spinBox_HiddenNeurons_editingFinished ()
- void on_spinBox_OutputNeurons_editingFinished ()
- void on_pushButton_selectSampleFolder_clicked ()
- void on_pushButton_SelectSettingFolder_clicked ()
- void on_pushButton_SelectNNFolder_clicked ()
- void on_pushButton_SelectNN_clicked ()
- void on_spinBox_NoShots_editingFinished ()
- void on_checkBox_PredictShape_clicked (bool checked)
- void on_checkBox_revolt_clicked (bool checked)

Private Member Functions

- void SetCamControl (Hardware::Microscope::Cam_t *selectedCam, QSlider *Brightness, QSlider *Contrast, QSlider *Saturation, QSlider *Hue, QSlider *Sharpness)

Private Attributes

- Ui::DialogSettings * ui
- Hardware::Microscope * Microscope
- SoilMath::NN * NN
- bool initfase = true

6.19.1 Detailed Description

Definition at line 16 of file dialogsettings.h.

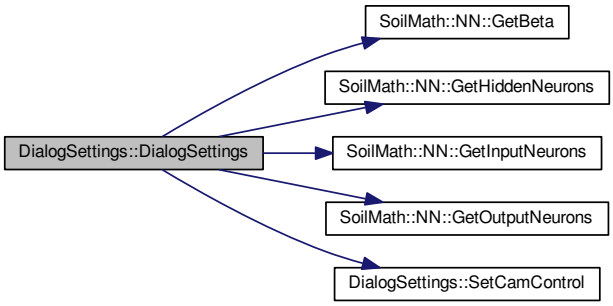
6.19.2 Constructor & Destructor Documentation

6.19.2.1 DialogSettings::DialogSettings (QWidget * *parent* = 0, SoilAnalyzer::SoilSettings * *settings* = nullptr, Hardware::Microscope * *microscope* = nullptr, SoilMath::NN * *nn* = nullptr, bool *openNN* = false) [explicit]

Definition at line 5 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::adaptContrastKernelFactor, SoilAnalyzer::SoilSettings::adaptContrastKernelSize, SoilAnalyzer::SoilSettings::blurKernelSize, Vision::Segment::Bright, SoilAnalyzer::SoilSettings::Brightness_front, SoilAnalyzer::SoilSettings::Brightness_proj, Vision::MorphologicalFilter::CLOSE, SoilAnalyzer::SoilSettings::Contrast_front, SoilAnalyzer::SoilSettings::Contrast_proj, Vision::Segment::Dark, Vision::MorphologicalFilter::DILATE, SoilMath::NN::ElitismeUsedByGA, SoilAnalyzer::SoilSettings::enableRainbow, SoilAnalyzer::SoilSettings::encInv, SoilMath::NN::EndErrorUsedByGA, Vision::MorphologicalFilter::ERODE, SoilAnalyzer::SoilSettings::fillHoles, SoilAnalyzer::SoilSettings::filterMaskSize, SoilMath::NN::GetBeta(), SoilMath::NN::GetHiddenNeurons(), SoilMath::NN::GetInputNeurons(), SoilMath::NN::GetOutputNeurons(), SoilAnalyzer::SoilSettings::HDRframes, SoilAnalyzer::SoilSettings::Hue_front, SoilAnalyzer::SoilSettings::Hue_proj, SoilAnalyzer::SoilSettings::ignorePartialBorderParticles, initfase, SoilMath::NN::MaxGenUsedByGA, SoilMath::NN::MaxWeightUsedByGA, SoilMath::NN::MinWeightUSedByGa, SoilAnalyzer::SoilSettings::morphFilterType, SoilMath::NN::MutationrateUsedByGA, SoilAnalyzer::SoilSettings::NNFolder, SoilAnalyzer::SoilSettings::NNlocation, Vision::MorphologicalFilter::OPEN, SoilMath::NN::PopulationSizeUsedByGA, SoilAnalyzer::SoilSettings::PredictTheShape, SoilAnalyzer::SoilSettings::Revolution, SoilAnalyzer::SoilSettings::SampleFolder, SoilAnalyzer::SoilSettings::Saturation_front, SoilAnalyzer::SoilSettings::Saturation_proj, SetCamControl(), Settings, SoilAnalyzer::SoilSettings::SettingsFolder, SoilAnalyzer::SoilSettings::Sharpness_front, SoilAnalyzer::SoilSettings::Sharpness_proj, SoilAnalyzer::SoilSettings::sigmaFactor, SoilAnalyzer::SoilSettings::StandardNumberOfShots, SoilAnalyzer::SoilSettings::StandardPrinter, SoilAnalyzer::SoilSettings::StandardSentTo, SoilAnalyzer::SoilSettings::typeOfObjectsSegmented, ui, SoilAnalyzer::SoilSettings::useAdaptiveContrast, SoilAnalyzer::SoilSettings::useBacklightProjection, SoilAnalyzer::SoilSettings::useBlur, SoilAnalyzer::SoilSettings::useCUDA, SoilAnalyzer::SoilSettings::useHDR, and Hardware::Microscope::X64.

Here is the call graph for this function:



6.19.2.2 DialogSettings::~DialogSettings ( )

Definition at line 188 of file dialogsettings.cpp.

References ui.

6.19.3 Member Function Documentation

6.19.3.1 void DialogSettings::on_cb_fillHoles_3_clicked (bool *checked*) [private], [slot]

Definition at line 393 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::fillHoles, and Settings.

6.19.3.2 void DialogSettings::on_cb_ignoreBorder_3_clicked (bool *checked*) [private], [slot]

Definition at line 389 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::ignorePartialBorderParticles, and Settings.

6.19.3.3 void DialogSettings::on_cb_use_adaptContrast_3_clicked (bool *checked*) [private], [slot]

Definition at line 370 of file dialogsettings.cpp.

References Settings, ui, and SoilAnalyzer::SoilSettings::useAdaptiveContrast.

6.19.3.4 void DialogSettings::on_cb_useBlur_3_clicked (bool *checked*) [private], [slot]

Definition at line 376 of file dialogsettings.cpp.

References Settings, ui, and SoilAnalyzer::SoilSettings::useBlur.

6.19.3.5 void DialogSettings::on_checkBox_Backlight_clicked (bool *checked*) [private], [slot]

Definition at line 222 of file dialogsettings.cpp.

References Settings, ui, and SoilAnalyzer::SoilSettings::useBacklightProjection.

6.19.3.6 void DialogSettings::on_checkBox_InvertEncoder_clicked (bool *checked*) [private], [slot]

Definition at line 299 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::encInv, and Settings.

6.19.3.7 void DialogSettings::on_checkBox_PredictShape_clicked (bool *checked*) [private], [slot]

Definition at line 515 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::PredictTheShape, and Settings.

6.19.3.8 void DialogSettings::on_checkBox_revolt_clicked (bool *checked*) [private], [slot]

Definition at line 519 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::Revolution, and Settings.

6.19.3.9 void DialogSettings::on_checkBox_useCUDA_clicked (bool *checked*) [private], [slot]

Definition at line 303 of file dialogsettings.cpp.

References Settings, and SoilAnalyzer::SoilSettings::useCUDA.

6.19.3.10 void DialogSettings::on_checkBox_useHDR_clicked (bool *checked*) [private], [slot]

Definition at line 256 of file dialogsettings.cpp.

References Settings, ui, and SoilAnalyzer::SoilSettings::useHDR.

6.19.3.11 void DialogSettings::on_checkBox_useRainbow_clicked (bool *checked*) [private], [slot]

Definition at line 295 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::enableRainbow, and Settings.

6.19.3.12 void DialogSettings::on_comboBox_Microscopes_currentIndexChanged (const QString & *arg1*) [private], [slot]

Definition at line 227 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::defaultWebcam, initfase, Settings, and ui.

6.19.3.13 void DialogSettings::on_comboBox_Resolution_currentIndexChanged (int *index*) [private], [slot]

Definition at line 247 of file dialogsettings.cpp.

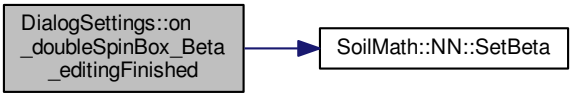
References initfase, SoilAnalyzer::SoilSettings::selectedResolution, and Settings.

6.19.3.14 void DialogSettings::on_doubleSpinBox_Beta_editingFinished ( ) [private], [slot]

Definition at line 449 of file dialogsettings.cpp.

References SoilMath::NN::SetBeta(), and ui.

Here is the call graph for this function:



6.19.3.15 void DialogSettings::on_doubleSpinBox_endError_editingFinished ( ) [private], [slot]

Definition at line 437 of file dialogsettings.cpp.

References SoilMath::NN::EndErrorUsedByGA, and ui.

6.19.3.16 void DialogSettings::on_doubleSpinBox_LightLevel_editingFinished ( ) [private], [slot]

Definition at line 290 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::lightLevel, Settings, and ui.

6.19.3.17 void DialogSettings::on_doubleSpinBox_maxWeight_editingFinished ( ) [private], [slot]

Definition at line 441 of file dialogsettings.cpp.

References SoilMath::NN::MaxWeightUsedByGA, and ui.

6.19.3.18 void DialogSettings::on_doubleSpinBox_MinWeight_editingFinished ( ) [private], [slot]

Definition at line 445 of file dialogsettings.cpp.

References SoilMath::NN::MinWeightUSedByGa, and ui.

6.19.3.19 void DialogSettings::on_doubleSpinBox_MutationRate_editingFinished ( ) [private], [slot]

Definition at line 429 of file dialogsettings.cpp.

References SoilMath::NN::MutationrateUsedByGA, and ui.

6.19.3.20 void DialogSettings::on_horizontalSlider_BrightFront_valueChanged (int *value*) [private], [slot]

Definition at line 307 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::Brightness_front, initfase, and Settings.

6.19.3.21 void DialogSettings::on_horizontalSlider_BrightProj_valueChanged (int *value*) [private], [slot]

Definition at line 339 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::Brightness_proj, initfase, and Settings.

6.19.3.22 void DialogSettings::on_horizontalSlider_ContrastFront_valueChanged (int *value*) [private], [slot]

Definition at line 313 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::Contrast_front, initfase, and Settings.

6.19.3.23 void DialogSettings::on_horizontalSlider_ContrastProj_valueChanged (int *value*) [private], [slot]

Definition at line 345 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::Contrast_proj, initfase, and Settings.

6.19.3.24 void DialogSettings::on_horizontalSlider_HueFront_valueChanged (int *value*) [private], [slot]

Definition at line 326 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::Hue_front, initfase, and Settings.

6.19.3.25 void DialogSettings::on_horizontalSlider_HueProj_valueChanged (int *value*) [private], [slot]

Definition at line 358 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::Hue_proj, initfase, and Settings.

6.19.3.26 void DialogSettings::on_horizontalSlider_SaturationFront_valueChanged (int *value*) [private], [slot]

Definition at line 319 of file dialogsettings.cpp.

References initfase, SoilAnalyzer::SoilSettings::Saturation_front, and Settings.

6.19.3.27 void DialogSettings::on_horizontalSlider_SaturationProj_valueChanged (int *value*) [private], [slot]

Definition at line 351 of file dialogsettings.cpp.

References initfase, SoilAnalyzer::SoilSettings::Saturation_proj, and Settings.

6.19.3.28 void DialogSettings::on_horizontalSlider_SharpnessFront_valueChanged (int *value*) [private], [slot]

Definition at line 332 of file dialogsettings.cpp.

References initfase, Settings, and SoilAnalyzer::SoilSettings::Sharpness_front.

6.19.3.29 void DialogSettings::on_horizontalSlider_SharpnessProj_valueChanged (int *value*) [private], [slot]

Definition at line 364 of file dialogsettings.cpp.

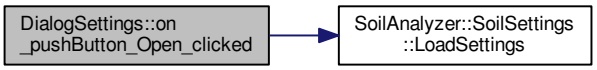
References initfase, Settings, and SoilAnalyzer::SoilSettings::Sharpness_proj.

6.19.3.30 void DialogSettings::on_pushButton_Open_clicked ( ) [private], [slot]

Definition at line 200 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::LoadSettings(), and Settings.

Here is the call graph for this function:

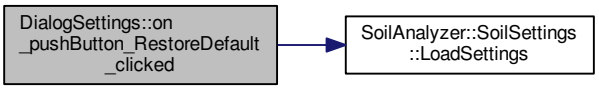


6.19.3.31 void DialogSettings::on_pushButton_RestoreDefault_clicked ( ) [private], [slot]

Definition at line 196 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::LoadSettings(), and Settings.

Here is the call graph for this function:

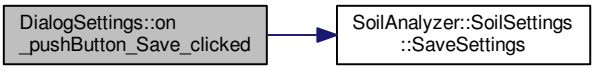


6.19.3.32 void DialogSettings::on_pushButton_Save_clicked ( ) [private], [slot]

Definition at line 211 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::SaveSettings(), and Settings.

Here is the call graph for this function:



6.19.3.33 void DialogSettings::on_pushButton_SelectNN_clicked ( ) [private], [slot]

Definition at line 498 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::NNlocation, Settings, and ui.

6.19.3.34 void DialogSettings::on_pushButton_SelectNNFolder_clicked ( ) [private], [slot]

Definition at line 487 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::NNFolder, Settings, and ui.

6.19.3.35 void DialogSettings::on_pushButton_selectSampleFolder_clicked ( ) [private], [slot]

Definition at line 465 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::SampleFolder, Settings, and ui.

6.19.3.36 void DialogSettings::on_pushButton_SelectSettingFolder_clicked ( ) [private], [slot]

Definition at line 476 of file dialogsettings.cpp.

References Settings, SoilAnalyzer::SoilSettings::SettingsFolder, and ui.

6.19.3.37 void DialogSettings::on_rb_useClose_3_clicked (bool *checked*) [private], [slot]

Definition at line 405 of file dialogsettings.cpp.

References Vision::MorphologicalFilter::CLOSE, SoilAnalyzer::SoilSettings::morphFilterType, and Settings.

6.19.3.38 void DialogSettings::on_rb_useDark_3_toggled (bool *checked*) [private], [slot]

Definition at line 381 of file dialogsettings.cpp.

References Vision::Segment::Bright, Vision::Segment::Dark, Settings, and SoilAnalyzer::SoilSettings::typeOfObjectsSegmented.

6.19.3.39 void DialogSettings::on_rb_useDilate_3_clicked (bool *checked*) [private], [slot]

Definition at line 413 of file dialogsettings.cpp.

References Vision::MorphologicalFilter::DILATE, SoilAnalyzer::SoilSettings::morphFilterType, and Settings.

6.19.3.40 void DialogSettings::on_rb_useErode_3_clicked (bool *checked*) [private], [slot]

Definition at line 409 of file dialogsettings.cpp.

References Vision::MorphologicalFilter::ERODE, SoilAnalyzer::SoilSettings::morphFilterType, and Settings.

6.19.3.41 void DialogSettings::on_rb_useOpen_3_clicked (bool *checked*) [private], [slot]

Definition at line 401 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::morphFilterType, Vision::MorphologicalFilter::OPEN, and Settings.

6.19.3.42 void DialogSettings::on_sb_morphMask_3_editingFinished ( ) [private], [slot]

Definition at line 417 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::filterMaskSize, Settings, and ui.

6.19.3.43 void DialogSettings::on_sb_sigmaFactor_3_editingFinished ( ) [private], [slot]

Definition at line 397 of file dialogsettings.cpp.

References Settings, SoilAnalyzer::SoilSettings::sigmaFactor, and ui.

6.19.3.44 void DialogSettings::on_spinBox_Elitisme_editingFinished ( ) [private], [slot]

Definition at line 433 of file dialogsettings.cpp.

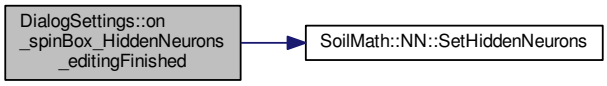
References SoilMath::NN::ElitismeUsedByGA, and ui.

6.19.3.45 void DialogSettings::on_spinBox_HiddenNeurons_editingFinished ( ) [private], [slot]

Definition at line 457 of file dialogsettings.cpp.

References SoilMath::NN::SetHiddenNeurons(), and ui.

Here is the call graph for this function:

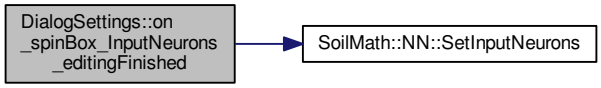


6.19.3.46 void DialogSettings::on_spinBox_InputNeurons_editingFinished ( ) [private], [slot]

Definition at line 453 of file dialogsettings.cpp.

References SoilMath::NN::SetInputNeurons(), and ui.

Here is the call graph for this function:



6.19.3.47 void DialogSettings::on_spinBox_MaxGen_editingFinished ( ) [private], [slot]

Definition at line 421 of file dialogsettings.cpp.

References SoilMath::NN::MaxGenUsedByGA, and ui.

6.19.3.48 void DialogSettings::on_spinBox_NoFrames_editingFinished ( ) [private], [slot]

Definition at line 286 of file dialogsettings.cpp.

References SoilAnalyzer::SoilSettings::HDRframes, Settings, and ui.

6.19.3.49 void DialogSettings::on_spinBox_NoShots_editingFinished ( ) [private], [slot]

Definition at line 511 of file dialogsettings.cpp.

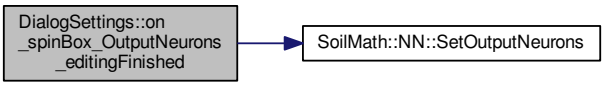
References Settings, SoilAnalyzer::SoilSettings::StandardNumberOfShots, and ui.

6.19.3.50 void DialogSettings::on_spinBox_OutputNeurons_editingFinished ( ) [private], [slot]

Definition at line 461 of file dialogsettings.cpp.

References SoilMath::NN::SetOutputNeurons(), and ui.

Here is the call graph for this function:



6.19.3.51 void DialogSettings::on_spinBox_PopSize_editingFinished ( ) [private],[slot]

Definition at line 425 of file dialogsettings.cpp.

References SoilMath::NN::PopulationSizeUsedByGA, and ui.

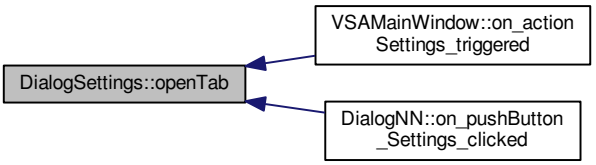
6.19.3.52 void DialogSettings::openTab (int *newValue*)

Definition at line 190 of file dialogsettings.cpp.

References ui.

Referenced by VSAMainWindow::on_actionSettings_triggered(), and DialogNN::on_pushButton_Settings_clicked().

Here is the caller graph for this function:



6.19.3.53 void DialogSettings::SetCamControl (Hardware::Microscope::Cam_t * *selectedCam*, QSlider * *Brightness*, QSlider * *Contrast*, QSlider * *Saturation*, QSlider * *Hue*, QSlider * *Sharpness*) [private]

Definition at line 262 of file dialogsettings.cpp.

References Hardware::Microscope::Cam_t::Controls.

Referenced by DialogSettings().

Here is the caller graph for this function:

6.19.4 Member Data Documentation

6.19.4.1 bool DialogSettings::initfase = true [private]

Definition at line 136 of file dialogsettings.h.

Referenced by DialogSettings(), on_comboBox_Microscopes_currentIndexChanged(), on_comboBox_Resolution_currentIndexChanged(), on_horizontalSlider_BrightFront_valueChanged(), on_horizontalSlider_BrightProj_valueChanged(), on_horizontalSlider_ContrastFront_value↩

Changed(), on_horizontalSlider_ContrastProj_valueChanged(), on_horizontalSlider_HueFront_valueChanged(), on_horizontalSlider_HueProj↩ _valueChanged(), on_horizontalSlider_SaturationFront_valueChanged(), on_horizontalSlider_SaturationProj_valueChanged(), on_horizontal↩ Slider_SharpnessFront_valueChanged(), and on_horizontalSlider_SharpnessProj_valueChanged().

6.19.4.2 Hardware::Microscope* DialogSettings::Microscope [private]

Definition at line 134 of file dialogsettings.h.

6.19.4.3 SoilMath::NN* DialogSettings::NN [private]

Definition at line 135 of file dialogsettings.h.

6.19.4.4 SoilAnalyzer::SoilSettings* DialogSettings::Settings = nullptr

Definition at line 20 of file dialogsettings.h.

Referenced by DialogSettings(), on_cb_fillHoles_3_clicked(), on_cb_ignoreBorder_3_clicked(), on_cb_use_adaptContrast_3_clicked(), on_↩ cb_useBlur_3_clicked(), on_checkBox_Backlight_clicked(), on_checkBox_InvertEncoder_clicked(), on_checkBox_PredictShape_clicked(), on↩ _checkBox_revolt_clicked(), on_checkBox_useCUDA_clicked(), on_checkBox_useHDR_clicked(), on_checkBox_useRainbow_clicked(), on_↩ comboBox_Microscopes_currentIndexChanged(), on_comboBox_Resolution_currentIndexChanged(), on_doubleSpinBox_LightLevel_editing↩ Finished(), on_horizontalSlider_BrightFront_valueChanged(), on_horizontalSlider_BrightProj_valueChanged(), on_horizontalSlider_Contrast↩ Front_valueChanged(), on_horizontalSlider_ContrastProj_valueChanged(), on_horizontalSlider_HueFront_valueChanged(), on_horizontal↩ Slider_HueProj_valueChanged(), on_horizontalSlider_SaturationFront_valueChanged(), on_horizontalSlider_SaturationProj_valueChanged(), on_horizontalSlider_SharpnessFront_valueChanged(), on_horizontalSlider_SharpnessProj_valueChanged(), on_pushButton_Open_clicked(), on_pushButton_RestoreDefault_clicked(), on_pushButton_Save_clicked(), on_pushButton_SelectNN_clicked(), on_pushButton_SelectNN↩ Folder_clicked(), on_pushButton_selectSampleFolder_clicked(), on_pushButton_SelectSettingFolder_clicked(), on_rb_useClose_3_clicked(), on_rb_useDark_3_toggled(), on_rb_useDilate_3_clicked(), on_rb_useErode_3_clicked(), on_rb_useOpen_3_clicked(), on_sb_morphMask_↩ 3_editingFinished(), on_sb_sigmaFactor_3_editingFinished(), on_spinBox_NoFrames_editingFinished(), and on_spinBox_NoShots_editing↩ Finished().

6.19.4.5 Ui::DialogSettings* DialogSettings::ui [private]

Definition at line 133 of file dialogsettings.h.

Referenced by DialogSettings(), on_cb_use_adaptContrast_3_clicked(), on_cb_useBlur_3_clicked(), on_checkBox_Backlight_clicked(), on_↩ checkBox_useHDR_clicked(), on_comboBox_Microscopes_currentIndexChanged(), on_doubleSpinBox_Beta_editingFinished(), on_double↩ SpinBox_endError_editingFinished(), on_doubleSpinBox_LightLevel_editingFinished(), on_doubleSpinBox_maxWeight_editingFinished(), on↩ _doubleSpinBox_MinWeight_editingFinished(), on_doubleSpinBox_MutationRate_editingFinished(), on_pushButton_SelectNN_clicked(), on↩ _pushButton_SelectNNFolder_clicked(), on_pushButton_selectSampleFolder_clicked(), on_pushButton_SelectSettingFolder_clicked(), on_↩ sb_morphMask_3_editingFinished(), on_sb_sigmaFactor_3_editingFinished(), on_spinBox_Elitisme_editingFinished(), on_spinBox_Hidden↩ Neurons_editingFinished(), on_spinBox_InputNeurons_editingFinished(), on_spinBox_MaxGen_editingFinished(), on_spinBox_NoFrames↩ _editingFinished(), on_spinBox_NoShots_editingFinished(), on_spinBox_OutputNeurons_editingFinished(), on_spinBox_PopSize_editing↩ Finished(), openTab(), and ~DialogSettings().

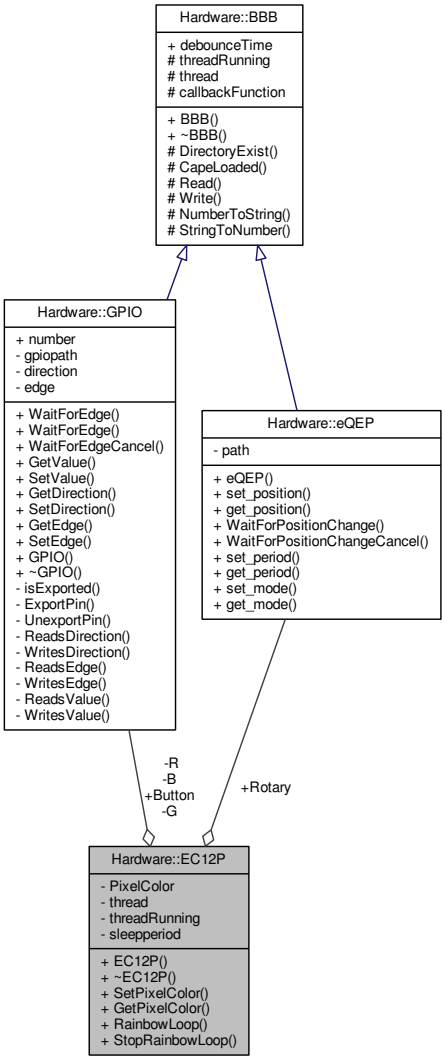
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/VSA/dialogsettings.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/VSA/dialogsettings.cpp

6.20 Hardware::EC12P Class Reference

`#include <EC12P.h>`

Collaboration diagram for Hardware::EC12P:



Public Types

- enum Color {
  Red, Pink, Blue, SkyBlue,
  Green, Yellow, White, None }

Public Member Functions

- EC12P ()
- ~EC12P ()
- void SetPixelColor (Color value)
- Color GetPixelColor ()
- void RainbowLoop (int sleepperiod)
- void StopRainbowLoop ()

Public Attributes

- eQEP Rotary {eQEP2, eQEP::eQEP_Mode_Absolute}
- GPIO Button {68}

Private Attributes

- Color PixelColor
- GPIO R {31}
- GPIO B {48}
- GPIO G {51}
- pthread_t thread
- bool threadRunning
- int sleepperiod

Friends

- void * colorLoop (void *value)

6.20.1 Detailed Description

Definition at line 23 of file EC12P.h.

6.20.2 Member Enumeration Documentation

6.20.2.1 enum Hardware::EC12P::Color

Enumerator indicating the color of the encoder shaft

Enumerator

Red Red

Pink Pink

Blue Blue

SkyBlue SkyBlue

Green Green

Yellow Yellow

White White

None Off

Definition at line 29 of file EC12P.h.

6.20.3 Constructor & Destructor Documentation

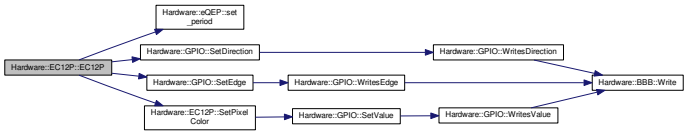
6.20.3.1 EC12P::EC12P ( )

Constructor

Definition at line 12 of file EC12P.cpp.

References B, Button, G, Hardware::GPIO::Input, None, Hardware::GPIO::Output, R, Hardware::GPIO::Rising, Rotary, Hardware::eQEP::set_period(), Hardware::GPIO::SetDirection(), Hardware::GPIO::SetEdge(), SetPixelColor(), and threadRunning.

Here is the call graph for this function:



6.20.3.2 EC12P::~EC12P ( )

De-constructor

Definition at line 30 of file EC12P.cpp.

6.20.4 Member Function Documentation

6.20.4.1 Color Hardware::EC12P::GetPixelColor ( ) [inline]

Definition at line 41 of file EC12P.h.

6.20.4.2 void EC12P::RainbowLoop (int *sleepperiod*)

Loops through all the colors except of as a thread

Definition at line 82 of file EC12P.cpp.

References colorLoop, sleepperiod, thread, and threadRunning.

6.20.4.3 void EC12P::SetPixelColor (Color *value*)

Set the shaft color

Parameters

value	as Color enumerator

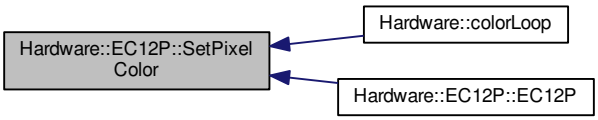
Definition at line 35 of file EC12P.cpp.

References B, Blue, G, Green, Hardware::GPIO::High, Hardware::GPIO::Low, None, Pink, PixelColor, R, Red, Hardware::GPIO::SetValue(), SkyBlue, White, and Yellow.

Referenced by Hardware::colorLoop(), and EC12P().

Here is the call graph for this function:

Here is the caller graph for this function:



6.20.4.4 void Hardware::EC12P::StopRainbowLoop ( ) [inline]

Definition at line 44 of file EC12P.h.

6.20.5 Friends And Related Function Documentation

6.20.5.1 void* colorLoop (void * *value*) [friend]

The thread function that runs trough all the colors

Definition at line 91 of file EC12P.cpp.

Referenced by RainbowLoop().

6.20.6 Member Data Documentation

6.20.6.1 GPIO Hardware::EC12P::B {48} [private]

Blue LED

Definition at line 53 of file EC12P.h.

Referenced by EC12P(), and SetPixelColor().

6.20.6.2 GPIO Hardware::EC12P::Button {68}

The pushbutton

Definition at line 47 of file EC12P.h.

Referenced by EC12P().

6.20.6.3 GPIO Hardware::EC12P::G {51} [private]

Green LED

Definition at line 54 of file EC12P.h.

Referenced by EC12P(), and SetPixelColor().

6.20.6.4 Color Hardware::EC12P::PixelColor [private]

Current shaft color

Definition at line 50 of file EC12P.h.

Referenced by SetPixelColor().

6.20.6.5 GPIO Hardware::EC12P::R {31} [private]

Red LED

Definition at line 52 of file EC12P.h.

Referenced by EC12P(), and SetPixelColor().

6.20.6.6 eQEP Hardware::EC12P::Rotary {eQEP2, eQEP::eQEP_Mode_Absolute}

The encoder

Definition at line 46 of file EC12P.h.

Referenced by EC12P().

6.20.6.7 int Hardware::EC12P::sleepperiod [private]

Sleep period

Definition at line 58 of file EC12P.h.

Referenced by Hardware::colorLoop(), and RainbowLoop().

6.20.6.8 pthread_t Hardware::EC12P::thread [private]

the thread

Definition at line 56 of file EC12P.h.

Referenced by RainbowLoop().

6.20.6.9 bool Hardware::EC12P::threadRunning [private]

Bool used to stop the thread

Definition at line 57 of file EC12P.h.

Referenced by Hardware::colorLoop(), EC12P(), and RainbowLoop().

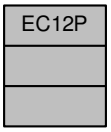
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/EC12P.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/EC12P.cpp

6.21 EC12P Class Reference

`#include <EC12P.h>`

Collaboration diagram for EC12P:



6.21.1 Detailed Description

Interaction with the sparksfun RGB encoder

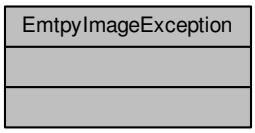
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/EC12P.h

6.22 EmtpyImageException Class Reference

`#include <EmptyImageException.h>`

Collaboration diagram for EmtpyImageException:



6.22.1 Detailed Description

Exception class which is thrown when operations are about to start on a empty image.

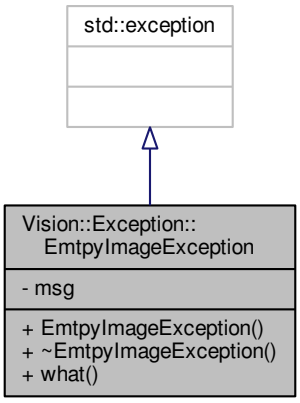
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/EmptyImageException.h

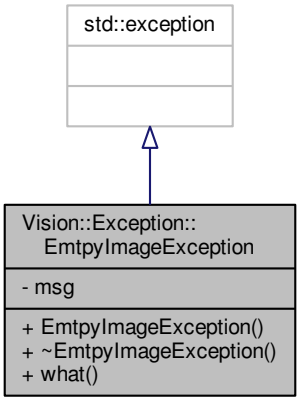
6.23 Vision::Exception::EmtpyImageException Class Reference

`#include <EmptyImageException.h>`

Inheritance diagram for Vision::Exception::EmtpyImageException:



Collaboration diagram for Vision::Exception::EmtpyImageException:



Public Member Functions

- EmtpyImageException (string m="Empty Image!")
- ~EmtpyImageException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.23.1 Detailed Description

Definition at line 22 of file EmptyImageException.h.

6.23.2 Constructor & Destructor Documentation

6.23.2.1 Vision::Exception::EmtpyImageException::EmtpyImageException (string *m* = "Empty Image!") [inline]

Definition at line 24 of file EmptyImageException.h.

6.23.2.2 Vision::Exception::EmtpyImageException::~EmtpyImageException ( ) [inline]

Definition at line 25 of file EmptyImageException.h.

6.23.3 Member Function Documentation

6.23.3.1 const char* Vision::Exception::EmtpyImageException::what ( ) const [inline]

Definition at line 26 of file EmptyImageException.h.

6.23.4 Member Data Documentation

6.23.4.1 string Vision::Exception::EmtpyImageException::msg [private]

Definition at line 26 of file EmptyImageException.h.

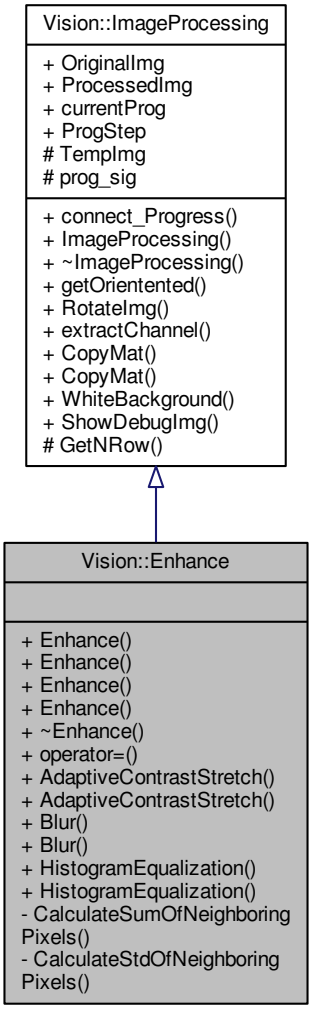
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/EmptyImageException.h

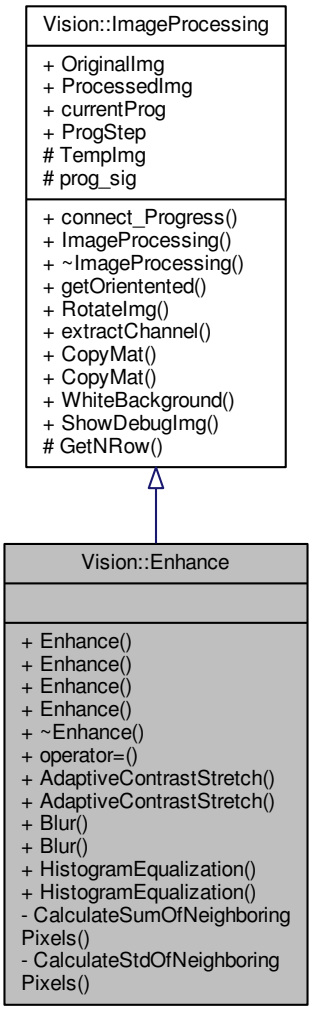
6.24 Vision::Enhance Class Reference

```
#include <Enhance.h>
```

Inheritance diagram for Vision::Enhance:



Collaboration diagram for Vision::Enhance:



Public Types

- enum EnhanceOperation { _AdaptiveContrastStretch, _Blur, _HistogramEqualization }

Public Member Functions

- Enhance ()
- Enhance (const Mat &src)
- Enhance (const Mat &src, Mat &dst, uint8_t kernelsize=9, float factor=1.0, EnhanceOperation operation=_Blur)
- Enhance (const Enhance &rhs)
- ~Enhance ()
- Enhance & operator= (Enhance rhs)
- void AdaptiveContrastStretch (uint8_t kernelsize, float factor, bool chain=false)
- void AdaptiveContrastStretch (const Mat &src, Mat &dst, uint8_t kernelsize, float factor)
- void Blur (uint8_t kernelsize, bool chain=false)
- void Blur (const Mat &src, Mat &dst, uint8_t kernelsize)

- void HistogramEqualization (bool chain=false)
- void HistogramEqualization (const Mat &src, Mat &dst)

Private Member Functions

- void CalculateSumOfNeighboringPixels (uchar *O, int i, int hKsize, int nCols, uint32_t &sum)
- float CalculateStdOfNeighboringPixels (uchar *O, int i, int hKsize, int nCols, int noNeighboursPix, float mean)

Additional Inherited Members

6.24.1 Detailed Description

Definition at line 18 of file Enhance.h.

6.24.2 Member Enumeration Documentation

6.24.2.1 enum Vision::Enhance::EnhanceOperation

Enumerator indicating the requested enhancement operation

Enumerator

_AdaptiveContrastStretch custom adaptive contrast stretch operation

_Blur Blur operation

_HistogramEqualization Histogram equalization

Definition at line 27 of file Enhance.h.

6.24.3 Constructor & Destructor Documentation

6.24.3.1 Enhance::Enhance ( )

Constructor

Definition at line 15 of file Enhance.cpp.

6.24.3.2 Enhance::Enhance (const Mat & *src*)

Constructor

Parameters

src	cv::Mat source image

Definition at line 20 of file Enhance.cpp.

References Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

6.24.3.3 Vision::Enhance::Enhance (const Mat & *src*, Mat & *dst*, uint8_t *kernelsize* = `9`, float *factor* = `1.0`, EnhanceOperation *operation* = *_Blur*)

6.24.3.4 Enhance::Enhance (const Enhance & *rhs*)

Definition at line 25 of file Enhance.cpp.

References Vision::ImageProcessing::OriginalImg, Vision::ImageProcessing::ProcessedImg, and Vision::ImageProcessing::TempImg.

6.24.3.5 Enhance::~Enhance ( )

Dec-constructor

Definition at line 60 of file Enhance.cpp.

6.24.4 Member Function Documentation

6.24.4.1 void Vision::Enhance::AdaptiveContrastStretch (uint8_t *kernelsize*, float *factor*, bool *chain* = `false`)

6.24.4.2 void Vision::Enhance::AdaptiveContrastStretch (const Mat & *src*, Mat & *dst*, uint8_t *kernelsize*, float *factor*)

6.24.4.3 void Vision::Enhance::Blur (uint8_t *kernelsize*, bool *chain* = false)

6.24.4.4 void Vision::Enhance::Blur (const Mat & *src*, Mat & *dst*, uint8_t *kernelsize*)

6.24.4.5 float Enhance::CalculateStdOfNeighboringPixels (uchar * *O*, int *i*, int *hKsize*, int *nCols*, int *noNeighboursPix*, float *mean*) [private]

Calculate the standard deviation of the neighboring pixels

Parameters

O	uchar pointer to the current pixel of the original image
i	current counter
hKsize	half the kernelsize
nCols	total number of columns
noNeighboursPix	total number of neighboring pixels
mean	mean value of the neighboring pixels

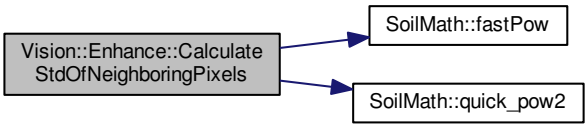
Returns

standard deviation

Definition at line 80 of file Enhance.cpp.

References SoilMath::fastPow(), and SoilMath::quick_pow2().

Here is the call graph for this function:



6.24.4.6 void Enhance::CalculateSumOfNeighboringPixels (uchar * *O*, int *i*, int *hKsize*, int *nCols*, uint32_t & *sum*) [private]

Calculate the sum of the neighboring pixels

Parameters

O	uchar pointer to the current pixel of the original image
i	current counter
hKsize	half the kernelsize
nCols	total number of columns
sum	Total sum of the neighboringpixels

Definition at line 105 of file Enhance.cpp.

6.24.4.7 void Enhance::HistogramEqualization (bool *chain* = false)

Stretches the image using a histogram

Parameters

chain	use the results from the previous operation default value = false;

Definition at line 277 of file Enhance.cpp.

References CHAIN_PROCESS, EMPTY_CHECK, SoilMath::Stats< T1, T2, T3 >::max, SoilMath::Stats< T1, T2, T3 >::min, Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

6.24.4.8 void Vision::Enhance::HistogramEqualization (const Mat & *src*, Mat & *dst*)

6.24.4.9 Enhance & Enhance::operator= (Enhance *rhs*)

Definition at line 62 of file Enhance.cpp.

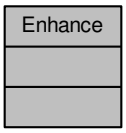
References Vision::ImageProcessing::OriginalImg, Vision::ImageProcessing::ProcessedImg, and Vision::ImageProcessing::TempImg.

The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Enhance.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Enhance.cpp

6.25 Enhance Class Reference

Collaboration diagram for Enhance:



6.25.1 Detailed Description

class which enhances a greyscale cv::Mat image

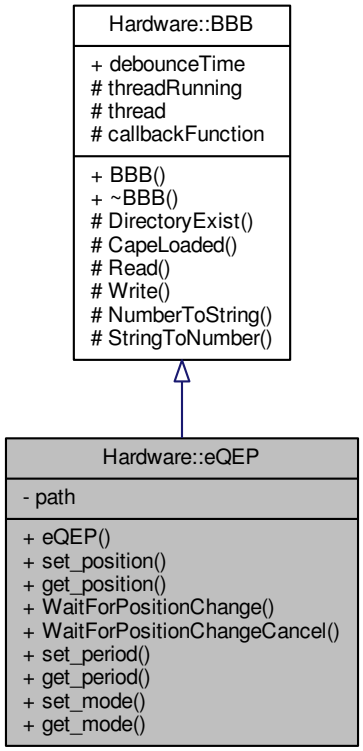
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Enhance.cpp

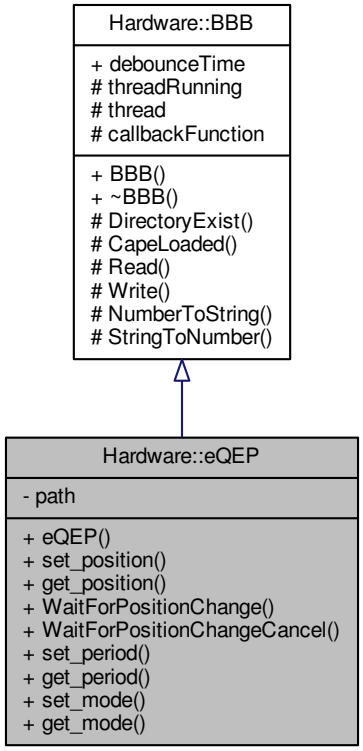
6.26 Hardware::eQEP Class Reference

```
#include <eqep.h>
```

Inheritance diagram for Hardware::eQEP:



Collaboration diagram for Hardware::eQEP:



Public Types

- enum eQEP_Mode { eQEP_Mode_Absolute = 0, eQEP_Mode_Relative = 1, eQEP_Mode_Error = 2 }

Public Member Functions

- eQEP (std::string _path, eQEP_Mode _mode)
- void set_position (int32_t position)
- int32_t get_position (bool _poll=true)
- int WaitForPositionChange (CallbackType callback)
- void WaitForPositionChangeCancel ()
- void set_period (long long unsigned int period)
- uint64_t get_period ()
- void set_mode (eQEP_Mode mode)
- eQEP_Mode get_mode ()

Private Attributes

- std::string path

Friends

- void * threadedPolleqep (void *value)

Additional Inherited Members

6.26.1 Detailed Description

Definition at line 39 of file eqep.h.

6.26.2 Member Enumeration Documentation

6.26.2.1 enum Hardware::eQEP::eQEP_Mode

Enumerator

eQEP_Mode_Absolute

eQEP_Mode_Relative

eQEP_Mode_Error

Definition at line 45 of file eqep.h.

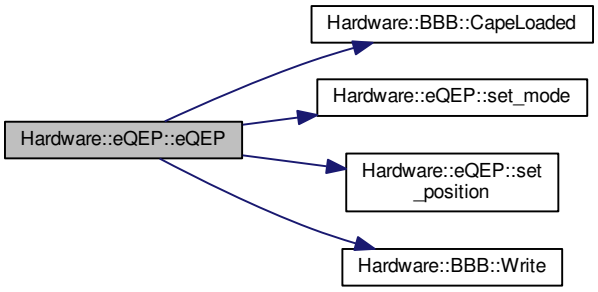
6.26.3 Constructor & Destructor Documentation

6.26.3.1 Hardware::eQEP::eQEP (std::string *_path,* eQEP::eQEP_Mode *_mode*)

Definition at line 42 of file eqep.cpp.

References Hardware::BBB::CapeLoaded(), eQEP0, eQEP1, eQEP2, set_mode(), set_position(), SLOTS, and Hardware::BBB::Write().

Here is the call graph for this function:



6.26.4 Member Function Documentation

6.26.4.1 eQEP::eQEP_Mode Hardware::eQEP::get_mode ( )

Definition at line 219 of file eqep.cpp.

References eQEP_Mode_Error, and path.

6.26.4.2 uint64_t Hardware::eQEP::get_period ( )

Definition at line 195 of file eqep.cpp.

References path.

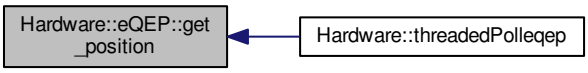
6.26.4.3 int32_t Hardware::eQEP::get_position (bool *_poll* = `true`)

Definition at line 137 of file eqep.cpp.

References path.

Referenced by Hardware::threadedPolleqep().

Here is the caller graph for this function:



6.26.4.4 void Hardware::eQEP::set_mode (eQEP::eQEP_Mode *_mode*)

Definition at line 105 of file eqep.cpp.

References path.

Referenced by eQEP().

Here is the caller graph for this function:

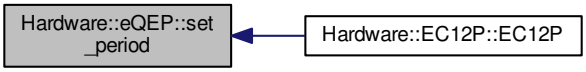
6.26.4.5 void Hardware::eQEP::set_period (long long unsigned int *period*)

Definition at line 85 of file eqep.cpp.

References path.

Referenced by Hardware::EC12P::EC12P().

Here is the caller graph for this function:



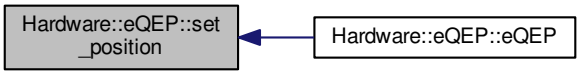
6.26.4.6 void Hardware::eQEP::set_position (int32_t *position*)

Definition at line 65 of file eqep.cpp.

References path.

Referenced by eQEP().

Here is the caller graph for this function:



6.26.4.7 int Hardware::eQEP::WaitForPositionChange (CallbackType *callback*)

Definition at line 124 of file eqep.cpp.

References Hardware::BBB::callbackFunction, Hardware::BBB::thread, threadedPolleqep, and Hardware::BBB::threadRunning.

6.26.4.8 void Hardware::eQEP::WaitForPositionChangeCancel ( ) [inline]

Definition at line 68 of file eqep.h.

References Hardware::BBB::threadRunning.

6.26.5 Friends And Related Function Documentation

6.26.5.1 void* threadedPolleqep (void * *value*) [friend]

Definition at line 242 of file eqep.cpp.

Referenced by WaitForPositionChange().

6.26.6 Member Data Documentation

6.26.6.1 std::string Hardware::eQEP::path [private]

Definition at line 41 of file eqep.h.

Referenced by get_mode(), get_period(), get_position(), set_mode(), set_period(), and set_position().

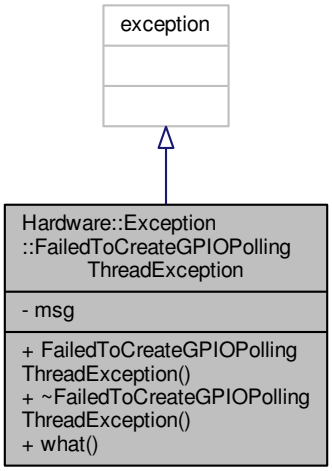
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/eqep.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/eqep.cpp

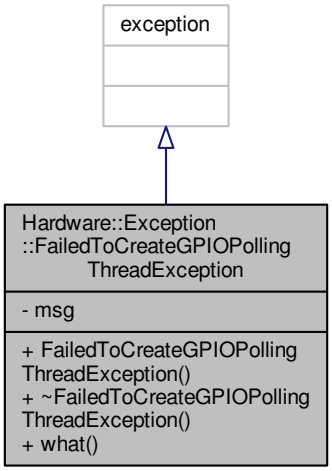
6.27 Hardware::Exception::FailedToCreateGPIOPollingThreadException Class Reference

`#include <FailedToCreateGPIOPollingThreadException.h>`

Inheritance diagram for Hardware::Exception::FailedToCreateGPIOPollingThreadException:



Collaboration diagram for Hardware::Exception::FailedToCreateGPIOPollingThreadException:



Public Member Functions

- FailedToCreateGPIOPollingThreadException (string m="Failed to create GPIO polling thread!")
- ~FailedToCreateGPIOPollingThreadException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.27.1 Detailed Description

Definition at line 17 of file FailedToCreateGPIOPollingThreadException.h.

6.27.2 Constructor & Destructor Documentation

6.27.2.1 Hardware::Exception::FailedToCreateGPIOPollingThreadException::FailedToCreateGPIOPollingThreadException (string *m* = "Failed to create GPIO polling thread!") [inline]

Definition at line 19 of file FailedToCreateGPIOPollingThreadException.h.

6.27.2.2 Hardware::Exception::FailedToCreateGPIOPollingThreadException::~FailedToCreateGPIOPollingThreadException ( ) [inline]

Definition at line 22 of file FailedToCreateGPIOPollingThreadException.h.

6.27.3 Member Function Documentation

6.27.3.1 const char* Hardware::Exception::FailedToCreateGPIOPollingThreadException::what ( ) const [inline]

Definition at line 23 of file FailedToCreateGPIOPollingThreadException.h.

6.27.4 Member Data Documentation

6.27.4.1 string Hardware::Exception::FailedToCreateGPIOPollingThreadException::msg [private]

Definition at line 23 of file FailedToCreateGPIOPollingThreadException.h.

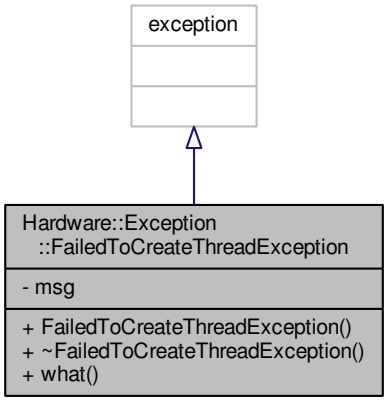
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/FailedToCreateGPIOPollingThreadException.h

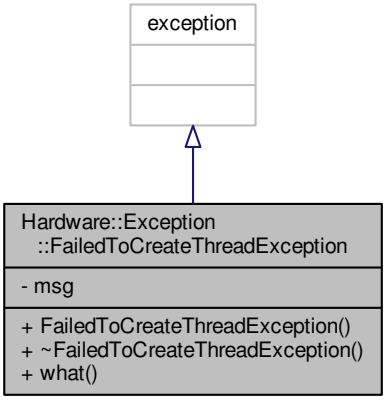
6.28 Hardware::Exception::FailedToCreateThreadException Class Reference

`#include <FailedToCreateThreadException.h>`

Inheritance diagram for Hardware::Exception::FailedToCreateThreadException:



Collaboration diagram for Hardware::Exception::FailedToCreateThreadException:



Public Member Functions

- FailedToCreateThreadException (string m="Couldn't create the thread!")
- ~FailedToCreateThreadException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.28.1 Detailed Description

Definition at line 17 of file FailedToCreateThreadException.h.

6.28.2 Constructor & Destructor Documentation

6.28.2.1 Hardware::Exception::FailedToCreateThreadException::FailedToCreateThreadException (string *m* = "Couldn't create the thread!") [inline]

Definition at line 19 of file FailedToCreateThreadException.h.

6.28.2.2 Hardware::Exception::FailedToCreateThreadException::~FailedToCreateThreadException ( ) [inline]

Definition at line 21 of file FailedToCreateThreadException.h.

6.28.3 Member Function Documentation

6.28.3.1 const char* Hardware::Exception::FailedToCreateThreadException::what ( ) const [inline]

Definition at line 22 of file FailedToCreateThreadException.h.

6.28.4 Member Data Documentation

6.28.4.1 string Hardware::Exception::FailedToCreateThreadException::msg [private]

Definition at line 22 of file FailedToCreateThreadException.h.

The documentation for this class was generated from the following file:

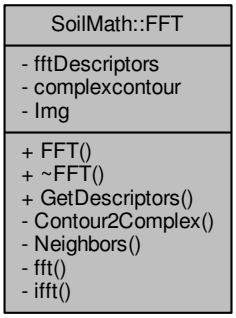
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/FailedToCreateThreadException.h

6.29 SoilMath::FFT Class Reference

Fast Fourier Transform class.

`#include <FFT.h>`

Collaboration diagram for SoilMath::FFT:



Public Member Functions

- FFT ()

  Standard constructor.
- ∼FFT ()

  Standard deconstructor.
- ComplexVect_t GetDescriptors (const cv::Mat &img)

  Transforming the img to the frequency domain and returning the Fourier Descriptors.

Private Member Functions

- ComplexVect_t Contour2Complex (const cv::Mat &img, float centerCol, float centerRow)

  Contour2Complex a private function which translates a continous contour image to a vector of complex values. The contour is found using a depth first search with extension list. The alghorithm is based upon `MIT opencourseware 6-034-artificial-intelligence lecture 4`
- iContour_t Neighbors (uchar ∗O, int pixel, uint32_t columns, uint32_t rows)

  Neighbors a private function returning the neighboring pixels which belong to a contour.
- void fft (ComplexArray_t &CA)

  fft a private function calculating the Fast Fourier Transform let m be an integer and let $N = 2^m$ also $CA = [x_0, \ldots, x_{N-1}]$ is an N dimensional complex vector let $\omega = \exp(\frac{-2\pi i}{N})$ then $c_k = \frac{1}{N} \sum_{j=0}^{j=N-1} CA_j \omega^{jk}$
- void ifft (ComplexArray_t &CA)

  ifft

Private Attributes

- ComplexVect_t fftDescriptors
- ComplexVect_t complexcontour
- cv::Mat Img

6.29.1 Detailed Description

Fast Fourier Transform class.

Use this class to transform a black and white blob presented as a cv::Mat with values 0 or 1 to a vector of complex values representing the Fourier Descriptors.

Definition at line 31 of file FFT.h.

6.29.2 Constructor & Destructor Documentation

6.29.2.1 SoilMath::FFT::FFT ( )

Standard constructor.

Definition at line 11 of file FFT.cpp.

6.29.2.2 SoilMath::FFT::~FFT ( )

Standard deconstructor.

Definition at line 13 of file FFT.cpp.

6.29.3 Member Function Documentation

6.29.3.1 ComplexVect_t SoilMath::FFT::Contour2Complex (const cv::Mat & *img*, float *centerCol*, float *centerRow*) [private]

Contour2Complex a private function which translates a continous contour image to a vector of complex values. The contour is found using a depth first search with extension list. The alghorithm is based upon MIT opencourseware 6-034-artificial-intelligence lecture 4

Parameters

img	contour in the form of a cv::Mat type CV_8UC1. Which should consist of a continous contour. $\{img \in \mathbb{Z} \| 0 \leq img \leq 1\}$
centerCol	centre of the contour X value
centerRow	centre of the contour Y value

Returns

a vector with complex values, represing the contour as a function

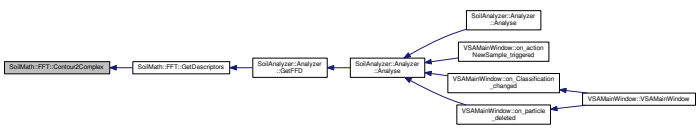
Definition at line 64 of file FFT.cpp.

References EXCEPTION_NO_CONTOUR_FOUND, EXCEPTION_NO_CONTOUR_FOUND_NR, and Neighbors().

Referenced by GetDescriptors().

Here is the call graph for this function:

Here is the caller graph for this function:



6.29.3.2 void SoilMath::FFT::fft (ComplexArray_t & *CA*) [private]

fft a private function calculating the Fast Fourier Transform let m be an integer and let $N = 2^m$ also $CA = [x_0, \ldots, x_{N-1}]$ is an N dimensional complex vector let $\omega = \exp(\frac{-2\pi i}{N})$ then $c_k = \frac{1}{N} \sum_{j=0}^{j=N-1} CA_j \omega^{jk}$

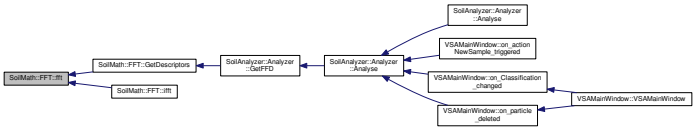
Parameters

CA	a $CA = [x_0, \ldots, x_{N-1}]$ is an N dimensional complex vector

Definition at line 149 of file FFT.cpp.

Referenced by GetDescriptors(), and ifft().

Here is the caller graph for this function:



6.29.3.3 ComplexVect_t SoilMath::FFT::GetDescriptors (const cv::Mat & *img*)

Transforming the img to the frequency domain and returning the Fourier Descriptors.

Parameters

img	contour in the form of a cv::Mat type CV_8UC1. Which should consist of a continous contour. $\{img \in \mathbb{Z} \vert 0 \leq img \leq 1\}$

Returns

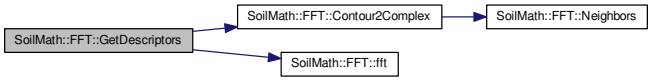
a vector with complex values, represing the contour in the frequency domain, expressed as Fourier Descriptors

Definition at line 15 of file FFT.cpp.

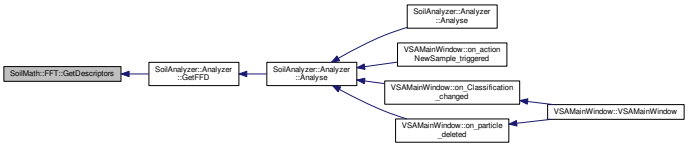
References complexcontour, Contour2Complex(), fft(), and fftDescriptors.

Referenced by SoilAnalyzer::Analyzer::GetFFD().

Here is the call graph for this function:



Here is the caller graph for this function:



6.29.3.4 void SoilMath::FFT::ifft (ComplexArray_t & *CA*) [private]

ifft

Parameters

CA	

Definition at line 169 of file FFT.cpp.

References fft().

Here is the call graph for this function:

6.29.3.5 iContour_t SoilMath::FFT::Neighbors (uchar * *O*, int *pixel*, uint32_t *columns*, uint32_t *rows*) [private]

Neighbors a private function returning the neighboring pixels which belong to a contour.

Parameters

O	uchar pointer to the data
pixel	current counter
columns	total number of columns
rows	total number of rows

Returns

Definition at line 43 of file FFT.cpp.

Referenced by Contour2Complex().

Here is the caller graph for this function:

6.29.4 Member Data Documentation

6.29.4.1 ComplexVect_t SoilMath::FFT::complexcontour [private]

Vector with complex values which represent the contour

Definition at line 59 of file FFT.h.

Referenced by GetDescriptors().

6.29.4.2 ComplexVect_t SoilMath::FFT::fftDescriptors [private]

Vector with complex values which represent the descriptors

Definition at line 56 of file FFT.h.

Referenced by GetDescriptors().

6.29.4.3 cv::Mat SoilMath::FFT::Img [private]

Img which will be analysed

Definition at line 61 of file FFT.h.

The documentation for this class was generated from the following files:

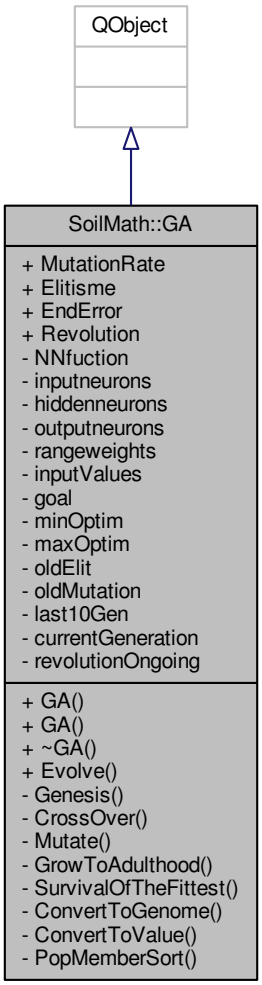
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/FFT.h

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/FFT.cpp

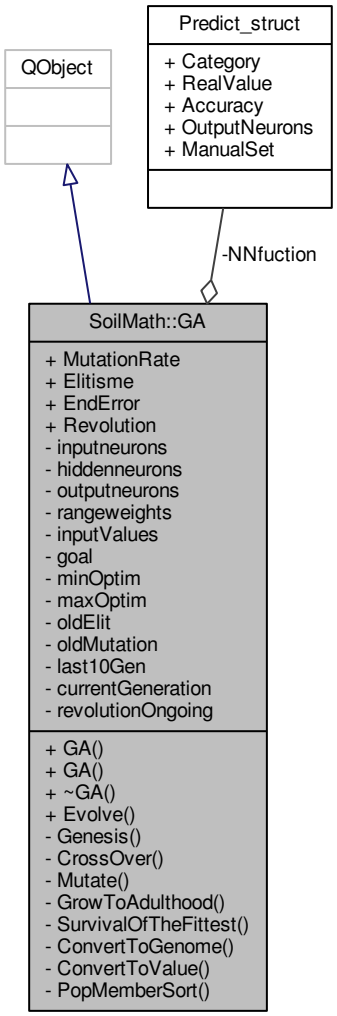
6.30 SoilMath::GA Class Reference

`#include <GA.h>`

Inheritance diagram for SoilMath::GA:



Collaboration diagram for SoilMath::GA:



Signals

- void learnErrorUpdate (double newError)

Public Member Functions

- GA ()

  GA Standard constructor.
- GA (NNfunctionType nnfunction, uint32_t inputneurons, uint32_t hiddenneurons, uint32_t outputneurons)

  GA Construction with a Neural Network initializers.
- ~GA ()

  GA standard de constructor.
- void Evolve (const InputLearnVector_t &inputValues, Weight_t &weights, MinMaxWeight_t rangeweights, OutputLearnVector_t &goal, uint32_t maxGenerations=200, uint32_t popSize=30)

  Evolve Darwin would be proud!!! This function creates a population and itterates through the generation till the maximum number off itterations has been reached of the error is acceptable.

Public Attributes

- float MutationRate = 0.075f
- uint32_t Elitisme = 4
- float EndError = 0.001f
- bool Revolution = true

Private Member Functions

- Population_t Genesis (const Weight_t &weights, uint32_t popSize)

  Genesis private function which is the spark of live, using a random seed.
- void CrossOver (Population_t &pop)

  CrossOver a private function where the partners mate with each other The values or PopMember_t are expressed as bits or ar cut at the point CROSSOVER the population members are paired with the nearest neighbor and new members are created pairing the Genome_t of each other at the CROSSOVER point. Afterwards all the top tiers partners are allowed to mate again.
- void Mutate (Population_t &pop)

  Mutate a private function where individual bits from the Genome_t are mutated at a random uniform distribution event defined by the MUTATIONRATE.
- void GrowToAdulthood (Population_t &pop, float &totalFitness)

  GrowToAdulthood a private function where the new population members serve as the the input for the Neural Network prediction function. The results are weight against the goal and this weight determine the fitness of the population member.
- bool SurvivalOfTheFittest (Population_t &pop, float &totalFitness)

  SurvivalOfTheFittest a private function where a battle to the death commences The fittest population members have the best chance of survival. Death is instigated with a random uniform distibution. The elite members don't partake in this desctruction The ELITISME rate indicate how many top tier members survive this catastrophic event.
- template<typename T >
  Genome_t ConvertToGenome (T value, std::pair< T, T > range)

  Conversion of the value of type T to Genome_t.
- template<typename T >
  T ConvertToValue (Genome_t gen, std::pair< T, T > range)

  Conversion of the Genome to a value.

Static Private Member Functions

- static bool PopMemberSort (PopMember_t i, PopMember_t j)

  PopMemberSort a private function where the members are sorted according to there fitness ranking.

Private Attributes

- NNfunctionType NNfuction
- uint32_t inputneurons
- uint32_t hiddenneurons
- uint32_t outputneurons
- MinMaxWeight_t rangeweights
- InputLearnVector_t inputValues
- OutputLearnVector_t goal
- float minOptim = 0
- float maxOptim = 0
- uint32_t oldElit = 0
- float oldMutation = 0.
- std::list< double > last10Gen
- uint32_t currentGeneration = 0
- bool revolutionOngoing = false

6.30.1 Detailed Description

Definition at line 36 of file GA.h.

6.30.2 Constructor & Destructor Documentation

6.30.2.1 SoilMath::GA::GA ( )

GA Standard constructor.

Definition at line 11 of file GA.cpp.

6.30.2.2 SoilMath::GA::GA (NNfunctionType *nnfunction*, uint32_t *inputneurons*, uint32_t *hiddenneurons*, uint32_t *outputneurons*)

GA Construction with a Neural Network initializers.

Parameters

nnfunction	the Neural Network prediction function which results will be optimized
inputneurons	the number of input neurons in the Neural Network don't count the bias
hiddenneurons	the number of hidden neurons in the Neural Network don't count the bias
outputneurons	the number of output neurons in the Neural Network

Definition at line 13 of file GA.cpp.

References hiddenneurons, inputneurons, NNfuction, and outputneurons.

6.30.2.3 SoilMath::GA::~GA ( )

GA standard de constructor.

Definition at line 21 of file GA.cpp.

6.30.3 Member Function Documentation

6.30.3.1 template<typename T > Genome_t SoilMath::GA::ConvertToGenome (T *value*, std::pair< T, T > *range*) [inline], [private]

Conversion of the value of type T to Genome_t.

Usage: Use `ConvertToGenome<Type>(type, range)`

Parameters

value	The current value wich should be converted to a Genome_t
range	the range in which the value should fall, this is to have a Genome_t which utilizes the complete range 0000...n till 1111...n

Definition at line 191 of file GA.h.

6.30.3.2 template<typename T > T SoilMath::GA::ConvertToValue (Genome_t *gen*, std::pair< T, T > *range*) [inline], [private]

Conversion of the Genome to a value.

Usage: use `ConvertToValue<Type>(genome, range)`

Parameters

gen	is the Genome which is to be converted
range	is the range in which the value should fall

Definition at line 205 of file GA.h.

6.30.3.3 void SoilMath::GA::CrossOver (Population_t & *pop*) [private]

CrossOver a private function where the partners mate with each other The values or PopMember_t are expressed as bits or ar cut at the point CROSSOVER the population members are paired with the nearest neighbor and new members are created pairing the Genome_t of each other at the CROSSOVER point. Afterwards all the top tiers partners are allowed to mate again.

Parameters

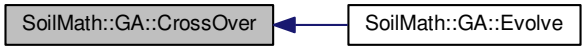
pop	reference to the population

Definition at line 72 of file GA.cpp.

References CROSSOVER, GENE_MAX, and PopMemberStruct::weightsGen.

Referenced by Evolve().

Here is the caller graph for this function:



6.30.3.4 void SoilMath::GA::Evolve (const InputLearnVector_t & *inputValues*, Weight_t & *weights*, MinMaxWeight_t *rangeweights*, OutputLearnVector_t & *goal*, uint32_t *maxGenerations* = 200, uint32_t *popSize* = 30)

Evolve Darwin would be proud!!! This function creates a population and itterates through the generation till the maximum number off itterations has been reached of the error is acceptable.

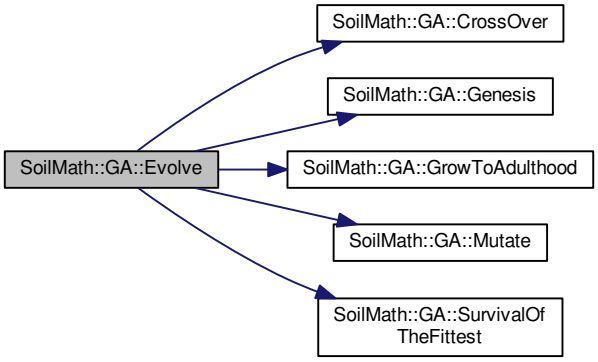
Parameters

inputValues	complex vector with a reference to the inputvalues
weights	reference to the vector of weights which will be optimized
rangeweights	reference to the range of weights, currently it doesn't support indivudal ranges this is because of the crossing
goal	target value towards the Neural Network prediction function will be optimized
maxGenerations	maximum number of itterations default value is 200
popSize	maximum number of population, this should be an even number

Definition at line 23 of file GA.cpp.

References CrossOver(), Elitisme, Genesis(), goal, GrowToAdulthood(), inputValues, maxOptim, minOptim, Mutate(), MutationRate, oldElit, oldMutation, rangeweights, and SurvivalOfTheFittest().

Here is the call graph for this function:



6.30.3.5 Population_t SoilMath::GA::Genesis (const Weight_t & *weights*, uint32_t *popSize*) [private]

Genesis private function which is the spark of live, using a random seed.

Parameters

weights	a reference to the used Weight_t vector
rangeweights	pointer to the range of weights, currently it doesn't support indivudal ranges
popSize	maximum number of population, this should be an even number

Returns

Definition at line 50 of file GA.cpp.

References rangeweights, PopMemberStruct::weights, and PopMemberStruct::weightsGen.

Referenced by Evolve().

Here is the caller graph for this function:

6.30.3.6 void SoilMath::GA::GrowToAdulthood (Population_t & *pop*, float & *totalFitness*) [private]

GrowToAdulthood a private function where the new population members serve as the the input for the Neural Network prediction function. The results are weight against the goal and this weight determine the fitness of the population member.

Parameters

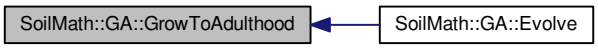
pop	reference to the population
inputValues	a InputLearnVector_t with a reference to the inputvalues
rangeweights	pointer to the range of weights, currently it doesn't support indivudal ranges
goal	a Predict_t type with the expected value
totalFitness	a reference to the total population fitness

Definition at line 152 of file GA.cpp.

References goal, hiddenneurons, inputneurons, inputValues, NNfuction, Predict_struct::OutputNeurons, outputneurons, and rangeweights.

Referenced by Evolve().

Here is the caller graph for this function:



6.30.3.7 void SoilMath::GA::learnErrorUpdate (double *newError*) [signal]

Referenced by SurvivalOfTheFittest().

Here is the caller graph for this function:

6.30.3.8 void SoilMath::GA::Mutate (Population_t & *pop*) [private]

Mutate a private function where individual bits from the Genome_t are mutated at a random uniform distribution event defined by the MUTATI↩ ONRATE.

Parameters

pop	reference to the population

Definition at line 135 of file GA.cpp.

References GENE_MAX, and MutationRate.

Referenced by Evolve().

Here is the caller graph for this function:

6.30.3.9 static bool SoilMath::GA::PopMemberSort (PopMember_t *i*, PopMember_t *j*) [inline],[static],[private]

PopMemberSort a private function where the members are sorted according to there fitness ranking.

Parameters

i	left hand population member
j	right hand population member

Returns

true if the left member is closser to the goal as the right member.

Definition at line 178 of file GA.h.

References PopMemberStruct::Fitness.

6.30.3.10 bool SoilMath::GA::SurvivalOfTheFittest (Population_t & *pop*, float & *totalFitness*) [private]

SurvivalOfTheFittest a private function where a battle to the death commences The fittest population members have the best chance of survival. Death is instigated with a random uniform distibution. The elite members don't partake in this desctruction The ELITISME rate indicate how many top tier members survive this catastrophic event.

Parameters

inputValues	a InputLearnVector_t with a reference to the inputvalues
totalFitness	a reference to the total population fitness

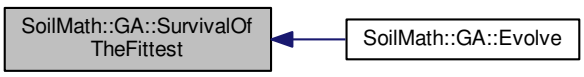
Returns

Definition at line 189 of file GA.cpp.

References currentGeneration, Elitisme, EndError, PopMemberStruct::Fitness, last10Gen, learnErrorUpdate(), maxOptim, minOptim, MutationRate, oldElit, oldMutation, and revolutionOngoing.

Referenced by Evolve().

Here is the caller graph for this function:



6.30.4 Member Data Documentation

6.30.4.1 uint32_t SoilMath::GA::currentGeneration = 0 [private]

Definition at line 105 of file GA.h.

Referenced by SurvivalOfTheFittest().

6.30.4.2 uint32_t SoilMath::GA::Elitisme = 4

total number of the elite bastard

Definition at line 41 of file GA.h.

Referenced by Evolve(), and SurvivalOfTheFittest().

6.30.4.3 float SoilMath::GA::EndError = 0.001f

acceptable error between last itteration

Definition at line 42 of file GA.h.

Referenced by SurvivalOfTheFittest().

6.30.4.4 OutputLearnVector_t SoilMath::GA::goal [private]

Definition at line 98 of file GA.h.

Referenced by Evolve(), and GrowToAdulthood().

6.30.4.5 uint32_t SoilMath::GA::hiddenneurons [private]

the total number of hidden neurons

Definition at line 93 of file GA.h.

Referenced by GA(), and GrowToAdulthood().

6.30.4.6 uint32_t SoilMath::GA::inputneurons [private]

the total number of input neurons

Definition at line 92 of file GA.h.

Referenced by GA(), and GrowToAdulthood().

6.30.4.7 InputLearnVector_t SoilMath::GA::inputValues [private]

Definition at line 97 of file GA.h.

Referenced by Evolve(), and GrowToAdulthood().

6.30.4.8 std::list<double> SoilMath::GA::last10Gen [private]

Definition at line 104 of file GA.h.

Referenced by SurvivalOfTheFittest().

6.30.4.9 float SoilMath::GA::maxOptim = 0 [private]

Definition at line 101 of file GA.h.

Referenced by Evolve(), and SurvivalOfTheFittest().

6.30.4.10 float SoilMath::GA::minOptim = 0 [private]

Definition at line 100 of file GA.h.

Referenced by Evolve(), and SurvivalOfTheFittest().

6.30.4.11 float SoilMath::GA::MutationRate = 0.075f

mutation rate

Definition at line 40 of file GA.h.

Referenced by Evolve(), Mutate(), and SurvivalOfTheFittest().

6.30.4.12 NNfunctionType SoilMath::GA::NNfuction [private]

The Neural Net work function

Definition at line 91 of file GA.h.

Referenced by GA(), and GrowToAdulthood().

6.30.4.13 uint32_t SoilMath::GA::oldElit = 0 [private]

Definition at line 102 of file GA.h.

Referenced by Evolve(), and SurvivalOfTheFittest().

6.30.4.14 float SoilMath::GA::oldMutation = 0. [private]

Definition at line 103 of file GA.h.

Referenced by Evolve(), and SurvivalOfTheFittest().

6.30.4.15 uint32_t SoilMath::GA::outputneurons [private]

the total number of output neurons

Definition at line 94 of file GA.h.

Referenced by GA(), and GrowToAdulthood().

6.30.4.16 MinMaxWeight_t SoilMath::GA::rangeweights [private]

Definition at line 96 of file GA.h.

Referenced by Evolve(), Genesis(), and GrowToAdulthood().

6.30.4.17 bool SoilMath::GA::Revolution = true

Definition at line 43 of file GA.h.

6.30.4.18 bool SoilMath::GA::revolutionOngoing = false [private]

Definition at line 106 of file GA.h.

Referenced by SurvivalOfTheFittest().

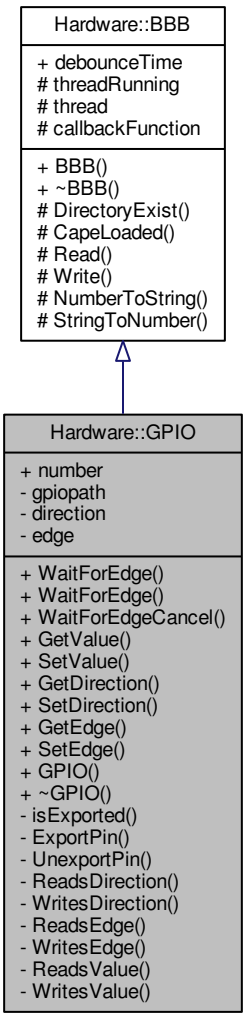
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/GA.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/GA.cpp

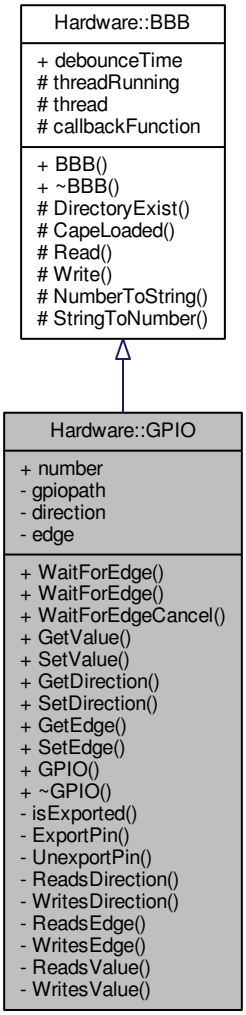
6.31 Hardware::GPIO Class Reference

```
#include <GPIO.h>
```

Inheritance diagram for Hardware::GPIO:



Collaboration diagram for Hardware::GPIO:



Public Types

- enum Direction { Input, Output }
- enum Value { Low = 0, High = 1 }
- enum Edge { None, Rising, Falling, Both }

Public Member Functions

- int WaitForEdge ()
- int WaitForEdge (CallbackType callback)
- void WaitForEdgeCancel ()
- Value GetValue ()
- void SetValue (Value value)
- Direction GetDirection ()
- void SetDirection (Direction direction)
- Edge GetEdge ()

- void SetEdge (Edge edge)
- GPIO (int number)
- ~GPIO ()

Public Attributes

- int number

Private Member Functions

- bool isExported (int number, Direction &dir, Edge &edge)
- bool ExportPin (int number)
- bool UnexportPin (int number)
- Direction ReadsDirection (const string &gpiopath)
- void WritesDirection (const string &gpiopath, Direction direction)
- Edge ReadsEdge (const string &gpiopath)
- void WritesEdge (const string &gpiopath, Edge edge)
- Value ReadsValue (const string &gpiopath)
- void WritesValue (const string &gpiopath, Value value)

Private Attributes

- string gpiopath
- Direction direction
- Edge edge

Friends

- void * threadedPollGPIO (void *value)

Additional Inherited Members

6.31.1 Detailed Description

Definition at line 25 of file GPIO.h.

6.31.2 Member Enumeration Documentation

6.31.2.1 enum Hardware::GPIO::Direction

Enumerator

Input

Output

Definition at line 27 of file GPIO.h.

6.31.2.2 enum Hardware::GPIO::Edge

Enumerator

None

Rising

Falling

Both

Definition at line 29 of file GPIO.h.

6.31.2.3 enum Hardware::GPIO::Value

Enumerator

Low

High

Definition at line 28 of file GPIO.h.

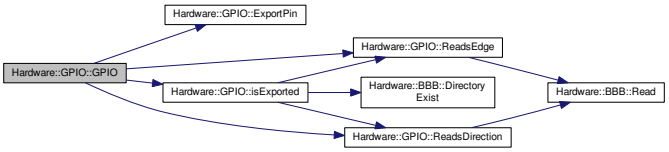
6.31.3 Constructor & Destructor Documentation

6.31.3.1 Hardware::GPIO::GPIO (int *number*)

Definition at line 11 of file GPIO.cpp.

References direction, edge, ExportPin(), gpiopath, GPIOS, isExported(), number, ReadsDirection(), and ReadsEdge().

Here is the call graph for this function:

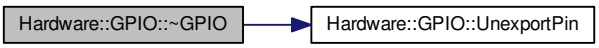


6.31.3.2 Hardware::GPIO::~GPIO ( )

Definition at line 24 of file GPIO.cpp.

References number, and UnexportPin().

Here is the call graph for this function:



6.31.4 Member Function Documentation

6.31.4.1 bool Hardware::GPIO::ExportPin (int *number*) [private]

Definition at line 102 of file GPIO.cpp.

Referenced by GPIO().

Here is the caller graph for this function:

6.31.4.2 GPIO::Direction Hardware::GPIO::GetDirection ( )

Definition at line 77 of file GPIO.cpp.

References direction.

6.31.4.3 GPIO::Edge Hardware::GPIO::GetEdge ( )

Definition at line 83 of file GPIO.cpp.

References edge.

6.31.4.4 GPIO::Value Hardware::GPIO::GetValue ( )

Definition at line 74 of file GPIO.cpp.

References gpiopath, and ReadsValue().

Here is the call graph for this function:

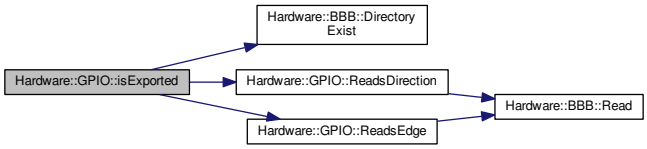
6.31.4.5 bool Hardware::GPIO::isExported (int *number*, Direction & *dir*, Edge & *edge*) [private]

Definition at line 89 of file GPIO.cpp.

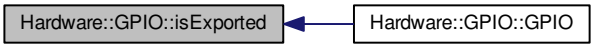
References Hardware::BBB::DirectoryExist(), gpiopath, ReadsDirection(), and ReadsEdge().

Referenced by GPIO().

Here is the call graph for this function:



Here is the caller graph for this function:



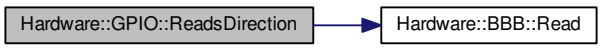
6.31.4.6 GPIO::Direction Hardware::GPIO::ReadsDirection (const string & *gpiopath*) [private]

Definition at line 205 of file GPIO.cpp.

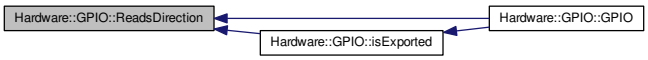
References DIRECTION, Input, Output, and Hardware::BBB::Read().

Referenced by GPIO(), and isExported().

Here is the call graph for this function:



Here is the caller graph for this function:



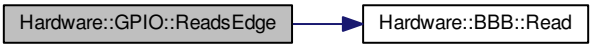
6.31.4.7 GPIO::Edge Hardware::GPIO::ReadsEdge (const string & *gpiopath*) [private]

Definition at line 224 of file GPIO.cpp.

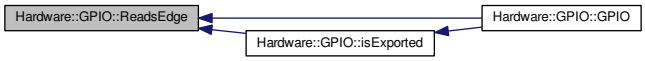
References Both, EDGE, Falling, None, Hardware::BBB::Read(), and Rising.

Referenced by GPIO(), and isExported().

Here is the call graph for this function:



Here is the caller graph for this function:



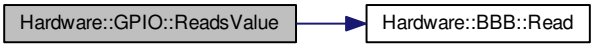
6.31.4.8 GPIO::Value Hardware::GPIO::ReadsValue (const string & *gpiopath*) [private]

Definition at line 256 of file GPIO.cpp.

References Hardware::BBB::Read(), and VALUE.

Referenced by GetValue().

Here is the call graph for this function:



Here is the caller graph for this function:

6.31.4.9 void Hardware::GPIO::SetDirection (Direction *direction*)

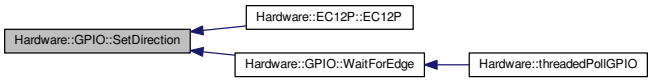
Definition at line 78 of file GPIO.cpp.

References direction, gpiopath, and WritesDirection().

Referenced by Hardware::EC12P::EC12P(), and WaitForEdge().

Here is the call graph for this function:

Here is the caller graph for this function:



6.31.4.10 void Hardware::GPIO::SetEdge (Edge *edge*)

Definition at line 84 of file GPIO.cpp.

References edge, gpiopath, and WritesEdge().

Referenced by Hardware::EC12P::EC12P().

Here is the call graph for this function:

Here is the caller graph for this function:

6.31.4.11 void Hardware::GPIO::SetValue (GPIO::Value *value*)

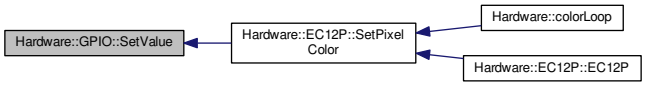
Definition at line 75 of file GPIO.cpp.

References gpiopath, and WritesValue().

Referenced by Hardware::EC12P::SetPixelColor().

Here is the call graph for this function:

Here is the caller graph for this function:

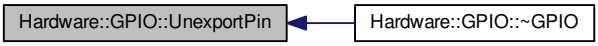


6.31.4.12 bool Hardware::GPIO::UnexportPin (int *number*) [private]

Definition at line 201 of file GPIO.cpp.

Referenced by ~GPIO().

Here is the caller graph for this function:



6.31.4.13 int Hardware::GPIO::WaitForEdge ( )

Definition at line 37 of file GPIO.cpp.

References direction, gpiopath, Input, Output, SetDirection(), and VALUE.

Referenced by Hardware::threadedPollGPIO().

Here is the call graph for this function:

Here is the caller graph for this function:

6.31.4.14 int Hardware::GPIO::WaitForEdge (CallbackType *callback*)

Definition at line 26 of file GPIO.cpp.

References Hardware::BBB::callbackFunction, Hardware::BBB::thread, threadedPollGPIO, and Hardware::BBB::threadRunning.

6.31.4.15 void Hardware::GPIO::WaitForEdgeCancel ( ) [inline]

Definition at line 35 of file GPIO.h.

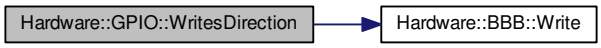
6.31.4.16 void Hardware::GPIO::WritesDirection (const string & *gpiopath,* Direction *direction*) [private]

Definition at line 213 of file GPIO.cpp.

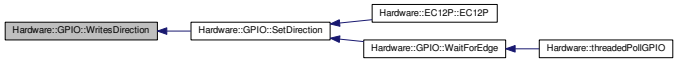
References DIRECTION, Input, Output, and Hardware::BBB::Write().

Referenced by SetDirection().

Here is the call graph for this function:



Here is the caller graph for this function:



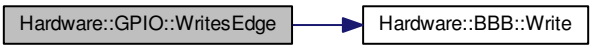
6.31.4.17 void Hardware::GPIO::WritesEdge (const string & *gpiopath,* Edge *edge*) [private]

Definition at line 237 of file GPIO.cpp.

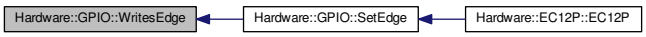
References Both, EDGE, Falling, None, Rising, and Hardware::BBB::Write().

Referenced by SetEdge().

Here is the call graph for this function:



Here is the caller graph for this function:



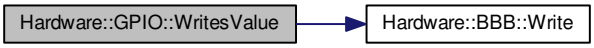
6.31.4.18 void Hardware::GPIO::WritesValue (const string & *gpiopath,* Value *value*) [private]

Definition at line 262 of file GPIO.cpp.

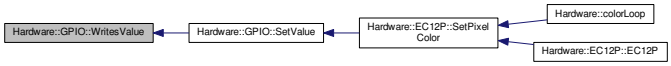
References VALUE, and Hardware::BBB::Write().

Referenced by SetValue().

Here is the call graph for this function:



Here is the caller graph for this function:



6.31.5 Friends And Related Function Documentation

6.31.5.1 void* threadedPollGPIO (void * *value*) [friend]

Definition at line 266 of file GPIO.cpp.

Referenced by WaitForEdge().

6.31.6 Member Data Documentation

6.31.6.1 Direction Hardware::GPIO::direction [private]

Definition at line 51 of file GPIO.h.

Referenced by GetDirection(), GPIO(), SetDirection(), and WaitForEdge().

6.31.6.2 Edge Hardware::GPIO::edge [private]

Definition at line 52 of file GPIO.h.

Referenced by GetEdge(), GPIO(), and SetEdge().

6.31.6.3 string Hardware::GPIO::gpiopath [private]

Definition at line 50 of file GPIO.h.

Referenced by GetValue(), GPIO(), isExported(), SetDirection(), SetEdge(), SetValue(), and WaitForEdge().

6.31.6.4 int Hardware::GPIO::number

Definition at line 31 of file GPIO.h.

Referenced by GPIO(), and ~GPIO().

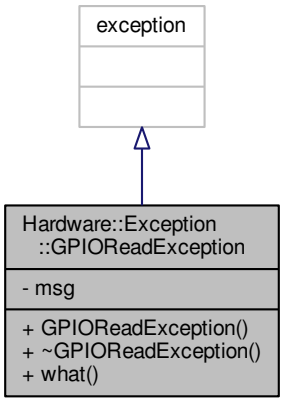
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/GPIO.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/GPIO.cpp

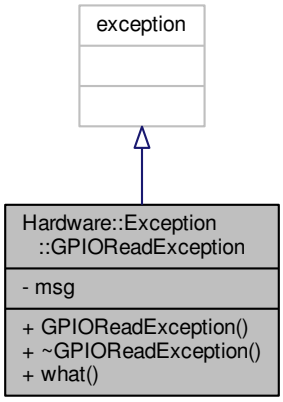
6.32 Hardware::Exception::GPIOReadException Class Reference

`#include <GPIOReadException.h>`

Inheritance diagram for Hardware::Exception::GPIOReadException:



Collaboration diagram for Hardware::Exception::GPIOReadException:



Public Member Functions

- GPIOReadException (string m="Can't read GPIO data!")
- ~GPIOReadException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.32.1 Detailed Description

Definition at line 17 of file GPIOReadException.h.

6.32.2 Constructor & Destructor Documentation

6.32.2.1 Hardware::Exception::GPIOReadException::GPIOReadException (string *m* = "Can't read GPIO data!") [inline]

Definition at line 19 of file GPIOReadException.h.

6.32.2.2 Hardware::Exception::GPIOReadException::~GPIOReadException ( ) [inline]

Definition at line 20 of file GPIOReadException.h.

6.32.3 Member Function Documentation

6.32.3.1 const char* Hardware::Exception::GPIOReadException::what ( ) const [inline]

Definition at line 21 of file GPIOReadException.h.

6.32.4 Member Data Documentation

6.32.4.1 string Hardware::Exception::GPIOReadException::msg [private]

Definition at line 21 of file GPIOReadException.h.

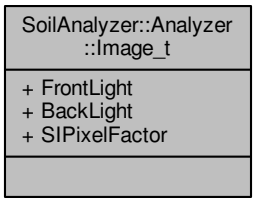
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/GPIOReadException.h

6.33 SoilAnalyzer::Analyzer::Image_t Struct Reference

`#include <analyzer.h>`

Collaboration diagram for SoilAnalyzer::Analyzer::Image_t:



Public Attributes

- cv::Mat FrontLight
- cv::Mat BackLight
- float SIPixelFactor = 0.0111915

6.33.1 Detailed Description

Definition at line 39 of file analyzer.h.

6.33.2 Member Data Documentation

6.33.2.1 cv::Mat SoilAnalyzer::Analyzer::Image_t::BackLight

Definition at line 41 of file analyzer.h.

Referenced by VSAMainWindow::TakeSnapShots().

6.33.2.2 cv::Mat SoilAnalyzer::Analyzer::Image_t::FrontLight

Definition at line 40 of file analyzer.h.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), and VSAMainWindow::TakeSnapShots().

6.33.2.3 float SoilAnalyzer::Analyzer::Image_t::SIPixelFactor = 0.0111915

Definition at line 42 of file analyzer.h.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), and VSAMainWindow::TakeSnapShots().

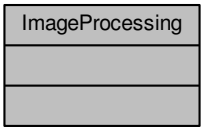
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/analyzer.h

6.34 ImageProcessing Class Reference

Core class of all the image classes Core class of all the image classes with a few commonly shared functions and variables.

Collaboration diagram for ImageProcessing:



6.34.1 Detailed Description

Core class of all the image classes Core class of all the image classes with a few commonly shared functions and variables.

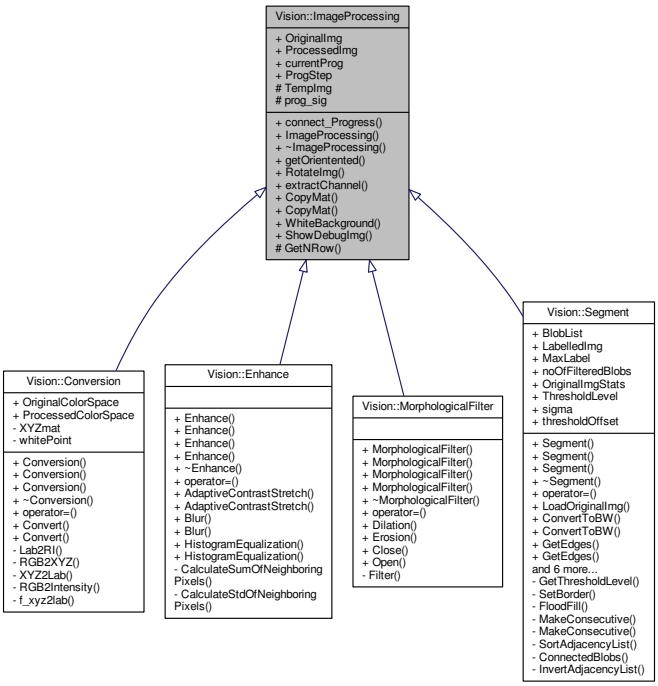
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/ImageProcessing.cpp

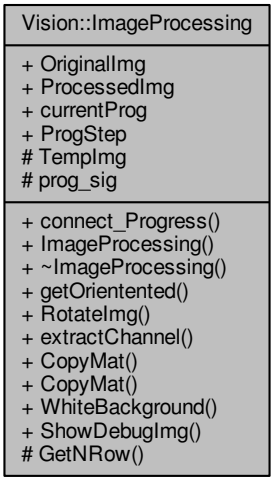
6.35 Vision::ImageProcessing Class Reference

```
#include <ImageProcessing.h>
```

Inheritance diagram for Vision::ImageProcessing:



Collaboration diagram for Vision::ImageProcessing:



Public Types

- typedef boost::signals2::signal< void(float, std::string)> Progress_t

Public Member Functions

- boost::signals2::connection connect_Progress (const Progress_t::slot_type &subscriber)
- ImageProcessing ()
- ~ImageProcessing ()

Static Public Member Functions

- static void getOrientented (Mat &BW, cv::Point_< double > &centroid, double &theta, double &eccentricty)
- static void RotateImg (Mat &src, Mat &dst, double &theta, cv::Point_< double > &Centroid, Rect &ROI)
- static std::vector< Mat > extractChannel (const Mat &src)
- template<typename T1 , typename T2 >
  static Mat CopyMat (const Mat &src, T1 *LUT, int cvType)
- template<typename T1 >
  static Mat CopyMat (const Mat &src, const Mat &mask, int cvType)
- static cv::Mat WhiteBackground (const cv::Mat &src)
- template<typename T1 >
  static void ShowDebugImg (cv::Mat img, T1 maxVal, std::string windowName, bool scale=true)

Public Attributes

- Mat OriginalImg
- Mat ProcessedImg
- double currentProg = 0.
- double ProgStep = 0.

Protected Member Functions

- uchar * GetNRow (int nData, int hKsize, int nCols, uint32_t totalRows)

Protected Attributes

- Mat TempImg
- Progress_t prog_sig

6.35.1 Detailed Description

Definition at line 48 of file ImageProcessing.h.

6.35.2 Member Typedef Documentation

6.35.2.1 typedef boost::signals2::signal<void(float, std::string)> Vision::ImageProcessing::Progress_t

Definition at line 50 of file ImageProcessing.h.

6.35.3 Constructor & Destructor Documentation

6.35.3.1 ImageProcessing::ImageProcessing ( )

Constructor of the core class

Definition at line 17 of file ImageProcessing.cpp.

6.35.3.2 ImageProcessing::~ImageProcessing ( )

De-constructor of the core class

Definition at line 20 of file ImageProcessing.cpp.

6.35.4 Member Function Documentation

6.35.4.1 boost::signals2::connection ImageProcessing::connect_Progress (const Progress_t::slot_type & *subscriber*)

Definition at line 130 of file ImageProcessing.cpp.

References prog_sig.

6.35.4.2 template<typename T1 , typename T2 > static Mat Vision::ImageProcessing::CopyMat (const Mat & *src*, T1 * *LUT*, int *cvType*) [inline], [static]

Copy a matrix to a new matrix with a LUT mask

Parameters

src	the source image
*LUT	type T with a LUT to filter out unwanted pixel values
cvType	an in where you can pas CV_UC8C1 etc.

Returns

The new matrix

Definition at line 82 of file ImageProcessing.h.

6.35.4.3 template<typename T1 > static Mat Vision::ImageProcessing::CopyMat (const Mat & *src*, const Mat & *mask*, int *cvType*) [inline], [static]

Copy a matrix to a new matrix with a mask

Parameters

src	the source image
*LUT	type T with a LUT to filter out unwanted pixel values
cvType	an in where you can pas CV_UC8C1 etc.

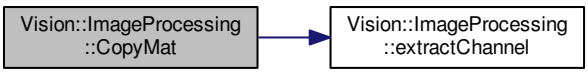
Returns

The new matrix

Definition at line 121 of file ImageProcessing.h.

References extractChannel().

Here is the call graph for this function:

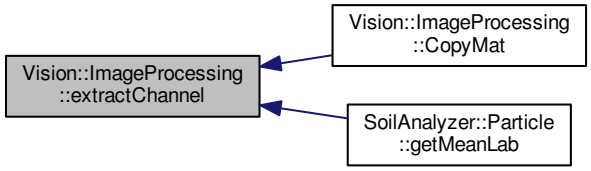


6.35.4.4 std::vector< Mat > ImageProcessing::extractChannel (const Mat & *src*) [static]

Definition at line 42 of file ImageProcessing.cpp.

Referenced by CopyMat(), and SoilAnalyzer::Particle::getMeanLab().

Here is the caller graph for this function:



6.35.4.5 uchar * ImageProcessing::GetNRow (int *nData*, int *hKsize*, int *nCols*, uint32_t *totalRows*) [protected]

Create a LUT indicating which iteration variable i is the end of an row

Parameters

nData	an int indicating total pixels
hKsize	int half the size of the kernel, if any. which acts as an offset from the border pixels
nCols	int number of columns in a row

Returns

array of uchars where a zero is a middle column and a 1 indicates an end of an row minus the offset from half the kernel size

Definition at line 30 of file ImageProcessing.cpp.

Referenced by Vision::MorphologicalFilter::Filter().

Here is the caller graph for this function:

6.35.4.6 void ImageProcessing::getOrientented (Mat & *BW*, cv::Point_< double > & *centroid*, double & *theta*, double & *eccentricty*) [static]

Definition at line 48 of file ImageProcessing.cpp.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList().

Here is the caller graph for this function:

6.35.4.7 void ImageProcessing::RotateImg (Mat & *src*, Mat & *dst*, double & *theta*, cv::Point_< double > & *Centroid*, Rect & *ROI*) [static]

Definition at line 70 of file ImageProcessing.cpp.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList().

Here is the caller graph for this function:

6.35.4.8 template<typename T1 > static void Vision::ImageProcessing::ShowDebugImg (cv::Mat *img,* T1 *maxVal,* std::string *windowName,* bool *scale* = true) [inline], [static]

Definition at line 156 of file ImageProcessing.h.

6.35.4.9 static cv::Mat Vision::ImageProcessing::WhiteBackground (const cv::Mat & *src*) [inline], [static]

Definition at line 149 of file ImageProcessing.h.

6.35.5 Member Data Documentation

6.35.5.1 double Vision::ImageProcessing::currentProg = 0.

Definition at line 70 of file ImageProcessing.h.

Referenced by Vision::Conversion::Convert().

6.35.5.2 Mat Vision::ImageProcessing::OriginalImg

Definition at line 63 of file ImageProcessing.h.

Referenced by Vision::Segment::ConnectedBlobs(), Vision::Conversion::Conversion(), Vision::Conversion::Convert(), Vision::Segment::↩ ConvertToBW(), Vision::Enhance::Enhance(), Vision::Segment::FillHoles(), Vision::MorphologicalFilter::Filter(), Vision::Segment::GetBlobList(), Vision::Segment::GetEdges(), Vision::Segment::GetEdgesEroding(), Vision::Segment::GetThresholdLevel(), Vision::Enhance::Histogram↩ Equalization(), Vision::Segment::LabelBlobs(), Vision::Segment::LoadOriginalImg(), Vision::MorphologicalFilter::MorphologicalFilter(), Vision↩ ::MorphologicalFilter::operator=(), Vision::Conversion::operator=(), Vision::Enhance::operator=(), Vision::Segment::operator=(), Vision::↩ Segment::RemoveBorderBlobs(), Vision::Conversion::RGB2XYZ(), Vision::Segment::Segment(), Vision::Segment::SetBorder(), and Vision::↩ Segment::Threshold().

6.35.5.3 Mat Vision::ImageProcessing::ProcessedImg

Definition at line 64 of file ImageProcessing.h.

Referenced by SoilAnalyzer::Analyzer::CalibrateSI(), Vision::Conversion::Conversion(), Vision::Conversion::Convert(), Vision::Segment::↩ ConvertToBW(), Vision::Enhance::Enhance(), Vision::Segment::FillHoles(), Vision::MorphologicalFilter::Filter(), SoilAnalyzer::Analyzer::↩ GetBW(), Vision::Segment::GetEdges(), Vision::Segment::GetEdgesEroding(), SoilAnalyzer::Particle::getLabImg(), SoilAnalyzer::Particle::↩ GetMeanRI(), SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), Vision::Enhance::HistogramEqualization(), Vision::Segment::LabelBlobs(), Vision::Segment::LoadOriginalImg(), Vision::MorphologicalFilter::MorphologicalFilter(), Vision::MorphologicalFilter::operator=(), Vision::↩ Conversion::operator=(), Vision::Enhance::operator=(), Vision::Segment::operator=(), Vision::Segment::RemoveBorderBlobs(), Vision::↩ Segment::Segment(), and Vision::Segment::Threshold().

6.35.5.4 Progress_t Vision::ImageProcessing::prog_sig [protected]

Definition at line 58 of file ImageProcessing.h.

Referenced by connect_Progress(), and Vision::Conversion::Convert().

6.35.5.5 double Vision::ImageProcessing::ProgStep = 0.

Definition at line 71 of file ImageProcessing.h.

Referenced by Vision::Conversion::Convert().

6.35.5.6 Mat Vision::ImageProcessing::TempImg [protected]

Definition at line 56 of file ImageProcessing.h.

Referenced by Vision::Conversion::Conversion(), Vision::Enhance::Enhance(), Vision::Segment::FillHoles(), Vision::Segment::GetEdges↩ Eroding(), Vision::Segment::LabelBlobs(), Vision::MorphologicalFilter::MorphologicalFilter(), Vision::MorphologicalFilter::operator=(), Vision::↩ Conversion::operator=(), Vision::Enhance::operator=(), Vision::Segment::operator=(), Vision::Segment::RemoveBorderBlobs(), and Vision::↩ Segment::Segment().

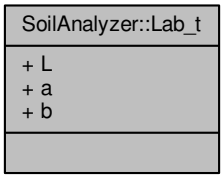
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/ImageProcessing.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/ImageProcessing.cpp

6.36 SoilAnalyzer::Lab_t Struct Reference

`#include <soilanalyzertypes.h>`

Collaboration diagram for SoilAnalyzer::Lab_t:



Public Attributes

- float L
- float a
- float b

6.36.1 Detailed Description

Definition at line 10 of file soilanalyzertypes.h.

6.36.2 Member Data Documentation

6.36.2.1 float SoilAnalyzer::Lab_t::a

Definition at line 12 of file soilanalyzertypes.h.

Referenced by SoilAnalyzer::Particle::getMeanLab(), boost::serialization::serialize(), and SoilAnalyzer::Particle::serialize().

6.36.2.2 float SoilAnalyzer::Lab_t::b

Definition at line 13 of file soilanalyzertypes.h.

Referenced by SoilAnalyzer::Particle::getMeanLab(), boost::serialization::serialize(), and SoilAnalyzer::Particle::serialize().

6.36.2.3 float SoilAnalyzer::Lab_t::L

Definition at line 11 of file soilanalyzertypes.h.

Referenced by SoilAnalyzer::Particle::getMeanLab(), boost::serialization::serialize(), and SoilAnalyzer::Particle::serialize().

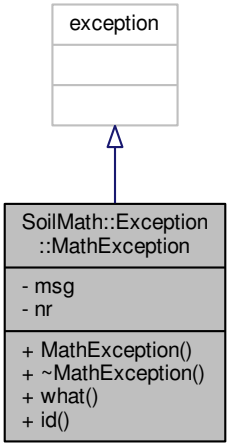
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/soilanalyzertypes.h

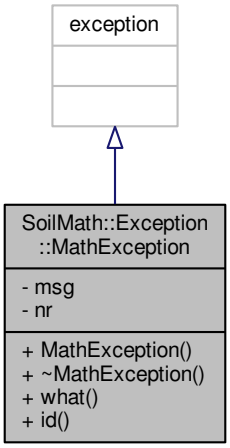
6.37 SoilMath::Exception::MathException Class Reference

`#include <MathException.h>`

Inheritance diagram for SoilMath::Exception::MathException:



Collaboration diagram for SoilMath::Exception::MathException:



Public Member Functions

- MathException (std::string m=EXCEPTION_MATH, int n=EXCEPTION_MATH_NR)
- ~MathException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT
- const int * id () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- std::string msg
- int nr

6.37.1 Detailed Description

Definition at line 28 of file MathException.h.

6.37.2 Constructor & Destructor Documentation

6.37.2.1 SoilMath::Exception::MathException::MathException (std::string *m* = EXCEPTION_MATH, int *n* = EXCEPTION_MATH_NR) [inline]

Definition at line 30 of file MathException.h.

6.37.2.2 SoilMath::Exception::MathException::~MathException ( ) [inline]

Definition at line 32 of file MathException.h.

6.37.3 Member Function Documentation

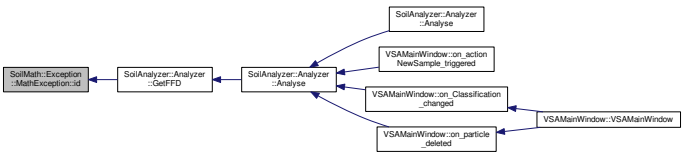
6.37.3.1 const int* SoilMath::Exception::MathException::id ( ) const [inline]

Definition at line 34 of file MathException.h.

References nr.

Referenced by SoilAnalyzer::Analyzer::GetFFD().

Here is the caller graph for this function:



6.37.3.2 const char* SoilMath::Exception::MathException::what ( ) const [inline]

Definition at line 33 of file MathException.h.

References msg.

6.37.4 Member Data Documentation

6.37.4.1 std::string SoilMath::Exception::MathException::msg [private]

Definition at line 37 of file MathException.h.

Referenced by what().

6.37.4.2 int SoilMath::Exception::MathException::nr [private]

Definition at line 38 of file MathException.h.

Referenced by id().

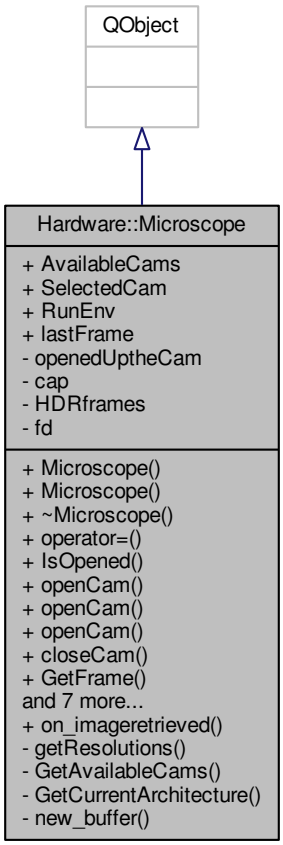
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/MathException.h

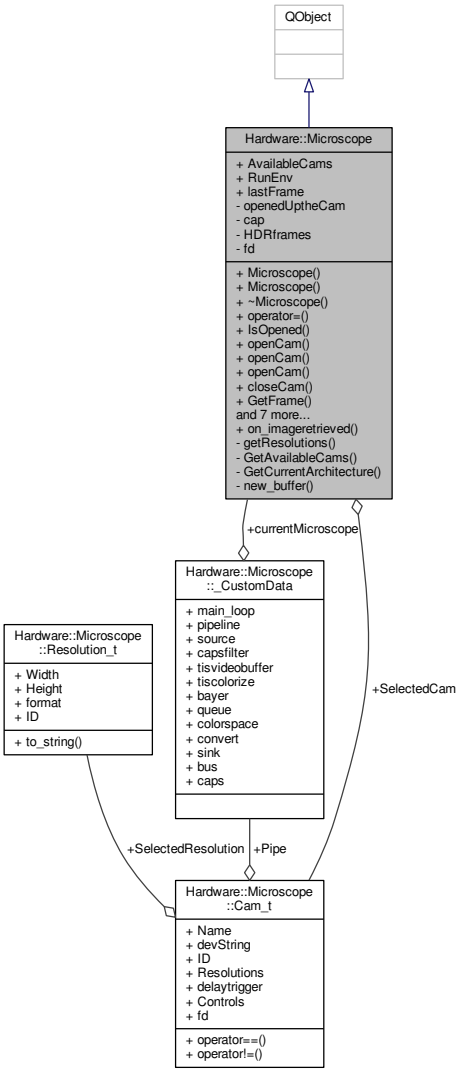
6.38 Hardware::Microscope Class Reference

`#include <Microscope.h>`

Inheritance diagram for Hardware::Microscope:



Collaboration diagram for Hardware::Microscope:



Classes

- struct _CustomData
- struct Cam_t
- struct Control_t
- struct Resolution_t

Public Types

- enum Arch { ARM, X64 }
- enum PixelFormat { YUYV, MJPG, GREY }
- typedef std::vector< Control_t > Controls_t
- typedef struct Hardware::Microscope::_CustomData CustomData

Public Slots

- void on_imageretrieved ()

Signals

- void imageretrieved ()

Public Member Functions

- Microscope ()
- Microscope (const Microscope &rhs)
- ~Microscope ()
- Microscope operator= (Microscope const &rhs)
- bool IsOpened ()
- bool openCam (Cam_t *cam)
- bool openCam (int &cam)
- bool openCam (std::string &cam)
- bool closeCam (Cam_t *cam)
- void GetFrame (cv::Mat &dst)
- void GetGstreamFrame (cv::Mat &dst)
- void GetHDRFrame (cv::Mat &dst, uint32_t noframes=3)
- Control_t * GetControl (const std::string name)
- void SetControl (Control_t *control)
- Cam_t * FindCam (std::string cam)
- Cam_t * FindCam (int cam)
- void SendImageRetrieved ()

Public Attributes

- std::vector< Cam_t > AvailableCams
- Cam_t * SelectedCam = nullptr
- Arch RunEnv
- cv::Mat lastFrame

Private Member Functions

- void getResolutions (Cam_t &currentCam, int FormatType)
- std::vector< Cam_t > GetAvailableCams ()
- Arch GetCurrentArchitecture ()

Static Private Member Functions

- static void new_buffer (GstElement *sink, CustomData *data)

Private Attributes

- bool openedUptheCam = false
- cv::VideoCapture * cap = nullptr
- std::vector< cv::Mat > HDRframes
- int fd

6.38.1 Detailed Description

Definition at line 49 of file Microscope.h.

6.38.2 Member Typedef Documentation

6.38.2.1 typedef std::vector<Control_t> Hardware::Microscope::Controls_t

Definition at line 103 of file Microscope.h.

6.38.2.2 typedef struct Hardware::Microscope::_CustomData Hardware::Microscope::CustomData

6.38.3 Member Enumeration Documentation

6.38.3.1 enum Hardware::Microscope::Arch

Enumerator

ARM

X64

Definition at line 53 of file Microscope.h.

6.38.3.2 enum Hardware::Microscope::PixelFormat

Enumerator

YUYV

MJPG

GREY

Definition at line 55 of file Microscope.h.

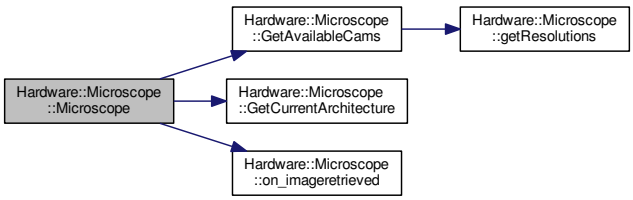
6.38.4 Constructor & Destructor Documentation

6.38.4.1 Microscope::Microscope ( )

Definition at line 12 of file Microscope.cpp.

References AvailableCams, GetAvailableCams(), GetCurrentArchitecture(), imageretrieved(), on_imageretrieved(), and RunEnv.

Here is the call graph for this function:



6.38.4.2 Microscope::Microscope (const Microscope & *rhs*)

Definition at line 21 of file Microscope.cpp.

References AvailableCams, cap, fd, HDRframes, imageretrieved(), on_imageretrieved(), RunEnv, and SelectedCam.

Here is the call graph for this function:

6.38.4.3 Microscope::~Microscope ( )

Definition at line 32 of file Microscope.cpp.

References cap.

6.38.5 Member Function Documentation

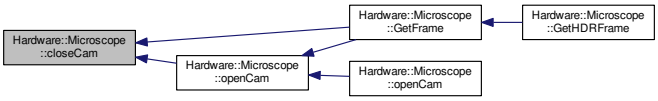
6.38.5.1 bool Microscope::closeCam (Cam_t * *cam*)

Definition at line 311 of file Microscope.cpp.

References openedUptheCam, Hardware::Microscope::Cam_t::Pipe, and Hardware::Microscope::_CustomData::pipeline.

Referenced by GetFrame(), and openCam().

Here is the caller graph for this function:



6.38.5.2 Cam_t* Hardware::Microscope::FindCam (std::string *cam*)

Referenced by openCam().

Here is the caller graph for this function:

6.38.5.3 Microscope::Cam_t * Microscope::FindCam (int *cam*)

Definition at line 293 of file Microscope.cpp.

References AvailableCams.

6.38.5.4 std::vector< Microscope::Cam_t > Microscope::GetAvailableCams ( ) [private]

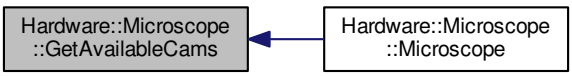
Definition at line 47 of file Microscope.cpp.

References Hardware::Microscope::Cam_t::Controls, Hardware::Microscope::Control_t::current_value, Hardware::Microscope::Control_t::default_value, Hardware::Microscope::Cam_t::devString, EXCEPTION_NOCAMS, EXCEPTION_NOCAMS_NR, EXCEPTION_QUERY, EXCEPTION_QUERY_NR, Hardware::Microscope::Cam_t::fd, getResolutions(), Hardware::Microscope::Control_t::ID, Hardware::Microscope::Cam_t::ID, Hardware::Microscope::Control_t::maximum, Hardware::Microscope::Control_t::minimum, Hardware::Microscope::Control_t::name, Hardware::Microscope::Cam_t::Name, and Hardware::Microscope::Control_t::step.

Referenced by Microscope().

Here is the call graph for this function:

Here is the caller graph for this function:



6.38.5.5 Microscope::Control_t * Microscope::GetControl (const std::string *name*)

Definition at line 364 of file Microscope.cpp.

References Hardware::Microscope::Cam_t::Controls, and SelectedCam.

Referenced by GetHDRFrame().

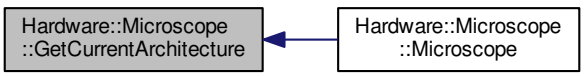
Here is the caller graph for this function:

6.38.5.6 Microscope::Arch Microscope::GetCurrentArchitecture ( ) [private]

Definition at line 34 of file Microscope.cpp.

Referenced by Microscope().

Here is the caller graph for this function:



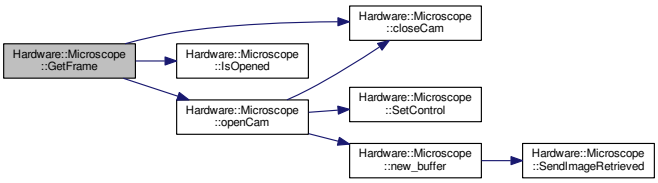
6.38.5.7 void Microscope::GetFrame (cv::Mat & *dst*)

Definition at line 319 of file Microscope.cpp.

References closeCam(), imageretrieved(), IsOpened(), lastFrame, openCam(), Hardware::Microscope::Cam_t::Pipe, Hardware::Microscope::↩ _CustomData::pipeline, and SelectedCam.

Referenced by GetHDRFrame().

Here is the call graph for this function:



Here is the caller graph for this function:

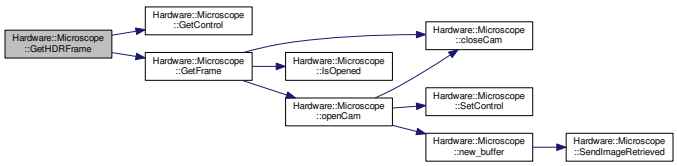
6.38.5.8 void Hardware::Microscope::GetGstreamFrame (cv::Mat & *dst*)

6.38.5.9 void Microscope::GetHDRFrame (cv::Mat & *dst*, uint32_t *noframes* = 3)

Definition at line 333 of file Microscope.cpp.

References Hardware::Microscope::Control_t::current_value, GetControl(), GetFrame(), HDRframes, Hardware::Microscope::Control_t↩ ::maximum, and Hardware::Microscope::Control_t::minimum.

Here is the call graph for this function:



6.38.5.10 void Microscope::getResolutions (Cam_t & *currentCam*, int *FormatType*) [private]

Definition at line 123 of file Microscope.cpp.

References Hardware::Microscope::Cam_t::fd, Hardware::Microscope::Resolution_t::format, Hardware::Microscope::Resolution_t::Height, Hardware::Microscope::Resolution_t::ID, Hardware::Microscope::Cam_t::Resolutions, and Hardware::Microscope::Resolution_t::Width.

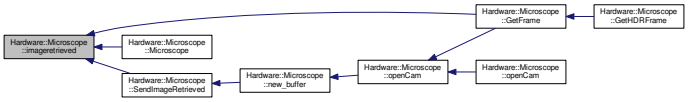
Referenced by GetAvailableCams().

Here is the caller graph for this function:

6.38.5.11 void Hardware::Microscope::imageretrieved ( ) [signal]

Referenced by GetFrame(), Microscope(), and SendImageRetrieved().

Here is the caller graph for this function:



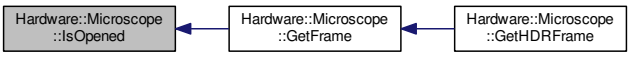
6.38.5.12 bool Microscope::IsOpened ( )

Definition at line 165 of file Microscope.cpp.

References openedUptheCam.

Referenced by GetFrame().

Here is the caller graph for this function:



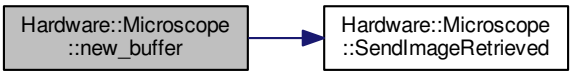
6.38.5.13 void Microscope::new_buffer (GstElement * *sink*, CustomData * *data*) [static], [private]

Definition at line 413 of file Microscope.cpp.

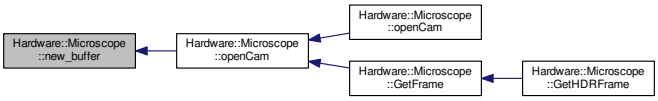
References Hardware::Microscope::_CustomData::currentMicroscope, Hardware::Microscope::Resolution_t::Height, lastFrame, SelectedCam, Hardware::Microscope::Cam_t::SelectedResolution, SendImageRetrieved(), and Hardware::Microscope::Resolution_t::Width.

Referenced by openCam().

Here is the call graph for this function:



Here is the caller graph for this function:



6.38.5.14 void Microscope::on_imageretrieved ( ) [slot]

Definition at line 331 of file Microscope.cpp.

Referenced by Microscope().

Here is the caller graph for this function:

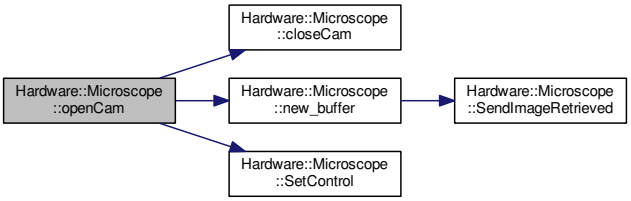
6.38.5.15 bool Microscope::openCam (Cam_t * *cam*)

Definition at line 167 of file Microscope.cpp.

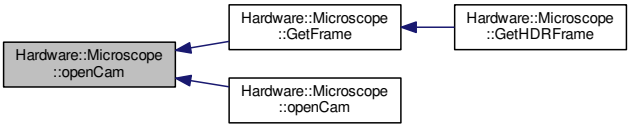
References AvailableCams, Hardware::Microscope::_CustomData::bayer, Hardware::Microscope::_CustomData::bus, Hardware::Microscope::_CustomData::caps, Hardware::Microscope::_CustomData::capsfilter, closeCam(), Hardware::Microscope::_CustomData::colorspace, Hardware::Microscope::Cam_t::Controls, Hardware::Microscope::_CustomData::convert, Hardware::Microscope::_CustomData::currentMicroscope, Hardware::Microscope::Cam_t::devString, EXCEPTION_GSTREAM_ELEM_EXCEPTION, EXCEPTION_GSTREAM_ELEM_EXCEPTION_NR, EXCEPTION_GSTREAM_INIT_EXCEPTION, EXCEPTION_GSTREAM_INIT_EXCEPTION_NR, Hardware::Microscope::Resolution_t::format, Hardware::Microscope::Resolution_t::Height, Hardware::Microscope::Cam_t::Name, new_buffer(), openedUptheCam, Hardware::Microscope::Cam_t::Pipe, Hardware::Microscope::_CustomData::pipeline, Hardware::Microscope::_CustomData::queue, SelectedCam, Hardware::Microscope::Cam_t::SelectedResolution, SetControl(), Hardware::Microscope::_CustomData::sink, Hardware::Microscope::_CustomData::source, Hardware::Microscope::_CustomData::tiscolorize, Hardware::Microscope::_CustomData::tisvideobuffer, and Hardware::Microscope::Resolution_t::Width.

Referenced by GetFrame(), and openCam().

Here is the call graph for this function:



Here is the caller graph for this function:

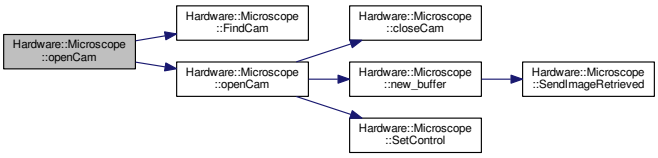


6.38.5.16 bool Microscope::openCam (int & *cam*)

Definition at line 291 of file Microscope.cpp.

References FindCam(), and openCam().

Here is the call graph for this function:

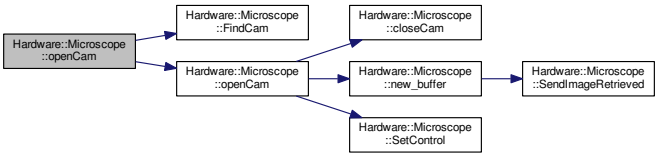


6.38.5.17 bool Microscope::openCam (std::string & *cam*)

Definition at line 289 of file Microscope.cpp.

References FindCam(), and openCam().

Here is the call graph for this function:



6.38.5.18 Microscope Hardware::Microscope::operator= (Microscope const & *rhs*)

6.38.5.19 void Microscope::SendImageRetrieved ( )

Definition at line 411 of file Microscope.cpp.

References imageretrieved().

Referenced by new_buffer().

Here is the caller graph for this function:

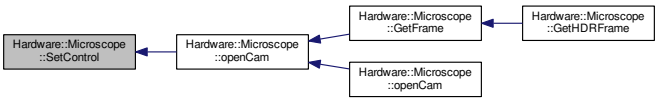
6.38.5.20 void Microscope::SetControl (Control_t * *control*)

Definition at line 374 of file Microscope.cpp.

References Hardware::Microscope::Control_t::current_value, Hardware::Microscope::Cam_t::devString, EXCEPTION_CTRL_NOT_FOUND, EXCEPTION_CTRL_NOT_FOUND_NR, EXCEPTION_NOCAMS, EXCEPTION_NOCAMS_NR, EXCEPTION_QUERY, EXCEPTION_QUERY_NR, Hardware::Microscope::Cam_t::fd, Hardware::Microscope::Control_t::ID, and SelectedCam.

Referenced by openCam().

Here is the caller graph for this function:



6.38.6 Member Data Documentation

6.38.6.1 std::vector<Cam_t> Hardware::Microscope::AvailableCams

Definition at line 148 of file Microscope.h.

Referenced by FindCam(), Microscope(), and openCam().

6.38.6.2 cv::VideoCapture* Hardware::Microscope::cap = nullptr [private]

Definition at line 189 of file Microscope.h.

Referenced by Microscope(), and ~Microscope().

6.38.6.3 int Hardware::Microscope::fd [private]

Definition at line 195 of file Microscope.h.

Referenced by Microscope().

6.38.6.4 std::vector<cv::Mat> Hardware::Microscope::HDRframes [private]

Definition at line 191 of file Microscope.h.

Referenced by GetHDRFrame(), and Microscope().

6.38.6.5 cv::Mat Hardware::Microscope::lastFrame

Definition at line 175 of file Microscope.h.

Referenced by GetFrame(), and new_buffer().

6.38.6.6 bool Hardware::Microscope::openedUptheCam = false [private]

Definition at line 188 of file Microscope.h.

Referenced by closeCam(), IsOpened(), and openCam().

6.38.6.7 Arch Hardware::Microscope::RunEnv

Definition at line 150 of file Microscope.h.

Referenced by Microscope().

6.38.6.8 Cam_t* Hardware::Microscope::SelectedCam = nullptr

Definition at line 149 of file Microscope.h.

Referenced by GetControl(), GetFrame(), Microscope(), new_buffer(), openCam(), and SetControl().

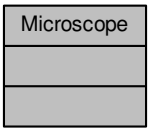
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/Microscope.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/Microscope.cpp

6.39 Microscope Class Reference

`#include <Microscope.h>`

Collaboration diagram for Microscope:



6.39.1 Detailed Description

Interaction with the microscope

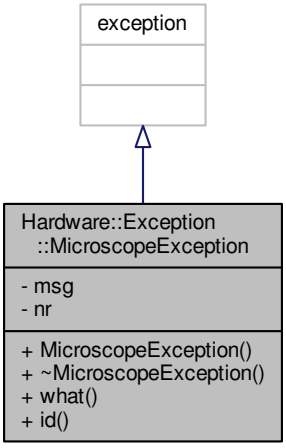
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/Microscope.h

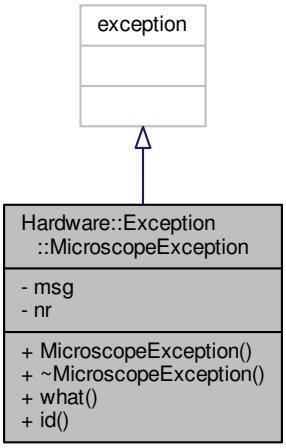
6.40 Hardware::Exception::MicroscopeException Class Reference

`#include <MicroscopeNotFoundException.h>`

Inheritance diagram for Hardware::Exception::MicroscopeException:



Collaboration diagram for Hardware::Exception::MicroscopeException:



Public Member Functions

- MicroscopeException (string m=EXCEPTION_OPENCAM, int n=EXCEPTION_OPENCAM_NR)
- ~MicroscopeException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT
- const int * id () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg
- int nr

6.40.1 Detailed Description

Definition at line 35 of file MicroscopeNotFoundException.h.

6.40.2 Constructor & Destructor Documentation

6.40.2.1 Hardware::Exception::MicroscopeException::MicroscopeException (string *m* = EXCEPTION_OPENCAM, int *n* = EXCEPTION_OPENCAM_NR) [inline]

Definition at line 37 of file MicroscopeNotFoundException.h.

6.40.2.2 Hardware::Exception::MicroscopeException::~MicroscopeException ( ) [inline]

Definition at line 39 of file MicroscopeNotFoundException.h.

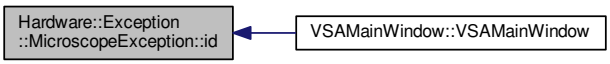
6.40.3 Member Function Documentation

6.40.3.1 const int* Hardware::Exception::MicroscopeException::id ( ) const [inline]

Definition at line 41 of file MicroscopeNotFoundException.h.

Referenced by VSAMainWindow::VSAMainWindow().

Here is the caller graph for this function:



6.40.3.2 const char* Hardware::Exception::MicroscopeException::what ( ) const [inline]

Definition at line 40 of file MicroscopeNotFoundException.h.

6.40.4 Member Data Documentation

6.40.4.1 string Hardware::Exception::MicroscopeException::msg [private]

Definition at line 44 of file MicroscopeNotFoundException.h.

6.40.4.2 int Hardware::Exception::MicroscopeException::nr [private]

Definition at line 45 of file MicroscopeNotFoundException.h.

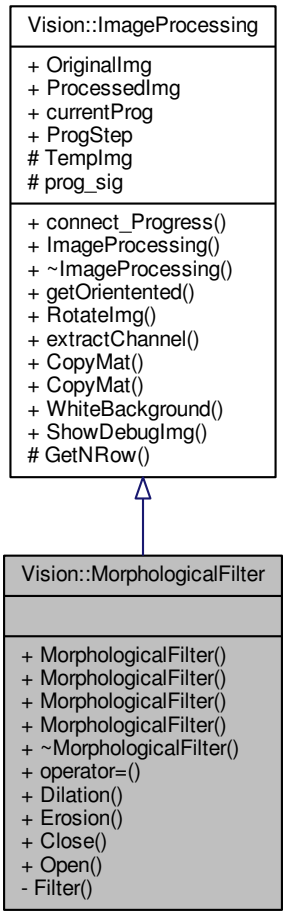
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/MicroscopeNotFoundException.h

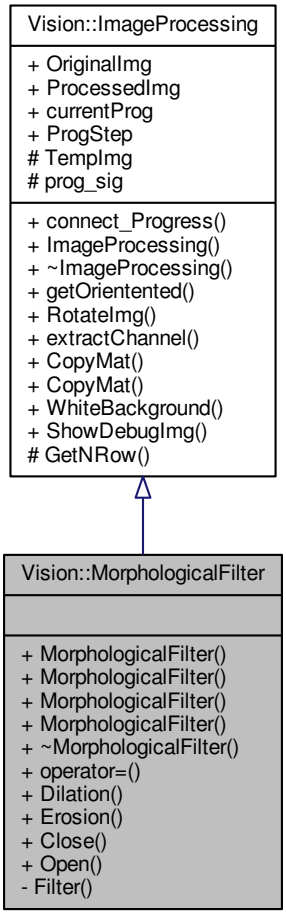
6.41 Vision::MorphologicalFilter Class Reference

`#include <MorphologicalFilter.h>`

Inheritance diagram for Vision::MorphologicalFilter:



Collaboration diagram for Vision::MorphologicalFilter:



Public Types

- enum FilterType {
  OPEN, CLOSE, ERODE, DILATE,
  NONE }

Public Member Functions

- MorphologicalFilter ()
- MorphologicalFilter (FilterType filtertype)
- MorphologicalFilter (const Mat &src, FilterType filtertype=FilterType::NONE)
- MorphologicalFilter (const MorphologicalFilter &rhs)
- ~MorphologicalFilter ()
- MorphologicalFilter & operator= (MorphologicalFilter &rhs)
- void Dilation (const Mat &mask, bool chain=false)
- void Erosion (const Mat &mask, bool chain=false)
- void Close (const Mat &mask, bool chain=false)
- void Open (const Mat &mask, bool chain=false)

Private Member Functions

- void Filter (const Mat &mask, bool chain, uchar startVal, uchar newVal, uchar switchVal)

Additional Inherited Members

6.41.1 Detailed Description

Definition at line 14 of file MorphologicalFilter.h.

6.41.2 Member Enumeration Documentation

6.41.2.1 enum Vision::MorphologicalFilter::FilterType

Enumerator

OPEN

CLOSE

ERODE

DILATE

NONE

Definition at line 16 of file MorphologicalFilter.h.

6.41.3 Constructor & Destructor Documentation

6.41.3.1 Vision::MorphologicalFilter::MorphologicalFilter ( )

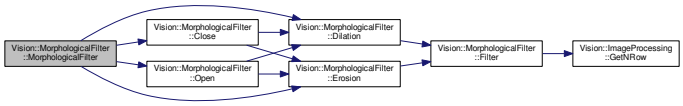
Definition at line 11 of file MorphologicalFilter.cpp.

6.41.3.2 Vision::MorphologicalFilter::MorphologicalFilter (FilterType *filtertype*)

Definition at line 13 of file MorphologicalFilter.cpp.

References Close(), Dilation(), Erosion(), Open(), and Vision::ImageProcessing::OriginalImg.

Here is the call graph for this function:

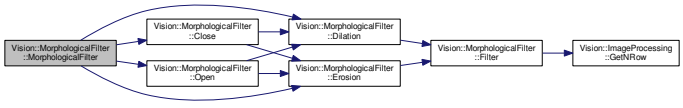


6.41.3.3 Vision::MorphologicalFilter::MorphologicalFilter (const Mat & *src*, FilterType *filtertype* = `FilterType::NONE`)

Definition at line 32 of file MorphologicalFilter.cpp.

References Close(), Dilation(), Erosion(), Open(), Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

Here is the call graph for this function:



6.41.3.4 Vision::MorphologicalFilter::MorphologicalFilter (const MorphologicalFilter & *rhs*)

Definition at line 54 of file MorphologicalFilter.cpp.

References Vision::ImageProcessing::OriginalImg, Vision::ImageProcessing::ProcessedImg, and Vision::ImageProcessing::TempImg.

6.41.3.5 Vision::MorphologicalFilter::~MorphologicalFilter ( )

Definition at line 60 of file MorphologicalFilter.cpp.

6.41.4 Member Function Documentation

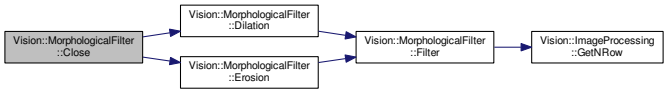
6.41.4.1 void Vision::MorphologicalFilter::Close (const Mat & *mask*, bool *chain* = `false`)

Definition at line 76 of file MorphologicalFilter.cpp.

References Dilation(), and Erosion().

Referenced by MorphologicalFilter().

Here is the call graph for this function:



Here is the caller graph for this function:

6.41.4.2 void Vision::MorphologicalFilter::Dilation (const Mat & *mask*, bool *chain* = `false`)

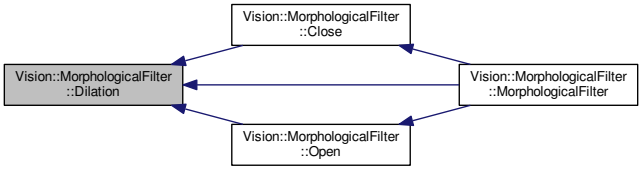
Definition at line 81 of file MorphologicalFilter.cpp.

References Filter().

Referenced by Close(), MorphologicalFilter(), and Open().

Here is the call graph for this function:

Here is the caller graph for this function:



6.41.4.3 void Vision::MorphologicalFilter::Erosion (const Mat & *mask*, bool *chain* = `false`)

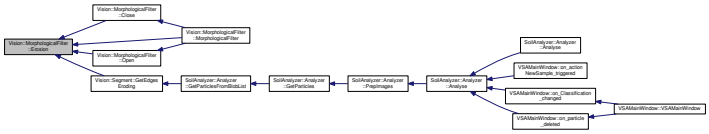
Definition at line 85 of file MorphologicalFilter.cpp.

References Filter().

Referenced by Close(), Vision::Segment::GetEdgesEroding(), MorphologicalFilter(), and Open().

Here is the call graph for this function:

Here is the caller graph for this function:



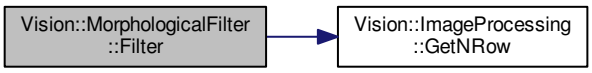
6.41.4.4 void Vision::MorphologicalFilter::Filter (const Mat & *mask*, bool *chain*, uchar *startVal*, uchar *newVal*, uchar *switchVal*) `[private]`

Definition at line 89 of file MorphologicalFilter.cpp.

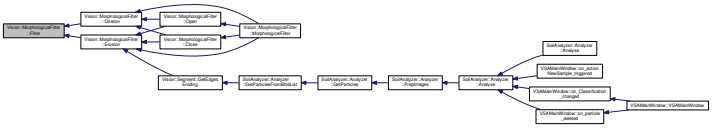
References EMPTY_CHECK, Vision::ImageProcessing::GetNRow(), Vision::ImageProcessing::OriginalImg, Vision::ImageProcessing::↩ ProcessedImg, and SHOW_DEBUG_IMG.

Referenced by Dilation(), and Erosion().

Here is the call graph for this function:



Here is the caller graph for this function:



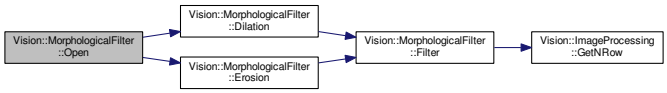
6.41.4.5 void Vision::MorphologicalFilter::Open (const Mat & *mask*, bool *chain* = `false`)

Definition at line 71 of file MorphologicalFilter.cpp.

References Dilation(), and Erosion().

Referenced by MorphologicalFilter().

Here is the call graph for this function:



Here is the caller graph for this function:

6.41.4.6 MorphologicalFilter & Vision::MorphologicalFilter::operator= (MorphologicalFilter & *rhs*)

Definition at line 62 of file MorphologicalFilter.cpp.

References Vision::ImageProcessing::OriginalImg, Vision::ImageProcessing::ProcessedImg, and Vision::ImageProcessing::TempImg.

The documentation for this class was generated from the following files:

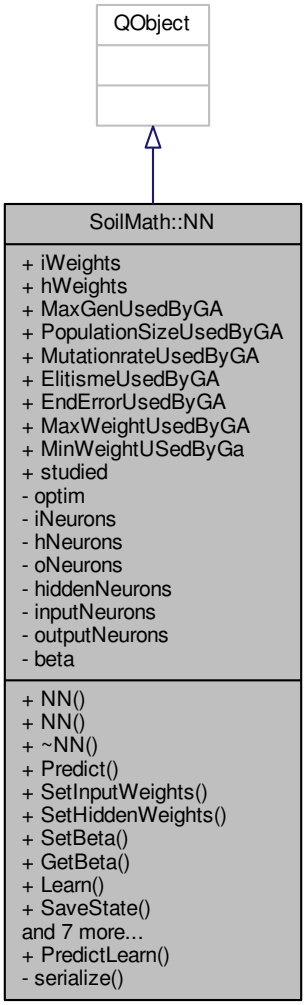
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/MorphologicalFilter.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/MorphologicalFilter.cpp

6.42 SoilMath::NN Class Reference

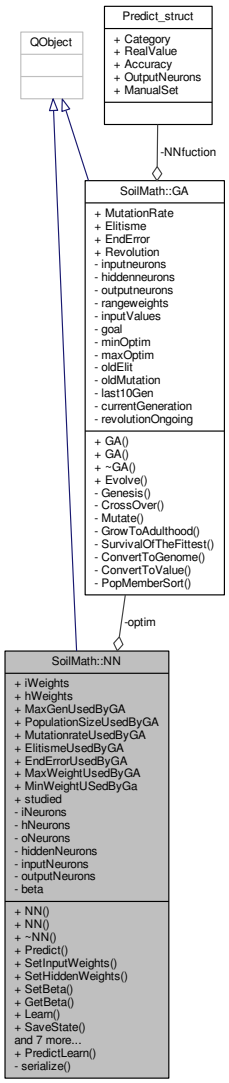
The Neural Network class.

`#include <NN.h>`

Inheritance diagram for SoilMath::NN:



Collaboration diagram for SoilMath::NN:



Signals

- void learnErrorUpdate (double newError)

Public Member Functions

- NN (uint32_t inputneurons, uint32_t hiddenneurons, uint32_t outputneurons)

  NN constructor for the Neural Net.
- NN ()

  NN constructor for the Neural Net.
- virtual ~NN ()

  ~NN virtual deconstructor for the Neural Net
- Predict_t Predict (ComplexVect_t input)

  Predict The prediction function.
- void SetInputWeights (Weight_t value)

SetInputWeights a function to set the input weights.

- void SetHiddenWeights (Weight_t value)

  SetHiddenWeights a function to set the hidden weights.
- void SetBeta (float value)

  SetBeta a function to set the beta value.
- float GetBeta ()
- void Learn (InputLearnVector_t input, OutputLearnVector_t cat, uint32_t noOfDescriptorsUsed)

  Learn the learning function.
- void SaveState (std::string filename)

  SaveState Serialize and save the values of the Neural Net to disk.
- void LoadState (std::string filename)

  LoadState Loads the previouse saved Neural Net from disk.
- uint32_t GetInputNeurons ()
- void SetInputNeurons (uint32_t value)
- uint32_t GetHiddenNeurons ()
- void SetHiddenNeurons (uint32_t value)
- uint32_t GetOutputNeurons ()
- void SetOutputNeurons (uint32_t value)

Static Public Member Functions

- static Predict_t PredictLearn (ComplexVect_t input, Weight_t inputweights, Weight_t hiddenweights, uint32_t inputneurons, uint32_t hiddenneurons, uint32_t outputneurons)

  PredictLearn a static function used in learning of the weights.

Public Attributes

- Weight_t iWeights
- Weight_t hWeights
- uint32_t MaxGenUsedByGA = 200
- uint32_t PopulationSizeUsedByGA = 30
- float MutationrateUsedByGA = 0.075f
- uint32_t ElitismeUsedByGA = 4
- float EndErrorUsedByGA = 0.001
- float MaxWeightUsedByGA = 50
- float MinWeightUSedByGa = -50
- bool studied

Private Member Functions

- template<class Archive >
  void serialize (Archive &ar, const unsigned int version)

  serialization function

Private Attributes

- GA * optim = nullptr
- std::vector< float > iNeurons
- std::vector< float > hNeurons
- std::vector< float > oNeurons
- uint32_t hiddenNeurons = 50
- uint32_t inputNeurons = 20
- uint32_t outputNeurons = 18
- float beta

Friends

- class boost::serialization::access

6.42.1 Detailed Description

The Neural Network class.

This class is used to make prediction on large data set. Using self learning algoritmes

Definition at line 33 of file NN.h.

6.42.2 Constructor & Destructor Documentation

6.42.2.1 SoilMath::NN::NN (uint32_t *inputneurons*, uint32_t *hiddenneurons*, uint32_t *outputneurons*)

NN constructor for the Neural Net.

Parameters

inputneurons	number of input neurons
hiddenneurons	number of hidden neurons
outputneurons	number of output neurons

Definition at line 14 of file NN.cpp.

6.42.2.2 SoilMath::NN::NN ( )

NN constructor for the Neural Net.

Definition at line 12 of file NN.cpp.

6.42.2.3 SoilMath::NN::~NN ( ) [virtual]

~NN virtual deconstructor for the Neural Net

Definition at line 27 of file NN.cpp.

6.42.3 Member Function Documentation

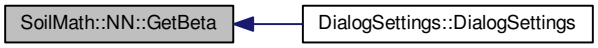
6.42.3.1 float SoilMath::NN::GetBeta ( ) [inline]

Definition at line 102 of file NN.h.

References beta.

Referenced by DialogSettings::DialogSettings().

Here is the caller graph for this function:



6.42.3.2 uint32_t SoilMath::NN::GetHiddenNeurons ( ) [inline]

Definition at line 143 of file NN.h.

References hiddenNeurons.

Referenced by DialogSettings::DialogSettings().

Here is the caller graph for this function:

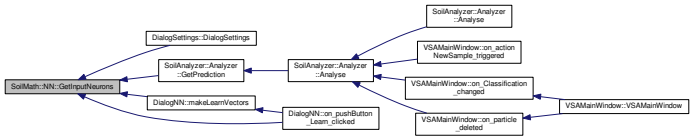
6.42.3.3 uint32_t SoilMath::NN::GetInputNeurons ( ) [inline]

Definition at line 140 of file NN.h.

References inputNeurons.

Referenced by DialogSettings::DialogSettings(), SoilAnalyzer::Analyzer::GetPrediction(), DialogNN::makeLearnVectors(), and DialogNN::on_↩ pushButton_Learn_clicked().

Here is the caller graph for this function:



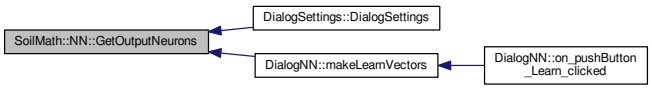
6.42.3.4 uint32_t SoilMath::NN::GetOutputNeurons ( ) [inline]

Definition at line 146 of file NN.h.

References outputNeurons.

Referenced by DialogSettings::DialogSettings(), and DialogNN::makeLearnVectors().

Here is the caller graph for this function:



6.42.3.5 void SoilMath::NN::Learn (InputLearnVector_t *input*, OutputLearnVector_t *cat*, uint32_t *noOfDescriptorsUsed*)

Learn the learning function.

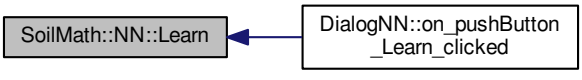
Parameters

input	a vector of vectors with complex input values
cat	a vector of vectors with the know output values
noOfDescriptors↩ Used	the total number of descriptos which should be used

Definition at line 113 of file NN.cpp.

Referenced by DialogNN::on_pushButton_Learn_clicked().

Here is the caller graph for this function:



6.42.3.6 void SoilMath::NN::learnErrorUpdate (double *newError*) [signal]

6.42.3.7 void SoilMath::NN::LoadState (std::string *filename*)

LoadState Loads the previouse saved Neural Net from disk.

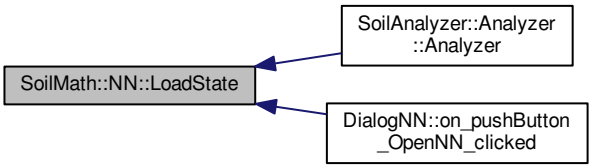
Parameters

filename	a string indicating the file location and name

Definition at line 34 of file NN.cpp.

Referenced by SoilAnalyzer::Analyzer::Analyzer(), and DialogNN::on_pushButton_OpenNN_clicked().

Here is the caller graph for this function:



6.42.3.8 Predict_t SoilMath::NN::Predict (ComplexVect_t *input*)

Predict The prediction function.

In this function the neural net is setup and the input which are the complex values descriping the contour in the frequency domein serve as input. The absolute value of these im. number because I'm not interrested in the orrientation of the particle but more in the degree of variations.

Parameters

input	vector of complex input values, these're the Fourier descriptors

Returns

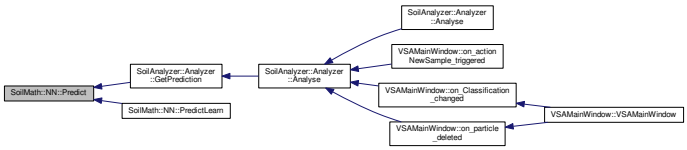
a real valued vector of the output neurons

Definition at line 56 of file NN.cpp.

References EXCEPTION_NEURAL_NET_NOT_STUDIED, EXCEPTION_NEURAL_NET_NOT_STUDIED_NR, EXCEPTION_SIZE_OF_INP↩UT_NEURONS, EXCEPTION_SIZE_OF_INPUT_NEURONS_NR, Predict_struct::ManualSet, and Predict_struct::OutputNeurons.

Referenced by SoilAnalyzer::Analyzer::GetPrediction(), and PredictLearn().

Here is the caller graph for this function:



6.42.3.9 Predict_t SoilMath::NN::PredictLearn (ComplexVect_t *input*, Weight_t *inputweights*, Weight_t *hiddenweights*, uint32_t *inputneurons*, uint32_t *hiddenneurons*, uint32_t *outputneurons*) [static]

PredictLearn a static function used in learning of the weights.

It starts a new Neural Network object and passes all the paramaters in to this newly created object. After this the predict function is called and the value is returned. This work around was needed to pass the neural network to the Genetic Algorithm class.

Parameters

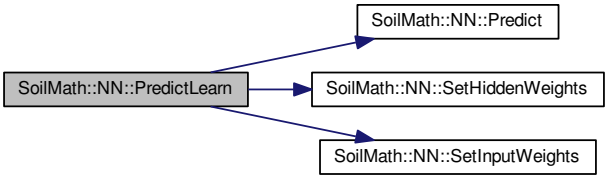
input	a complex vector of input values
inputweights	the input weights
hiddenweights	the hidden weights
inputneurons	the input neurons
hiddenneurons	the hidden neurons
outputneurons	the output neurons

Returns

Definition at line 46 of file NN.cpp.

References Predict(), SetHiddenWeights(), SetInputWeights(), and studied.

Here is the call graph for this function:



6.42.3.10 void SoilMath::NN::SaveState (std::string *filename*)

SaveState Serialize and save the values of the Neural Net to disk.

Save the Neural Net in XML valued text file to disk so that a object can be reconstructed on a latter stadia.

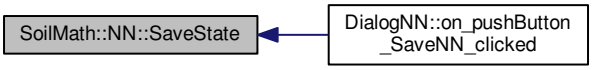
Parameters

filename	a string indicating the file location and name

Definition at line 40 of file NN.cpp.

Referenced by DialogNN::on_pushButton_SaveNN_clicked().

Here is the caller graph for this function:



6.42.3.11 template<class Archive > void SoilMath::NN::serialize (Archive & *ar*, const unsigned int *version*) [inline], [private]

serialization function

Parameters

ar	the object
version	the version of the class

Definition at line 181 of file NN.h.

6.42.3.12 void SoilMath::NN::SetBeta (float *value*) [inline]

SetBeta a function to set the beta value.

Parameters

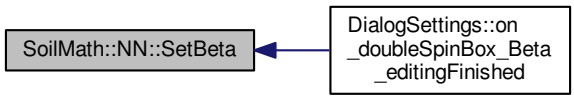
value	a floating value ussualy between 0.5 and 1.5

Definition at line 101 of file NN.h.

References beta.

Referenced by DialogSettings::on_doubleSpinBox_Beta_editingFinished().

Here is the caller graph for this function:

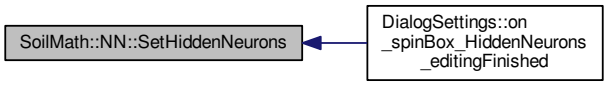


6.42.3.13 void SoilMath::NN::SetHiddenNeurons (uint32_t *value*)

Definition at line 150 of file NN.cpp.

Referenced by DialogSettings::on_spinBox_HiddenNeurons_editingFinished().

Here is the caller graph for this function:



6.42.3.14 void SoilMath::NN::SetHiddenWeights (Weight_t *value*) [inline]

SetHiddenWeights a function to set the hidden weights.

Parameters

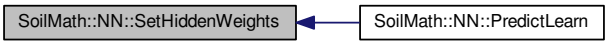
value	the real valued vector with the values

Definition at line 95 of file NN.h.

References hWeights.

Referenced by PredictLearn().

Here is the caller graph for this function:

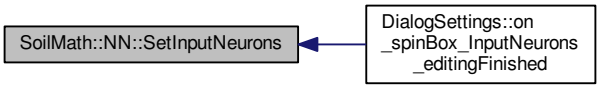


6.42.3.15 void SoilMath::NN::SetInputNeurons (uint32_t *value*)

Definition at line 141 of file NN.cpp.

Referenced by DialogSettings::on_spinBox_InputNeurons_editingFinished().

Here is the caller graph for this function:



6.42.3.16 void SoilMath::NN::SetInputWeights (Weight_t *value*) [inline]

SetInputWeights a function to set the input weights.

Parameters

value	the real valued vector with the values

Definition at line 89 of file NN.h.

References iWeights.

Referenced by PredictLearn().

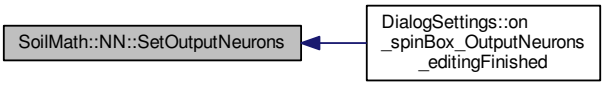
Here is the caller graph for this function:

6.42.3.17 void SoilMath::NN::SetOutputNeurons (uint32_t *value*)

Definition at line 159 of file NN.cpp.

Referenced by DialogSettings::on_spinBox_OutputNeurons_editingFinished().

Here is the caller graph for this function:



6.42.4 Friends And Related Function Documentation

6.42.4.1 friend class boost::serialization::access [friend]

a private friend class so the serialization can access all the needed functions

Definition at line 172 of file NN.h.

6.42.5 Member Data Documentation

6.42.5.1 float SoilMath::NN::beta [private]

the beta value, this indicates the steepness of the sigmoid function

Definition at line 169 of file NN.h.

Referenced by GetBeta(), and SetBeta().

6.42.5.2 uint32_t SoilMath::NN::ElitismeUsedByGA = 4

Definition at line 135 of file NN.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_spinBox_Elitisme_editingFinished().

6.42.5.3 float SoilMath::NN::EndErrorUsedByGA = 0.001

Definition at line 136 of file NN.h.

Referenced by DialogSettings::DialogSettings(), DialogNN::on_actionAbort_triggered(), DialogSettings::on_doubleSpinBox_endError_editing↩Finished(), and DialogNN::setupErrorGraph().

6.42.5.4 uint32_t SoilMath::NN::hiddenNeurons = 50 [private]

number of hidden neurons minus bias

Definition at line 166 of file NN.h.

Referenced by GetHiddenNeurons().

6.42.5.5 std::vector<float> SoilMath::NN::hNeurons [private]

a vector of hidden values, the bias is included and is the first value

Definition at line 162 of file NN.h.

6.42.5.6 Weight_t SoilMath::NN::hWeights

a vector of real valued floating point hidden weight

Definition at line 130 of file NN.h.

Referenced by SetHiddenWeights().

6.42.5.7 std::vector<float> SoilMath::NN::iNeurons [private]

a vector of input values, the bias is included, the bias is included and is the first value

Definition at line 158 of file NN.h.

6.42.5.8 uint32_t SoilMath::NN::inputNeurons = 20 [private]

number of input neurons minus bias

Definition at line 167 of file NN.h.

Referenced by GetInputNeurons().

6.42.5.9 Weight_t SoilMath::NN::iWeights

a vector of real valued floating point input weights

Definition at line 129 of file NN.h.

Referenced by SetInputWeights().

6.42.5.10 uint32_t SoilMath::NN::MaxGenUsedByGA = 200

Definition at line 132 of file NN.h.

Referenced by DialogSettings::DialogSettings(), DialogSettings::on_spinBox_MaxGen_editingFinished(), and DialogNN::setupErrorGraph().

6.42.5.11 float SoilMath::NN::MaxWeightUsedByGA = 50

Definition at line 137 of file NN.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_doubleSpinBox_maxWeight_editingFinished().

6.42.5.12 float SoilMath::NN::MinWeightUSedByGa = -50

Definition at line 138 of file NN.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_doubleSpinBox_MinWeight_editingFinished().

6.42.5.13 float SoilMath::NN::MutationrateUsedByGA = 0.075f

Definition at line 134 of file NN.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_doubleSpinBox_MutationRate_editingFinished().

6.42.5.14 std::vector<float> SoilMath::NN::oNeurons [private]

a vector of output values

Definition at line 164 of file NN.h.

6.42.5.15 GA* SoilMath::NN::optim = nullptr [private]

Definition at line 157 of file NN.h.

6.42.5.16 uint32_t SoilMath::NN::outputNeurons = 18 [private]

number of output neurons

Definition at line 168 of file NN.h.

Referenced by GetOutputNeurons().

6.42.5.17 uint32_t SoilMath::NN::PopulationSizeUsedByGA = 30

Definition at line 133 of file NN.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_spinBox_PopSize_editingFinished().

6.42.5.18 bool SoilMath::NN::studied

Initial value:

```
=
    false
```

a value indicating if the weights are a results of a learning curve

Definition at line 149 of file NN.h.

Referenced by PredictLearn().

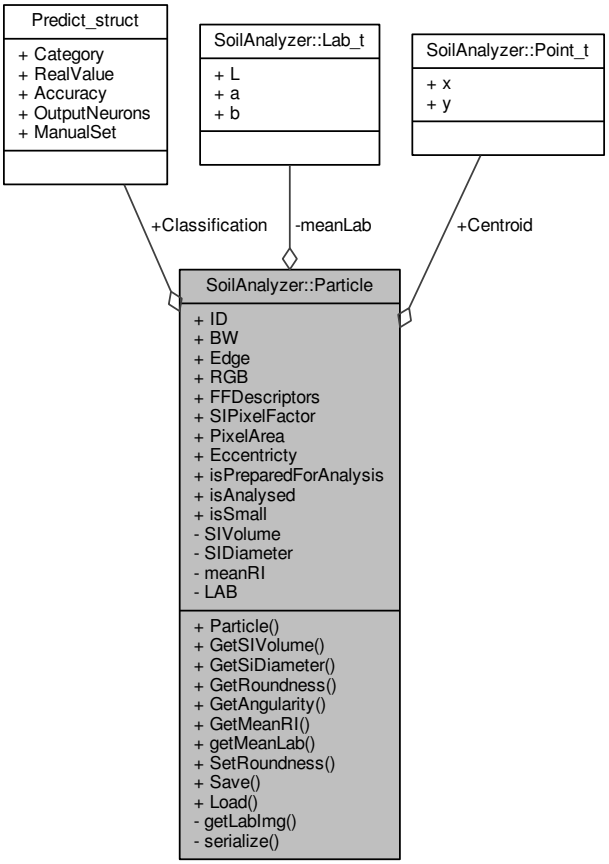
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/NN.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/NN.cpp

6.43 SoilAnalyzer::Particle Class Reference

```
#include <particle.h>
```

Collaboration diagram for SoilAnalyzer::Particle:



Public Types

- typedef std::vector< Particle > ParticleVector_t
- typedef std::vector< double > PSDVector_t
- typedef std::vector< uint8_t > ClassVector_t
- typedef std::vector< float > floatVector_t
- typedef std::vector< double > doubleVector_t

Public Member Functions

- Particle ()
- float GetSIVolume ()

  Particle::GetSIVolume.
- float GetSiDiameter ()
- uint8_t GetRoundness ()
- uint8_t GetAngularity ()
- float GetMeanRI ()
- Lab_t getMeanLab ()
- void SetRoundness ()
- void Save (const std::string &filename)

  Particle::Save.
- void Load (const std::string &filename)

  Particle::Load.

Public Attributes

- uint32_t ID
- cv::Mat BW
- cv::Mat Edge
- cv::Mat RGB
- Point_t Centroid = {0, 0}
- std::vector< Complex_t > FFDescriptors
- Predict_t Classification
- double SIPixelFactor = 0.0111915
- uint32_t PixelArea = 0
- double Eccentricty = 1
- bool isPreparedForAnalysis = false
- bool isAnalysed = false
- bool isSmall = false

Private Member Functions

- void getLabImg ()
- template<class Archive >
  void serialize (Archive &ar, const unsigned int version)

Private Attributes

- float SIVolume = 0.
- float SIDiameter = 0.
- float meanRI = 0
- Lab_t meanLab {0,0,0}
- cv::Mat LAB

Friends

- class boost::serialization::access

6.43.1 Detailed Description

Definition at line 28 of file particle.h.

6.43.2 Member Typedef Documentation

6.43.2.1 typedef std::vector<uint8_t> SoilAnalyzer::Particle::ClassVector_t

a vector used in the classification histogram

Definition at line 34 of file particle.h.

6.43.2.2 typedef std::vector<double> SoilAnalyzer::Particle::doubleVector_t

Definition at line 36 of file particle.h.

6.43.2.3 typedef std::vector<float> SoilAnalyzer::Particle::floatVector_t

Definition at line 35 of file particle.h.

6.43.2.4 typedef std::vector<Particle> SoilAnalyzer::Particle::ParticleVector_t

a vector consisting of individual particles

Definition at line 31 of file particle.h.

6.43.2.5 typedef std::vector<double> SoilAnalyzer::Particle::PSDVector_t

a vector used in the PSD

Definition at line 32 of file particle.h.

6.43.3 Constructor & Destructor Documentation

6.43.3.1 SoilAnalyzer::Particle::Particle ( )

Definition at line 13 of file particle.cpp.

6.43.4 Member Function Documentation

6.43.4.1 uint8_t SoilAnalyzer::Particle::GetAngularity ( )

Definition at line 79 of file particle.cpp.

References Predict_struct::Category, and Classification.

Referenced by SetRoundness().

Here is the caller graph for this function:

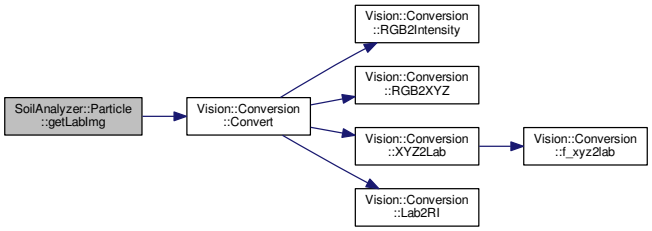
6.43.4.2 void SoilAnalyzer::Particle::getLabImg ( ) [private]

Definition at line 138 of file particle.cpp.

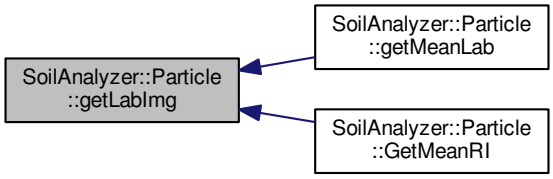
References Vision::Conversion::CIE_lab, Vision::Conversion::Convert(), LAB, Vision::ImageProcessing::ProcessedImg, Vision::Conversion::↩
RGB, and RGB.

Referenced by getMeanLab(), and GetMeanRI().

Here is the call graph for this function:



Here is the caller graph for this function:

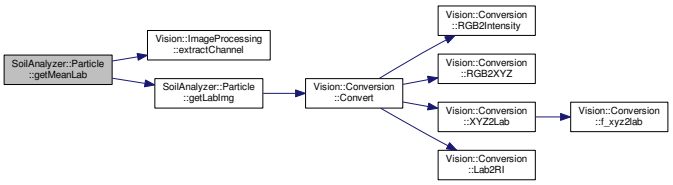


6.43.4.3 Lab_t SoilAnalyzer::Particle::getMeanLab ( )

Definition at line 96 of file particle.cpp.

References SoilAnalyzer::Lab_t::a, SoilAnalyzer::Lab_t::b, BW, EXCEPTION_NO_IMAGES_PRESENT, EXCEPTION_NO_IMAGES_PRESENT_NR, Vision::ImageProcessing::extractChannel(), getLabImg(), SoilAnalyzer::Lab_t::L, LAB, SoilMath::Stats< T1, T2, T3 >::Mean, meanLab, and RGB.

Here is the call graph for this function:

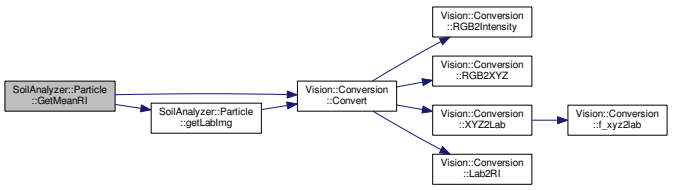


6.43.4.4 float SoilAnalyzer::Particle::GetMeanRI ( )

Definition at line 120 of file particle.cpp.

References BW, Vision::Conversion::CIE_lab, Vision::Conversion::Convert(), EXCEPTION_NO_IMAGES_PRESENT, EXCEPTION_NO_IMAGES_PRESENT_NR, getLabImg(), LAB, SoilMath::Stats< T1, T2, T3 >::Mean, meanRI, Vision::ImageProcessing::ProcessedImg, RGB, and Vision::Conversion::RI.

Here is the call graph for this function:



6.43.4.5 uint8_t SoilAnalyzer::Particle::GetRoundness ( )

Definition at line 84 of file particle.cpp.

References Predict_struct::Category, and Classification.

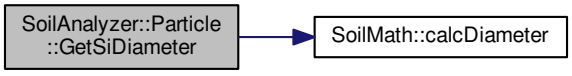
6.43.4.6 float SoilAnalyzer::Particle::GetSiDiameter ( )

Definition at line 68 of file particle.cpp.

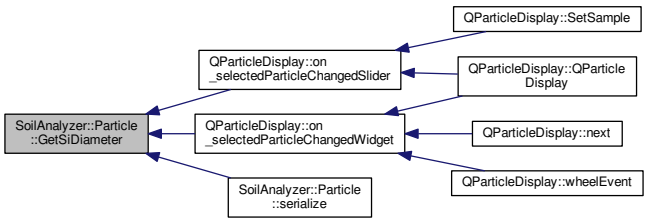
References SoilMath::calcDiameter(), Eccentricty, EXCEPTION_PARTICLE_NOT_ANALYZED, EXCEPTION_PARTICLE_NOT_ANALYZED_NR, PixelArea, SIDiameter, and SIPixelFactor.

Referenced by QParticleDisplay::on_selectedParticleChangedSlider(), QParticleDisplay::on_selectedParticleChangedWidget(), and serialize().

Here is the call graph for this function:



Here is the caller graph for this function:



6.43.4.7 float SoilAnalyzer::Particle::GetSIVolume ( )

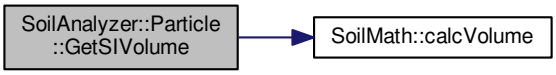
Particle::GetSIVolume.

Returns

Definition at line 57 of file particle.cpp.

References SoilMath::calcVolume(), Eccentricty, EXCEPTION_PARTICLE_NOT_ANALYZED, EXCEPTION_PARTICLE_NOT_ANALYZED_NR, PixelArea, SIPixelFactor, and SIVolume.

Here is the call graph for this function:



6.43.4.8 void SoilAnalyzer::Particle::Load (const std::string & *filename*)

Particle::Load.

Parameters

filename	

Definition at line 38 of file particle.cpp.

6.43.4.9 void SoilAnalyzer::Particle::Save (const std::string & *filename*)

Particle::Save.

Parameters

filename	

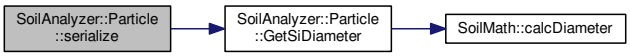
Definition at line 19 of file particle.cpp.

6.43.4.10 template<class Archive > void SoilAnalyzer::Particle::serialize (Archive & *ar,* const unsigned int *version*) [inline], [private]

Definition at line 83 of file particle.h.

References SoilAnalyzer::Lab_t::a, SoilAnalyzer::Lab_t::b, BW, Classification, Eccentricty, Edge, FFDescriptors, GetSiDiameter(), ID, isAnalysed, isPreparedForAnalysis, isSmall, SoilAnalyzer::Lab_t::L, meanLab, meanRI, PixelArea, RGB, SIDiameter, SIPixelFactor, SIVolume, SoilAnalyzer::Point_t::x, and SoilAnalyzer::Point_t::y.

Here is the call graph for this function:



6.43.4.11 void SoilAnalyzer::Particle::SetRoundness ( )

Definition at line 89 of file particle.cpp.

References Predict_struct::Category, Classification, Eccentricty, GetAngularity(), and Predict_struct::ManualSet.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList().

Here is the call graph for this function:

Here is the caller graph for this function:

6.43.5 Friends And Related Function Documentation

6.43.5.1 friend class boost::serialization::access [friend]

Definition at line 81 of file particle.h.

6.43.6 Member Data Documentation

6.43.6.1 cv::Mat SoilAnalyzer::Particle::BW

The binary image of the particle

Definition at line 42 of file particle.h.

Referenced by QParticleDisplay::ConvertParticleToQImage(), getMeanLab(), GetMeanRI(), SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), and serialize().

6.43.6.2 Point_t SoilAnalyzer::Particle::Centroid = {0, 0}

Definition at line 46 of file particle.h.

6.43.6.3 Predict_t SoilAnalyzer::Particle::Classification

The classification prediction

Definition at line 50 of file particle.h.

Referenced by GetAngularity(), GetRoundness(), QParticleDisplay::on_selectedParticleChangedSlider(), QParticleDisplay::on_selectedParticleChangedWidget(), serialize(), and SetRoundness().

6.43.6.4 double SoilAnalyzer::Particle::Eccentricty = 1

Definition at line 53 of file particle.h.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), GetSiDiameter(), GetSIVolume(), serialize(), and SetRoundness().

6.43.6.5 cv::Mat SoilAnalyzer::Particle::Edge

The binary edge image of the particle

Definition at line 43 of file particle.h.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), and serialize().

6.43.6.6 std::vector<Complex_t> SoilAnalyzer::Particle::FFDescriptors

The Fast Fourier Descriptors describing the contour in the Frequency domain

Definition at line 47 of file particle.h.

Referenced by serialize().

6.43.6.7 uint32_t SoilAnalyzer::Particle::ID

The particle ID

Definition at line 40 of file particle.h.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), and serialize().

6.43.6.8 bool SoilAnalyzer::Particle::isAnalysed = false

is the particle analyzed

Definition at line 68 of file particle.h.

Referenced by serialize().

6.43.6.9 bool SoilAnalyzer::Particle::isPreparedForAnalysis = false

is the particle ready for analysis

Definition at line 67 of file particle.h.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), and serialize().

6.43.6.10 bool SoilAnalyzer::Particle::isSmall = false

Definition at line 69 of file particle.h.

Referenced by serialize().

6.43.6.11 cv::Mat SoilAnalyzer::Particle::LAB [private]

Definition at line 77 of file particle.h.

Referenced by getLabImg(), getMeanLab(), and GetMeanRI().

6.43.6.12 Lab_t SoilAnalyzer::Particle::meanLab {0,0,0} [private]

Definition at line 76 of file particle.h.

Referenced by getMeanLab(), and serialize().

6.43.6.13 float SoilAnalyzer::Particle::meanRI = 0 [private]

Definition at line 75 of file particle.h.

Referenced by GetMeanRI(), and serialize().

6.43.6.14 uint32_t SoilAnalyzer::Particle::PixelArea = 0

The total area of the binary image

Definition at line 52 of file particle.h.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), GetSiDiameter(), GetSIVolume(), and serialize().

6.43.6.15 cv::Mat SoilAnalyzer::Particle::RGB

The RGB image of the particle

Definition at line 44 of file particle.h.

Referenced by QParticleDisplay::ConvertParticleToQImage(), getLabImg(), getMeanLab(), GetMeanRI(), SoilAnalyzer::Analyzer::GetParticles↩FromBlobList(), and serialize().

6.43.6.16 float SoilAnalyzer::Particle::SIDiameter = 0. [private]

Definition at line 73 of file particle.h.

Referenced by GetSiDiameter(), and serialize().

6.43.6.17 double SoilAnalyzer::Particle::SIPixelFactor = 0.0111915

The conversion factor from pixel to SI

Definition at line 51 of file particle.h.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList(), GetSiDiameter(), GetSIVolume(), and serialize().

6.43.6.18 float SoilAnalyzer::Particle::SIVolume = 0. [private]

The correspondening SI volume

Definition at line 72 of file particle.h.

Referenced by GetSIVolume(), and serialize().

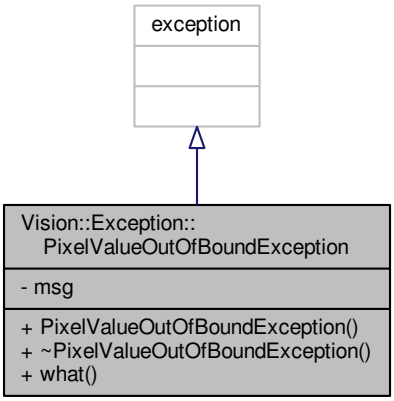
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/particle.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/particle.cpp

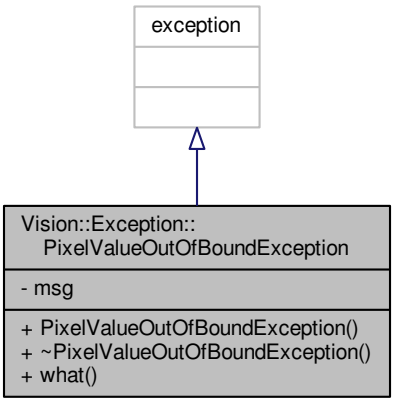
6.44 Vision::Exception::PixelValueOutOfBoundException Class Reference

`#include <PixelValueOutOfBoundException.h>`

Inheritance diagram for Vision::Exception::PixelValueOutOfBoundException:



Collaboration diagram for Vision::Exception::PixelValueOutOfBoundException:



Public Member Functions

- PixelValueOutOfBoundException (string m="Current pixel value out of bounds!")
- ~PixelValueOutOfBoundException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.44.1 Detailed Description

Definition at line 21 of file PixelValueOutOfBoundException.h.

6.44.2 Constructor & Destructor Documentation

6.44.2.1 Vision::Exception::PixelValueOutOfBoundException::PixelValueOutOfBoundException (string *m* = "Current pixel value out of bounds!") [inline]

Definition at line 23 of file PixelValueOutOfBoundException.h.

6.44.2.2 Vision::Exception::PixelValueOutOfBoundException::~PixelValueOutOfBoundException ( ) [inline]

Definition at line 25 of file PixelValueOutOfBoundException.h.

6.44.3 Member Function Documentation

6.44.3.1 const char* Vision::Exception::PixelValueOutOfBoundException::what ( ) const [inline]

Definition at line 26 of file PixelValueOutOfBoundException.h.

6.44.4 Member Data Documentation

6.44.4.1 string Vision::Exception::PixelValueOutOfBoundException::msg [private]

Definition at line 26 of file PixelValueOutOfBoundException.h.

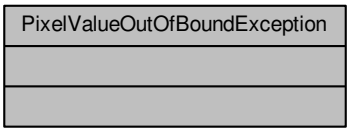
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/PixelValueOutOfBoundException.h

6.45 PixelValueOutOfBoundException Class Reference

`#include <PixelValueOutOfBoundException.h>`

Collaboration diagram for PixelValueOutOfBoundException:



6.45.1 Detailed Description

Exception class which is thrown when an unexpected pixel value has to be computed

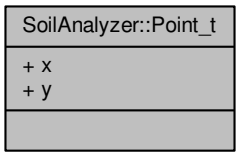
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/PixelValueOutOfBoundException.h

6.46 SoilAnalyzer::Point_t Struct Reference

`#include <soilanalyzertypes.h>`

Collaboration diagram for SoilAnalyzer::Point_t:



Public Attributes

- double x
- double y

6.46.1 Detailed Description

Definition at line 5 of file soilanalyzertypes.h.

6.46.2 Member Data Documentation

6.46.2.1 double SoilAnalyzer::Point_t::x

Definition at line 6 of file soilanalyzertypes.h.

Referenced by SoilAnalyzer::Particle::serialize().

6.46.2.2 double SoilAnalyzer::Point_t::y

Definition at line 7 of file soilanalyzertypes.h.

Referenced by SoilAnalyzer::Particle::serialize().

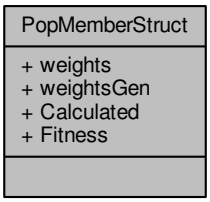
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/soilanalyzertypes.h

6.47 PopMemberStruct Struct Reference

`#include <SoilMathTypes.h>`

Collaboration diagram for PopMemberStruct:



Public Attributes

- Weight_t weights
- GenVect_t weightsGen
- float Calculated = 0.0
- float Fitness = 0.0

6.47.1 Detailed Description

Definition at line 33 of file SoilMathTypes.h.

6.47.2 Member Data Documentation

6.47.2.1 float PopMemberStruct::Calculated = 0.0

the calculated value

Definition at line 36 of file SoilMathTypes.h.

6.47.2.2 float PopMemberStruct::Fitness = 0.0

the fitness of the population member

Definition at line 37 of file SoilMathTypes.h.

Referenced by SoilMath::GA::PopMemberSort(), and SoilMath::GA::SurvivalOfTheFittest().

6.47.2.3 Weight_t PopMemberStruct::weights

the weights the core of a population member

Definition at line 34 of file SoilMathTypes.h.

Referenced by SoilMath::GA::Genesis().

6.47.2.4 GenVect_t PopMemberStruct::weightsGen

the weights as genomes

Definition at line 35 of file SoilMathTypes.h.

Referenced by SoilMath::GA::CrossOver(), and SoilMath::GA::Genesis().

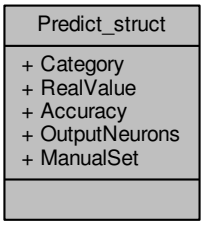
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/SoilMathTypes.h

6.48 Predict_struct Struct Reference

`#include <SoilMathTypes.h>`

Collaboration diagram for Predict_struct:



Public Attributes

- uint8_t Category = 1
- float RealValue = 1.
- float Accuracy = 1.
- std::vector< float > OutputNeurons
- bool ManualSet = true

6.48.1 Detailed Description

Definition at line 43 of file SoilMathTypes.h.

6.48.2 Member Data Documentation

6.48.2.1 float Predict_struct::Accuracy = 1.

the accuracy of the category

Definition at line 47 of file SoilMathTypes.h.

Referenced by boost::serialization::serialize().

6.48.2.2 uint8_t Predict_struct::Category = 1

the category number

Definition at line 44 of file SoilMathTypes.h.

Referenced by SoilAnalyzer::Particle::GetAngularity(), SoilAnalyzer::Particle::GetRoundness(), QParticleDisplay::on_selectedParticleChangedSlider(), QParticleDisplay::on_selectedParticleChangedWidget(), boost::serialization::serialize(), and SoilAnalyzer::Particle::SetRoundness().

6.48.2.3 bool Predict_struct::ManualSet = true

Definition at line 49 of file SoilMathTypes.h.

Referenced by SoilMath::NN::Predict(), and SoilAnalyzer::Particle::SetRoundness().

6.48.2.4 std::vector<float> Predict_struct::OutputNeurons

the output Neurons

Definition at line 48 of file SoilMathTypes.h.

Referenced by SoilMath::GA::GrowToAdulthood(), DialogNN::makeLearnVectors(), SoilMath::NN::Predict(), and boost::serialization::serialize().

6.48.2.5 float Predict_struct::RealValue = 1.

category number as float in order to estimate how precise to outcome is

Definition at line 45 of file SoilMathTypes.h.

Referenced by boost::serialization::serialize().

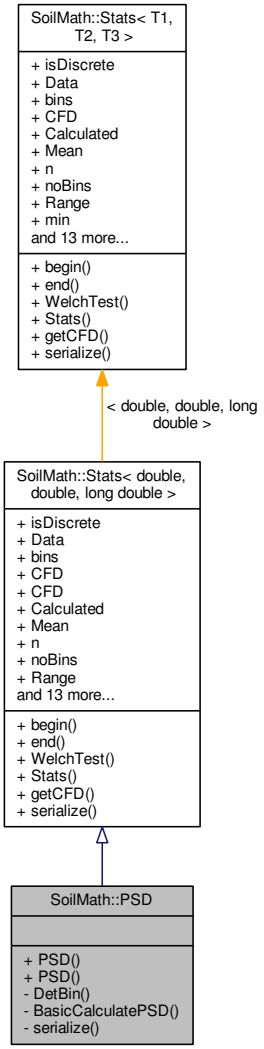
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/SoilMathTypes.h

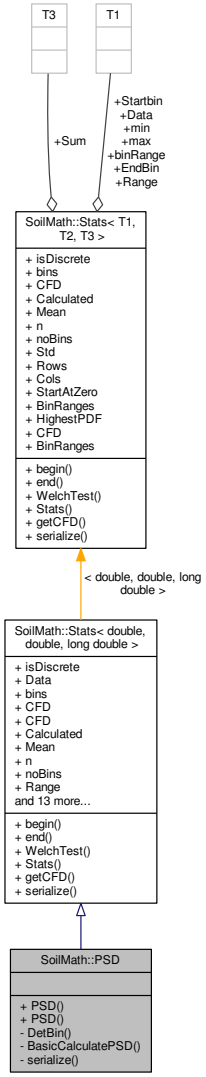
6.49 SoilMath::PSD Class Reference

```
#include <psd.h>
```

Inheritance diagram for SoilMath::PSD:



Collaboration diagram for SoilMath::PSD:



Public Member Functions

- PSD ()
- PSD (double ∗data, uint32_t nodata, double ∗binranges, uint32_t nobins, uint32_t endbin)

Private Member Functions

- uint32_t DetBin (float value)
- void BasicCalculatePSD ()
- template<class Archive >
  void serialize (Archive &ar, const unsigned int version)

Friends

- class boost::serialization::access

Additional Inherited Members

6.49.1 Detailed Description

Definition at line 14 of file psd.h.

6.49.2 Constructor & Destructor Documentation

6.49.2.1 SoilMath::PSD::PSD ( ) [inline]

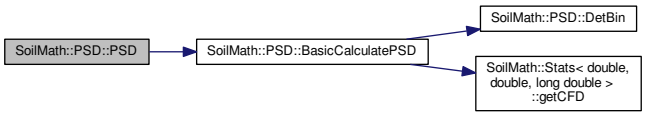
Definition at line 62 of file psd.h.

6.49.2.2 SoilMath::PSD::PSD (double * *data*, uint32_t *nodata*, double * *binranges*, uint32_t *nobins*, uint32_t *endbin*) [inline]

Definition at line 64 of file psd.h.

References BasicCalculatePSD(), SoilMath::Stats< double, double, long double >::BinRanges, SoilMath::Stats< double, double, long double >::Cols, SoilMath::Stats< double, double, long double >::Data, and SoilMath::Stats< double, double, long double >::Rows.

Here is the call graph for this function:



6.49.3 Member Function Documentation

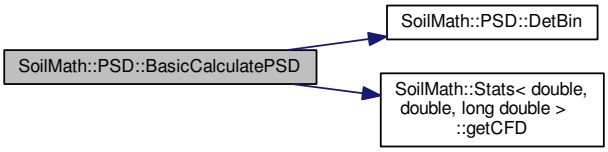
6.49.3.1 void SoilMath::PSD::BasicCalculatePSD ( ) [inline], [private]

Definition at line 27 of file psd.h.

References SoilMath::Stats< double, double, long double >::bins, SoilMath::Stats< double, double, long double >::Calculated, SoilMath::Stats< double, double, long double >::Cols, SoilMath::Stats< double, double, long double >::Data, DetBin(), SoilMath::Stats< double, double, long double >::getCFD(), SoilMath::Stats< double, double, long double >::max, SoilMath::Stats< double, double, long double >::Mean, SoilMath::Stats< double, double, long double >::min, SoilMath::Stats< double, double, long double >::n, SoilMath::Stats< double, double, long double >::Range, SoilMath::Stats< double, double, long double >::Rows, SoilMath::Stats< double, double, long double >::Std, and SoilMath::Stats< double, double, long double >::Sum.

Referenced by PSD().

Here is the call graph for this function:



Here is the caller graph for this function:

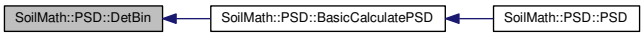
6.49.3.2 uint32_t SoilMath::PSD::DetBin (float *value*) [inline], [private]

Definition at line 16 of file psd.h.

References SoilMath::Stats< double, double, long double >::BinRanges, and SoilMath::Stats< double, double, long double >::noBins.

Referenced by BasicCalculatePSD().

Here is the caller graph for this function:



6.49.3.3 template<class Archive > void SoilMath::PSD::serialize (Archive & *ar,* const unsigned int *version*) [inline], [private]

Definition at line 54 of file psd.h.

6.49.4 Friends And Related Function Documentation

6.49.4.1 friend class boost::serialization::access [friend]

Definition at line 51 of file psd.h.

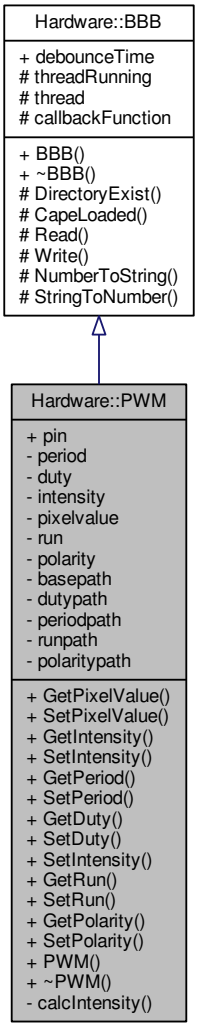
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/psd.h

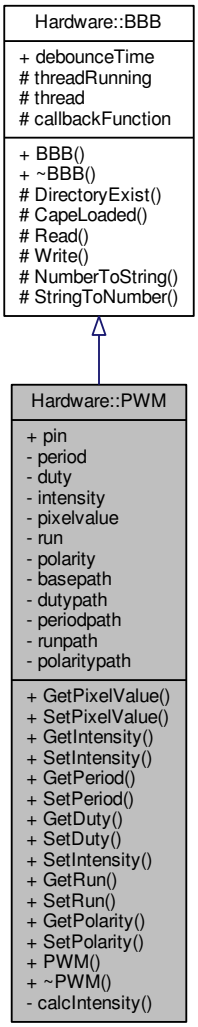
6.50 Hardware::PWM Class Reference

`#include <PWM.h>`

Inheritance diagram for Hardware::PWM:



Collaboration diagram for Hardware::PWM:



Public Types

- enum Pin { P8_13, P8_19, P9_14, P9_16 }
- enum Run { On = 1, Off = 0 }
- enum Polarity { Normal = 1, Inverted = 0 }

Public Member Functions

- uint8_t GetPixelValue ()
- void SetPixelValue (uint8_t value)

  Set the output as a corresponding uint8_t value
- float GetIntensity ()
- void SetIntensity (float value)

  Set the intensity level as percentage
- int GetPeriod ()
- void SetPeriod (int value)

Set the period of the signal

- int GetDuty ()
- void SetDuty (int value)

  Set the duty of the signal
- void SetIntensity ()
- Run GetRun ()
- void SetRun (Run value)

  Run the signal
- Polarity GetPolarity ()
- void SetPolarity (Polarity value)

  Set the polarity
- PWM (Pin pin)

  Constructeur
- ~PWM ()

Public Attributes

- Pin pin

Private Member Functions

- void calcIntensity ()

  Calculate the current intensity

Private Attributes

- int period
- int duty
- float intensity
- uint8_t pixelvalue
- Run run
- Polarity polarity
- string basepath
- string dutypath
- string periodpath
- string runpath
- string polaritypath

Additional Inherited Members

6.50.1 Detailed Description

Definition at line 16 of file PWM.h.

6.50.2 Member Enumeration Documentation

6.50.2.1 enum Hardware::PWM::Pin

Enumerator

P8_13

P8_19

P9_14

P9_16

Definition at line 18 of file PWM.h.

6.50.2.2 enum Hardware::PWM::Polarity

Enumerator

Normal

Inverted

Definition at line 26 of file PWM.h.

6.50.2.3 enum Hardware::PWM::Run

Enumerator

On

Off

Definition at line 23 of file PWM.h.

6.50.3 Constructor & Destructor Documentation

6.50.3.1 Hardware::PWM::PWM (Pin *pin*)

Constructeur

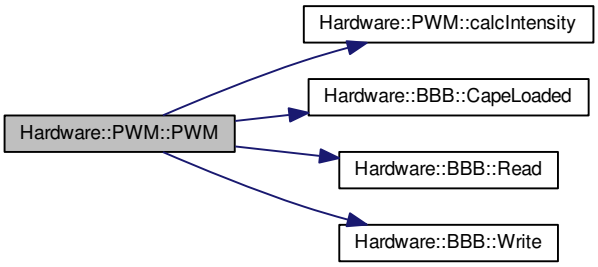
Parameters

pin	Pin

Definition at line 15 of file PWM.cpp.

References basepath, calcIntensity(), Hardware::BBB::CapeLoaded(), duty, dutypath, OCP_PATH, P8_13, P8_19, P9_14, P9_16, period, periodpath, pin, polarity, polaritypath, PWM_CAPE, Hardware::BBB::Read(), run, runpath, SLOTS, and Hardware::BBB::Write().

Here is the call graph for this function:



6.50.3.2 Hardware::PWM::~PWM ( )

Definition at line 65 of file PWM.cpp.

6.50.4 Member Function Documentation

6.50.4.1 void Hardware::PWM::calcIntensity ( ) [private]

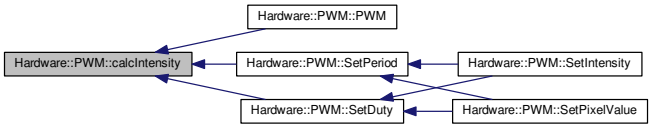
Calculate the current intensity

Definition at line 70 of file PWM.cpp.

References duty, intensity, Normal, period, and polarity.

Referenced by PWM(), SetDuty(), and SetPeriod().

Here is the caller graph for this function:



6.50.4.2 int Hardware::PWM::GetDuty ( ) [inline]

Definition at line 41 of file PWM.h.

References duty.

6.50.4.3 float Hardware::PWM::GetIntensity ( ) [inline]

Definition at line 35 of file PWM.h.

References intensity.

6.50.4.4 int Hardware::PWM::GetPeriod ( ) [inline]

Definition at line 38 of file PWM.h.

References period.

6.50.4.5 uint8_t Hardware::PWM::GetPixelValue ( ) [inline]

Definition at line 32 of file PWM.h.

References pixelvalue.

6.50.4.6 Polarity Hardware::PWM::GetPolarity ( ) [inline]

Definition at line 48 of file PWM.h.

References polarity.

6.50.4.7 Run Hardware::PWM::GetRun ( ) [inline]

Definition at line 45 of file PWM.h.

References run.

6.50.4.8 void Hardware::PWM::SetDuty (int *value*)

Set the duty of the signal

Parameters

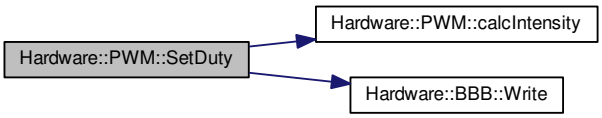
value	duty : int

Definition at line 126 of file PWM.cpp.

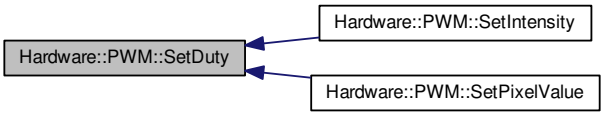
References calcIntensity(), duty, dutypath, and Hardware::BBB::Write().

Referenced by SetIntensity(), and SetPixelValue().

Here is the call graph for this function:



Here is the caller graph for this function:



6.50.4.9 void Hardware::PWM::SetIntensity (float *value*)

Set the intensity level as percentage

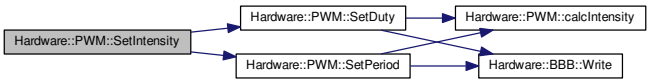
Parameters

value	floating value multipication factor

Definition at line 90 of file PWM.cpp.

References duty, Normal, period, polarity, SetDuty(), and SetPeriod().

Here is the call graph for this function:



6.50.4.10 void Hardware::PWM::SetIntensity ( )

6.50.4.11 void Hardware::PWM::SetPeriod (int *value*)

Set the period of the signal

Parameters

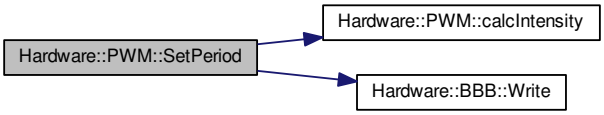
value	period : int

Definition at line 114 of file PWM.cpp.

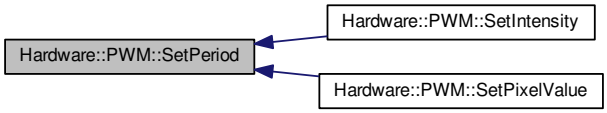
References calcIntensity(), period, periodpath, and Hardware::BBB::Write().

Referenced by SetIntensity(), and SetPixelValue().

Here is the call graph for this function:



Here is the caller graph for this function:



6.50.4.12 void Hardware::PWM::SetPixelValue (uint8_t *value*)

Set the output as a corresponding uint8_t value

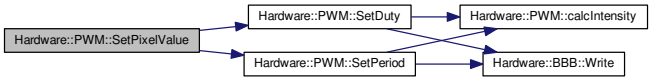
Parameters

value	pixel value 0-255

Definition at line 102 of file PWM.cpp.

References period, pixelvalue, SetDuty(), and SetPeriod().

Here is the call graph for this function:



6.50.4.13 void Hardware::PWM::SetPolarity (Polarity *value*)

Set the polarity

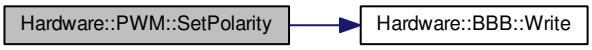
Parameters

value	Normal or Inverted signal

Definition at line 149 of file PWM.cpp.

References polarity, runpath, and Hardware::BBB::Write().

Here is the call graph for this function:



6.50.4.14 void Hardware::PWM::SetRun (Run *value*)

Run the signal

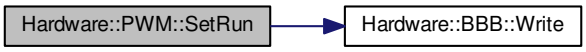
Parameters

value	On or Off

Definition at line 138 of file PWM.cpp.

References run, runpath, and Hardware::BBB::Write().

Here is the call graph for this function:



6.50.5 Member Data Documentation

6.50.5.1 string Hardware::PWM::basepath [private]

Definition at line 62 of file PWM.h.

Referenced by PWM().

6.50.5.2 int Hardware::PWM::duty [private]

Definition at line 56 of file PWM.h.

Referenced by calcIntensity(), GetDuty(), PWM(), SetDuty(), and SetIntensity().

6.50.5.3 string Hardware::PWM::dutypath [private]

Definition at line 63 of file PWM.h.

Referenced by PWM(), and SetDuty().

6.50.5.4 float Hardware::PWM::intensity [private]

Definition at line 57 of file PWM.h.

Referenced by calcIntensity(), and GetIntensity().

6.50.5.5 int Hardware::PWM::period [private]

Definition at line 55 of file PWM.h.

Referenced by calcIntensity(), GetPeriod(), PWM(), SetIntensity(), SetPeriod(), and SetPixelValue().

6.50.5.6 string Hardware::PWM::periodpath [private]

Definition at line 64 of file PWM.h.

Referenced by PWM(), and SetPeriod().

6.50.5.7 Pin Hardware::PWM::pin

Definition at line 30 of file PWM.h.

Referenced by PWM().

6.50.5.8 uint8_t Hardware::PWM::pixelvalue [private]

Definition at line 58 of file PWM.h.

Referenced by GetPixelValue(), and SetPixelValue().

6.50.5.9 Polarity Hardware::PWM::polarity [private]

Definition at line 60 of file PWM.h.

Referenced by calcIntensity(), GetPolarity(), PWM(), SetIntensity(), and SetPolarity().

6.50.5.10 string Hardware::PWM::polaritypath [private]

Definition at line 66 of file PWM.h.

Referenced by PWM().

6.50.5.11 Run Hardware::PWM::run [private]

Definition at line 59 of file PWM.h.

Referenced by GetRun(), PWM(), and SetRun().

6.50.5.12 string Hardware::PWM::runpath [private]

Definition at line 65 of file PWM.h.

Referenced by PWM(), SetPolarity(), and SetRun().

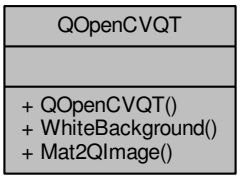
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/PWM.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/PWM.cpp

6.51 QOpenCVQT Class Reference

`#include <qopencvqt.h>`

Collaboration diagram for QOpenCVQT:



Public Member Functions

- QOpenCVQT ()

Static Public Member Functions

- static cv::Mat WhiteBackground (const cv::Mat &src)
- static QImage Mat2QImage (const cv::Mat &src)

6.51.1 Detailed Description

Definition at line 16 of file qopencvqt.h.

6.51.2 Constructor & Destructor Documentation

6.51.2.1 QOpenCVQT::QOpenCVQT ( )

Definition at line 11 of file qopencvqt.cpp.

6.51.3 Member Function Documentation

6.51.3.1 static QImage QOpenCVQT::Mat2QImage (const cv::Mat & *src*) [inline], [static]

Definition at line 26 of file qopencvqt.h.

6.51.3.2 static cv::Mat QOpenCVQT::WhiteBackground (const cv::Mat & *src*) [inline], [static]

Definition at line 20 of file qopencvqt.h.

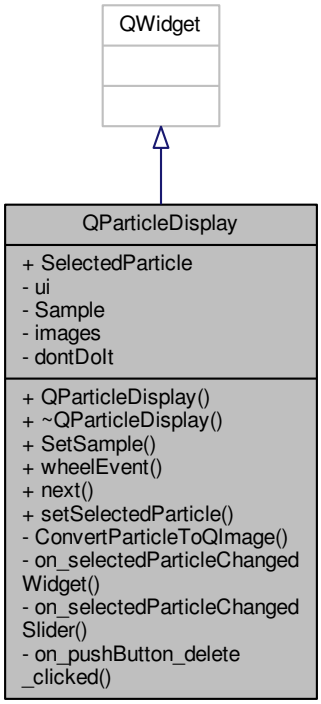
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/QOpenCVQT/qopencvqt.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/QOpenCVQT/qopencvqt.cpp

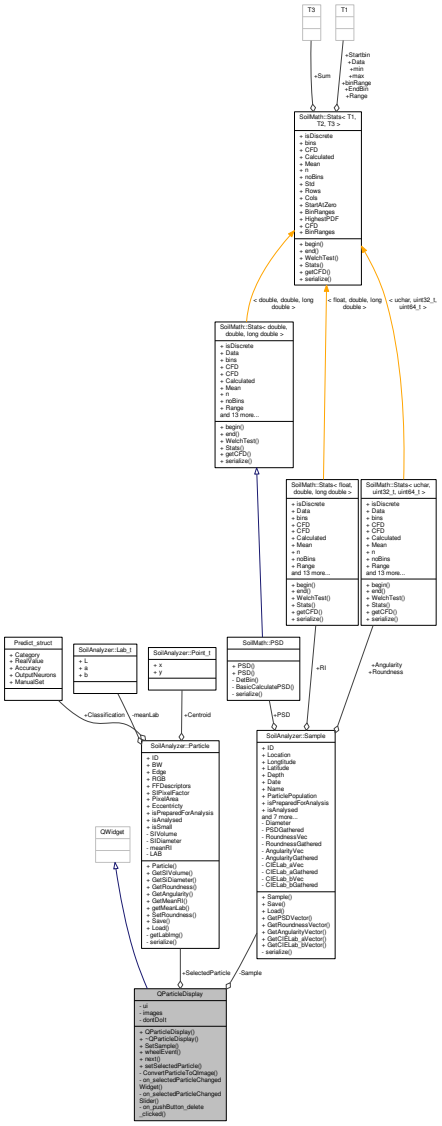
6.52 QParticleDisplay Class Reference

`#include <qparticledisplay.h>`

Inheritance diagram for QParticleDisplay:



Collaboration diagram for QParticleDisplay:



Public Slots

- void setSelectedParticle (int newValue)

Signals

- void particleChanged (int newValue)
- void shapeClassificationChanged (int newValue)
- void particleDeleted ()

Public Member Functions

- QParticleDisplay (QWidget ∗parent=0)
- ∼QParticleDisplay ()
- void SetSample (SoilAnalyzer::Sample ∗sample)
- void wheelEvent (QWheelEvent ∗event)

- void next ()

Public Attributes

- SoilAnalyzer::Particle * SelectedParticle

Private Slots

- void on_selectedParticleChangedWidget (int value)
- void on_selectedParticleChangedSlider (int value)
- void on_pushButton_delete_clicked ()

Private Member Functions

- QImage ConvertParticleToQImage (SoilAnalyzer::Particle *particle)

Private Attributes

- Ui::QParticleDisplay * ui
- SoilAnalyzer::Sample * Sample
- QVector< QImage > images
- bool dontDoIt = false

6.52.1 Detailed Description

Definition at line 21 of file qparticledisplay.h.

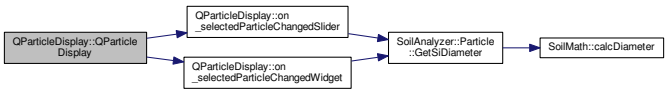
6.52.2 Constructor & Destructor Documentation

6.52.2.1 QParticleDisplay::QParticleDisplay (QWidget * *parent* = 0) [explicit]

Definition at line 11 of file qparticledisplay.cpp.

References on_selectedParticleChangedSlider(), on_selectedParticleChangedWidget(), and ui.

Here is the call graph for this function:



6.52.2.2 QParticleDisplay::~QParticleDisplay ( )

Definition at line 22 of file qparticledisplay.cpp.

References ui.

6.52.3 Member Function Documentation

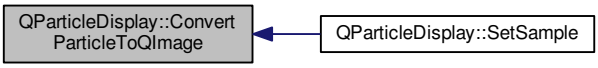
6.52.3.1 QImage QParticleDisplay::ConvertParticleToQImage (SoilAnalyzer::Particle * *particle*) [private]

Definition at line 50 of file qparticledisplay.cpp.

References SoilAnalyzer::Particle::BW, and SoilAnalyzer::Particle::RGB.

Referenced by SetSample().

Here is the caller graph for this function:



6.52.3.2 void QParticleDisplay::next ( )

Definition at line 150 of file qparticledisplay.cpp.

References on_selectedParticleChangedWidget(), and ui.

Here is the call graph for this function:

6.52.3.3 void QParticleDisplay::on_pushButton_delete_clicked ( ) [private], [slot]

Definition at line 96 of file qparticledisplay.cpp.

References SoilAnalyzer::Sample::ChangesSinceLastSave, SoilAnalyzer::Sample::ColorChange, SoilAnalyzer::Sample::ParticleChanged↩StateAngularity, SoilAnalyzer::Sample::ParticleChangedStatePSD, SoilAnalyzer::Sample::ParticleChangedStateRoundness, particleDeleted(), SoilAnalyzer::Sample::ParticlePopulation, Sample, SelectedParticle, and ui.

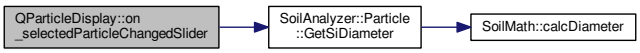
6.52.3.4 void QParticleDisplay::on_selectedParticleChangedSlider (int *value*) [private], [slot]

Definition at line 124 of file qparticledisplay.cpp.

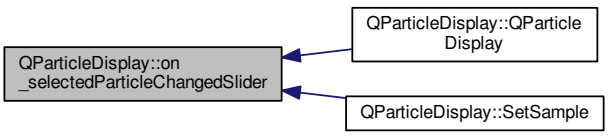
References Predict_struct::Category, SoilAnalyzer::Particle::Classification, dontDoIt, SoilAnalyzer::Particle::GetSiDiameter(), particleChanged(), SoilAnalyzer::Sample::ParticlePopulation, Sample, SelectedParticle, shapeClassificationChanged(), and ui.

Referenced by QParticleDisplay(), and SetSample().

Here is the call graph for this function:



Here is the caller graph for this function:



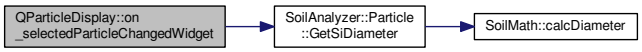
6.52.3.5 void QParticleDisplay::on_selectedParticleChangedWidget (int *value*) [private], [slot]

Definition at line 110 of file qparticledisplay.cpp.

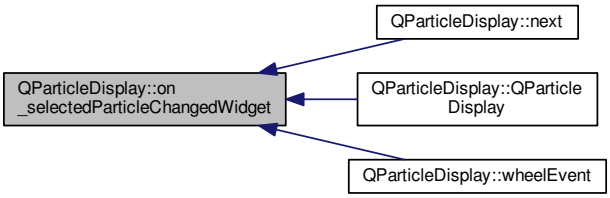
References Predict_struct::Category, SoilAnalyzer::Particle::Classification, dontDoIt, SoilAnalyzer::Particle::GetSiDiameter(), particleChanged(), SoilAnalyzer::Sample::ParticlePopulation, Sample, SelectedParticle, shapeClassificationChanged(), and ui.

Referenced by next(), QParticleDisplay(), and wheelEvent().

Here is the call graph for this function:



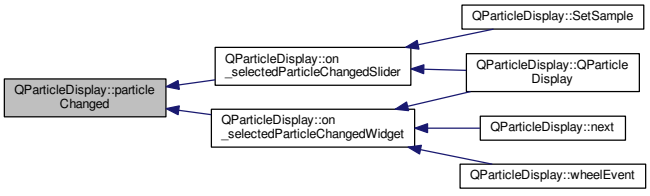
Here is the caller graph for this function:



6.52.3.6 void QParticleDisplay::particleChanged (int *newValue*) [signal]

Referenced by on_selectedParticleChangedSlider(), and on_selectedParticleChangedWidget().

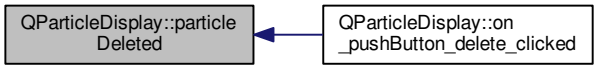
Here is the caller graph for this function:



6.52.3.7 void QParticleDisplay::particleDeleted ( ) [signal]

Referenced by on_pushButton_delete_clicked().

Here is the caller graph for this function:

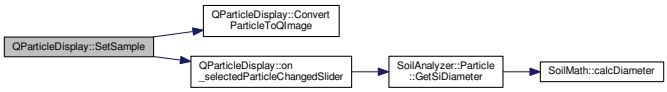


6.52.3.8 void QParticleDisplay::SetSample (SoilAnalyzer::Sample * *sample*)

Definition at line 35 of file qparticledisplay.cpp.

References ConvertParticleToQImage(), images, on_selectedParticleChangedSlider(), SoilAnalyzer::Sample::ParticlePopulation, Sample, SelectedParticle, and ui.

Here is the call graph for this function:



6.52.3.9 void QParticleDisplay::setSelectedParticle (int *newValue*) [slot]

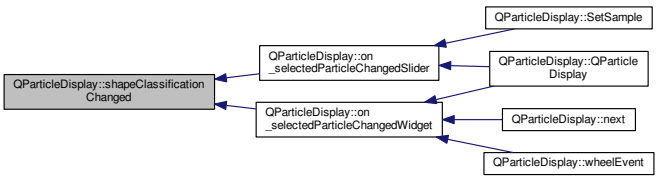
Definition at line 30 of file qparticledisplay.cpp.

References ui.

6.52.3.10 void QParticleDisplay::shapeClassificationChanged (int *newValue*) [signal]

Referenced by on_selectedParticleChangedSlider(), and on_selectedParticleChangedWidget().

Here is the caller graph for this function:



6.52.3.11 void QParticleDisplay::wheelEvent (QWheelEvent * *event*)

Definition at line 138 of file qparticledisplay.cpp.

References on_selectedParticleChangedWidget(), and ui.

Here is the call graph for this function:

6.52.4 Member Data Documentation

6.52.4.1 bool QParticleDisplay::dontDoIt = false [private]

Definition at line 51 of file qparticledisplay.h.

Referenced by on_selectedParticleChangedSlider(), and on_selectedParticleChangedWidget().

6.52.4.2 QVector<QImage> QParticleDisplay::images [private]

Definition at line 49 of file qparticledisplay.h.

Referenced by SetSample().

6.52.4.3 SoilAnalyzer::Sample* QParticleDisplay::Sample [private]

Definition at line 48 of file qparticledisplay.h.

Referenced by on_pushButton_delete_clicked(), on_selectedParticleChangedSlider(), on_selectedParticleChangedWidget(), and SetSample().

6.52.4.4 SoilAnalyzer::Particle* QParticleDisplay::SelectedParticle

Definition at line 29 of file qparticledisplay.h.

Referenced by on_pushButton_delete_clicked(), on_selectedParticleChangedSlider(), on_selectedParticleChangedWidget(), and SetSample().

6.52.4.5 Ui::QParticleDisplay* QParticleDisplay::ui [private]

Definition at line 47 of file qparticledisplay.h.

Referenced by next(), on_pushButton_delete_clicked(), on_selectedParticleChangedSlider(), on_selectedParticleChangedWidget(), QParticleDisplay(), SetSample(), setSelectedParticle(), wheelEvent(), and ~QParticleDisplay().

The documentation for this class was generated from the following files:

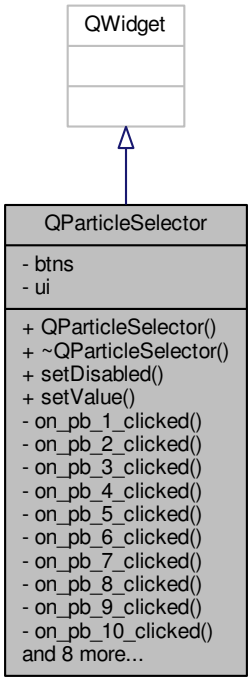
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/QParticleDisplay/qparticledisplay.h

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/QParticleDisplay/qparticledisplay.cpp

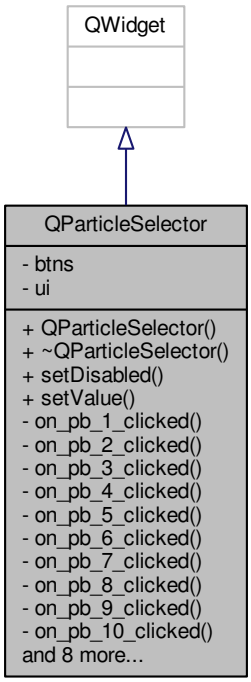
6.53 QParticleSelector Class Reference

```
#include <qparticleselector.h>
```

Inheritance diagram for QParticleSelector:



Collaboration diagram for QParticleSelector:



Public Slots

- void setValue (int newValue)

Signals

- void valueChanged (int newValue)

Public Member Functions

- QParticleSelector (QWidget *parent=0)
- ~QParticleSelector ()
- void setDisabled (bool value, int currentClass=1)

Private Slots

- void on_pb_1_clicked (bool checked)
- void on_pb_2_clicked (bool checked)
- void on_pb_3_clicked (bool checked)
- void on_pb_4_clicked (bool checked)
- void on_pb_5_clicked (bool checked)
- void on_pb_6_clicked (bool checked)
- void on_pb_7_clicked (bool checked)
- void on_pb_8_clicked (bool checked)
- void on_pb_9_clicked (bool checked)
- void on_pb_10_clicked (bool checked)
- void on_pb_11_clicked (bool checked)

- void on_pb_12_clicked (bool checked)
- void on_pb_13_clicked (bool checked)
- void on_pb_14_clicked (bool checked)
- void on_pb_15_clicked (bool checked)
- void on_pb_16_clicked (bool checked)
- void on_pb_17_clicked (bool checked)
- void on_pb_18_clicked (bool checked)

Private Attributes

- QVector< QPushButton * > btns
- Ui::QParticleSelector * ui

6.53.1 Detailed Description

Definition at line 11 of file qparticleselector.h.

6.53.2 Constructor & Destructor Documentation

6.53.2.1 QParticleSelector::QParticleSelector (QWidget * *parent* = 0) [explicit]

Definition at line 4 of file qparticleselector.cpp.

References btns, and ui.

6.53.2.2 QParticleSelector::~QParticleSelector ( )

Definition at line 27 of file qparticleselector.cpp.

References btns, and ui.

6.53.3 Member Function Documentation

6.53.3.1 void QParticleSelector::on_pb_10_clicked (bool *checked*) [private], [slot]

Definition at line 104 of file qparticleselector.cpp.

References valueChanged().

6.53.3.2 void QParticleSelector::on_pb_11_clicked (bool *checked*) [private], [slot]

Definition at line 110 of file qparticleselector.cpp.

References valueChanged().

6.53.3.3 void QParticleSelector::on_pb_12_clicked (bool *checked*) [private], [slot]

Definition at line 116 of file qparticleselector.cpp.

References valueChanged().

6.53.3.4 void QParticleSelector::on_pb_13_clicked (bool *checked*) [private], [slot]

Definition at line 122 of file qparticleselector.cpp.

References valueChanged().

6.53.3.5 void QParticleSelector::on_pb_14_clicked (bool *checked*) [private], [slot]

Definition at line 128 of file qparticleselector.cpp.

References valueChanged().

6.53.3.6 void QParticleSelector::on_pb_15_clicked (bool *checked*) [private], [slot]

Definition at line 134 of file qparticleselector.cpp.

References valueChanged().

6.53.3.7 void QParticleSelector::on_pb_16_clicked (bool *checked*) [private], [slot]

Definition at line 140 of file qparticleselector.cpp.

References valueChanged().

6.53.3.8 void QParticleSelector::on_pb_17_clicked (bool *checked*) [private], [slot]

Definition at line 146 of file qparticleselector.cpp.

References valueChanged().

6.53.3.9 void QParticleSelector::on_pb_18_clicked (bool *checked*) [private], [slot]

Definition at line 152 of file qparticleselector.cpp.

References valueChanged().

6.53.3.10 void QParticleSelector::on_pb_1_clicked (bool *checked*) [private], [slot]

Definition at line 50 of file qparticleselector.cpp.

References valueChanged().

6.53.3.11 void QParticleSelector::on_pb_2_clicked (bool *checked*) [private], [slot]

Definition at line 56 of file qparticleselector.cpp.

References valueChanged().

6.53.3.12 void QParticleSelector::on_pb_3_clicked (bool *checked*) [private], [slot]

Definition at line 62 of file qparticleselector.cpp.

References valueChanged().

6.53.3.13 void QParticleSelector::on_pb_4_clicked (bool *checked*) [private], [slot]

Definition at line 68 of file qparticleselector.cpp.

References valueChanged().

6.53.3.14 void QParticleSelector::on_pb_5_clicked (bool *checked*) [private], [slot]

Definition at line 74 of file qparticleselector.cpp.

References valueChanged().

6.53.3.15 void QParticleSelector::on_pb_6_clicked (bool *checked*) [private], [slot]

Definition at line 80 of file qparticleselector.cpp.

References valueChanged().

6.53.3.16 void QParticleSelector::on_pb_7_clicked (bool *checked*) [private], [slot]

Definition at line 86 of file qparticleselector.cpp.

References valueChanged().

6.53.3.17 void QParticleSelector::on_pb_8_clicked (bool *checked*) [private], [slot]

Definition at line 92 of file qparticleselector.cpp.

References valueChanged().

6.53.3.18 void QParticleSelector::on_pb_9_clicked (bool *checked*) [private], [slot]

Definition at line 98 of file qparticleselector.cpp.

References valueChanged().

6.53.3.19 void QParticleSelector::setDisabled (bool *value*, int *currentClass* = 1)

Definition at line 39 of file qparticleselector.cpp.

References btns.

6.53.3.20 void QParticleSelector::setValue (int *newValue*) [slot]

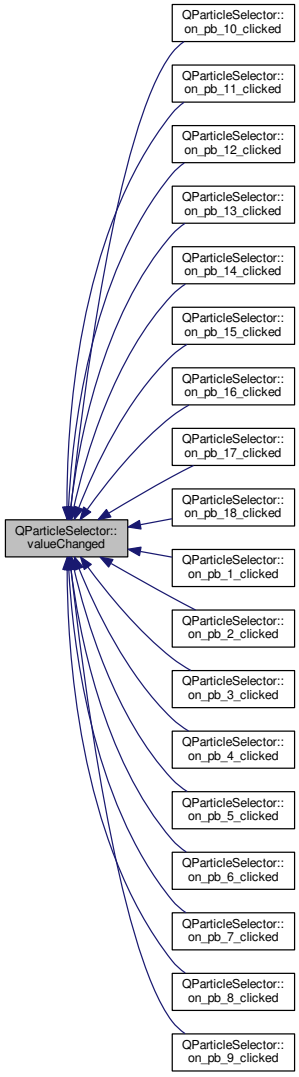
Definition at line 35 of file qparticleselector.cpp.

References btns.

6.53.3.21 void QParticleSelector::valueChanged (int *newValue*) [signal]

Referenced by on_pb_10_clicked(), on_pb_11_clicked(), on_pb_12_clicked(), on_pb_13_clicked(), on_pb_14_clicked(), on_pb_15_clicked(), on_pb_16_clicked(), on_pb_17_clicked(), on_pb_18_clicked(), on_pb_1_clicked(), on_pb_2_clicked(), on_pb_3_clicked(), on_pb_4_clicked(), on_pb_5_clicked(), on_pb_6_clicked(), on_pb_7_clicked(), on_pb_8_clicked(), and on_pb_9_clicked().

Here is the caller graph for this function:



6.53.4 Member Data Documentation

6.53.4.1 QVector<QPushButton *> QParticleSelector::btns [private]

Definition at line 65 of file qparticleselector.h.

Referenced by QParticleSelector(), setDisabled(), setValue(), and ~QParticleSelector().

6.53.4.2 Ui::QParticleSelector* QParticleSelector::ui [private]

Definition at line 66 of file qparticleselector.h.

Referenced by QParticleSelector(), and ~QParticleSelector().

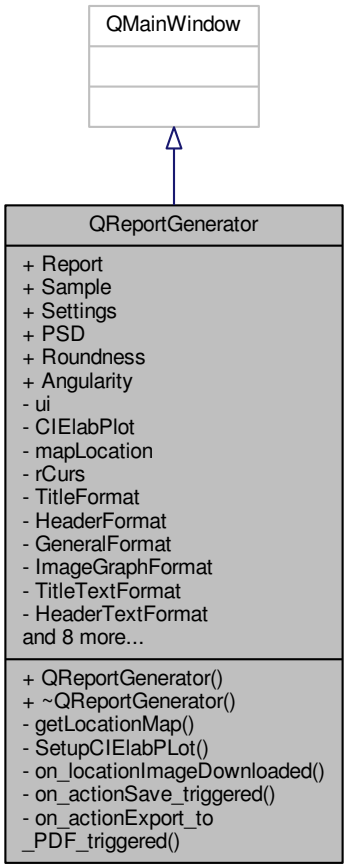
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/QParticleSelector/qparticleselector.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/QParticleSelector/qparticleselector.cpp

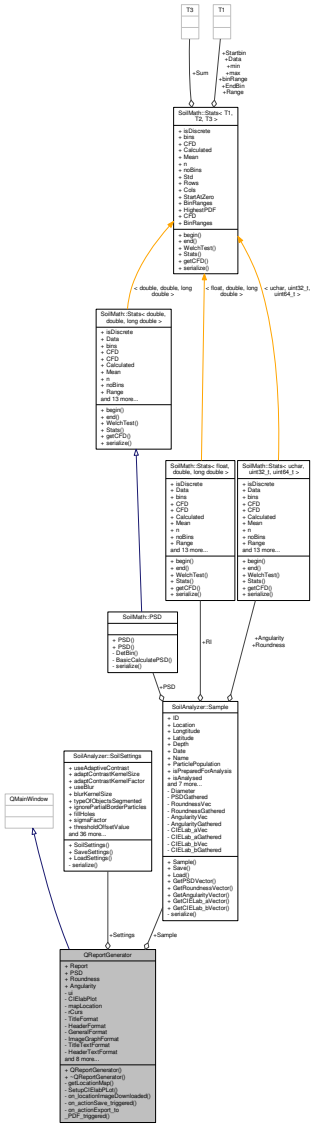
6.54 QReportGenerator Class Reference

`#include <qreportgenerator.h>`

Inheritance diagram for QReportGenerator:



Collaboration diagram for QReportGenerator:



Public Member Functions

- QReportGenerator (QWidget *parent=0, SoilAnalyzer::Sample *sample=nullptr, SoilAnalyzer::SoilSettings *settings=nullptr, QCustom↩ Plot *psd=nullptr, QCustomPlot *roundness=nullptr, QCustomPlot *angularity=nullptr)
- ~QReportGenerator ()

Public Attributes

- QTextDocument * Report = nullptr
- SoilAnalyzer::Sample * Sample = nullptr
- SoilAnalyzer::SoilSettings * Settings = nullptr
- QCustomPlot * PSD = nullptr
- QCustomPlot * Roundness = nullptr
- QCustomPlot * Angularity = nullptr

Private Slots

- void on_locationImageDownloaded (QNetworkReply *reply)
- void on_actionSave_triggered ()
- void on_actionExport_to_PDF_triggered ()

Private Member Functions

- void getLocationMap (double &latitude, double &longtitude)
- void SetupCIElabPLot ()

Private Attributes

- Ui::QReportGenerator * ui
- QCustomPlot * CIElabPlot = nullptr
- QImage * mapLocation = nullptr
- QTextCursor rCurs
- QTextBlockFormat TitleFormat
- QTextBlockFormat HeaderFormat
- QTextBlockFormat GeneralFormat
- QTextBlockFormat ImageGraphFormat
- QTextCharFormat TitleTextFormat
- QTextCharFormat HeaderTextFormat
- QTextCharFormat GtxtFormat
- QTextCharFormat GFieldtxtFormat
- QTextListFormat GeneralSampleList
- QTextTableFormat GeneralTextTableFormat
- QFont TitleFont
- QFont HeaderFont
- QFont GeneralFont
- QFont FieldFont

6.54.1 Detailed Description

Definition at line 25 of file qreportgenerator.h.

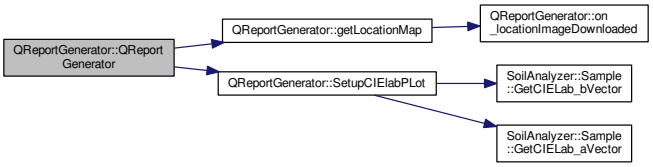
6.54.2 Constructor & Destructor Documentation

6.54.2.1 QReportGenerator::QReportGenerator (QWidget * *parent* = 0, SoilAnalyzer::Sample * *sample* = nullptr, SoilAnalyzer::SoilSettings * *settings* = nullptr, QCustomPlot * *psd* = nullptr, QCustomPlot * *roundness* = nullptr, QCustomPlot * *angularity* = nullptr) [explicit]

Definition at line 4 of file qreportgenerator.cpp.

References Angularity, SoilAnalyzer::Sample::Angularity, SoilMath::Stats< T1, T2, T3 >::bins, SoilMath::Stats< T1, T2, T3 >::CFD, CIElabPlot, SoilAnalyzer::Sample::Date, SoilAnalyzer::Sample::Depth, FieldFont, GeneralFont, GeneralFormat, GeneralSampleList, GeneralTextTableFormat, getLocationMap(), GFieldtxtFormat, GtxtFormat, HeaderFont, HeaderFormat, HeaderTextFormat, SoilAnalyzer::Sample::ID, ImageGraphFormat, SoilAnalyzer::Sample::Latitude, SoilAnalyzer::Sample::Longtitude, SoilMath::Stats< T1, T2, T3 >::max, SoilMath::Stats< T1, T2, T3 >::Mean, SoilMath::Stats< T1, T2, T3 >::min, SoilMath::Stats< T1, T2, T3 >::n, SoilAnalyzer::Sample::Name, SoilAnalyzer::Sample::PSD, SoilMath::Stats< T1, T2, T3 >::Range, rCurs, Report, Roundness, SoilAnalyzer::Sample::Roundness, Sample, Settings, SetupCIElabPLot(), SoilMath::Stats< T1, T2, T3 >::Std, TitleFont, TitleFormat, TitleTextFormat, and ui.

Here is the call graph for this function:



6.54.2.2 QReportGenerator::~QReportGenerator ( )

Definition at line 394 of file qreportgenerator.cpp.

References CIElabPlot, mapLocation, and ui.

6.54.3 Member Function Documentation

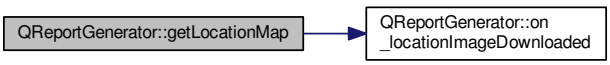
6.54.3.1 void QReportGenerator::getLocationMap (double & *latitude*, double & *longtitude*) [private]

Definition at line 357 of file qreportgenerator.cpp.

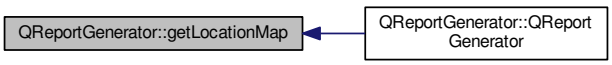
References on_locationImageDownloaded().

Referenced by QReportGenerator().

Here is the call graph for this function:



Here is the caller graph for this function:



6.54.3.2 void QReportGenerator::on_actionExport_to_PDF_triggered ( ) [private], [slot]

Definition at line 416 of file qreportgenerator.cpp.

References Report, SoilAnalyzer::SoilSettings::SampleFolder, and Settings.

6.54.3.3 void QReportGenerator::on_actionSave_triggered ( ) [private], [slot]

Definition at line 401 of file qreportgenerator.cpp.

References Report, SoilAnalyzer::SoilSettings::SampleFolder, and Settings.

6.54.3.4 void QReportGenerator::on_locationImageDownloaded (QNetworkReply * *reply*) [private], [slot]

Definition at line 376 of file qreportgenerator.cpp.

References ImageGraphFormat, mapLocation, and Report.

Referenced by getLocationMap().

Here is the caller graph for this function:

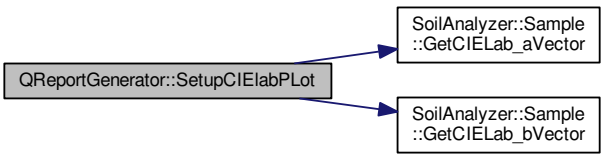
6.54.3.5 void QReportGenerator::SetupCIElabPLot ( ) [private]

Definition at line 431 of file qreportgenerator.cpp.

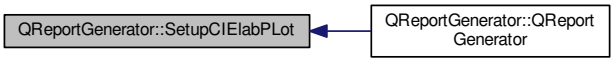
References CIElabPlot, SoilAnalyzer::Sample::GetCIELab_aVector(), SoilAnalyzer::Sample::GetCIELab_bVector(), and Sample.

Referenced by QReportGenerator().

Here is the call graph for this function:



Here is the caller graph for this function:



6.54.4 Member Data Documentation

6.54.4.1 QCustomPlot* QReportGenerator::Angularity = nullptr

Definition at line 35 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.2 QCustomPlot* QReportGenerator::CIElabPlot = nullptr [private]

Definition at line 49 of file qreportgenerator.h.

Referenced by QReportGenerator(), SetupCIElabPLot(), and ~QReportGenerator().

6.54.4.3 QFont QReportGenerator::FieldFont [private]

Definition at line 76 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.4 QFont QReportGenerator::GeneralFont [private]

Definition at line 75 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.5 QTextBlockFormat QReportGenerator::GeneralFormat [private]

Definition at line 61 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.6 QTextListFormat QReportGenerator::GeneralSampleList [private]

Definition at line 69 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.7 QTextTableFormat QReportGenerator::GeneralTextTableFormat [private]

Definition at line 70 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.8 QTextCharFormat QReportGenerator::GFieldtxtFormat [private]

Definition at line 67 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.9 QTextCharFormat QReportGenerator::GtxtFormat [private]

Definition at line 66 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.10 QFont QReportGenerator::HeaderFont [private]

Definition at line 74 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.11 QTextBlockFormat QReportGenerator::HeaderFormat [private]

Definition at line 60 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.12 QTextCharFormat QReportGenerator::HeaderTextFormat [private]

Definition at line 65 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.13 QTextBlockFormat QReportGenerator::ImageGraphFormat [private]

Definition at line 62 of file qreportgenerator.h.

Referenced by on_locationImageDownloaded(), and QReportGenerator().

6.54.4.14 QImage* QReportGenerator::mapLocation = nullptr [private]

Definition at line 54 of file qreportgenerator.h.

Referenced by on_locationImageDownloaded(), and ~QReportGenerator().

6.54.4.15 QCustomPlot* QReportGenerator::PSD = nullptr

Definition at line 33 of file qreportgenerator.h.

6.54.4.16 QTextCursor QReportGenerator::rCurs [private]

Definition at line 56 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.17 QTextDocument* QReportGenerator::Report = nullptr

Definition at line 30 of file qreportgenerator.h.

Referenced by on_actionExport_to_PDF_triggered(), on_actionSave_triggered(), on_locationImageDownloaded(), and QReportGenerator().

6.54.4.18 QCustomPlot* QReportGenerator::Roundness = nullptr

Definition at line 34 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.19 SoilAnalyzer::Sample* QReportGenerator::Sample = nullptr

Definition at line 31 of file qreportgenerator.h.

Referenced by QReportGenerator(), and SetupCIElabPLot().

6.54.4.20 SoilAnalyzer::SoilSettings* QReportGenerator::Settings = nullptr

Definition at line 32 of file qreportgenerator.h.

Referenced by on_actionExport_to_PDF_triggered(), on_actionSave_triggered(), and QReportGenerator().

6.54.4.21 QFont QReportGenerator::TitleFont [private]

Definition at line 73 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.22 QTextBlockFormat QReportGenerator::TitleFormat [private]

Definition at line 59 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.23 QTextCharFormat QReportGenerator::TitleTextFormat [private]

Definition at line 64 of file qreportgenerator.h.

Referenced by QReportGenerator().

6.54.4.24 Ui::QReportGenerator* QReportGenerator::ui [private]

Definition at line 48 of file qreportgenerator.h.

Referenced by QReportGenerator(), and ~QReportGenerator().

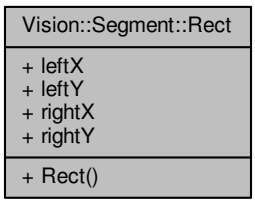
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/QReportGenerator/qreportgenerator.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/QReportGenerator/qreportgenerator.cpp

6.55 Vision::Segment::Rect Struct Reference

`#include <Segment.h>`

Collaboration diagram for Vision::Segment::Rect:



Public Member Functions

- Rect (uint16_t lx, uint16_t ly, uint16_t rx, uint16_t ry)

Public Attributes

- uint16_t leftX
- uint16_t leftY
- uint16_t rightX
- uint16_t rightY

6.55.1 Detailed Description

Coordinates for the region of interest

Definition at line 30 of file Segment.h.

6.55.2 Constructor & Destructor Documentation

6.55.2.1 Vision::Segment::Rect::Rect (uint16_t *lx*, uint16_t *ly*, uint16_t *rx*, uint16_t *ry*) [inline]

Definition at line 35 of file Segment.h.

6.55.3 Member Data Documentation

6.55.3.1 uint16_t Vision::Segment::Rect::leftX

Left X coordinate

Definition at line 31 of file Segment.h.

6.55.3.2 uint16_t Vision::Segment::Rect::leftY

Left Y coordinate

Definition at line 32 of file Segment.h.

6.55.3.3 uint16_t Vision::Segment::Rect::rightX

Right X coordinate

Definition at line 33 of file Segment.h.

6.55.3.4 uint16_t Vision::Segment::Rect::rightY

Right Y coordinate

Definition at line 34 of file Segment.h.

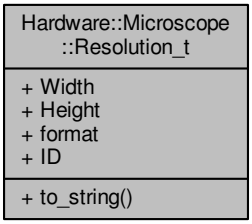
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Segment.h

6.56 Hardware::Microscope::Resolution_t Struct Reference

`#include <Microscope.h>`

Collaboration diagram for Hardware::Microscope::Resolution_t:



Public Member Functions

- std::string to_string ()

Public Attributes

- uint16_t Width = 2048
- uint16_t Height = 1536
- PixelFormat format = PixelFormat::MJPG
- uint32_t ID

6.56.1 Detailed Description

Definition at line 57 of file Microscope.h.

6.56.2 Member Function Documentation

6.56.2.1 std::string Hardware::Microscope::Resolution_t::to_string ( ) [inline]

Definition at line 61 of file Microscope.h.

6.56.3 Member Data Documentation

6.56.3.1 PixelFormat Hardware::Microscope::Resolution_t::format = PixelFormat::MJPG

Definition at line 60 of file Microscope.h.

Referenced by Hardware::Microscope::getResolutions(), and Hardware::Microscope::openCam().

6.56.3.2 uint16_t Hardware::Microscope::Resolution_t::Height = 1536

Definition at line 59 of file Microscope.h.

Referenced by Hardware::Microscope::getResolutions(), Hardware::Microscope::new_buffer(), and Hardware::Microscope::openCam().

6.56.3.3 uint32_t Hardware::Microscope::Resolution_t::ID

Definition at line 76 of file Microscope.h.

Referenced by Hardware::Microscope::getResolutions().

6.56.3.4 uint16_t Hardware::Microscope::Resolution_t::Width = 2048

Definition at line 58 of file Microscope.h.

Referenced by Hardware::Microscope::getResolutions(), Hardware::Microscope::new_buffer(), and Hardware::Microscope::openCam().

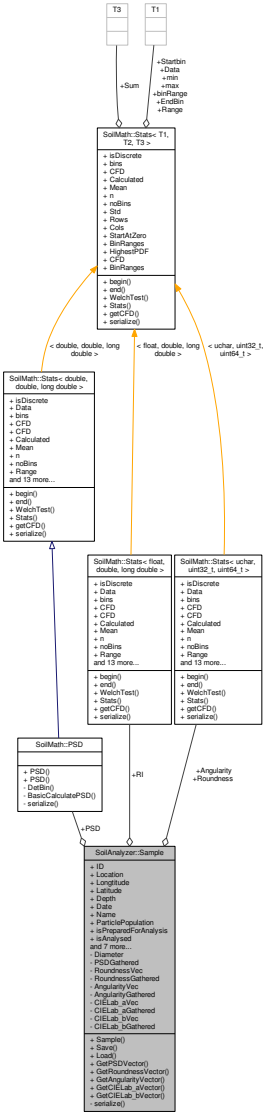
The documentation for this struct was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/Microscope.h

6.57 SoilAnalyzer::Sample Class Reference

```
#include <sample.h>
```

Collaboration diagram for SoilAnalyzer::Sample:



Public Member Functions

- Sample ()

  Sample::Sample.
- void Save (const std::string &filename)

  Sample::Save.
- void Load (const std::string &filename)

  Sample::Load.
- Particle::PSDVector_t * GetPSDVector ()

  Sample::GetPSDVector.
- Particle::ClassVector_t * GetRoundnessVector ()
- Particle::ClassVector_t * GetAngularityVector ()
- Particle::doubleVector_t * GetCIELab_aVector ()
- Particle::doubleVector_t * GetCIELab_bVector ()

Public Attributes

- uint32_t ID
- std::string Location
- double Longtitude = 4.629618299999947
- double Latitude = 51.8849149
- double Depth = 0
- std::string Date = "01-09-2015"
- std::string Name
- Particle::ParticleVector_t ParticlePopulation
- SoilMath::PSD PSD
- ucharStat_t Roundness
- ucharStat_t Angularity
- floatStat_t RI
- bool isPreparedForAnalysis
- bool isAnalysed = false
- bool ChangesSinceLastSave = false
- bool ParticleChangedStatePSD = false
- bool ParticleChangedStateClass = false
- bool ParticleChangedStateRoundness = false
- bool ParticleChangedStateAngularity = false
- bool ColorChange = false
- bool IsLoadedFromDisk = false

Private Member Functions

- template<class Archive >
  void serialize (Archive &ar, const unsigned int version)

Private Attributes

- Particle::PSDVector_t Diameter
- bool PSDGathered = false
- Particle::ClassVector_t RoundnessVec
- bool RoundnessGathered = false
- Particle::ClassVector_t AngularityVec
- bool AngularityGathered = false
- Particle::doubleVector_t CIELab_aVec
- bool CIELab_aGathered = false
- Particle::doubleVector_t CIELab_bVec
- bool CIELab_bGathered = false

Friends

- class boost::serialization::access

6.57.1 Detailed Description

Definition at line 28 of file sample.h.

6.57.2 Constructor & Destructor Documentation

6.57.2.1 SoilAnalyzer::Sample::Sample ( )

Sample::Sample.

Definition at line 17 of file sample.cpp.

6.57.3 Member Function Documentation

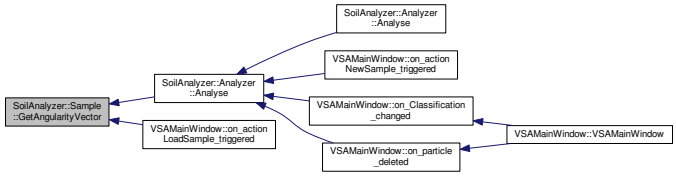
6.57.3.1 Particle::ClassVector_t * SoilAnalyzer::Sample::GetAngularityVector ( )

Definition at line 72 of file sample.cpp.

References AngularityGathered, AngularityVec, ParticleChangedStateAngularity, and ParticlePopulation.

Referenced by SoilAnalyzer::Analyzer::Analyse(), and VSAMainWindow::on_actionLoadSample_triggered().

Here is the caller graph for this function:



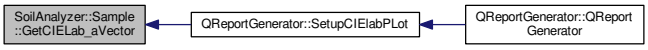
6.57.3.2 Particle::doubleVector_t * SoilAnalyzer::Sample::GetCIELab_aVector ( )

Definition at line 94 of file sample.cpp.

References CIELab_aGathered, CIELab_aVec, ColorChange, and ParticlePopulation.

Referenced by QReportGenerator::SetupCIElabPLot().

Here is the caller graph for this function:



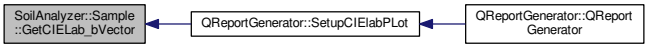
6.57.3.3 Particle::doubleVector_t * SoilAnalyzer::Sample::GetCIELab_bVector ( )

Definition at line 104 of file sample.cpp.

References CIELab_bGathered, CIELab_bVec, ColorChange, and ParticlePopulation.

Referenced by QReportGenerator::SetupCIElabPLot().

Here is the caller graph for this function:



6.57.3.4 Particle::PSDVector_t * SoilAnalyzer::Sample::GetPSDVector ( )

Sample::GetPSDVector.

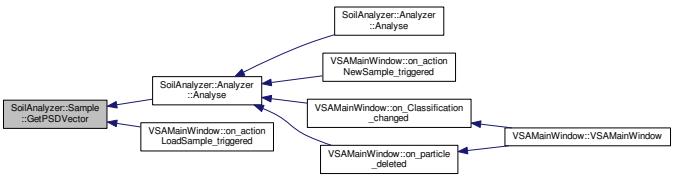
Returns

Definition at line 61 of file sample.cpp.

References Diameter, ParticleChangedStatePSD, ParticlePopulation, and PSDGathered.

Referenced by SoilAnalyzer::Analyzer::Analyse(), and VSAMainWindow::on_actionLoadSample_triggered().

Here is the caller graph for this function:



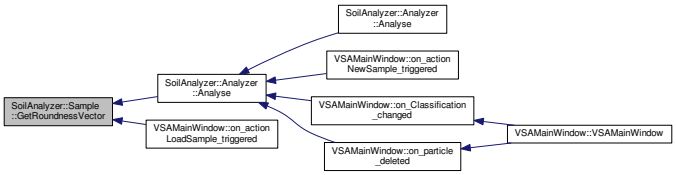
6.57.3.5 Particle::ClassVector_t * SoilAnalyzer::Sample::GetRoundnessVector ( )

Definition at line 83 of file sample.cpp.

References ParticleChangedStateRoundness, ParticlePopulation, RoundnessGathered, and RoundnessVec.

Referenced by SoilAnalyzer::Analyzer::Analyse(), and VSAMainWindow::on_actionLoadSample_triggered().

Here is the caller graph for this function:



6.57.3.6 void SoilAnalyzer::Sample::Load (const std::string & *filename*)

Sample::Load.

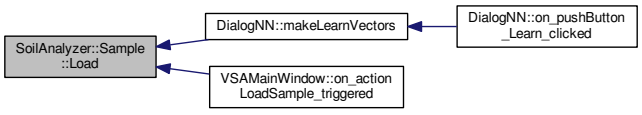
Parameters

filename	

Definition at line 42 of file sample.cpp.

Referenced by DialogNN::makeLearnVectors(), and VSAMainWindow::on_actionLoadSample_triggered().

Here is the caller graph for this function:



6.57.3.7 void SoilAnalyzer::Sample::Save (const std::string & *filename*)

Sample::Save.

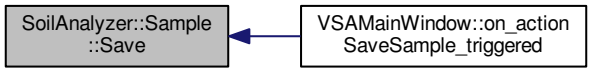
Parameters

filename	

Definition at line 23 of file sample.cpp.

Referenced by VSAMainWindow::on_actionSaveSample_triggered().

Here is the caller graph for this function:



6.57.3.8 template<class Archive > void SoilAnalyzer::Sample::serialize (Archive & *ar,* const unsigned int *version*) [inline], [private]

Definition at line 85 of file sample.h.

References Angularity, AngularityGathered, AngularityVec, ChangesSinceLastSave, CIELab_aGathered, CIELab_aVec, CIELab_bGathered, CIELab_bVec, ColorChange, Date, Depth, Diameter, ID, isAnalysed, IsLoadedFromDisk, isPreparedForAnalysis, Latitude, Location, Longtitude, Name, ParticleChangedStateAngularity, ParticleChangedStateClass, ParticleChangedStatePSD, ParticleChangedStateRoundness, Particle↩Population, PSD, PSDGathered, RI, Roundness, RoundnessGathered, and RoundnessVec.

6.57.4 Friends And Related Function Documentation

6.57.4.1 friend class boost::serialization::access [friend]

Definition at line 83 of file sample.h.

6.57.5 Member Data Documentation

6.57.5.1 ucharStat_t SoilAnalyzer::Sample::Angularity

Definition at line 45 of file sample.h.

Referenced by SoilAnalyzer::Analyzer::Analyse(), VSAMainWindow::on_actionLoadSample_triggered(), QReportGenerator::QReport↩Generator(), serialize(), and VSAMainWindow::setAngularityHistogram().

6.57.5.2 bool SoilAnalyzer::Sample::AngularityGathered = false [private]

Definition at line 77 of file sample.h.

Referenced by GetAngularityVector(), and serialize().

6.57.5.3 Particle::ClassVector_t SoilAnalyzer::Sample::AngularityVec [private]

Definition at line 76 of file sample.h.

Referenced by GetAngularityVector(), and serialize().

6.57.5.4 bool SoilAnalyzer::Sample::ChangesSinceLastSave = false

Definition at line 62 of file sample.h.

Referenced by VSAMainWindow::on_actionLoadSample_triggered(), VSAMainWindow::on_actionNewSample_triggered(), VSAMainWindow↩::on_actionSaveSample_triggered(), VSAMainWindow::on_Classification_changed(), QParticleDisplay::on_pushButton_delete_clicked(), and serialize().

6.57.5.5 bool SoilAnalyzer::Sample::CIELab_aGathered = false [private]

Definition at line 79 of file sample.h.

Referenced by GetCIELab_aVector(), and serialize().

6.57.5.6 Particle::doubleVector_t SoilAnalyzer::Sample::CIELab_aVec [private]

Definition at line 78 of file sample.h.

Referenced by GetCIELab_aVector(), and serialize().

6.57.5.7 bool SoilAnalyzer::Sample::CIELab_bGathered = false [private]

Definition at line 81 of file sample.h.

Referenced by GetCIELab_bVector(), and serialize().

6.57.5.8 Particle::doubleVector_t SoilAnalyzer::Sample::CIELab_bVec [private]

Definition at line 80 of file sample.h.

Referenced by GetCIELab_bVector(), and serialize().

6.57.5.9 bool SoilAnalyzer::Sample::ColorChange = false

Definition at line 67 of file sample.h.

Referenced by GetCIELab_aVector(), GetCIELab_bVector(), QParticleDisplay::on_pushButton_delete_clicked(), and serialize().

6.57.5.10 std::string SoilAnalyzer::Sample::Date = "01-09-2015"

Definition at line 37 of file sample.h.

Referenced by QReportGenerator::QReportGenerator(), and serialize().

6.57.5.11 double SoilAnalyzer::Sample::Depth = 0

Definition at line 36 of file sample.h.

Referenced by QReportGenerator::QReportGenerator(), and serialize().

6.57.5.12 Particle::PSDVector_t SoilAnalyzer::Sample::Diameter [private]

The PSD raw data

Definition at line 72 of file sample.h.

Referenced by GetPSDVector(), and serialize().

6.57.5.13 uint32_t SoilAnalyzer::Sample::ID

The sample ID

Definition at line 32 of file sample.h.

Referenced by QReportGenerator::QReportGenerator(), and serialize().

6.57.5.14 bool SoilAnalyzer::Sample::isAnalysed = false

is the sample analyzed

Definition at line 60 of file sample.h.

Referenced by serialize().

6.57.5.15 bool SoilAnalyzer::Sample::IsLoadedFromDisk = false

Definition at line 69 of file sample.h.

Referenced by SoilAnalyzer::Analyzer::Analyse(), VSAMainWindow::on_actionSaveSample_triggered(), and serialize().

6.57.5.16 bool SoilAnalyzer::Sample::isPreparedForAnalysis

Initial value:

```
=
    false
```

is the sample ready for analysis, are all the particles extracted

Definition at line 57 of file sample.h.

Referenced by SoilAnalyzer::Analyzer::Analyse(), SoilAnalyzer::Analyzer::PrepImages(), and serialize().

6.57.5.17 double SoilAnalyzer::Sample::Latitude = 51.8849149

Definition at line 35 of file sample.h.

Referenced by QReportGenerator::QReportGenerator(), and serialize().

6.57.5.18 std::string SoilAnalyzer::Sample::Location

The Location where the sample was taken

Definition at line 33 of file sample.h.

Referenced by serialize().

6.57.5.19 double SoilAnalyzer::Sample::Longtitude = 4.629618299999947

Definition at line 34 of file sample.h.

Referenced by QReportGenerator::QReportGenerator(), and serialize().

6.57.5.20 std::string SoilAnalyzer::Sample::Name

The sample name identifier

Definition at line 38 of file sample.h.

Referenced by QReportGenerator::QReportGenerator(), and serialize().

6.57.5.21 bool SoilAnalyzer::Sample::ParticleChangedStateAngularity = false

Definition at line 66 of file sample.h.

Referenced by GetAngularityVector(), VSAMainWindow::on_Classification_changed(), QParticleDisplay::on_pushButton_delete_clicked(), and serialize().

6.57.5.22 bool SoilAnalyzer::Sample::ParticleChangedStateClass = false

Definition at line 64 of file sample.h.

Referenced by serialize().

6.57.5.23 bool SoilAnalyzer::Sample::ParticleChangedStatePSD = false

Definition at line 63 of file sample.h.

Referenced by GetPSDVector(), QParticleDisplay::on_pushButton_delete_clicked(), and serialize().

6.57.5.24 bool SoilAnalyzer::Sample::ParticleChangedStateRoundness = false

Definition at line 65 of file sample.h.

Referenced by GetRoundnessVector(), VSAMainWindow::on_Classification_changed(), QParticleDisplay::on_pushButton_delete_clicked(), and serialize().

6.57.5.25 Particle::ParticleVector_t SoilAnalyzer::Sample::ParticlePopulation

the individual particles of the sample

Definition at line 41 of file sample.h.

Referenced by SoilAnalyzer::Analyzer::Analyse(), SoilAnalyzer::Analyzer::CalcMaxProgressAnalyze(), GetAngularityVector(), GetCIELab_aVector(), GetCIELab_bVector(), GetPSDVector(), GetRoundnessVector(), DialogNN::makeLearnVectors(), VSAMainWindow::on_actionNewSample_triggered(), VSAMainWindow::on_analyzer_finished(), QParticleDisplay::on_pushButton_delete_clicked(), QParticleDisplay::on_selectedParticleChangedSlider(), QParticleDisplay::on_selectedParticleChangedWidget(), SoilAnalyzer::Analyzer::PrepImages(), serialize(), and QParticleDisplay::SetSample().

6.57.5.26 SoilMath::PSD SoilAnalyzer::Sample::PSD

The Particle Size Distribution

Definition at line 43 of file sample.h.

Referenced by SoilAnalyzer::Analyzer::Analyse(), VSAMainWindow::on_actionLoadSample_triggered(), QReportGenerator::QReportGenerator(), serialize(), and VSAMainWindow::SetPSDgraph().

6.57.5.27 bool SoilAnalyzer::Sample::PSDGathered = false [private]

is the raw data gathered

Definition at line 73 of file sample.h.

Referenced by GetPSDVector(), and serialize().

6.57.5.28 floatStat_t SoilAnalyzer::Sample::RI

The statistical Redness Index data

Definition at line 46 of file sample.h.

Referenced by serialize().

6.57.5.29 ucharStat_t SoilAnalyzer::Sample::Roundness

Definition at line 44 of file sample.h.

Referenced by SoilAnalyzer::Analyzer::Analyse(), VSAMainWindow::on_actionLoadSample_triggered(), QReportGenerator::QReportGenerator(), serialize(), and VSAMainWindow::setRoundnessHistogram().

6.57.5.30 bool SoilAnalyzer::Sample::RoundnessGathered = false [private]

Definition at line 75 of file sample.h.

Referenced by GetRoundnessVector(), and serialize().

6.57.5.31 Particle::ClassVector_t SoilAnalyzer::Sample::RoundnessVec [private]

Definition at line 74 of file sample.h.

Referenced by GetRoundnessVector(), and serialize().

The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/sample.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/sample.cpp

6.58 Segment Class Reference

Segmentation algorithms With this class, various segmentation routines can be applied to a greyscale or black and white source image.

Collaboration diagram for Segment:

6.58.1 Detailed Description

Segmentation algorithms With this class, various segmentation routines can be applied to a greyscale or black and white source image.

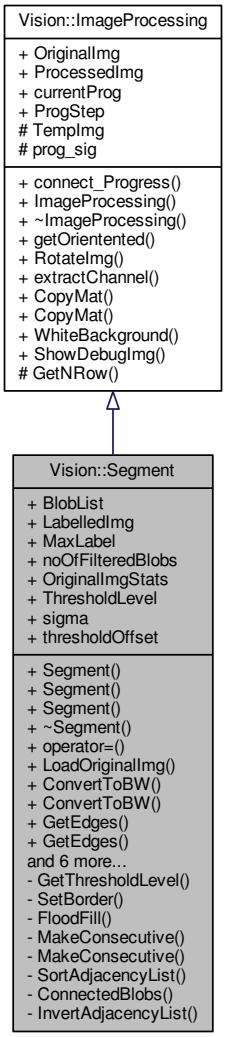
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Segment.cpp

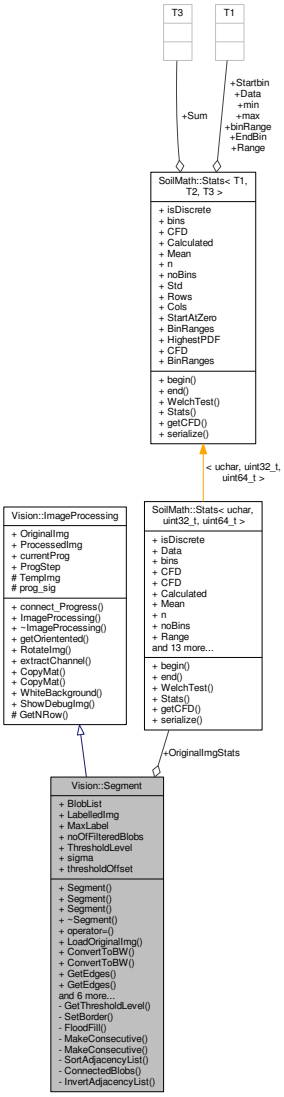
6.59 Vision::Segment Class Reference

```
#include <Segment.h>
```

Inheritance diagram for Vision::Segment:



Collaboration diagram for Vision::Segment:



Classes

- struct Blob
- struct Rect

Public Types

- enum TypeOfObjects { Bright, Dark }
- enum Connected { Four, Eight }
- enum SegmentationType { Normal, LabNeuralNet, GraphMinCut }
- typedef struct Vision::Segment::Rect Rect_t
- typedef std::vector< Vision::Segment::Rect_t > RectList_t
- typedef struct Vision::Segment::Blob Blob_t
- typedef std::vector< Blob_t > BlobList_t

Public Member Functions

- Segment ()
  Constructor of the Segmentation class.
- Segment (const Mat &src)
  Constructor of the Segmentation class.
- Segment (const Segment &rhs)
- ~Segment ()
  De-constructor.
- Segment & operator= (Segment &rhs)
- void LoadOriginalImg (const Mat &src)
- void ConvertToBW (TypeOfObjects Typeobjects)
- void ConvertToBW (const Mat &src, Mat &dst, TypeOfObjects Typeobjects)
- void GetEdges (bool chain=false, Connected conn=Eight)
- void GetEdges (const Mat &src, Mat &dst, bool chain=false, Connected conn=Eight)
- void GetEdgesEroding (bool chain=false)
- void GetBlobList (bool chain=false, Connected conn=Eight)
- void Threshold (uchar t, TypeOfObjects Typeobjects)
- void LabelBlobs (bool chain=false, uint16_t minBlobArea=25, Connected conn=Eight)
- void RemoveBorderBlobs (uint32_t border=1, bool chain=false)
- void FillHoles (bool chain=false)

Public Attributes

- BlobList_t BlobList
- cv::Mat LabelledImg
- uint16_t MaxLabel = 0
- uint16_t noOfFilteredBlobs
- ucharStat_t OriginalImgStats
- uint8_t ThresholdLevel = 0
- float sigma = 2
- uint32_t thresholdOffset = 4

Private Member Functions

- uint8_t GetThresholdLevel (TypeOfObjects TypeObject)
- void SetBorder (uchar *P, uchar setValue)
- void FloodFill (uchar *O, uchar *P, uint16_t x, uint16_t y, uchar fillValue, uchar OldValue)
- void MakeConsecutive (uint16_t *valueArr, uint32_t noElem, uint16_t &maxlabel)
  Segment::MakeConsecutive make the valueArr consequative numbers.
- void MakeConsecutive (uint16_t *valueArr, uint16_t *keyArr, uint16_t noElem, uint16_t &maxlabel)
  Segment::MakeConsecutive probably a fault in this function. Don't use.
- void SortAdjacencyList (std::vector< std::vector< uint16_t >> &adj)
  Segment::SortAdjacencyList Sort the the sub vectors.
- void ConnectedBlobs (uchar *O, uint16_t *P, std::vector< std::vector< uint16_t >> &adj, uint32_t nCols, uint32_t nRows, Connected conn)
  Segment::ConnectedBlobs Connect all the blobs and created the adjacency list.
- void InvertAdjacencyList (std::vector< std::vector< uint16_t >> &adj, std::vector< std::vector< uint16_t >> &adjInv)
  Segment::InvertAdjacencyList invert the adjecencylist for upstream (unused)

Additional Inherited Members

6.59.1 Detailed Description

Definition at line 27 of file Segment.h.

6.59.2 Member Typedef Documentation

6.59.2.1 typedef struct Vision::Segment::Blob Vision::Segment::Blob_t

Individual blob

6.59.2.2 typedef std::vector<Blob_t> Vision::Segment::BlobList_t

Definition at line 54 of file Segment.h.

6.59.2.3 typedef struct Vision::Segment::Rect Vision::Segment::Rect_t

Coordinates for the region of interest

6.59.2.4 typedef std::vector<Vision::Segment::Rect_t> Vision::Segment::RectList_t

Definition at line 39 of file Segment.h.

6.59.3 Member Enumeration Documentation

6.59.3.1 enum Vision::Segment::Connected

Enumerator to indicate how the pixel correlate between each other in a blob

Enumerator

Four Enum Four connected, relation between Center, North, East, South and West

Eight Enum Eight connected, relation between Center, North, NorthEast, East, SouthEast, South, SouthWest, West and NorthWest

Definition at line 65 of file Segment.h.

6.59.3.2 enum Vision::Segment::SegmentationType

Enumerator

Normal Segmentation looking at the intensity of an individual pixel

LabNeuralNet Segmentation looking at the chromatic a∗ and b∗ of the processed pixel and it's surrounding pixels, feeding it in an Neural Net

GraphMinCut Segmentation using a graph function and the minimum cut

Definition at line 75 of file Segment.h.

6.59.3.3 enum Vision::Segment::TypeOfObjects

Enumerator to indicate what kind of object to extract

Enumerator

Bright Enum value Bright object

Dark Enum value Dark object.

Definition at line 58 of file Segment.h.

6.59.4 Constructor & Destructor Documentation

6.59.4.1 Segment::Segment ( )

Constructor of the Segmentation class.

Definition at line 17 of file Segment.cpp.

6.59.4.2 Segment::Segment (const Mat & *src*)

Constructor of the Segmentation class.

Definition at line 20 of file Segment.cpp.

References LabelledImg, Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

6.59.4.3 Segment::Segment (const Segment & *rhs*)

Definition at line 26 of file Segment.cpp.

References BlobList, LabelledImg, MaxLabel, noOfFilteredBlobs, Vision::ImageProcessing::OriginalImg, OriginalImgStats, Vision::ImageProcessing::ProcessedImg, Vision::ImageProcessing::TempImg, and ThresholdLevel.

6.59.4.4 Segment::~Segment ( )

De-constructor.

Definition at line 39 of file Segment.cpp.

6.59.5 Member Function Documentation

6.59.5.1 void Segment::ConnectedBlobs (uchar * *O*, uint16_t * *P*, std::vector< std::vector< uint16_t >> & *adj*, uint32_t *nCols*, uint32_t *nRows*, Connected *conn*) [private]

Segment::ConnectedBlobs Connect all the blobs and created the adjacency list.

Parameters

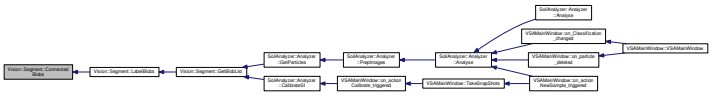
O	
P	
adj	
nCols	
nRows	
conn	

Definition at line 688 of file Segment.cpp.

References Four, and Vision::ImageProcessing::OriginalImg.

Referenced by LabelBlobs().

Here is the caller graph for this function:



6.59.5.2 void Segment::ConvertToBW (TypeOfObjects *Typeobjects*)

Convert a greyscale image to a BW using an automatic Threshold

Parameters

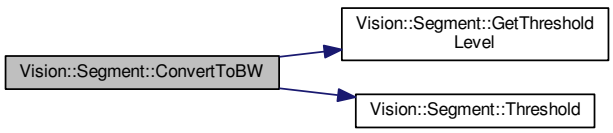
TypeObject	is an enumerator indicating if the bright or the dark pixels are the object and should be set to one

Definition at line 164 of file Segment.cpp.

References GetThresholdLevel(), and Threshold().

Referenced by SoilAnalyzer::Analyzer::CalibrateSI(), and ConvertToBW().

Here is the call graph for this function:



Here is the caller graph for this function:

6.59.5.3 void Segment::ConvertToBW (const Mat & *src*, Mat & *dst*, TypeOfObjects *Typeobjects*)

Convert a greyscale image to a BW using an automatic Threshold

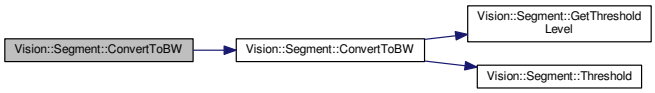
Parameters

src	is the source image as a cv::Mat
dst	destination image as a cv::Mat
TypeObject	is an enumerator indicating if the bright or the dark pixels are the object and should be set to one

Definition at line 153 of file Segment.cpp.

References ConvertToBW(), LabelledImg, Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

Here is the call graph for this function:



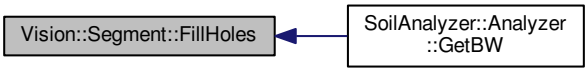
6.59.5.4 void Segment::FillHoles (bool *chain* = `false`)

Definition at line 615 of file Segment.cpp.

References CHAIN_PROCESS, EMPTY_CHECK, Vision::ImageProcessing::OriginalImg, Vision::ImageProcessing::ProcessedImg, and Vision::ImageProcessing::TempImg.

Referenced by SoilAnalyzer::Analyzer::GetBW().

Here is the caller graph for this function:



6.59.5.5 void Vision::Segment::FloodFill (uchar * *O*, uchar * *P*, uint16_t *x*, uint16_t *y*, uchar *fillValue*, uchar *OldValue*) [private]

6.59.5.6 void Segment::GetBlobList (bool *chain* = `false`, Connected *conn* = Eight)

Create a BlobList subtracting each individual blob out of a Labelled image. If the labelled image is empty build a new one with a BW image.

Parameters

conn	set the pixel connection eight or four
chain	use the results from the previous operation default value = false;

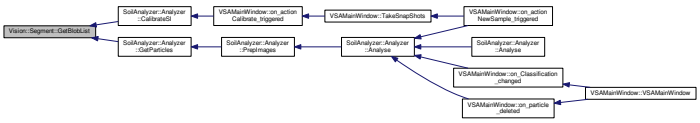
Definition at line 534 of file Segment.cpp.

References SoilMath::Stats< T1, T2, T3 >::bins, BlobList, EMPTY_CHECK, SoilMath::Stats< T1, T2, T3 >::EndBin, LabelBlobs(), LabelledImg, MaxLabel, and Vision::ImageProcessing::OriginalImg.

Referenced by SoilAnalyzer::Analyzer::CalibrateSI(), and SoilAnalyzer::Analyzer::GetParticles().

Here is the call graph for this function:

Here is the caller graph for this function:



6.59.5.7 void Segment::GetEdges (bool *chain* = `false`, Connected *conn* = Eight)

Create a BW image with only edges from a BW image

Parameters

conn	set the pixel connection eight or four
chain	use the results from the previous operation default value = false;

Definition at line 399 of file Segment.cpp.

References CHAIN_PROCESS, EMPTY_CHECK, Four, Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

Referenced by GetEdges().

Here is the caller graph for this function:

6.59.5.8 void Segment::GetEdges (const Mat & *src*, Mat & *dst*, bool *chain* = `false`, Connected *conn* = Eight)

Create a BW image with only edges from a BW image

Parameters

src	source image as a const cv::Mat
dst	destination image as a cv::Mat
conn	set the pixel connection eight or four
chain	use the results from the previous operation default value = false;

Definition at line 389 of file Segment.cpp.

References GetEdges(), Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

Here is the call graph for this function:

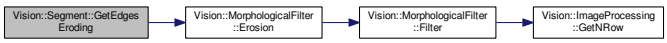
6.59.5.9 void Segment::GetEdgesEroding (bool *chain* = `false`)

Definition at line 483 of file Segment.cpp.

References CHAIN_PROCESS, EMPTY_CHECK, Vision::MorphologicalFilter::Erosion(), Vision::ImageProcessing::OriginalImg, Vision::↩ ImageProcessing::ProcessedImg, SHOW_DEBUG_IMG, and Vision::ImageProcessing::TempImg.

Referenced by SoilAnalyzer::Analyzer::GetParticlesFromBlobList().

Here is the call graph for this function:



Here is the caller graph for this function:

6.59.5.10 uint8_t Segment::GetThresholdLevel (TypeOfObjects *TypeObject*) `[private]`

Determine the threshold level by iteration, between two distribution, presumably back- and foreground. It works towards the average of the two averages and finally sets the threshold with two time the standard deviation from the mean of the set object

Parameters

TypeObject	is an enumerator indicating if the bright or the dark pixels are the object and should be set to one

Returns

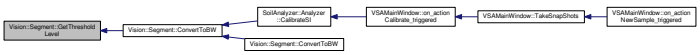
The threshold level as an uint8_t

Definition at line 69 of file Segment.cpp.

References SoilMath::Stats< T1, T2, T3 >::bins, Bright, Dark, EMPTY_CHECK, SoilMath::Stats< T1, T2, T3 >::Mean, Vision::Image↩ Processing::OriginalImg, OriginalImgStats, sigma, SoilMath::Stats< T1, T2, T3 >::Std, and thresholdOffset.

Referenced by ConvertToBW().

Here is the caller graph for this function:



6.59.5.11 void Segment::InvertAdjacencyList (std::vector< std::vector< uint16_t >> & *adj*, std::vector< std::vector< uint16_t >> & *adjInv*) `[private]`

Segment::InvertAdjacencyList invert the adjecencylist for upstream (unused)

Parameters

adj	
adjInv	

Definition at line 801 of file Segment.cpp.

6.59.5.12 void Segment::LabelBlobs (bool *chain* = `false`, uint16_t *minBlobArea* = `25`, Connected *conn* = Eight)

Label all the individual blobs in a BW source image. The result are written to the labelledImg as an ushort

Parameters

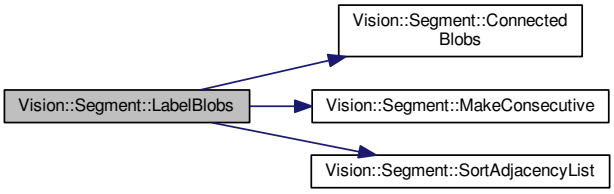
conn	set the pixel connection eight or four
chain	use the results from the previous operation default value = false;
minBlobArea	minimum area when an artifact is considered a blob

Definition at line 316 of file Segment.cpp.

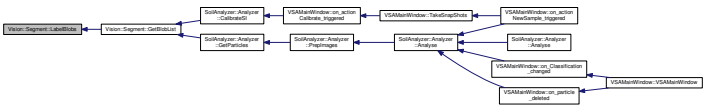
References ConnectedBlobs(), EMPTY_CHECK, LabelledImg, MakeConsecutive(), MaxLabel, Vision::ImageProcessing::OriginalImg, Vision::ImageProcessing::ProcessedImg, SortAdjacencyList(), and Vision::ImageProcessing::TempImg.

Referenced by GetBlobList().

Here is the call graph for this function:



Here is the caller graph for this function:



6.59.5.13 void Segment::LoadOriginalImg (const Mat & *src*)

Definition at line 56 of file Segment.cpp.

References LabelledImg, Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

6.59.5.14 void Segment::MakeConsecutive (uint16_t * *valueArr*, uint32_t *noElem*, uint16_t & *maxLabel*) [private]

Segment::MakeConsecutive make the valueArr consequative numbers.

Parameters

valueArr	
noElem	
maxLabel	

Definition at line 819 of file Segment.cpp.

Referenced by LabelBlobs().

Here is the caller graph for this function:

6.59.5.15 void Segment::MakeConsecutive (uint16_t * *valueArr*, uint16_t * *keyArr*, uint16_t *noElem*, uint16_t & *maxlabel*) [private]

Segment::MakeConsecutive probably a fault in this function. Don't use.

Parameters

valueArr	
keyArr	
noElem	
maxlabel	

Definition at line 845 of file Segment.cpp.

6.59.5.16 Segment & Segment::operator= (Segment & *rhs*)

Definition at line 41 of file Segment.cpp.

References BlobList, LabelledImg, MaxLabel, noOfFilteredBlobs, Vision::ImageProcessing::OriginalImg, OriginalImgStats, Vision::ImageProcessing::ProcessedImg, Vision::ImageProcessing::TempImg, and ThresholdLevel.

6.59.5.17 void Segment::RemoveBorderBlobs (uint32_t *border* = 1, bool *chain* = false)

Remove the blobs that are connected to the border

Parameters

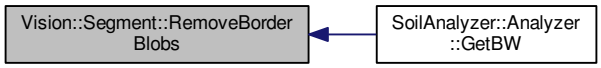
conn	set the pixel connection eight or four
chain	use the results from the previous operation default value = false;

Definition at line 245 of file Segment.cpp.

References CHAIN_PROCESS, EMPTY_CHECK, Vision::ImageProcessing::OriginalImg, Vision::ImageProcessing::ProcessedImg, SHOW_DEBUG_IMG, and Vision::ImageProcessing::TempImg.

Referenced by SoilAnalyzer::Analyzer::GetBW().

Here is the caller graph for this function:



6.59.5.18 void Segment::SetBorder (uchar * *P*, uchar *setValue*) [private]

Set all the border pixels to a set value

Parameters

*P	uchar pointer to the Mat.data
setValue	uchar the value which is written to the border pixels

Definition at line 208 of file Segment.cpp.

References EMPTY_CHECK, and Vision::ImageProcessing::OriginalImg.

6.59.5.19 void Segment::SortAdjacencyList (std::vector< std::vector< uint16_t >> & *adj*) [private]

Segment::SortAdjacencyList Sort the the sub vectors.

Parameters

adj	std::vector<std::vector<uint16_t>> &adj

Definition at line 658 of file Segment.cpp.

Referenced by LabelBlobs().

Here is the caller graph for this function:

6.59.5.20 void Segment::Threshold (uchar *t*, TypeOfObjects *Typeobjects*)

Convert a greyscale image to a BW

Parameters

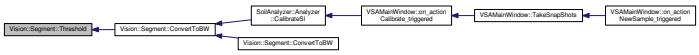
t	uchar set the value which is the tiping point
TypeObject	is an enumerator indicating if the bright or the dark pixels are the object and should be set to one

Definition at line 176 of file Segment.cpp.

References Bright, EMPTY_CHECK, Vision::ImageProcessing::OriginalImg, and Vision::ImageProcessing::ProcessedImg.

Referenced by ConvertToBW().

Here is the caller graph for this function:



6.59.6 Member Data Documentation

6.59.6.1 BlobList_t Vision::Segment::BlobList

vector with all the individual blobs

Definition at line 55 of file Segment.h.

Referenced by SoilAnalyzer::Analyzer::CalibrateSI(), GetBlobList(), SoilAnalyzer::Analyzer::GetParticles(), operator=(), and Segment().

6.59.6.2 cv::Mat Vision::Segment::LabelledImg

Image with each individual blob labeled with a individual number

Definition at line 83 of file Segment.h.

Referenced by ConvertToBW(), GetBlobList(), LabelBlobs(), LoadOriginalImg(), operator=(), and Segment().

6.59.6.3 uint16_t Vision::Segment::MaxLabel = 0

Maximum labels found in the labelled image

Definition at line 85 of file Segment.h.

Referenced by GetBlobList(), LabelBlobs(), operator=(), and Segment().

6.59.6.4 uint16_t Vision::Segment::noOfFilteredBlobs

Initial value:

=
0

Total numbers of blobs that where filtered beacuse the where smaller than the minBlobArea

Definition at line 86 of file Segment.h.

Referenced by operator=(), and Segment().

6.59.6.5 ucharStat_t Vision::Segment::OriginalImgStats

Statistical data from the original image

Definition at line 90 of file Segment.h.

Referenced by GetThresholdLevel(), operator=(), and Segment().

6.59.6.6 float Vision::Segment::sigma = 2

Definition at line 93 of file Segment.h.

Referenced by SoilAnalyzer::Analyzer::GetBW(), and GetThresholdLevel().

6.59.6.7 uint8_t Vision::Segment::ThresholdLevel = 0

Current calculated threshold level

Definition at line 91 of file Segment.h.

Referenced by operator=(), and Segment().

6.59.6.8 uint32_t Vision::Segment::thresholdOffset = 4

Definition at line 94 of file Segment.h.

Referenced by GetThresholdLevel().

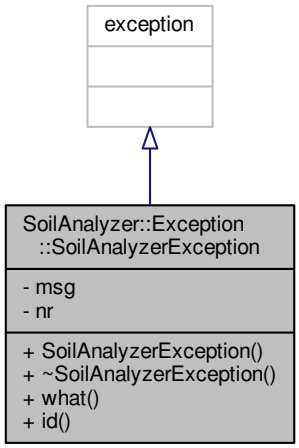
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Segment.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/Segment.cpp

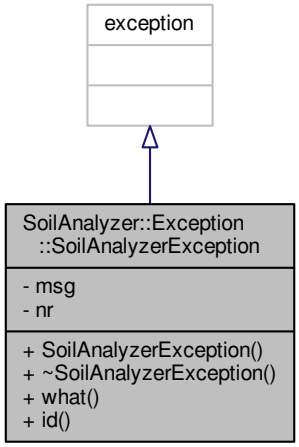
6.60 SoilAnalyzer::Exception::SoilAnalyzerException Class Reference

`#include <soilanalyzerexception.h>`

Inheritance diagram for SoilAnalyzer::Exception::SoilAnalyzerException:



Collaboration diagram for SoilAnalyzer::Exception::SoilAnalyzerException:



Public Member Functions

- SoilAnalyzerException (std::string m=EXCEPTION_PARTICLE_NOT_ANALYZED, int n=EXCEPTION_PARTICLE_NOT_ANALYZED↩ _NR)
- ~SoilAnalyzerException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT
- const int * id () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- std::string msg
- int nr

6.60.1 Detailed Description

Definition at line 20 of file soilanalyzerexception.h.

6.60.2 Constructor & Destructor Documentation

6.60.2.1 SoilAnalyzer::Exception::SoilAnalyzerException::SoilAnalyzerException (std::string *m* = EXCEPTION_PARTICLE_NOT_ANALYZED, int *n* = EXCEPTION_PARTICLE_NOT_ANALYZED_NR) [inline]

Definition at line 22 of file soilanalyzerexception.h.

6.60.2.2 SoilAnalyzer::Exception::SoilAnalyzerException::~SoilAnalyzerException ( ) [inline]

Definition at line 24 of file soilanalyzerexception.h.

6.60.3 Member Function Documentation

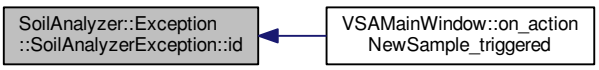
6.60.3.1 const int* SoilAnalyzer::Exception::SoilAnalyzerException::id ( ) const [inline]

Definition at line 26 of file soilanalyzerexception.h.

References nr.

Referenced by VSAMainWindow::on_actionNewSample_triggered().

Here is the caller graph for this function:



6.60.3.2 const char* SoilAnalyzer::Exception::SoilAnalyzerException::what ( ) const [inline]

Definition at line 25 of file soilanalyzerexception.h.

References msg.

6.60.4 Member Data Documentation

6.60.4.1 std::string SoilAnalyzer::Exception::SoilAnalyzerException::msg [private]

Definition at line 29 of file soilanalyzerexception.h.

Referenced by what().

6.60.4.2 int SoilAnalyzer::Exception::SoilAnalyzerException::nr [private]

Definition at line 30 of file soilanalyzerexception.h.

Referenced by id().

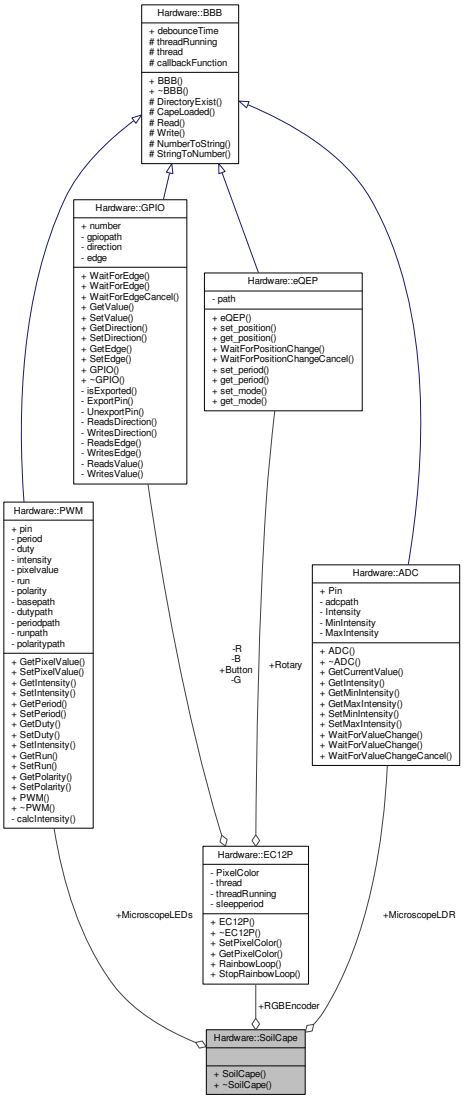
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/soilanalyzerexception.h

6.61 Hardware::SoilCape Class Reference

```
#include <SoilCape.h>
```

Collaboration diagram for Hardware::SoilCape:



Public Member Functions

- SoilCape ()
- ~SoilCape ()

Public Attributes

- EC12P RGBEncoder
- PWM MicroscopeLEDs {PWM::P9_14}
- ADC MicroscopeLDR {ADC::ADC0}

6.61.1 Detailed Description

Definition at line 16 of file SoilCape.h.

6.61.2 Constructor & Destructor Documentation

6.61.2.1 Hardware::SoilCape::SoilCape ( )

Definition at line 11 of file SoilCape.cpp.

6.61.2.2 Hardware::SoilCape::~SoilCape ( )

Definition at line 13 of file SoilCape.cpp.

6.61.3 Member Data Documentation

6.61.3.1 ADC Hardware::SoilCape::MicroscopeLDR {ADC::ADC0}

Definition at line 20 of file SoilCape.h.

6.61.3.2 PWM Hardware::SoilCape::MicroscopeLEDs {PWM::P9_14}

Definition at line 19 of file SoilCape.h.

6.61.3.3 EC12P Hardware::SoilCape::RGBEncoder

Definition at line 18 of file SoilCape.h.

The documentation for this class was generated from the following files:

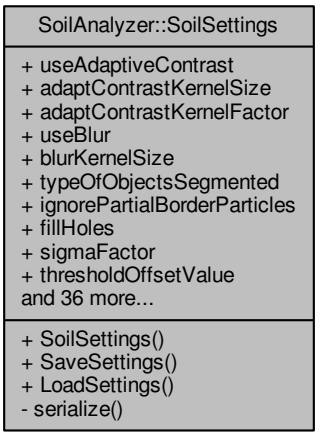
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/SoilCape.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/SoilCape.cpp

6.62 SoilAnalyzer::SoilSettings Class Reference

The SoilSettings class.

`#include <soilsettings.h>`

Collaboration diagram for SoilAnalyzer::SoilSettings:



Public Member Functions

- SoilSettings ()
- void SaveSettings (std::string filename)

  SaveSettings a function to save the settings to disk.

- void LoadSettings (std::string filename)

  LoadSettings a function to load the settings from disk.

Public Attributes

- bool useAdaptiveContrast
- uint32_t adaptContrastKernelSize
- float adaptContrastKernelFactor = 1.
- bool useBlur = false
- uint32_t blurKernelSize = 5
- Vision::Segment::TypeOfObjects typeOfObjectsSegmented
- bool ignorePartialBorderParticles
- bool fillHoles = true
- float sigmaFactor = 2
- int thresholdOffsetValue = 0
- Vision::MorphologicalFilter::FilterType morphFilterType
- uint32_t filterMaskSize = 5
- uint32_t HDRframes
- float lightLevel = 0.5
- bool encInv = false
- bool enableRainbow
- bool useBacklightProjection = true
- bool useHDR = false
- std::string defaultWebcam = "USB Microscope"
- int Brightness_front = 0
- int Brightness_proj = -10
- int Contrast_front = 36
- int Contrast_proj = 36
- int Saturation_front = 64
- int Saturation_proj = 0
- int Hue_front = 0
- int Hue_proj = -40
- int Gamma_front = 100
- int Gamma_proj = 200
- int PowerLineFrequency_front
- int PowerLineFrequency_proj
- int Sharpness_front = 12
- int Sharpness_proj = 25
- int BackLightCompensation_front
- int BackLightCompensation_proj
- std::string NNlocation = "NeuralNet/Default.NN"
- bool useCUDA = false
- int selectedResolution = 0
- std::string SampleFolder = "~/Samples"
- std::string SettingsFolder = "Settings"
- std::string NNFolder = "NeuralNet"
- std::string StandardSentTo = "j.spijker@ihcmerwede.com"
- std::string StandardPrinter = "PDF printer"
- uint32_t StandardNumberOfShots = 10
- bool PredictTheShape = true
- bool Revolution = true

Private Member Functions

- template<class Archive >
  void serialize (Archive &ar, const unsigned int version)

Friends

- class boost::serialization::access

6.62.1 Detailed Description

The SoilSettings class.

A class with which the used settings can easily transfered to setup the Sample class in one go. This class is also used in the GUI. and has a possibility to saved to disk as a serialized object

Definition at line 24 of file soilsettings.h.

6.62.2 Constructor & Destructor Documentation

6.62.2.1 SoilAnalyzer::SoilSettings::SoilSettings ( )

Definition at line 11 of file soilsettings.cpp.

6.62.3 Member Function Documentation

6.62.3.1 void SoilAnalyzer::SoilSettings::LoadSettings (std::string *filename*)

LoadSettings a function to load the settings from disk.

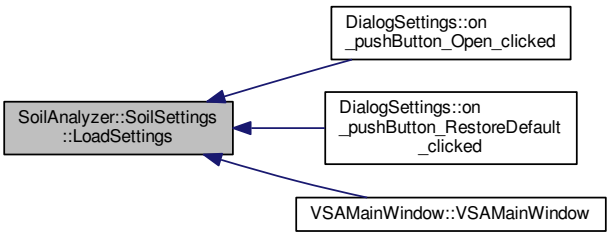
Parameters

filename	a string with the filename

Definition at line 13 of file soilsettings.cpp.

Referenced by DialogSettings::on_pushButton_Open_clicked(), DialogSettings::on_pushButton_RestoreDefault_clicked(), and VSAMainWindow::VSAMainWindow().

Here is the caller graph for this function:



6.62.3.2 void SoilAnalyzer::SoilSettings::SaveSettings (std::string *filename*)

SaveSettings a function to save the settings to disk.

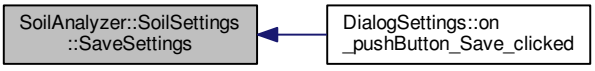
Parameters

filename	a string with the filename

Definition at line 19 of file soilsettings.cpp.

Referenced by DialogSettings::on_pushButton_Save_clicked().

Here is the caller graph for this function:



6.62.3.3 template<class Archive > void SoilAnalyzer::SoilSettings::serialize (Archive & *ar*, const unsigned int *version*) [inline], [private]

Definition at line 109 of file soilsettings.h.

6.62.4 Friends And Related Function Documentation

6.62.4.1 friend class boost::serialization::access [friend]

Definition at line 107 of file soilsettings.h.

6.62.5 Member Data Documentation

6.62.5.1 float SoilAnalyzer::SoilSettings::adaptContrastKernelFactor = 1.

the factor with which to multiply the effect of the adaptive contrast stretch

Definition at line 44 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings().

6.62.5.2 uint32_t SoilAnalyzer::SoilSettings::adaptContrastKernelSize

Initial value:

```
=
    9
```

The size of the adaptive contrast kernelsize

Definition at line 42 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings().

6.62.5.3 int SoilAnalyzer::SoilSettings::BackLightCompensation_front

Initial value:

```
=
    1
```

cam backlight compensation setting front light

Definition at line 91 of file soilsettings.h.

6.62.5.4 int SoilAnalyzer::SoilSettings::BackLightCompensation_proj

Initial value:

```
=
    1
```

cam backlight compensation setting projected light

Definition at line 93 of file soilsettings.h.

6.62.5.5 uint32_t SoilAnalyzer::SoilSettings::blurKernelSize = 5

the median blurkernel

Definition at line 49 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings().

6.62.5.6 int SoilAnalyzer::SoilSettings::Brightness_front = 0

cam brightness setting front light

Definition at line 75 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_BrightFront_valueChanged().

6.62.5.7 int SoilAnalyzer::SoilSettings::Brightness_proj = -10

cam brightness setting projected light

Definition at line 76 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_BrightProj_valueChanged().

6.62.5.8 int SoilAnalyzer::SoilSettings::Contrast_front = 36

cam contrast setting front light

Definition at line 77 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_ContrastFront_valueChanged().

6.62.5.9 int SoilAnalyzer::SoilSettings::Contrast_proj = 36

cam contrast setting projected light

Definition at line 78 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_ContrastProj_valueChanged().

6.62.5.10 std::string SoilAnalyzer::SoilSettings::defaultWebcam = "USB Microscope"

The defaultWebcam string

Definition at line 74 of file soilsettings.h.

Referenced by DialogSettings::on_comboBox_Microscopes_currentIndexChanged(), and VSAMainWindow::VSAMainWindow().

6.62.5.11 bool SoilAnalyzer::SoilSettings::enableRainbow

Initial value:

```
=
    true
```

run a rainbow loop on the RGB encoder during analysis

Definition at line 70 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_checkBox_useRainbow_clicked().

6.62.5.12 bool SoilAnalyzer::SoilSettings::enclnv = false

invert the values gained form the encoder

Definition at line 69 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_checkBox_InvertEncoder_clicked().

6.62.5.13 bool SoilAnalyzer::SoilSettings::fillHoles = true

should the holes be filled

Definition at line 55 of file soilsettings.h.

Referenced by SoilAnalyzer::Analyzer::CalcMaxProgress(), DialogSettings::DialogSettings(), SoilAnalyzer::Analyzer::GetBW(), and DialogSettings::on_cb_fillHoles_3_clicked().

6.62.5.14 uint32_t SoilAnalyzer::SoilSettings::filterMaskSize = 5

the filter mask

Definition at line 64 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), SoilAnalyzer::Analyzer::GetBW(), and DialogSettings::on_sb_morphMask_3_editingFinished().

6.62.5.15 int SoilAnalyzer::SoilSettings::Gamma_front = 100

cam gamma setting front light

Definition at line 83 of file soilsettings.h.

6.62.5.16 int SoilAnalyzer::SoilSettings::Gamma_proj = 200

cam gamma setting projected light

Definition at line 84 of file soilsettings.h.

6.62.5.17 uint32_t SoilAnalyzer::SoilSettings::HDRframes

Initial value:

```
=
    5
```

The number of frames which should be used for the HDR image

Definition at line 66 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), DialogSettings::on_spinBox_NoFrames_editingFinished(), and VSAMainWindow::TakeSnapShots().

6.62.5.18 int SoilAnalyzer::SoilSettings::Hue_front = 0

cam hue setting front light

Definition at line 81 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_HueFront_valueChanged().

6.62.5.19 int SoilAnalyzer::SoilSettings::Hue_proj = -40

cam hue setting projected light

Definition at line 82 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_HueProj_valueChanged().

6.62.5.20 bool SoilAnalyzer::SoilSettings::ignorePartialBorderParticles

Initial value:

```
=
    true
```

Indication of partial border particles should be used

Definition at line 53 of file soilsettings.h.

Referenced by SoilAnalyzer::Analyzer::CalcMaxProgress(), DialogSettings::DialogSettings(), SoilAnalyzer::Analyzer::GetBW(), and DialogSettings::on_cb_ignoreBorder_3_clicked().

6.62.5.21 float SoilAnalyzer::SoilSettings::lightLevel = 0.5

The light level of the environmental case

Definition at line 68 of file soilsettings.h.

Referenced by DialogSettings::on_doubleSpinBox_LightLevel_editingFinished().

6.62.5.22 Vision::MorphologicalFilter::FilterType SoilAnalyzer::SoilSettings::morphFilterType

Initial value:

```
=
    Vision::MorphologicalFilter::OPEN
```

Indicating which type of morhpological filter should be used

Definition at line 60 of file soilsettings.h.

Referenced by SoilAnalyzer::Analyzer::CalcMaxProgress(), DialogSettings::DialogSettings(), SoilAnalyzer::Analyzer::GetBW(), DialogSettings::on_rb_useClose_3_clicked(), DialogSettings::on_rb_useDilate_3_clicked(), DialogSettings::on_rb_useErode_3_clicked(), and DialogSettings::on_rb_useOpen_3_clicked().

6.62.5.23 std::string SoilAnalyzer::SoilSettings::NNFolder = "NeuralNet"

Definition at line 100 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), DialogNN::on_pushButton_SaveNN_clicked(), and DialogSettings::on_pushButton_SelectNNFolder_clicked().

6.62.5.24 std::string SoilAnalyzer::SoilSettings::NNlocation = "NeuralNet/Default.NN"

Definition at line 95 of file soilsettings.h.

Referenced by SoilAnalyzer::Analyzer::Analyzer(), DialogSettings::DialogSettings(), and DialogSettings::on_pushButton_SelectNN_clicked().

6.62.5.25 int SoilAnalyzer::SoilSettings::PowerLineFrequency_front

Initial value:

```
=
    1
```

cam powerline freq setting front light

Definition at line 85 of file soilsettings.h.

6.62.5.26 int SoilAnalyzer::SoilSettings::PowerLineFrequency_proj

Initial value:

```
=
    1
```

cam powerline freq setting projected light

Definition at line 87 of file soilsettings.h.

6.62.5.27 bool SoilAnalyzer::SoilSettings::PredictTheShape = true

Definition at line 104 of file soilsettings.h.

Referenced by SoilAnalyzer::Analyzer::Analyse(), DialogSettings::DialogSettings(), VSAMainWindow::on_actionAutomatic_Shape_Pediction_↩triggered(), DialogSettings::on_checkBox_PredictShape_clicked(), and VSAMainWindow::VSAMainWindow().

6.62.5.28 bool SoilAnalyzer::SoilSettings::Revolution = true

Definition at line 105 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_checkBox_revolt_clicked().

6.62.5.29 std::string SoilAnalyzer::SoilSettings::SampleFolder = "~/Samples"

Definition at line 98 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), QReportGenerator::on_actionExport_to_PDF_triggered(), VSAMainWindow::on_actionLoad↩Sample_triggered(), QReportGenerator::on_actionSave_triggered(), VSAMainWindow::on_actionSaveSample_triggered(), VSAMainWindow↩::on_compare_against(), DialogNN::on_pushButton_OpenNN_clicked(), DialogSettings::on_pushButton_selectSampleFolder_clicked(), and DialogNN::on_pushButton_SelectSamples_clicked().

6.62.5.30 int SoilAnalyzer::SoilSettings::Saturation_front = 64

cam saturation setting front light

Definition at line 79 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_SaturationFront_valueChanged().

6.62.5.31 int SoilAnalyzer::SoilSettings::Saturation_proj = 0

cam saturation setting projected light

Definition at line 80 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_SaturationProj_valueChanged().

6.62.5.32 int SoilAnalyzer::SoilSettings::selectedResolution = 0

Definition at line 97 of file soilsettings.h.

Referenced by DialogSettings::on_comboBox_Resolution_currentIndexChanged(), and VSAMainWindow::VSAMainWindow().

6.62.5.33 std::string SoilAnalyzer::SoilSettings::SettingsFolder = "Settings"

Definition at line 99 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_pushButton_SelectSettingFolder_clicked().

6.62.5.34 int SoilAnalyzer::SoilSettings::Sharpness_front = 12

cam sharpness setting front light

Definition at line 89 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_SharpnessFront_valueChanged().

6.62.5.35 int SoilAnalyzer::SoilSettings::Sharpness_proj = 25

cam sharpness setting projected light

Definition at line 90 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_horizontalSlider_SharpnessProj_valueChanged().

6.62.5.36 float SoilAnalyzer::SoilSettings::sigmaFactor = 2

The sigma factor or the bandwidth indicating which pixel intensity values count belong to an object

Definition at line 56 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), SoilAnalyzer::Analyzer::GetBW(), and DialogSettings::on_sb_sigmaFactor_3_editingFinished().

6.62.5.37 uint32_t SoilAnalyzer::SoilSettings::StandardNumberOfShots = 10

Definition at line 103 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), DialogSettings::on_spinBox_NoShots_editingFinished(), and VSAMainWindow::TakeSnapShots().

6.62.5.38 std::string SoilAnalyzer::SoilSettings::StandardPrinter = "PDF printer"

Definition at line 102 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings().

6.62.5.39 std::string SoilAnalyzer::SoilSettings::StandardSentTo = "j.spijker@ihcmerwede.com"

Definition at line 101 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings().

6.62.5.40 int SoilAnalyzer::SoilSettings::thresholdOffsetValue = 0

an tweaking offset value

Definition at line 58 of file soilsettings.h.

Referenced by SoilAnalyzer::Analyzer::GetBW().

6.62.5.41 Vision::Segment::TypeOfObjects SoilAnalyzer::SoilSettings::typeOfObjectsSegmented

Initial value:

```
=
    Vision::Segment::Dark
```

Which type of object should be segmented

Definition at line 51 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), SoilAnalyzer::Analyzer::GetBW(), and DialogSettings::on_rb_useDark_3_toggled().

6.62.5.42 bool SoilAnalyzer::SoilSettings::useAdaptiveContrast

Initial value:

```
=
    false
```

Should adaptive contrast stretch be used default is true

Definition at line 40 of file soilsettings.h.

Referenced by SoilAnalyzer::Analyzer::CalcMaxProgress(), DialogSettings::DialogSettings(), and DialogSettings::on_cb_use_adaptContrast_3_clicked().

6.62.5.43 bool SoilAnalyzer::SoilSettings::useBacklightProjection = true

use Projection

Definition at line 72 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), DialogSettings::on_checkBox_Backlight_clicked(), and VSAMainWindow::TakeSnapShots().

6.62.5.44 bool SoilAnalyzer::SoilSettings::useBlur = false

Should the mediaan blur be used during analsyis

Definition at line 48 of file soilsettings.h.

Referenced by SoilAnalyzer::Analyzer::CalcMaxProgress(), DialogSettings::DialogSettings(), and DialogSettings::on_cb_useBlur_3_clicked().

6.62.5.45 bool SoilAnalyzer::SoilSettings::useCUDA = false

CUDA enabled

Definition at line 96 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), and DialogSettings::on_checkBox_useCUDA_clicked().

6.62.5.46 bool SoilAnalyzer::SoilSettings::useHDR = false

use HDR

Definition at line 73 of file soilsettings.h.

Referenced by DialogSettings::DialogSettings(), DialogSettings::on_checkBox_useHDR_clicked(), and VSAMainWindow::TakeSnapShots().

The documentation for this class was generated from the following files:

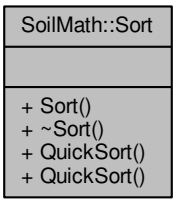
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/soilsettings.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilAnalyzer/soilsettings.cpp

6.63 SoilMath::Sort Class Reference

The Sort template class.

`#include <Sort.h>`

Collaboration diagram for SoilMath::Sort:



Public Member Functions

- Sort ()
- ~Sort ()

Static Public Member Functions

- template<typename T >
  static void QuickSort (T *arr, int i)

  QuickSort a static sort a Type T array with i values.
- template<typename T >
  static void QuickSort (T *arr, T *key, int i)

  QuickSort a static sort a Type T array with i values where the key are also changed accordingly.

6.63.1 Detailed Description

The Sort template class.

Definition at line 15 of file Sort.h.

6.63.2 Constructor & Destructor Documentation

6.63.2.1 SoilMath::Sort::Sort ( ) [inline]

Definition at line 17 of file Sort.h.

6.63.2.2 SoilMath::Sort::~Sort ( ) [inline]

Definition at line 18 of file Sort.h.

6.63.3 Member Function Documentation

6.63.3.1 template<typename T > static void SoilMath::Sort::QuickSort (T * *arr,* int *i*) [inline], [static]

QuickSort a static sort a Type T array with i values.

Usage: QuickSort<type>(*type , i)

Parameters

arr	an array of Type T
i	the number of elements

Definition at line 26 of file Sort.h.

6.63.3.2 template<typename T > static void SoilMath::Sort::QuickSort (T * *arr,* T * *key,* int *i*) [inline], [static]

QuickSort a static sort a Type T array with i values where the key are also changed accordingly.

Usage: QuickSort<type>(*type *type , i)

Parameters

arr	an array of Type T
key	an array of 0..i-1 representing the index
i	the number of elements

Definition at line 58 of file Sort.h.

The documentation for this class was generated from the following file:

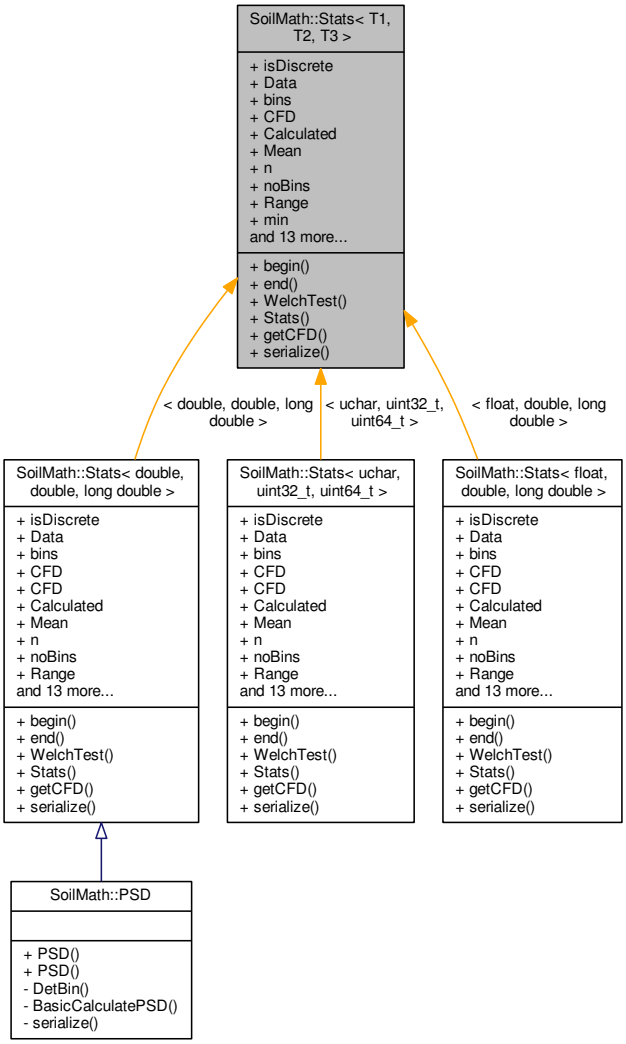
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/Sort.h

6.64 SoilMath::Stats< T1, T2, T3 > Class Template Reference

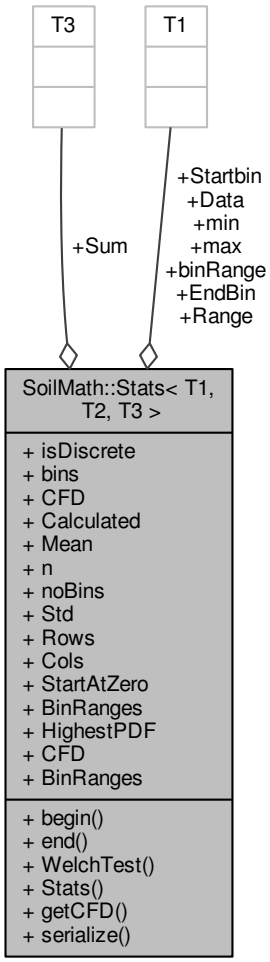
Stats class.

`#include <Stats.h>`

Inheritance diagram for SoilMath::Stats< T1, T2, T3 >:



Collaboration diagram for SoilMath::Stats< T1, T2, T3 >:



Public Member Functions

- uint32_t * begin ()
- uint32_t * end ()
- bool WelchTest (SoilMath::Stats< T1, T2, T3 > &statComp)

  WelchTest Compare the sample using the Welch's Test.
- Stats (const Stats &rhs)

  Stats Constructor.
- void getCFD ()

  getCFD get the CFD matrix;
- template<class Archive >
  void serialize (Archive &ar, const unsigned int version)

  serialize the object

Public Attributes

- bool isDiscrete = true

- T1 * Data = nullptr
- uint32_t * bins = nullptr
- double * CFD = nullptr
- bool Calculated = false
- float Mean = 0.0
- uint32_t n = 0
- uint32_t noBins = 0
- T1 Range = 0
- T1 min = 0
- T1 max = 0
- T1 Startbin = 0
- T1 EndBin = 0
- T1 binRange = 0
- float Std = 0.0
- T3 Sum = 0
- uint16_t Rows = 0
- uint16_t Cols = 0
- bool StartAtZero = true
- double * BinRanges = nullptr
- double HighestPDF = 0.
- CFD {new double[rhs.noBins]{}}
- BinRanges

Friends

- class boost::serialization::access

6.64.1 Detailed Description

template<typename T1, typename T2, typename T3>class SoilMath::Stats< T1, T2, T3 >

Stats class.

Usage Stats<type1, type2, type3>Stats() type 1, 2 and 3 shoudl be of the same value and concecuative in size

Definition at line 39 of file Stats.h.

6.64.2 Constructor & Destructor Documentation

6.64.2.1 template<typename T1, typename T2, typename T3> SoilMath::Stats< T1, T2, T3 >::Stats (const Stats< T1, T2, T3 > & *rhs*) [inline]

Stats Constructor.

Parameters

rhs	Right hand side

Definition at line 112 of file Stats.h.

6.64.3 Member Function Documentation

6.64.3.1 template<typename T1, typename T2, typename T3> uint32_t* SoilMath::Stats< T1, T2, T3 >::begin ( ) [inline]

pointer to the first bin

Definition at line 65 of file Stats.h.

6.64.3.2 template<typename T1, typename T2, typename T3> uint32_t* SoilMath::Stats< T1, T2, T3 >::end ( ) [inline]

pointer to the last + 1 bin

Definition at line 66 of file Stats.h.

6.64.3.3 template<typename T1, typename T2, typename T3> void SoilMath::Stats< T1, T2, T3 >::getCFD ( ) [inline]

getCFD get the CFD matrix;

Definition at line 629 of file Stats.h.

6.64.3.4 template<typename T1, typename T2, typename T3> template<class Archive > void SoilMath::Stats< T1, T2, T3 >::serialize (Archive & *ar,* const unsigned int *version*) [inline]

serialize the object

Parameters

ar	argument
version	

Definition at line 651 of file Stats.h.

6.64.3.5 template<typename T1, typename T2, typename T3> bool SoilMath::Stats< T1, T2, T3 >::WelchTest (SoilMath::Stats< T1, T2, T3 > & *statComp*) [inline]

WelchTest Compare the sample using the Welch's Test.

(source: http://www.boost.org/doc/libs/1_57_0/libs/math/doc/html/math_toolkit/stat_tut/weg/st_↩eg/two_sample_students_t.html)

Parameters

statComp	Statiscs Results of which it should be tested against

Returns

Definition at line 75 of file Stats.h.

6.64.4 Friends And Related Function Documentation

6.64.4.1 template<typename T1, typename T2, typename T3> friend class boost::serialization::access [friend]

Serialization class

Definition at line 643 of file Stats.h.

6.64.5 Member Data Documentation

6.64.5.1 template<typename T1, typename T2, typename T3> T1 SoilMath::Stats< T1, T2, T3 >::binRange = 0

the range of a single bin

Definition at line 55 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::serialize().

6.64.5.2 template<typename T1, typename T2, typename T3> double* SoilMath::Stats< T1, T2, T3 >::BinRanges = nullptr

Definition at line 62 of file Stats.h.

6.64.5.3 template<typename T1, typename T2, typename T3> SoilMath::Stats< T1, T2, T3 >::BinRanges

data end counter used with mask

Definition at line 114 of file Stats.h.

6.64.5.4 template<typename T1, typename T2, typename T3> uint32_t* SoilMath::Stats< T1, T2, T3 >::bins = nullptr

the histogram

Definition at line 44 of file Stats.h.

Referenced by Vision::Segment::GetBlobList(), Vision::Segment::GetThresholdLevel(), QReportGenerator::QReportGenerator(), VSAMain↩Window::setAngularityHistogram(), and VSAMainWindow::setRoundnessHistogram().

6.64.5.5 template<typename T1, typename T2, typename T3> bool SoilMath::Stats< T1, T2, T3 >::Calculated = false

indication if the data has been calculated

Definition at line 46 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::serialize().

6.64.5.6 template<typename T1, typename T2, typename T3> double* SoilMath::Stats< T1, T2, T3 >::CFD = nullptr

the CFD

Definition at line 45 of file Stats.h.

Referenced by QReportGenerator::QReportGenerator(), and VSAMainWindow::SetPSDgraph().

6.64.5.7 template<typename T1, typename T2, typename T3> SoilMath::Stats< T1, T2, T3 >::CFD {new double[rhs.noBins]{}}

Definition at line 113 of file Stats.h.

6.64.5.8 template<typename T1, typename T2, typename T3> uint16_t SoilMath::Stats< T1, T2, T3 >::Cols = 0

number of cols from the data matrix

Definition at line 59 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::serialize().

6.64.5.9 template<typename T1, typename T2, typename T3> T1* SoilMath::Stats< T1, T2, T3 >::Data = nullptr

Pointer the data

Definition at line 43 of file Stats.h.

Referenced by VSAMainWindow::on_actionLoadSample_triggered().

6.64.5.10 template<typename T1, typename T2, typename T3> T1 SoilMath::Stats< T1, T2, T3 >::EndBin = 0

End bin value

Definition at line 54 of file Stats.h.

Referenced by Vision::Segment::GetBlobList(), and SoilMath::Stats< float, double, long double >::serialize().

6.64.5.11 template<typename T1, typename T2, typename T3> double SoilMath::Stats< T1, T2, T3 >::HighestPDF = 0.

Definition at line 63 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::serialize(), VSAMainWindow::setAngularityHistogram(), and VSAMainWindow::setRoundnessHistogram().

6.64.5.12 template<typename T1, typename T2, typename T3> bool SoilMath::Stats< T1, T2, T3 >::isDiscrete = true

indicates if the data is discrete or real

Definition at line 41 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::serialize().

6.64.5.13 template<typename T1, typename T2, typename T3> T1 SoilMath::Stats< T1, T2, T3 >::max = 0

maximum value

Definition at line 52 of file Stats.h.

Referenced by Vision::Enhance::HistogramEqualization(), QReportGenerator::QReportGenerator(), and SoilMath::Stats< float, double, long double >::serialize().

6.64.5.14 template<typename T1, typename T2, typename T3> float SoilMath::Stats< T1, T2, T3 >::Mean = 0.0

the mean value of the data

Definition at line 47 of file Stats.h.

Referenced by SoilAnalyzer::Particle::getMeanLab(), SoilAnalyzer::Particle::GetMeanRI(), Vision::Segment::GetThresholdLevel(), QReportGenerator::QReportGenerator(), SoilMath::Stats< float, double, long double >::serialize(), VSAMainWindow::setAngularityHistogram(), VSAMainWindow::setRoundnessHistogram(), and SoilMath::Stats< float, double, long double >::WelchTest().

6.64.5.15 template<typename T1, typename T2, typename T3> T1 SoilMath::Stats< T1, T2, T3 >::min = 0

minimum value

Definition at line 51 of file Stats.h.

Referenced by Vision::Enhance::HistogramEqualization(), QReportGenerator::QReportGenerator(), and SoilMath::Stats< float, double, long double >::serialize().

6.64.5.16 template<typename T1, typename T2, typename T3> uint32_t SoilMath::Stats< T1, T2, T3 >::n = 0

number of data points

Definition at line 48 of file Stats.h.

Referenced by QReportGenerator::QReportGenerator(), SoilMath::Stats< float, double, long double >::serialize(), and SoilMath::Stats< float, double, long double >::WelchTest().

6.64.5.17 template<typename T1, typename T2, typename T3> uint32_t SoilMath::Stats< T1, T2, T3 >::noBins = 0

number of bins

Definition at line 49 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::end(), SoilMath::Stats< float, double, long double >::getCFD(), and SoilMath::Stats< float, double, long double >::serialize().

6.64.5.18 template<typename T1, typename T2, typename T3> T1 SoilMath::Stats< T1, T2, T3 >::Range = 0

range of the data

Definition at line 50 of file Stats.h.

Referenced by QReportGenerator::QReportGenerator(), and SoilMath::Stats< float, double, long double >::serialize().

6.64.5.19 template<typename T1, typename T2, typename T3> uint16_t SoilMath::Stats< T1, T2, T3 >::Rows = 0

number of rows from the data matrix

Definition at line 58 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::serialize().

6.64.5.20 template<typename T1, typename T2, typename T3> bool SoilMath::Stats< T1, T2, T3 >::StartAtZero = true

indication of the minimum value starts at zero or could be less

Definition at line 60 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::serialize().

6.64.5.21 template<typename T1, typename T2, typename T3> T1 SoilMath::Stats< T1, T2, T3 >::Startbin = 0

First bin value

Definition at line 53 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::serialize().

6.64.5.22 template<typename T1, typename T2, typename T3> float SoilMath::Stats< T1, T2, T3 >::Std = 0.0

standard deviation

Definition at line 56 of file Stats.h.

Referenced by Vision::Segment::GetThresholdLevel(), QReportGenerator::QReportGenerator(), SoilMath::Stats< float, double, long double >::serialize(), and SoilMath::Stats< float, double, long double >::WelchTest().

6.64.5.23 template<typename T1, typename T2, typename T3> T3 SoilMath::Stats< T1, T2, T3 >::Sum = 0

total sum of all the data values

Definition at line 57 of file Stats.h.

Referenced by SoilMath::Stats< float, double, long double >::serialize().

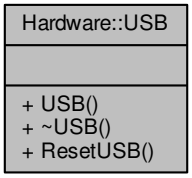
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilMath/Stats.h

6.65 Hardware::USB Class Reference

```
#include <USB.h>
```

Collaboration diagram for Hardware::USB:



Public Member Functions

- USB ()
- ~USB ()
- void ResetUSB ()

6.65.1 Detailed Description

Definition at line 19 of file USB.h.

6.65.2 Constructor & Destructor Documentation

6.65.2.1 Hardware::USB::USB ( )

Definition at line 11 of file USB.cpp.

6.65.2.2 Hardware::USB::~USB ( )

Definition at line 13 of file USB.cpp.

6.65.3 Member Function Documentation

6.65.3.1 void Hardware::USB::ResetUSB ( )

Definition at line 15 of file USB.cpp.

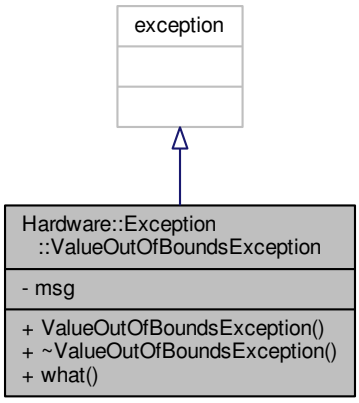
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/USB.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/USB.cpp

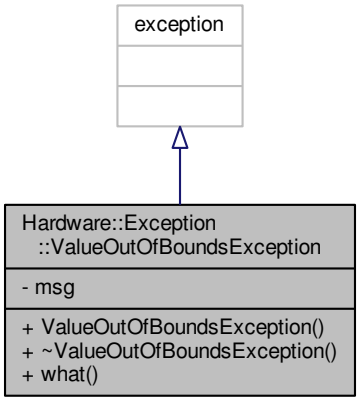
6.66 Hardware::Exception::ValueOutOfBoundsException Class Reference

```
#include <ValueOutOfBoundsException.h>
```

Inheritance diagram for Hardware::Exception::ValueOutOfBoundsException:



Collaboration diagram for Hardware::Exception::ValueOutOfBoundsException:



Public Member Functions

- ValueOutOfBoundsException (string m="Value out of bounds!")
- ~ValueOutOfBoundsException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.66.1 Detailed Description

Definition at line 17 of file ValueOutOfBoundsException.h.

6.66.2 Constructor & Destructor Documentation

6.66.2.1 Hardware::Exception::ValueOutOfBoundsException::ValueOutOfBoundsException (string *m* = "Value out of bounds!") [inline]

Definition at line 19 of file ValueOutOfBoundsException.h.

6.66.2.2 Hardware::Exception::ValueOutOfBoundsException::~ValueOutOfBoundsException ( ) [inline]

Definition at line 20 of file ValueOutOfBoundsException.h.

6.66.3 Member Function Documentation

6.66.3.1 const char* Hardware::Exception::ValueOutOfBoundsException::what ( ) const [inline]

Definition at line 21 of file ValueOutOfBoundsException.h.

6.66.4 Member Data Documentation

6.66.4.1 string Hardware::Exception::ValueOutOfBoundsException::msg [private]

Definition at line 21 of file ValueOutOfBoundsException.h.

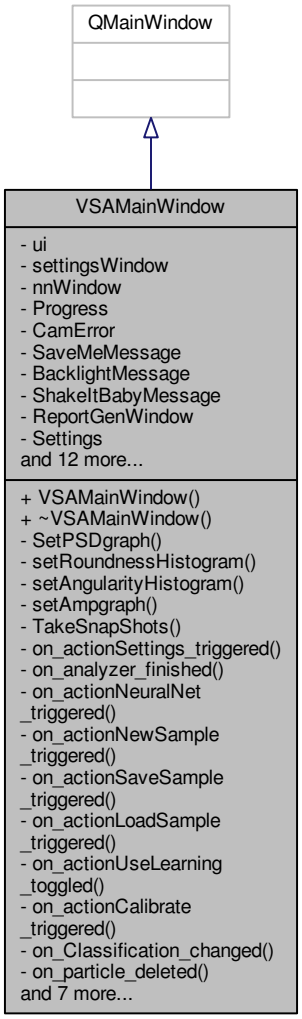
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilHardware/ValueOutOfBoundsException.h

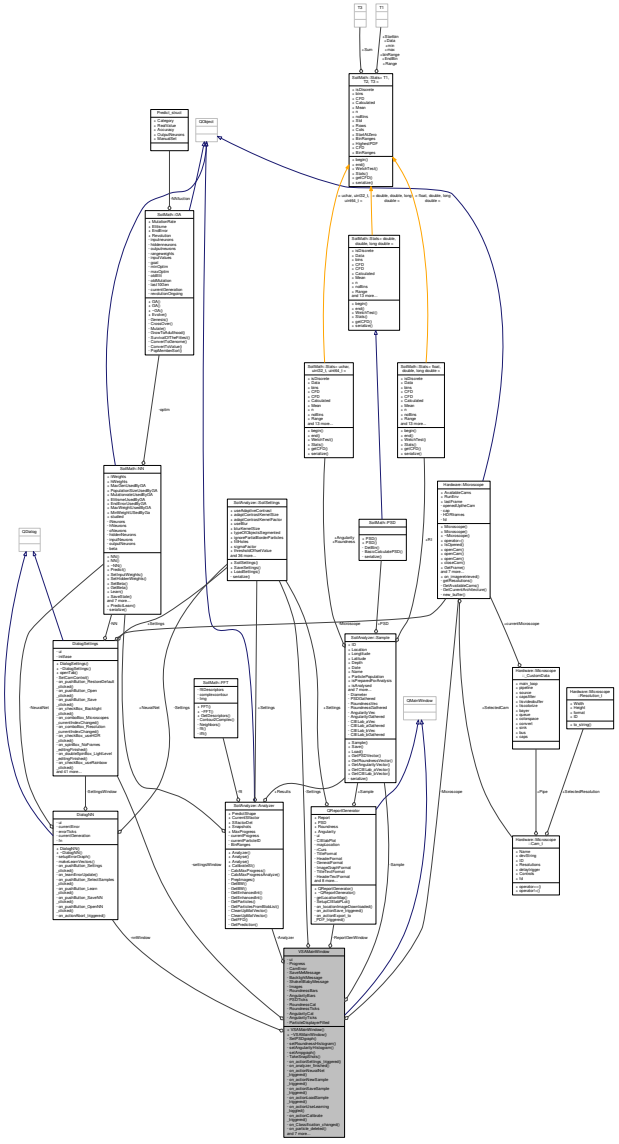
6.67 VSAMainWindow Class Reference

```
#include <vsamainwindow.h>
```

Inheritance diagram for VSAMainWindow:



Collaboration diagram for VSAMainWindow:



Public Member Functions

- VSAMainWindow (QWidget ∗parent=0)
- ∼VSAMainWindow ()

Private Slots

- void on_actionSettings_triggered ()
- void on_analyzer_finished ()
- void on_actionNeuralNet_triggered ()
- void on_actionNewSample_triggered ()
- void on_actionSaveSample_triggered ()
- void on_actionLoadSample_triggered ()
- void on_actionUseLearning_toggled (bool arg1)
- void on_actionCalibrate_triggered ()
- void on_Classification_changed (int newValue)

- void on_particle_deleted ()
- void on_actionAutomatic_Shape_Pediction_triggered (bool checked)
- void on_reset_graph (QMouseEvent *e)
- void on_actionReport_Generator_triggered ()
- void on_particleChanged (int newPart)
- void on_PSD_contextMenuRequest (QPoint point)
- void on_compare_against ()
- void on_restore_PSD ()

Private Member Functions

- void SetPSDgraph ()
- void setRoundnessHistogram ()
- void setAngularityHistogram ()
- void setAmpgraph ()
- void TakeSnapShots ()

Private Attributes

- Ui::VSAMainWindow * ui
- DialogSettings * settingsWindow = nullptr
- DialogNN * nnWindow = nullptr
- QProgressBar * Progress
- QErrorMessage * CamError = nullptr
- QMessageBox * SaveMeMessage = nullptr
- QMessageBox * BacklightMessage = nullptr
- QMessageBox * ShakeItBabyMessage = nullptr
- QReportGenerator * ReportGenWindow = nullptr
- SoilAnalyzer::SoilSettings * Settings = nullptr
- Hardware::Microscope * Microscope = nullptr
- SoilAnalyzer::Sample * Sample = nullptr
- SoilAnalyzer::Analyzer * Analyzer = nullptr
- SoilAnalyzer::Analyzer::Images_t * Images = nullptr
- QCPBars * RoundnessBars = nullptr
- QCPBars * AngularityBars = nullptr
- std::vector< double > PSDTicks
- QVector< QString > RoundnessCat = {"High", "Medium", "Low"}
- std::vector< double > RoundnessTicks = {1, 2, 3}
- QVector< QString > AngularityCat
- std::vector< double > AngularityTicks = {1, 2, 3, 4, 5, 6}
- bool ParticleDisplayerFilled = false

6.67.1 Detailed Description

Definition at line 27 of file vsamainwindow.h.

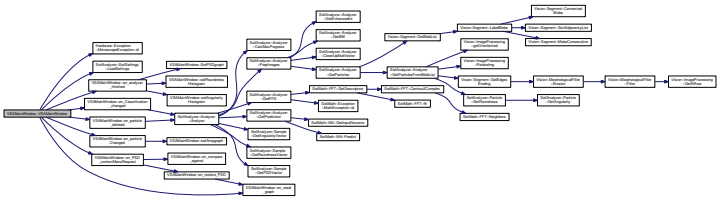
6.67.2 Constructor & Destructor Documentation

6.67.2.1 VSAMainWindow::VSAMainWindow (QWidget * *parent* = 0) [explicit]

Definition at line 4 of file vsamainwindow.cpp.

References Analyzer, AngularityBars, AngularityCat, AngularityTicks, BacklightMessage, CamError, SoilAnalyzer::SoilSettings::defaultWebcam, EXCEPTION_NOCAMS_NR, EXCEPTION_OPENCAM_NR, Hardware::Exception::MicroscopeException::id(), Images, SoilAnalyzer::SoilSettings::LoadSettings(), SoilAnalyzer::Analyzer::MaxProgress, SoilAnalyzer::Analyzer::NeuralNet, nnWindow, on_analyzer_finished(), on_Classification_changed(), on_particle_deleted(), on_particleChanged(), on_PSD_contextMenuRequest(), on_reset_graph(), SoilAnalyzer::SoilSettings::PredictTheShape, Progress, PSDTicks, RoundnessBars, RoundnessCat, RoundnessTicks, Sample, SaveMeMessage, SoilAnalyzer::SoilSettings::selectedResolution, Settings, settingsWindow, ShakeItBabyMessage, and ui.

Here is the call graph for this function:



6.67.2.2 VSAMainWindow::~VSAMainWindow ( )

Definition at line 254 of file vsamainwindow.cpp.

References Analyzer, BacklightMessage, CamError, Images, Microscope, nnWindow, Sample, SaveMeMessage, Settings, settingsWindow, ShakeItBabyMessage, and ui.

6.67.3 Member Function Documentation

6.67.3.1 void VSAMainWindow::on_actionAutomatic_Shape_Pediction_triggered (bool *checked*) [private], [slot]

Definition at line 541 of file vsamainwindow.cpp.

References SoilAnalyzer::SoilSettings::PredictTheShape, and Settings.

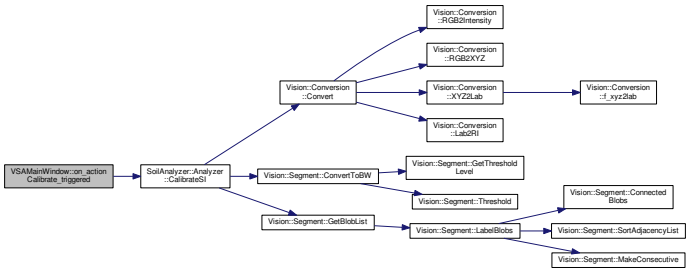
6.67.3.2 void VSAMainWindow::on_actionCalibrate_triggered ( ) [private], [slot]

Definition at line 516 of file vsamainwindow.cpp.

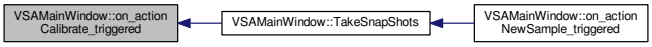
References Analyzer, and SoilAnalyzer::Analyzer::CalibrateSI().

Referenced by TakeSnapShots().

Here is the call graph for this function:



Here is the caller graph for this function:

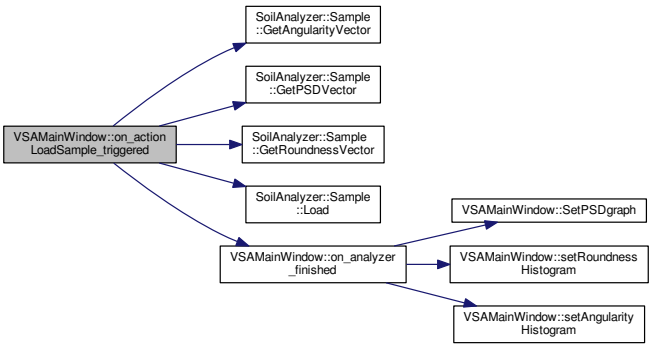


6.67.3.3 void VSAMainWindow::on_actionLoadSample_triggered ( ) [private], [slot]

Definition at line 475 of file vsamainwindow.cpp.

References Analyzer, SoilAnalyzer::Sample::Angularity, SoilAnalyzer::Sample::ChangesSinceLastSave, SoilMath::Stats< T1, T2, T3 >::↩ Data, SoilAnalyzer::Sample::GetAngularityVector(), SoilAnalyzer::Sample::GetPSDVector(), SoilAnalyzer::Sample::GetRoundnessVector(), Images, SoilAnalyzer::Sample::Load(), on_analyzer_finished(), ParticleDisplayerFilled, SoilAnalyzer::Sample::PSD, SoilAnalyzer::Analyzer::↩ Results, SoilAnalyzer::Sample::Roundness, Sample, SoilAnalyzer::SoilSettings::SampleFolder, SaveMeMessage, Settings, and ui.

Here is the call graph for this function:



6.67.3.4 void VSAMainWindow::on_actionNeuralNet_triggered ( ) [private], [slot]

Definition at line 353 of file vsamainwindow.cpp.

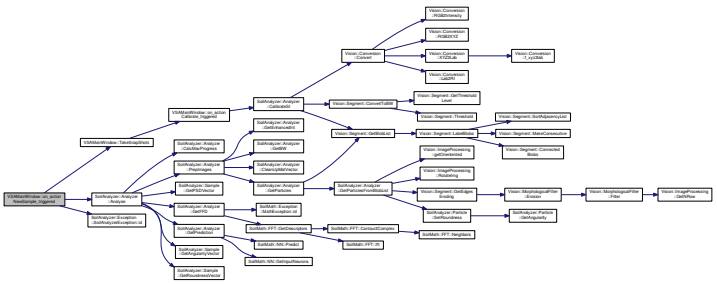
References Analyzer, SoilAnalyzer::Analyzer::NeuralNet, nnWindow, Settings, and settingsWindow.

6.67.3.5 void VSAMainWindow::on_actionNewSample_triggered ( ) [private], [slot]

Definition at line 361 of file vsamainwindow.cpp.

References SoilAnalyzer::Analyzer::Analyse(), Analyzer, CamError, SoilAnalyzer::Sample::ChangesSinceLastSave, EXCEPTION_NO_SN↩
APSHOTS_NR, SoilAnalyzer::Exception::SoilAnalyzerException::id(), Images, SoilAnalyzer::Sample::ParticlePopulation, Sample, SaveMe↩
Message, Settings, TakeSnapShots(), and ui.

Here is the call graph for this function:



6.67.3.6 void VSAMainWindow::on_actionReport_Generator_triggered ( ) [private], [slot]

Definition at line 552 of file vsamainwindow.cpp.

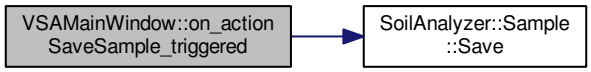
References ReportGenWindow, Sample, Settings, and ui.

6.67.3.7 void VSAMainWindow::on_actionSaveSample_triggered ( ) [private], [slot]

Definition at line 460 of file vsamainwindow.cpp.

References SoilAnalyzer::Sample::ChangesSinceLastSave, SoilAnalyzer::Sample::IsLoadedFromDisk, Sample, SoilAnalyzer::SoilSettings::↩
SampleFolder, SoilAnalyzer::Sample::Save(), and Settings.

Here is the call graph for this function:

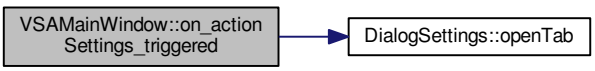


6.67.3.8 void VSAMainWindow::on_actionSettings_triggered ( ) [private], [slot]

Definition at line 270 of file vsamainwindow.cpp.

References DialogSettings::openTab(), and settingsWindow.

Here is the call graph for this function:



6.67.3.9 void VSAMainWindow::on_actionUseLearning_toggled (bool *arg1*) [private], [slot]

Definition at line 512 of file vsamainwindow.cpp.

References Analyzer, and SoilAnalyzer::Analyzer::PredictShape.

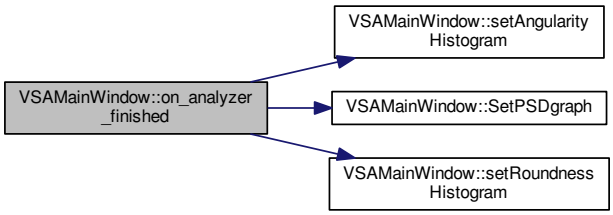
6.67.3.10 void VSAMainWindow::on_analyzer_finished ( ) [private], [slot]

Definition at line 275 of file vsamainwindow.cpp.

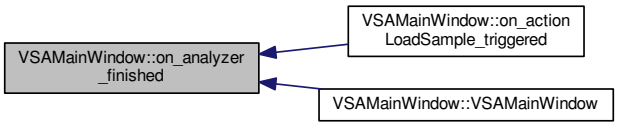
References ParticleDisplayerFilled, SoilAnalyzer::Sample::ParticlePopulation, Sample, setAngularityHistogram(), SetPSDgraph(), setRoundnessHistogram(), and ui.

Referenced by on_actionLoadSample_triggered(), and VSAMainWindow().

Here is the call graph for this function:



Here is the caller graph for this function:



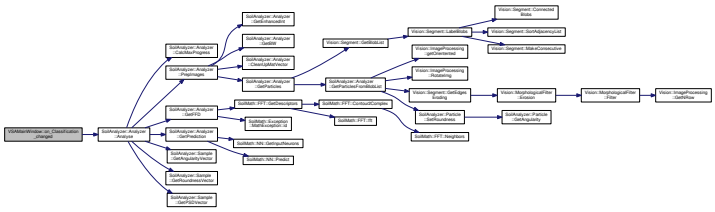
6.67.3.11 void VSAMainWindow::on_Classification_changed (int *newValue*) [private], [slot]

Definition at line 522 of file vsamainwindow.cpp.

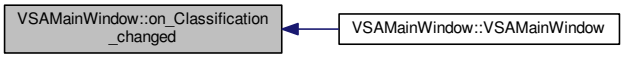
References SoilAnalyzer::Analyzer::Analyse(), Analyzer, SoilAnalyzer::Sample::ChangesSinceLastSave, SoilAnalyzer::Sample::Particle↩ ChangedStateAngularity, SoilAnalyzer::Sample::ParticleChangedStateRoundness, Sample, and ui.

Referenced by VSAMainWindow().

Here is the call graph for this function:



Here is the caller graph for this function:



6.67.3.12 void VSAMainWindow::on_compare_against ( ) [private], [slot]

Definition at line 570 of file vsamainwindow.cpp.

References PSDTicks, SoilAnalyzer::SoilSettings::SampleFolder, Settings, and ui.

Referenced by on_PSD_contextMenuRequest().

Here is the caller graph for this function:

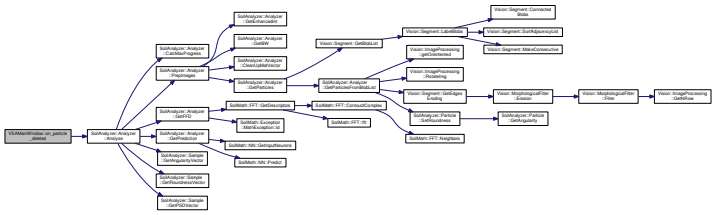
6.67.3.13 void VSAMainWindow::on_particle_deleted ( ) [private], [slot]

Definition at line 539 of file vsamainwindow.cpp.

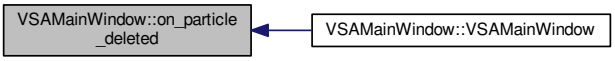
References SoilAnalyzer::Analyzer::Analyse(), and Analyzer.

Referenced by VSAMainWindow().

Here is the call graph for this function:



Here is the caller graph for this function:



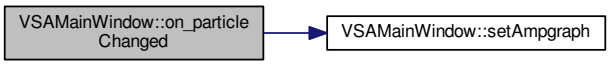
6.67.3.14 void VSAMainWindow::on_particleChanged (int *newPart*) [private],[slot]

Definition at line 351 of file vsamainwindow.cpp.

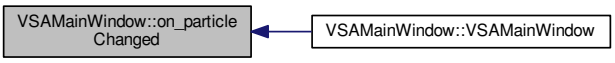
References setAmpgraph().

Referenced by VSAMainWindow().

Here is the call graph for this function:



Here is the caller graph for this function:



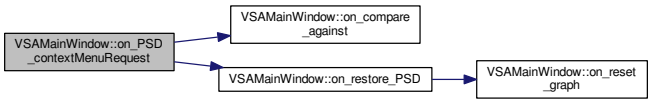
6.67.3.15 void VSAMainWindow::on_PSD_contextMenuRequest (QPoint *point*) [private],[slot]

Definition at line 561 of file vsamainwindow.cpp.

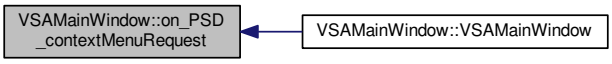
References on_compare_against(), on_restore_PSD(), and ui.

Referenced by VSAMainWindow().

Here is the call graph for this function:



Here is the caller graph for this function:



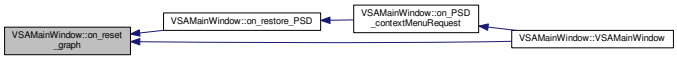
6.67.3.16 void VSAMainWindow::on_reset_graph (QMouseEvent * *e*) [private], [slot]

Definition at line 545 of file vsamainwindow.cpp.

References ui.

Referenced by on_restore_PSD(), and VSAMainWindow().

Here is the caller graph for this function:



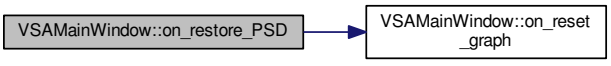
6.67.3.17 void VSAMainWindow::on_restore_PSD ( ) [private], [slot]

Definition at line 628 of file vsamainwindow.cpp.

References on_reset_graph(), and ui.

Referenced by on_PSD_contextMenuRequest().

Here is the call graph for this function:



Here is the caller graph for this function:

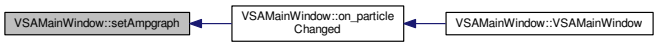
6.67.3.18 void VSAMainWindow::setAmpgraph ( ) [private]

Definition at line 339 of file vsamainwindow.cpp.

References ui.

Referenced by on_particleChanged().

Here is the caller graph for this function:



6.67.3.19 void VSAMainWindow::setAngularityHistogram ( ) [private]

Definition at line 315 of file vsamainwindow.cpp.

References SoilAnalyzer::Sample::Angularity, AngularityBars, AngularityTicks, SoilMath::Stats< T1, T2, T3 >::bins, SoilMath::Stats< T1, T2, T3 >::HighestPDF, SoilMath::Stats< T1, T2, T3 >::Mean, Sample, and ui.

Referenced by on_analyzer_finished().

Here is the caller graph for this function:

6.67.3.20 void VSAMainWindow::SetPSDgraph ( ) [private]

Definition at line 285 of file vsamainwindow.cpp.

References SoilMath::Stats< T1, T2, T3 >::CFD, SoilAnalyzer::Sample::PSD, PSDTicks, Sample, and ui.

Referenced by on_analyzer_finished().

Here is the caller graph for this function:

6.67.3.21 void VSAMainWindow::setRoundnessHistogram ( ) [private]

Definition at line 291 of file vsamainwindow.cpp.

References SoilMath::Stats< T1, T2, T3 >::bins, SoilMath::Stats< T1, T2, T3 >::HighestPDF, SoilMath::Stats< T1, T2, T3 >::Mean, SoilAnalyzer::Sample::Roundness, RoundnessBars, RoundnessTicks, Sample, and ui.

Referenced by on_analyzer_finished().

Here is the caller graph for this function:

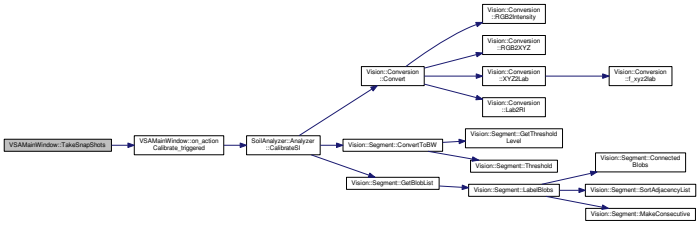
6.67.3.22 void VSAMainWindow::TakeSnapShots ( ) [private]

Definition at line 391 of file vsamainwindow.cpp.

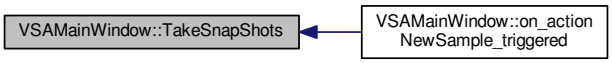
References Analyzer, SoilAnalyzer::Analyzer::Image_t::BackLight, BacklightMessage, SoilAnalyzer::Analyzer::CurrentSIfactor, SoilAnalyzer::Analyzer::Image_t::FrontLight, SoilAnalyzer::SoilSettings::HDRframes, Images, on_actionCalibrate_triggered(), Settings, ShakeItBabyMessage, SoilAnalyzer::Analyzer::SIfactorDet, SoilAnalyzer::Analyzer::Image_t::SIPixelFactor, SoilAnalyzer::SoilSettings::StandardNumberOfShots, SoilAnalyzer::SoilSettings::useBacklightProjection, and SoilAnalyzer::SoilSettings::useHDR.

Referenced by on_actionNewSample_triggered().

Here is the call graph for this function:



Here is the caller graph for this function:



6.67.4 Member Data Documentation

6.67.4.1 SoilAnalyzer::Analyzer* VSAMainWindow::Analyzer = nullptr [private]

Definition at line 83 of file vsamainwindow.h.

Referenced by on_actionCalibrate_triggered(), on_actionLoadSample_triggered(), on_actionNeuralNet_triggered(), on_actionNewSample_triggered(), on_actionUseLearning_toggled(), on_Classification_changed(), on_particle_deleted(), TakeSnapShots(), VSAMainWindow(), and ~VSAMainWindow().

6.67.4.2 QCPBars* VSAMainWindow::AngularityBars = nullptr [private]

Definition at line 86 of file vsamainwindow.h.

Referenced by setAngularityHistogram(), and VSAMainWindow().

6.67.4.3 QVector<QString> VSAMainWindow::AngularityCat [private]

Initial value:

```
= {"Very Angular", "Angular", "Sub Angular",
                                "Sub Rounded",  "Rounded", "Well Rounded"}
```

Definition at line 92 of file vsamainwindow.h.

Referenced by VSAMainWindow().

6.67.4.4 std::vector<double> VSAMainWindow::AngularityTicks = {1, 2, 3, 4, 5, 6} [private]

Definition at line 94 of file vsamainwindow.h.

Referenced by setAngularityHistogram(), and VSAMainWindow().

6.67.4.5 QMessageBox* VSAMainWindow::BacklightMessage = nullptr [private]

Definition at line 76 of file vsamainwindow.h.

Referenced by TakeSnapShots(), VSAMainWindow(), and ~VSAMainWindow().

6.67.4.6 QErrorMessage* VSAMainWindow::CamError = nullptr [private]

Definition at line 74 of file vsamainwindow.h.

Referenced by on_actionNewSample_triggered(), VSAMainWindow(), and ~VSAMainWindow().

6.67.4.7 SoilAnalyzer::Analyzer::Images_t* VSAMainWindow::Images = nullptr [private]

Definition at line 84 of file vsamainwindow.h.

Referenced by on_actionLoadSample_triggered(), on_actionNewSample_triggered(), TakeSnapShots(), VSAMainWindow(), and ~VSAMain↩Window().

6.67.4.8 Hardware::Microscope* VSAMainWindow::Microscope = nullptr [private]

Definition at line 81 of file vsamainwindow.h.

Referenced by ~VSAMainWindow().

6.67.4.9 DialogNN* VSAMainWindow::nnWindow = nullptr [private]

Definition at line 72 of file vsamainwindow.h.

Referenced by on_actionNeuralNet_triggered(), VSAMainWindow(), and ~VSAMainWindow().

6.67.4.10 bool VSAMainWindow::ParticleDisplayerFilled = false [private]

Definition at line 96 of file vsamainwindow.h.

Referenced by on_actionLoadSample_triggered(), and on_analyzer_finished().

6.67.4.11 QProgressBar* VSAMainWindow::Progress [private]

Definition at line 73 of file vsamainwindow.h.

Referenced by VSAMainWindow().

6.67.4.12 std::vector<double> VSAMainWindow::PSDTicks [private]

Initial value:

```
= {0.0,  0.038, 0.045, 0.063, 0.075,
                               0.09, 0.125, 0.18,  0.25,  0.355,
                               0.5,  0.71,  1.0,   1.4,   2.0}
```

Definition at line 87 of file vsamainwindow.h.

Referenced by on_compare_against(), SetPSDgraph(), and VSAMainWindow().

6.67.4.13 QReportGenerator* VSAMainWindow::ReportGenWindow = nullptr [private]

Definition at line 78 of file vsamainwindow.h.

Referenced by on_actionReport_Generator_triggered().

6.67.4.14 QCPBars* VSAMainWindow::RoundnessBars = nullptr [private]

Definition at line 85 of file vsamainwindow.h.

Referenced by setRoundnessHistogram(), and VSAMainWindow().

6.67.4.15 QVector<QString> VSAMainWindow::RoundnessCat = {"High", "Medium", "Low"} [private]

Definition at line 90 of file vsamainwindow.h.

Referenced by VSAMainWindow().

6.67.4.16 std::vector<double> VSAMainWindow::RoundnessTicks = {1, 2, 3} [private]

Definition at line 91 of file vsamainwindow.h.

Referenced by setRoundnessHistogram(), and VSAMainWindow().

6.67.4.17 SoilAnalyzer::Sample* VSAMainWindow::Sample = nullptr [private]

Definition at line 82 of file vsamainwindow.h.

Referenced by on_actionLoadSample_triggered(), on_actionNewSample_triggered(), on_actionReport_Generator_triggered(), on_action↩SaveSample_triggered(), on_analyzer_finished(), on_Classification_changed(), setAngularityHistogram(), SetPSDgraph(), setRoundness↩Histogram(), VSAMainWindow(), and ~VSAMainWindow().

6.67.4.18 QMessageBox* VSAMainWindow::SaveMeMessage = nullptr [private]

Definition at line 75 of file vsamainwindow.h.

Referenced by on_actionLoadSample_triggered(), on_actionNewSample_triggered(), VSAMainWindow(), and ~VSAMainWindow().

6.67.4.19 SoilAnalyzer::SoilSettings* VSAMainWindow::Settings = nullptr [private]

Definition at line 80 of file vsamainwindow.h.

Referenced by on_actionAutomatic_Shape_Pediction_triggered(), on_actionLoadSample_triggered(), on_actionNeuralNet_triggered(), on↩_actionNewSample_triggered(), on_actionReport_Generator_triggered(), on_actionSaveSample_triggered(), on_compare_against(), Take↩SnapShots(), VSAMainWindow(), and ~VSAMainWindow().

6.67.4.20 DialogSettings* VSAMainWindow::settingsWindow = nullptr [private]

Definition at line 71 of file vsamainwindow.h.

Referenced by on_actionNeuralNet_triggered(), on_actionSettings_triggered(), VSAMainWindow(), and ~VSAMainWindow().

6.67.4.21 QMessageBox* VSAMainWindow::ShakeItBabyMessage = nullptr [private]

Definition at line 77 of file vsamainwindow.h.

Referenced by TakeSnapShots(), VSAMainWindow(), and ~VSAMainWindow().

6.67.4.22 Ui::VSAMainWindow* VSAMainWindow::ui [private]

Definition at line 70 of file vsamainwindow.h.

Referenced by on_actionLoadSample_triggered(), on_actionNewSample_triggered(), on_actionReport_Generator_triggered(), on_analyzer_↩finished(), on_Classification_changed(), on_compare_against(), on_PSD_contextMenuRequest(), on_reset_graph(), on_restore_PSD(), set↩Ampgraph(), setAngularityHistogram(), SetPSDgraph(), setRoundnessHistogram(), VSAMainWindow(), and ~VSAMainWindow().

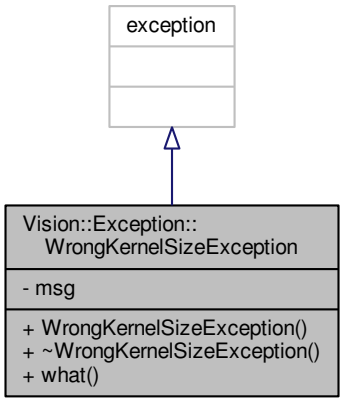
The documentation for this class was generated from the following files:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/VSA/vsamainwindow.h
- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/VSA/vsamainwindow.cpp

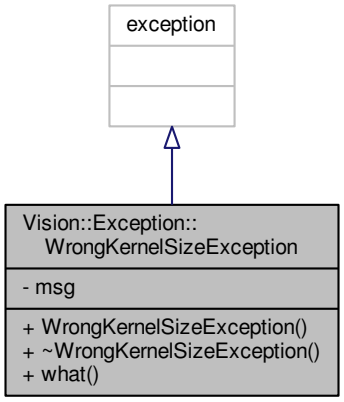
6.68 Vision::Exception::WrongKernelSizeException Class Reference

`#include <WrongKernelSizeException.h>`

Inheritance diagram for Vision::Exception::WrongKernelSizeException:



Collaboration diagram for Vision::Exception::WrongKernelSizeException:



Public Member Functions

- WrongKernelSizeException (string m="Wrong kernel dimensions!")
- ~WrongKernelSizeException () _GLIBCXX_USE_NOEXCEPT
- const char * what () const _GLIBCXX_USE_NOEXCEPT

Private Attributes

- string msg

6.68.1 Detailed Description

Definition at line 20 of file WrongKernelSizeException.h.

6.68.2 Constructor & Destructor Documentation

6.68.2.1 Vision::Exception::WrongKernelSizeException::WrongKernelSizeException (string *m* = "Wrong kernel dimensions!") [inline]

Definition at line 22 of file WrongKernelSizeException.h.

6.68.2.2 Vision::Exception::WrongKernelSizeException::~WrongKernelSizeException ( ) [inline]

Definition at line 23 of file WrongKernelSizeException.h.

6.68.3 Member Function Documentation

6.68.3.1 const char* Vision::Exception::WrongKernelSizeException::what ( ) const [inline]

Definition at line 24 of file WrongKernelSizeException.h.

6.68.4 Member Data Documentation

6.68.4.1 string Vision::Exception::WrongKernelSizeException::msg [private]

Definition at line 24 of file WrongKernelSizeException.h.

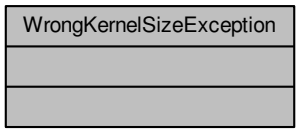
The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/WrongKernelSizeException.h

6.69 WrongKernelSizeException Class Reference

`#include <WrongKernelSizeException.h>`

Collaboration diagram for WrongKernelSizeException:



6.69.1 Detailed Description

Exception class which is thrown when a wrong kernelsize is requested

The documentation for this class was generated from the following file:

- /home/peer23peer/programmingspace/VSA/VisionSoilAnalyzer/src/SoilVision/WrongKernelSizeException.h