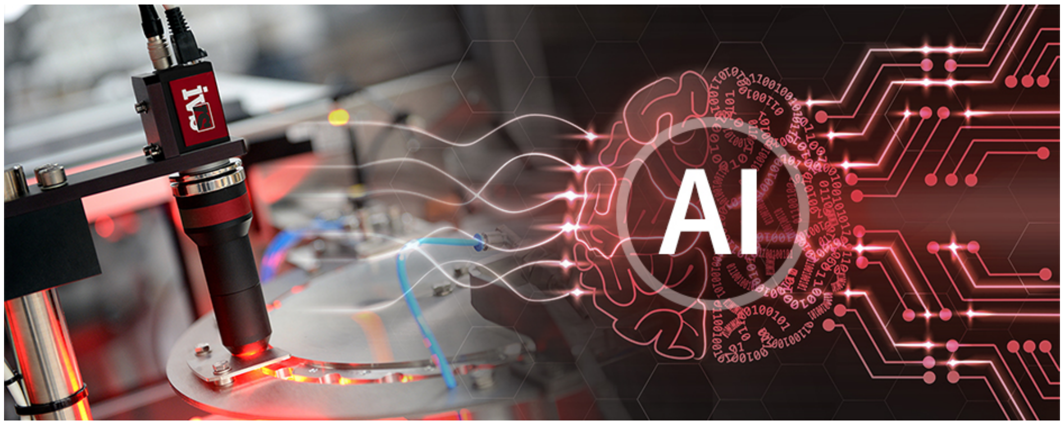
Installation / User Manual



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DEye: Keep an Eye on Defects Inspection

30/10/2020

Abstract

Defect Eye (DEye) is a deep learning-based software for manufacturing surface defect inspection. It provides the basic function modules to facilitate the development of different defect inspection applications. The applications cover the full rang of manufacturing environment, including incoming process tool qualification, wafer qualification, glass surface qualification, reticle qualification, research and development. Also, It can be used for medical image inpsection, including Lung PET/CT,breast MRI, CT Colongraphy, Digital Chest X-ray images. This software library contains the basic function modules about data processing, model training and model inference. It is developed to reduce the burden of programmers who works in this field. Based on this software, developers can design the added functions according to their requirements. This document describes how to build DEye software and how to use it.

1 Introduction

The DEye [4] software library consists of 7 modules with some inter-dependence. The function of each module is shown as below:

- **GUI**: a simple user interface for model training and inference (programmed with C#).
- **trainer**: it contains data processing and model training based on Tensorflow framework (programmed with C++).
- **classifier**: it contains model inference when feed the input images (programmed with C++).
- **dataGen**: a module to generate training data under the specified size (programmed with C++).
- **example**: some function test cases (programmed with C++).
- **SVM**: a simple demo to show how to use SVM classifier to classify images (programmed with C++).
- **txt2xml**: a tool to convert txt format to xml format (programmed with C++).

2 Development Environment

The Microsoft Visual Studio 2017 (VS2017) is used to develop the DEye software under Window (English version, 64 bits) operation system, the version of VS2017 is show in Figure 2.

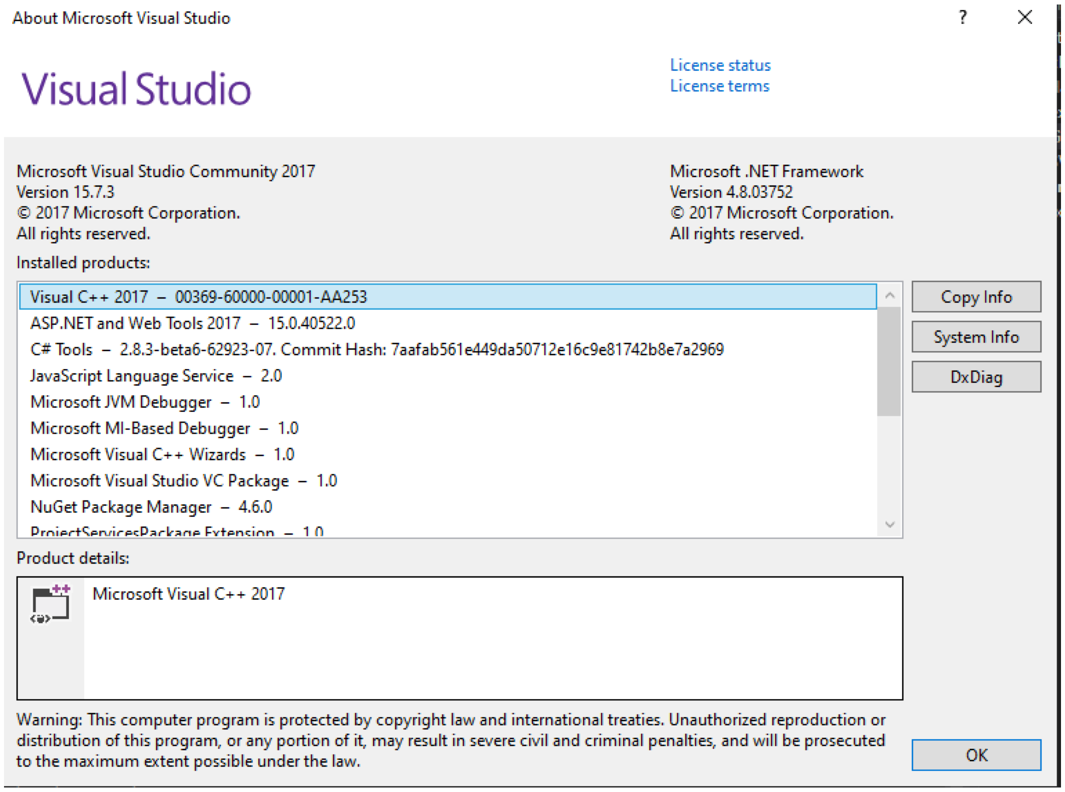
Besides, the configuration of each module is shown in Figure 3 and Figure 4. All of these modules should be configured in a right way.

3 3rd Party Library

DEye is depended on several third party libraries, i.e., Tensorflow [1], OpenCV [2], Glog [3], which all of them are open source. In this project, the C++ version of Tensorflow 1.4, OpenCV 3.4, and Glog are used to support DEye library development. The newest 3rd-party libraries should be built by developers who want to update the version. Fortunately, the default version is provided with the following links:

- BaiduYun Link: https://pan.baidu.com/s/1o9tv1n8, password: ekec
- Google Link: https://drive.google.com/open?id=1kANDNErMNLU9wNR3rKhUTz–ltwPNPUv

All the libraries should be downloaded into the computer, then configuring the environment with the following steps:



Microsoft Visual Studio Community 2017
Version 15.7.3
© 2017 Microsoft Corporation.
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Microsoft .NET Framework
Version 4.8.03752
© 2017 Microsoft Corporation.
All rights reserved.

Installed products:

Visual C++ 2017 – 00369-60000-00001-AA253
ASP.NET and Web Tools 2017 – 15.0.40522.0
C# Tools – 2.8.3-beta6-62923-07. Commit Hash: 7aafab561e449da50712e16c9e81742b8e7a2969
JavaScript Language Service – 2.0
Microsoft JVM Debugger – 1.0
Microsoft MI-Based Debugger – 1.0
Microsoft Visual C++ Wizards – 1.0
Microsoft Visual Studio VC Package – 1.0
NuGet Package Manager – 4.6.0
ProjectServicesPackage Extension – 1.0

Product details:

Microsoft Visual C++ 2017

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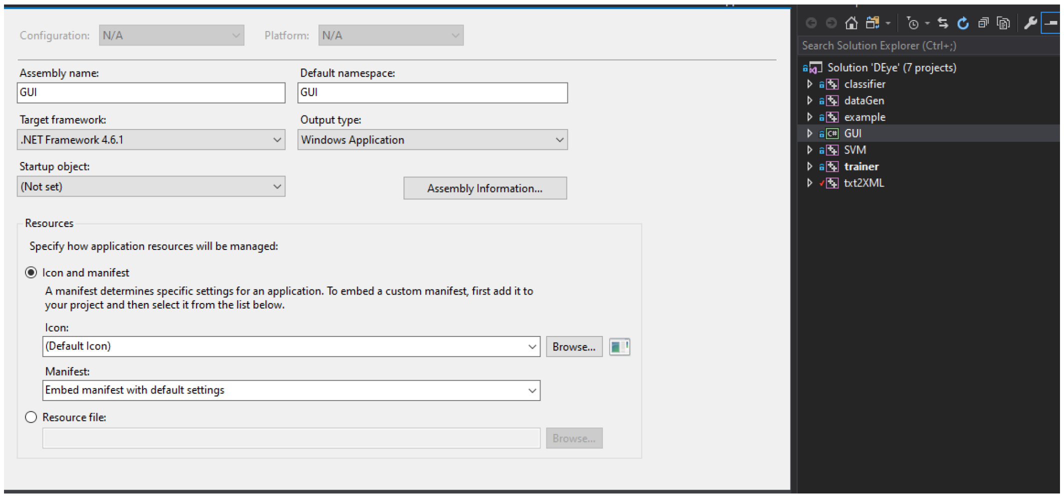
Figure 1: Visual Studio 2017 version



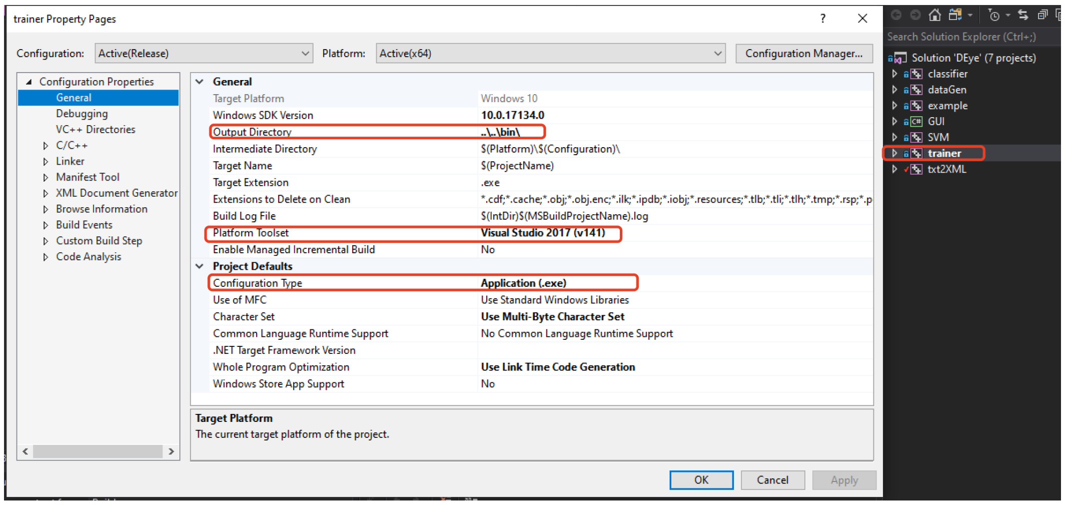
Configuration: N/A Platform: N/A

Assembly name: GUI
Default namespace: GUI
Target framework: .NET Framework 4.6.1
Output type: Windows Application
Startup object: (Not set)

Resources
Specify how application resources will be managed:
(●) Icon and manifest
A manifest determines specific settings for an application. To embed a custom manifest, first add it to your project and then select it from the list below.
Icon: (Default Icon)
Manifest: Embed manifest with default settings
( ) Resource file:

Solution 'DEye' (7 projects)
classifier
dataGen
example
GUI
SVM
trainer
txt2XML

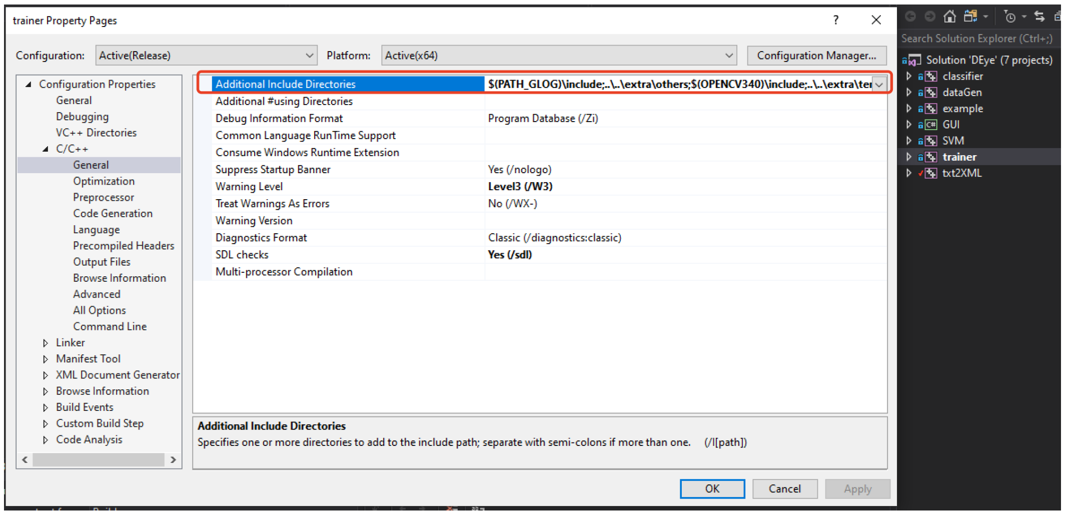
Figure 2: Configuration of GUI module.



General	
Target Platform	Windows 10
Windows SDK Version	**10.0.17134.0**
Output Directory	**..\..\bin**
Intermediate Directory	$(Platform)\$(Configuration)\
Target Name	$(ProjectName)
Target Extension	.exe
Extensions to Delete on Clean	*.cdf;*.cache;*.obj;*.obj.enc;*.ilk;*.ipdb;*.iobj;*.resources;*.tlb;*.tli;*.tlh;*.tmp;*.rsp;*.p
Build Log File	$(IntDir)$(MSBuildProjectName).log
Platform Toolset	**Visual Studio 2017 (v141)**
Enable Managed Incremental Build	No
Project Defaults	
Configuration Type	**Application (.exe)**
Use of MFC	Use Standard Windows Libraries
Character Set	**Use Multi-Byte Character Set**
Common Language Runtime Support	No Common Language Runtime Support
.NET Target Framework Version	
Whole Program Optimization	**Use Link Time Code Generation**
Windows Store App Support	No

Target Platform
The current target platform of the project.

(a) Configuration Properties.



Additional Include Directories	**$(PATH_GLOG)\include;..\..\extra\others;$(OPENCV340)\include;..\..\extra\te**
Additional #using Directories	
Debug Information Format	Program Database (/Zi)
Common Language RunTime Support	
Consume Windows Runtime Extension	
Suppress Startup Banner	Yes (/nologo)
Warning Level	**Level3 (/W3)**
Treat Warnings As Errors	No (/WX-)
Warning Version	
Diagnostics Format	Classic (/diagnostics:classic)
SDL checks	**Yes (/sdl)**
Multi-processor Compilation	

Additional Include Directories
Specifies one or more directories to add to the include path; separate with semi-colons if more than one. (/I[path])

(b) Configuration of Include Directories.

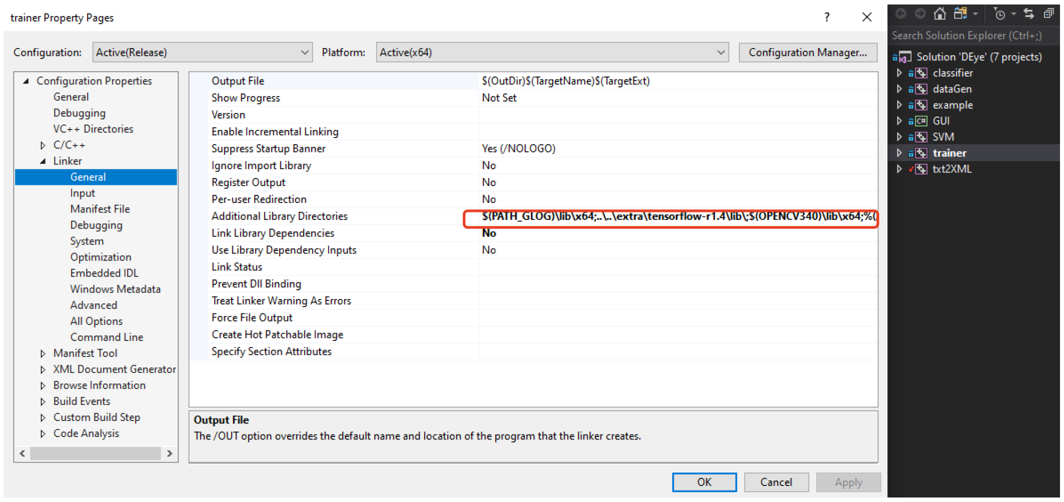
Figure 3: General Configuration.

- Step 1: put the libprotobuf.lib and tensorflow.lib into DEye->extra->tensorflow-r1.4->lib
- Step 2: put all the needed dll files into DEye->bin
- Step 3: configure the system parameters. Open the environment setting windows: Advanced system settings -> Environment variables -> System variables. The example is shown in Figure 5. **Note that the value of variables should be changed to your own.**

4 DEye Compilation

The 7 modules can be complied when finished the above configurations. Please follow the the steps show in Figure 6.

If all the modules are build successfully, you will find the executable files under DEye->bin, which is shown in Figure 7.

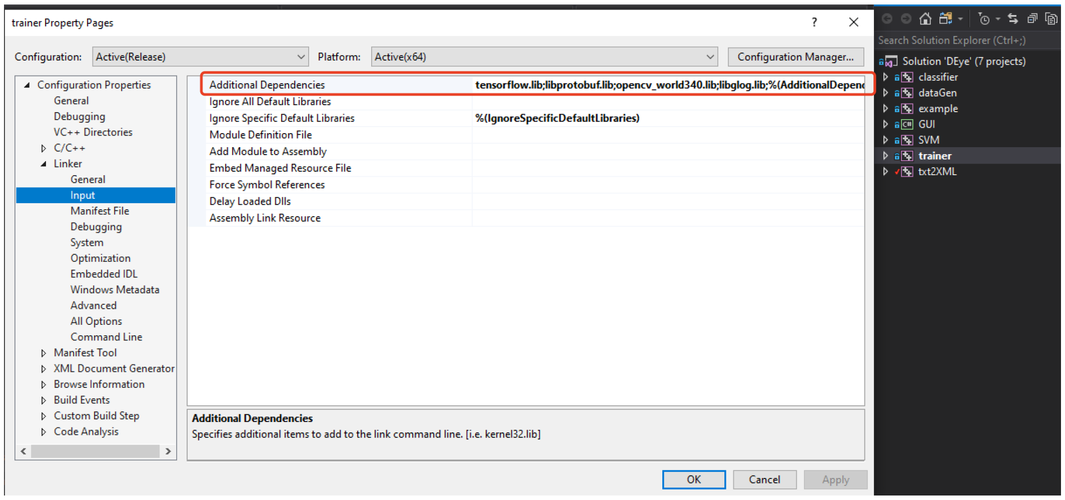


Configuration: Active(Release) Platform: Active(x64) Configuration Manager...

Output File	$(OutDir)$(TargetName)$(TargetExt)
Show Progress	Not Set
Version	
Enable Incremental Linking	
Suppress Startup Banner	Yes (/NOLOGO)
Ignore Import Library	No
Register Output	No
Per-user Redirection	No
Additional Library Directories	**$(PATH_GLOG)\lib\x64;..\..\extra\tensorflow-r1.4\lib\;$(OPENCV340)\lib\x64;%(**
Link Library Dependencies	**No**
Use Library Dependency Inputs	No
Link Status	
Prevent Dll Binding	
Treat Linker Warning As Errors	
Force File Output	
Create Hot Patchable Image	
Specify Section Attributes	

Output File
The /OUT option overrides the default name and location of the program that the linker creates.

(a) Configuration of Linker->General.



Configuration: Active(Release) Platform: Active(x64) Configuration Manager...

Additional Dependencies	**tensorflow.lib;libprotobuf.lib;opencv_world340.lib;libglog.lib;%(AdditionalDepend**
Ignore All Default Libraries	
Ignore Specific Default Libraries	**%(IgnoreSpecificDefaultLibraries)**
Module Definition File	
Add Module to Assembly	
Embed Managed Resource File	
Force Symbol References	
Delay Loaded Dlls	
Assembly Link Resource	

Additional Dependencies
Specifies additional items to add to the link command line. [i.e. kernel32.lib]

(b) Configuration of Linker->Input.

Figure 4: Configuration of Linker.

5 DEye Training

5.1 Use the GUI

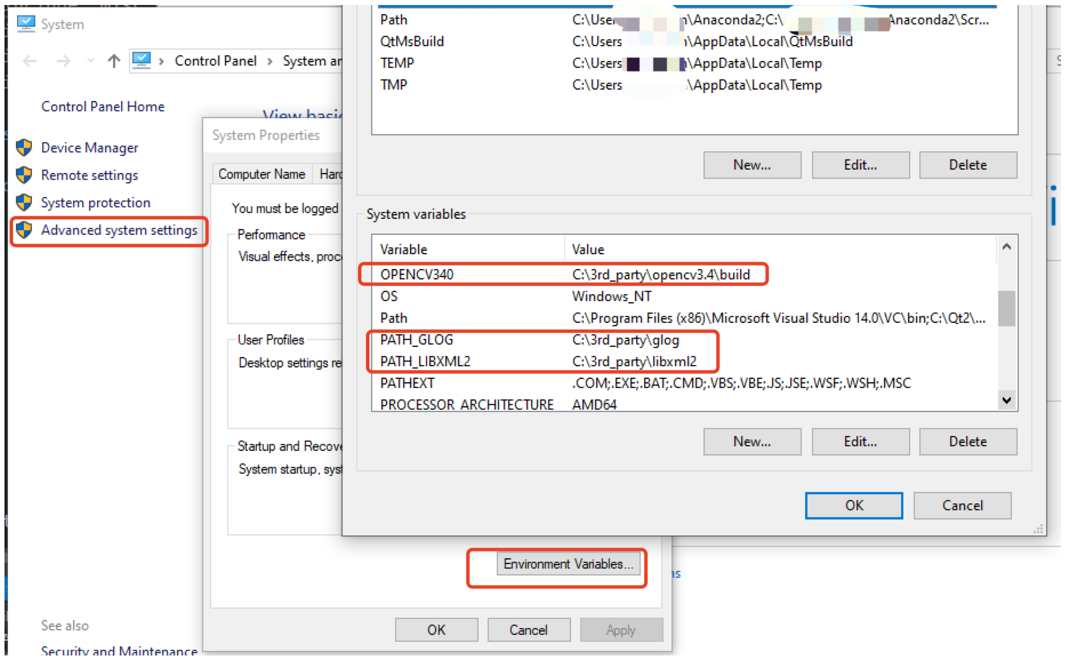
Please follow the steps as shown in Figure 8.

If you want to change the the event of "Start Training" button, please modify the bt_train_Click() function as shown in Figure 9.

5.2 Use the command

The trainer module have 5 input arguments, please find the descriptions in following:

- –method: 1: input model is Tensorflow pb file, 2: input model is Tensorflow checkpoint file.
- –graph: the path of input model.
- –config: training configuration file.
- –neg: the path of negative samples (i.e.: defectiveness images)



Path	C:\User[redacted]\Anaconda2;C:\[redacted]Anaconda2\Scr...
QtMsBuild	C:\Users[redacted]\AppData\Local\QtMsBuild
TEMP	C:\Users[redacted]\AppData\Local\Temp
TMP	C:\Users[redacted]\AppData\Local\Temp

Variable	Value
OPENCV340	C:\3rd_party\opencv3.4\build
OS	Windows_NT
Path	C:\Program Files (x86)\Microsoft Visual Studio 14.0\VC\bin;C:\Qt2\...
PATH_GLOG	C:\3rd_party\glog
PATH_LIBXML2	C:\3rd_party\libxml2
PATHEXT	.COM;.EXE;.BAT;.CMD;.VBS;.VBE;.JS;.JSE;.WSF;.WSH;.MSC
PROCESSOR_ARCHITECTURE	AMD64

Figure 5: Environment variables configuration of OPENCV340, PATH_GLOG, and PATH_LIBXML2.

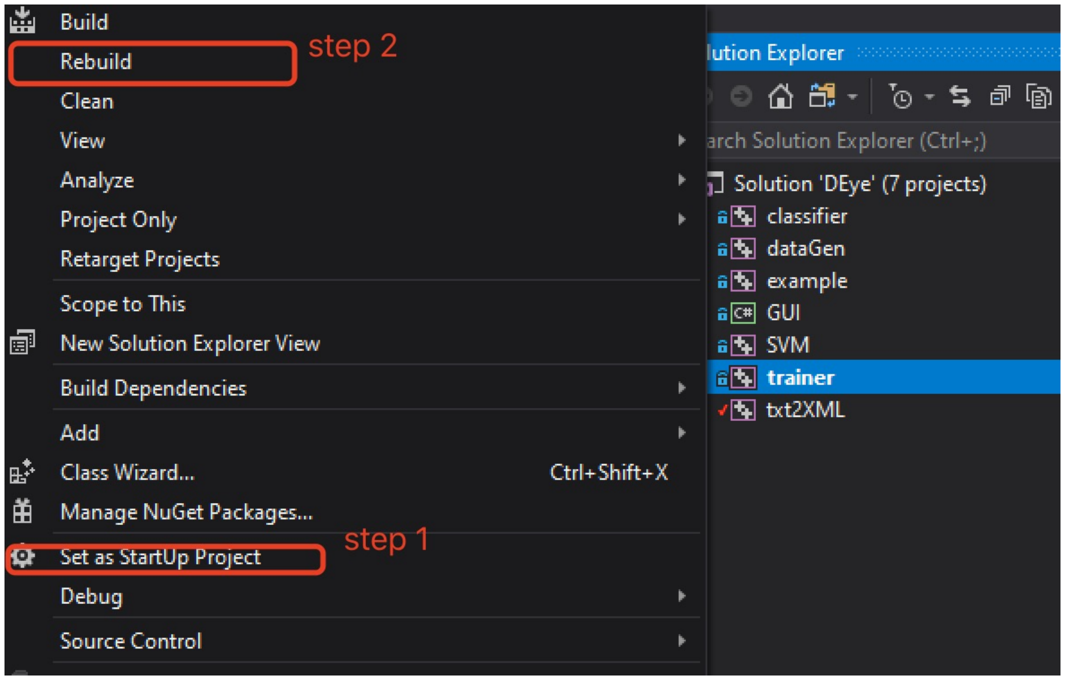
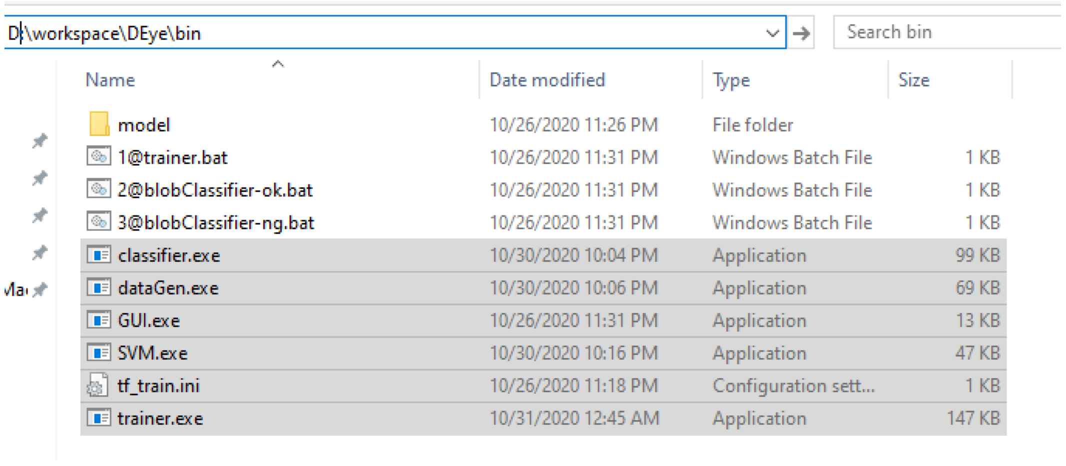


Figure 6: Build the module.



D:\workspace\DEye\bin

Name	Date modified	Type	Size
model	10/26/2020 11:26 PM	File folder	
1@trainer.bat	10/26/2020 11:31 PM	Windows Batch File	1 KB
2@blobClassifier-ok.bat	10/26/2020 11:31 PM	Windows Batch File	1 KB
3@blobClassifier-ng.bat	10/26/2020 11:31 PM	Windows Batch File	1 KB
classifier.exe	10/30/2020 10:04 PM	Application	99 KB
dataGen.exe	10/30/2020 10:06 PM	Application	69 KB
GUI.exe	10/26/2020 11:31 PM	Application	13 KB
SVM.exe	10/30/2020 10:16 PM	Application	47 KB
tf_train.ini	10/26/2020 11:18 PM	Configuration sett...	1 KB
trainer.exe	10/31/2020 12:45 AM	Application	147 KB

Figure 7: All the executable files after compilation.

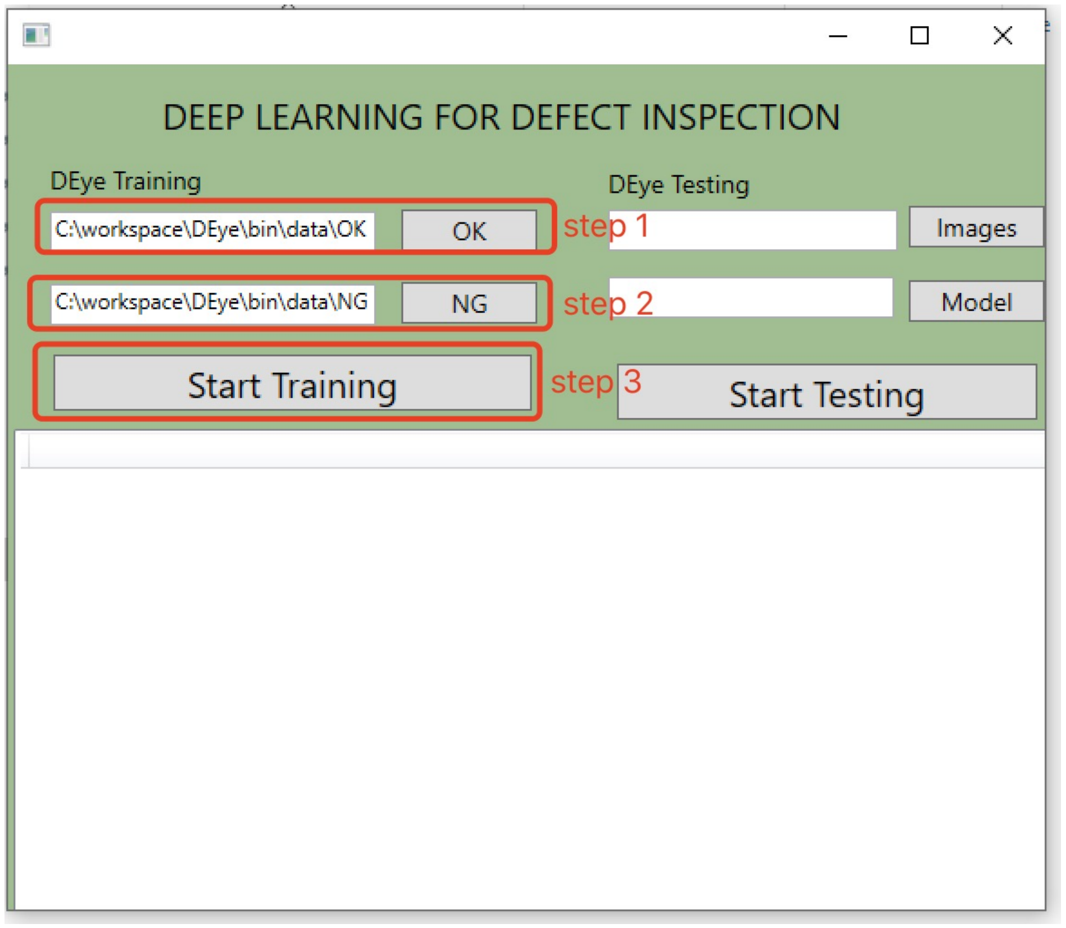
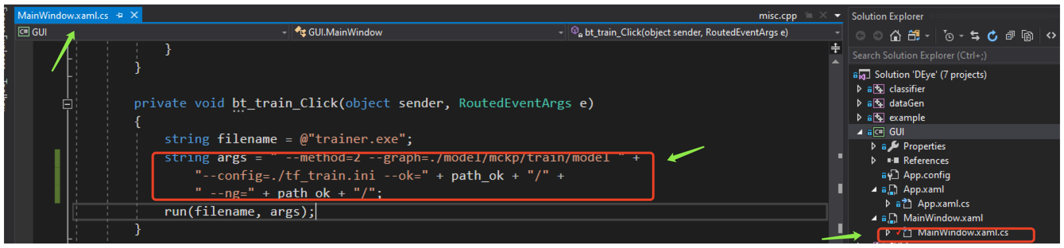

DEEP LEARNING FOR DEFECT INSPECTION
DEye Training
C:\workspace\DEye\bin\data\OK
OK
C:\workspace\DEye\bin\data\NG
NG
Start Training
step 1
step 2
step 3
DEye Testing
Images
Model
Start Testing

Figure 8: Illustration of model training.



```
        }
    }

    private void bt_train_Click(object sender, RoutedEventArgs e)
    {
        string filename = @"trainer.exe";
        string args = " --method=2 --graph=./model/mckp/train/model " +
            "--config=./tf_train.ini --ok=" + path_ok + "/" +
            " --ng=" + path_ok + "/";
        run(filename, args);
    }
```

Figure 9: The backend of bt_train_Click().

- –pos: the path of positive samples(i.e.: defective images)

Example:
trainer.exe –method=2 –graph=./model/mckp/train/model –config=./tf_train.ini –neg=./data/train/OK/ –pos=./data/train/NG/

6 DEye Inference

6.1 Use the GUI

Please follow the steps as shown in Figure 10.

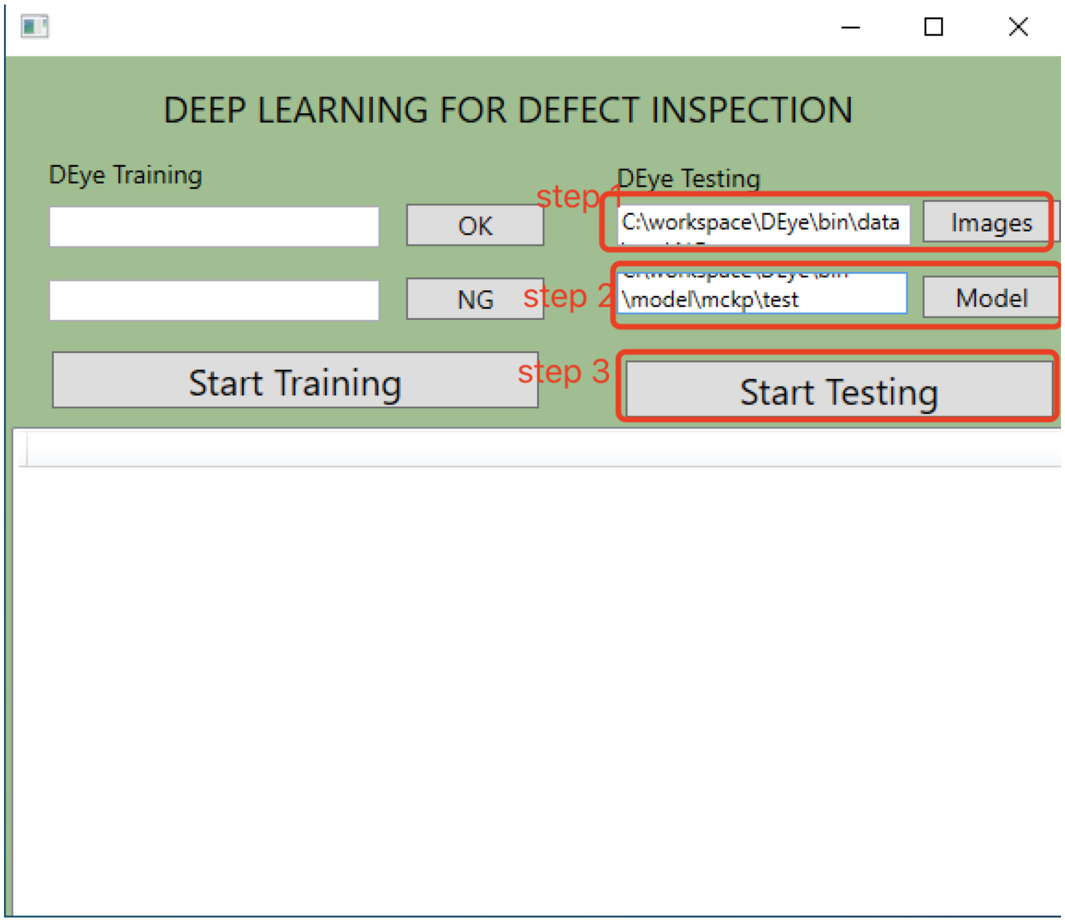
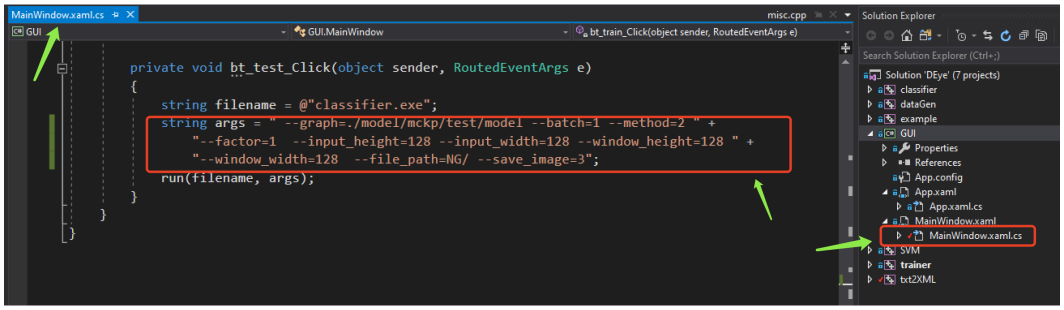


Figure 10: Illustration of model inference.

If you want to change the event of "Start Testing" button, please modify the bt_test_Click() function as shown in Figure 11.



```
        private void bt_test_Click(object sender, RoutedEventArgs e)
        {
            string filename = @"classifier.exe";
            string args = " --graph=./model/mckp/test/model --batch=1 --method=2 " +
                "--factor=1  --input_height=128 --input_width=128 --window_height=128 " +
                "--window_width=128  --file_path=NG/ --save_image=3";
            run(filename, args);
        }
    }
}
```

Figure 11: The backend of bt_test_Click().

6.2 Use the command

The classifier module have 11 input arguments, please find the descriptions in following:

- –method: 1: input model is Tensorflow pb file, 2: input model is Tensorflow checkpoint file.
- –graph: the path of input model.
- –batch: batch size of input images.
- –factor: the down sample factor.
- –load_channel: the number of channels of input image, 1 for grey image, 3 for color images.
- –input_height: the height of input images.
- –input_width: the width of input images.
- –window_height: the height of sliding windows.
- –window_width: the width of sliding windows.
- –file_path: the path of input images.
- –save_image: save output images or not.

Example:
classifier.exe –graph=./model/mckp/test/model –batch=1 –method=2 –factor=1 –load_channel=1 –input_height=128 –input_width=128 –window_height=128 –window_width=128 –file_path=test_data_ng –save_image=3

7 Acknowledgement

Welcome to contact with me if you want to be a collaborator of this open source project.

References

[1] Martín Abadi, Paul Barham, Jianmin Chen, Zhifeng Chen, Andy Davis, Jeffrey Dean, Matthieu Devin, Sanjay Ghemawat, Geoffrey Irving, Michael Isard, et al. Tensorflow: A system for large-scale machine learning. In *12th {USENIX} symposium on operating systems design and implementation ({OSDI} 16)*, pages 265–283, 2016.

[2] G. Bradski. The OpenCV Library. *Dr. Dobb's Journal of Software Tools*, 2000.

[3] Google Inc. Google logging library, 2020. [Online; accessed 30-Oct-2020].

[4] Sundy. A deep learning-based software for manufacturing defect inspection. `https://github.com/sundyCoder/DEye`, 2017.