Description / Documentation

MSC I Process

Table of Contents

1 definition

terms:

term	statement
Library	The software collection this project
class	A structured data type with features and functions. Currently, the classes "MSC Image" and "MSC Video" are available in this library.
VI	Name of a realized in LabVIEW program function.
reference	"Link" to a storage area on which there are the actual data.
Memory Leak	If not all references properly closed, the data still exist in memory, even though they are no longer needed. This usually leads to program crashes (eg out of memory error). A memory leak is the point in the program code, which loses this reference.

Table 1: Definitions

Presentation:

remark	
	> Contains a text note which will contribute to the further understanding.

Note	
	> Contains a text note, which must be observed.

citation	
	> Reference for further reading

Program code, VI names:
The VI's described in the document are displayed in italics. The VIs can be searched in the LabVIEW programming environment under the names specified here.

2 Abstract

MSC I Process allows easy and user-friendly access to the image processing with LabVIEW. The library is based in part on OpenCV, enabling access and high Perfomanz a variety of functions.

3 dependencies

The following software components are required or provided for use of the library.

component needed	available from / by
LabVIEW 2014 or later	Installation of the programming environment (National Instruments)
OpenCV 02/04/11	MSC or www.opencv.org (Part of this library)
OpenG Toolkit	VI Package Manager
NI IMAQ / NI Vision	National Instruments (optional, for ROI selection)
MSC User Library	MSC (Part of this library)

Table 2: Dependencies

4 installation

Copy the contents of the folder "user.lib" in the user.lib your LabVIEW installation. (Eg C: \ Program Files (x86) \ National Instruments \ LabVIEW 2014 \ user.lib) The next time the development environment, the Vis are in the range of functions.

5 Troubleshooting

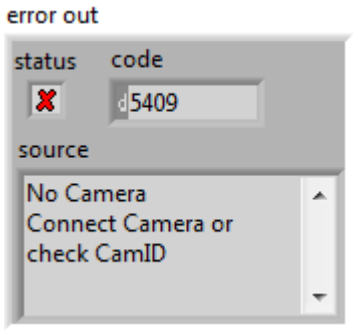

Figure 1 Error Cluster Figure

The error handling as used herein is based on LabVIEW Standard. All functions have a Fehlerclusterein- and output. There is next to the status (fault / no fault) a

unique error code and source of error or error description. The above error occurs, for example, if the selected camera is not connected.

The error codes range from 5401 to the 5499th This is to avoid that codes are overwritten by other parts of the program. nevertheless enters an intersection on a change in VI *error handling* be made.

6 Function Reference MSC Image

6.1 structure

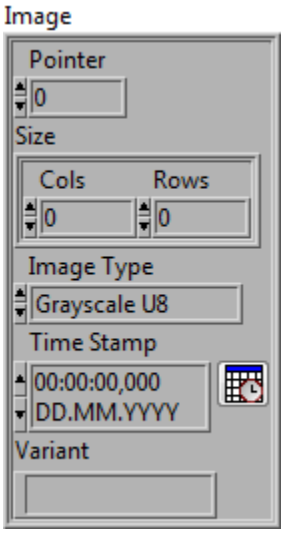

Figure 2: Structure of the MSC Image

The basic structure of the MSC Images based on references. This ensures that both the LabVIEW code and external code without unnecessary copying can work with the data. In this case, the pointer directly to the memory area which is occupied by the image. can be identified by the timestamp of when the picture was taken. There's no telling what other parameters are required in the respective project, a variant was additionally added. In this placeholder, any data can be stored, for example, comments or camera parameters.

6.2 image types

Currently, it is possible to create grayscale images in U8, U16, single and double and edit. The only color type is RGB with three U8 channels.

6.3 masks

Some of the functions used here need a mask. A mask marked areas in the image which are to be used for the operation (for example, *Inpaint* - Restoration of defective image segments). These masks are made of a U8 grayscale image. Each pixel value other than zero is considered to be marked.

6.4 Memory Leaks

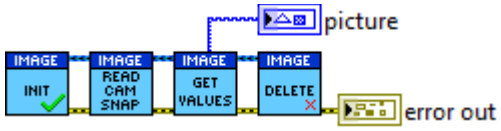

Figure 3: Camera Snapshot Demo Program

Deleting images, which is no longer needed essential to prevent program crashes. Especially in continuous shooting, the memory fills rapidly, and the user gets an "out of memory" error. the VI *Delete* is responsible for deallocate all the data associated with the image correctly, so to speak clean up. Logically, the data are then no longer be read. In the demo program *Camera snapshot* is illustrated a typical application. After Bildinitialisierung (*Initialize)* a frame of the camera is received (*Read Camera Snapshot)* and output to a Picture Control (*Get Values).* If after this function chain not *Delete*

executed, the data of the image remain (~ 1 to 15 MB, depending on the camera) in the memory was obtained through the complete program ended.

6.5 functions

6.5.1 Understanding

Initialize

Figure 4: image content during initialization (NA.png)

The constructor of an image object is called here. By default, is loaded here "NA.png" into memory.

Delete

The reference is destroyed. In addition, the memory area is released. Note

If this function is not called for each created image, this leads to memory leaks.

Clone

Copies all data into a new image object. Both objects must be deleted to free up (over the memory area *Delete).*

6.5.2 interfaces

Read Camera Snapshot

Simple camera recording function. different cameras can be addressed by the ID. It currently supports the following camera driver:

MIL, VFW, V4L, V4L2, Fireware, Firewire, IEEE 1394, DC, Stereo TYZX, QuickTime, Unicap, DirectShow, PvAPI,

Prosilica GigE, OpenNI, XIMEA Camera citation

OpenCV http://docs.opencv.org/modules/highgui/doc/reading_and_writing_images_and_video.html#vide ocapture

remark
The class MSC video offers more configuration options, such as exposure and works much perfomanter Continuous recording.

Get / Set Values

Reads or writes the current values as a 2D array LabVIEW or Picture. Depending on the type of image the correct output must be selected here. remark

 The RGB data type returns U32 values. In order to extract channels can be *Color To RGB* use.

remark
 If the refresh rate of the Picture Controls very high, so it is recommended that the "Erase First" feature off. (Right click on the Picture Control)

Read / Write IMAQ Image

Converts the image to a MSC IMAQ image and vice versa. Note

 The data is stored twice. Thus, in addition must *IMAQ Dispose* be called to clean up the memory of the IMAQ image.

remark
 The MSC Image ROI data type contains more information than the type IMAQ. Therefore, the conversion to IMAQ should be used only for display.

ReadImage

Reads a stored image. Supported formats:

- Windows bitmaps: bmp, dib
- JPEG: jpeg, jpg, jpe
- JPEG 2000: jp2
- Portable Network Graphics: png
- Portable image format: pdm, pgm, ppm
- Sun grid: sr, ras
- TIFF: tiff, tif

can be applied to the invitee image via the input "read image properties" a previously saved file Built shaft. (See also *Write Image)*

citation
OpenCV http://docs.opencv.org/modules/highgui/doc/reading_and_writing_images_and_video.html#imre ad

Write Image

Save the image on the hard drive. There are the same sizes as *ReadImage* supported. In addition, PNG compression can be selected. The value 0 stands for an uncompressed, 9 is maximal compression. The JPEG quality can be defined from 0 to 100. PNG compression is always lossless, it being a JPEG quality of 100 already includes losses.

Please also note that any format can not be saved in a file type. citation

OpenCV http://docs.opencv.org/modules/highgui/doc/reading_and_writing_images_and_video.html#imwr ite

The activated input "write image properties" generates an attribute file, which size, image type, time stamp, and includes Variant.

remark

The path "image properties path" is optional. If it is left blank, the property file is saved with the same name of the image file.

Get / Set Image

This is the interface to any other software. the image via the pointer, the image size and image type can be exchange perfomant.

6.5.3 Operations

arithmetics

are all simple arithmetic operations to view this folder - Image, - scalar and image - - scalar. Currently, it is possible to add, multiply, subtract and divide.

Typecast

Converts the type of image and scaled optional values.

Resize

Changes the size of an image and scaled its contents. There are different interpolation algorithms available.

citation

 OpenCV http://docs.opencv.org/modules/imgproc/doc/geometric_transformations.html#resize

Crop

Intersects an image to a rectangular area. If this area outside of the image, so it shall be adjusted. citation

 OpenCV http://docs.opencv.org/modules/core/doc/basic_structures.html#Mat::Mat%28const%20Mat&% 20m, 20const%%% & 20Rect 20roi 29%

Blur

Blurs the image a box filter of defined size. The larger the filter core, the stronger the effect.

citation
 OpenCV http://docs.opencv.org/modules/imgproc/doc/filtering.html#blur

Canny

Performs a Canny edge detection of a gray-scale image U8. it is suggested that "Threshold 2" is three times greater than

"Threshold 1". citation

 OpenCV http://docs.opencv.org/modules/imgproc/doc/feature_detection.html#canny

overlay Images

Superimposed two images with adjustable weights. The weights alpha and beta can be set from zero to one.

image = (alpha * image) + (beta * image2) Literature

reference
OpenCV http://docs.opencv.org/modules/core/doc/operations_on_arrays.html#addweighted

Equalize Histogram

Spreads the histogram so that the spectrum is ideally exploited.

Invert

Inverts the image.

citation
OpenCV http://docs.opencv.org/modules/core/doc/operations_on_arrays.html#invert

Gaussian Noise

Fills the frame with Gaussian noise.

Salt and Pepper Noise

Fills the frame with Salt and Pepper Noise.

Dead Pixel Detection

Detects dead pixels of the image by simple threshold detection.

The input image should be a recording with maximum exposure, so that no false detection occurs.

Following the detection, for example, by *Inpaint* the defective pixels are replaced. citation

Wikipedia http://en.wikipedia.org/wiki/Defective_pixel

Inpaint

Inpaint is a method for replacing defective or noisy picture regions. Neighboring pixels are selected and used for image reconstruction using an algorithm based on a radius. citation

 OpenCV http://docs.opencv.org/modules/photo/doc/inpainting.html#inpaint

Tint

Gives the image a distinct color cast a defined color. This is useful, for example, to highlight areas of an image to the user.

Valid Image

Checks if the current picture is valid and integrity. It is recommended above all for pointer operations call this function.

6.5.4 NUC

The Non Uniformity Correction is applied above all in infrared cameras.

NUC Calibration

As used herein, two-point calibration, two images are needed - one high and one low temperature. The temperature should in this case be constant at the whole picture and represent an ideal black body.

Depending on the differences of the detectors of the array, a 2D table is filled with linear calibration data. These may occur *NUC* Function used to be suppressed a captured image.

This calibration table consists of the parameters b and m of the linear function y = m * x + b for each pixel value. citation

 Non-uniformity Correction Group http://nuc.die.udec.cl/?page_id=18

NUC

The calibration of *NUC Calibration* is needed here to Suppress the current image.

6.5.5 Calibrate Camera

radial

$$x_{corrected} = x(1 + k_1 r^2 + k_2 r^4 + k_3 r^6)$$
$$y_{corrected} = y(1 + k_1 r^2 + k_2 r^4 + k_3 r^6)$$

tangential

$$x_{corrected} = x + [2p_1 xy + p_2(r^2 + 2x^2)]$$
$$y_{corrected} = y + [p_1(r^2 + 2y^2) + 2p_2 xy]$$

unit conversion
f - focal length
c - optical centers

$$\begin{bmatrix} x \\ y \\ w \end{bmatrix} = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

Figure 5: Calibration functions

Using a camera calibration can generate two matrices with which one can remove distortions from images.

The removable here appear distorted by "fisheye lenses" and non-parallelism of the camera lens to the camera sensor.

Calibration should be performed only once for each camera as long as the sensor and the lens does not change.

Calibrate Camera / Undistort

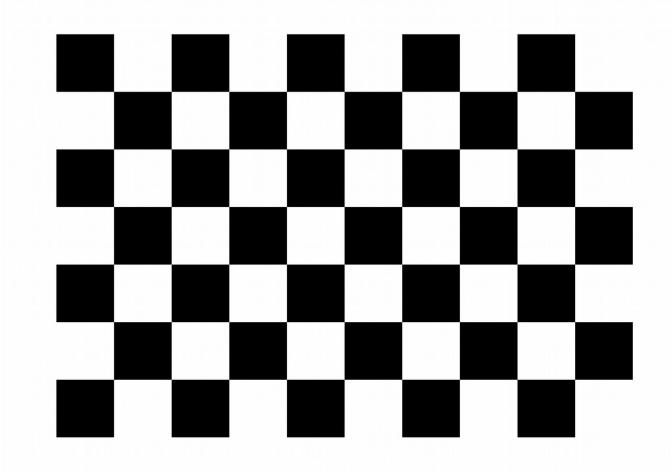

Figure 6: Test Pattern Chess Board

To perform the camera calibration, it is necessary to take a test pattern several times with the camera.

The test pattern should be applied in sufficient size to a planar surface. A commercial printer and cramping on a wooden plate is usually sufficient for this.

After the camera calibration is started, a new window opens with a live stream from the camera. Theoretically it is possible to perform the calibration with two shots of the test pattern. Because in reality, disorders or motion blur reduce the quality of the image, a recording of 20 frames is recommended.

Each recording of the test pattern results in a set of equations. In order to achieve the best possible calibration, the test pattern should be moved by the image so as to get different angles and positions, and also different equations. The calibration routine has four stages:

1. Choose a starting position
   the test pattern in the desired position is started, the key detection by the "g".

2. detection is performed
   The test pattern is detected. this Please move the test pattern through the image. In the lower right corner of the progress is displayed.

3. Calculation of Distortion matrix
   After capturing all frames they can be evaluated. A higher number of frames results in a higher computation time.

4. consideration of the result
   The live stream will show the result of the calibration. Pressing the "u" key, you can switch between original and interference suppressed Live Stream. In addition, the acquisition can be restarted by "g".

   "Esc" ends calibration, closes the stream and returns to LabVIEW back with the determined matrices.

In the stream, the test pattern recognized is highlighted in color. If there is no mark, the pattern was not detected. Each time the calibration can be canceled by the Esc key. If the calibration is not completed, an error code is generated.

If you are in the collection, but no frames are recorded, this can have different reasons:

- False test pattern
  The test pattern of the wrong type, or the size was not specified correctly.
- Test pattern or only partially in the picture
  The test pattern must be completely in the frame, to allow an unambiguous detection.

- not recognized test pattern
  The most common reasons for this motion blur and dirty camera lenses. In addition, there are other settings routine:

- "Tangent Distortion"
  Specifies whether the tangential part of the distortion matrix is used or not.
- "Fixed Aspect Ratio"
  If the focal lengths fx and fy are the same, so you should set this value to True.
- "Fixed Principal Point"
  Defines whether the main point is fixed, or can be changed by the algorithm.
- "Skip Keys"
  Skips keystrokes.
- "Frames"
  Number of frames required for calibration
- "Frame Skip"
  Time delay in ms that must be at least between two frames. This gives the user time to position the test pattern again.

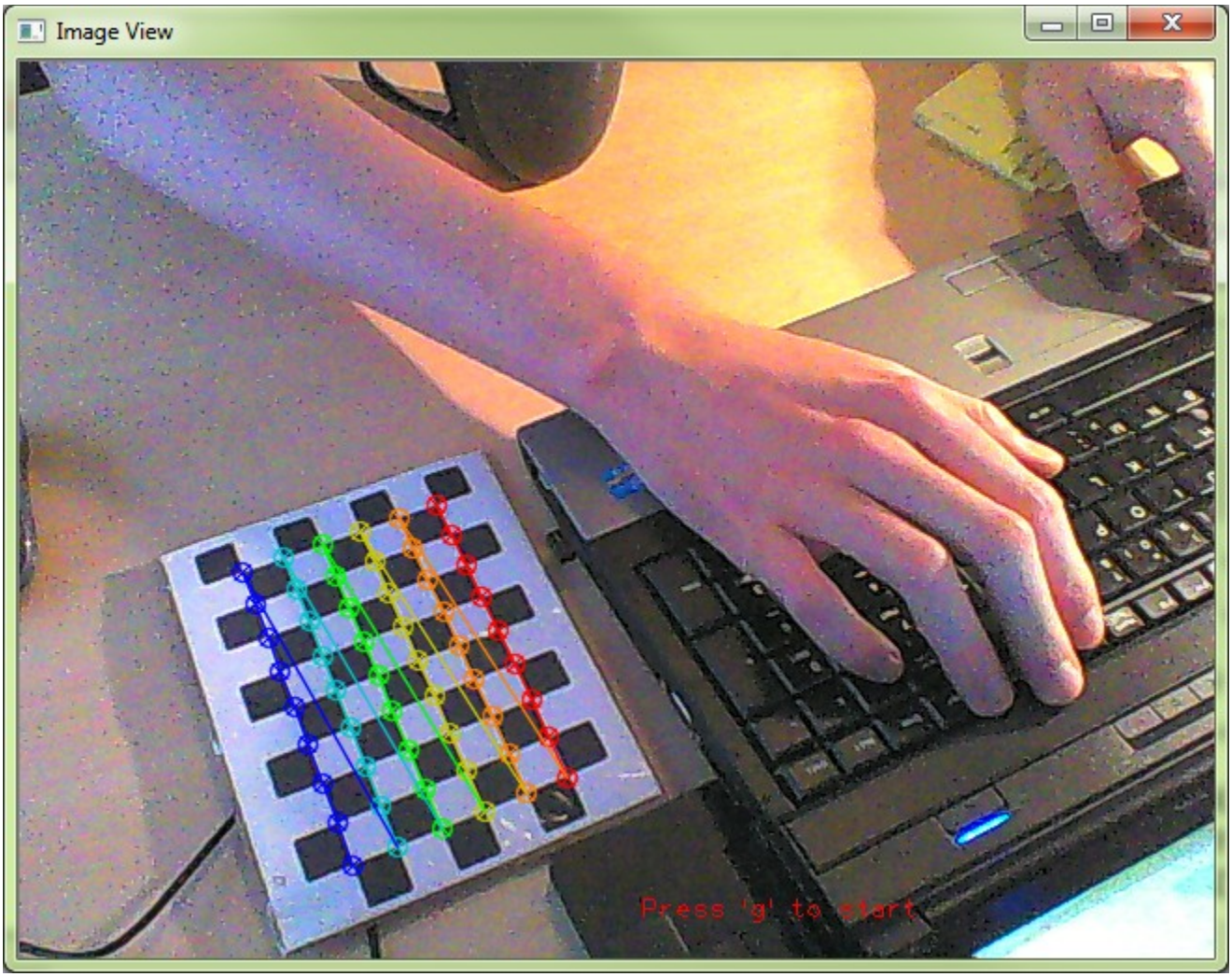

Figure 7: camera calibration with color-labeled test pattern

Figure 8: fisheye effect

For more information on this process, please visit the web link: citation

	OpenCV http://docs.opencv.org/doc/tutorials/calib3d/camera_calibration/camera_calibration.html

6.5.6 Optical Measurement

Based on the mathematical model of the thin lens and the measurement of the distance of the camera is a pixel value in real sizes can be converted. But first, the image distance has to be calculated:

Estimate Image Distance

Determines the image distance of a camera.

First, an object having a known size and a known distance from the camera is placed in parallel to the camera sensor. After you have marked in the image the object with two points, the image distance can be determined.

In addition, as long as it is known, the size of a pixel on the sensor are given. In this way it is also possible to use non-square pixel cameras for surveying.

Optical Line Measurement

With the information, the image distance and the object distance the size of which can be determined by labeling the object in the image.

Again, it is possible to set the pixel size on the sensor.

Extract Line

Extracts a line profile. citation

	OpenCV http://docs.opencv.org/modules/core/doc/drawing_functions.html#lineiterator

6.5.7 ROI

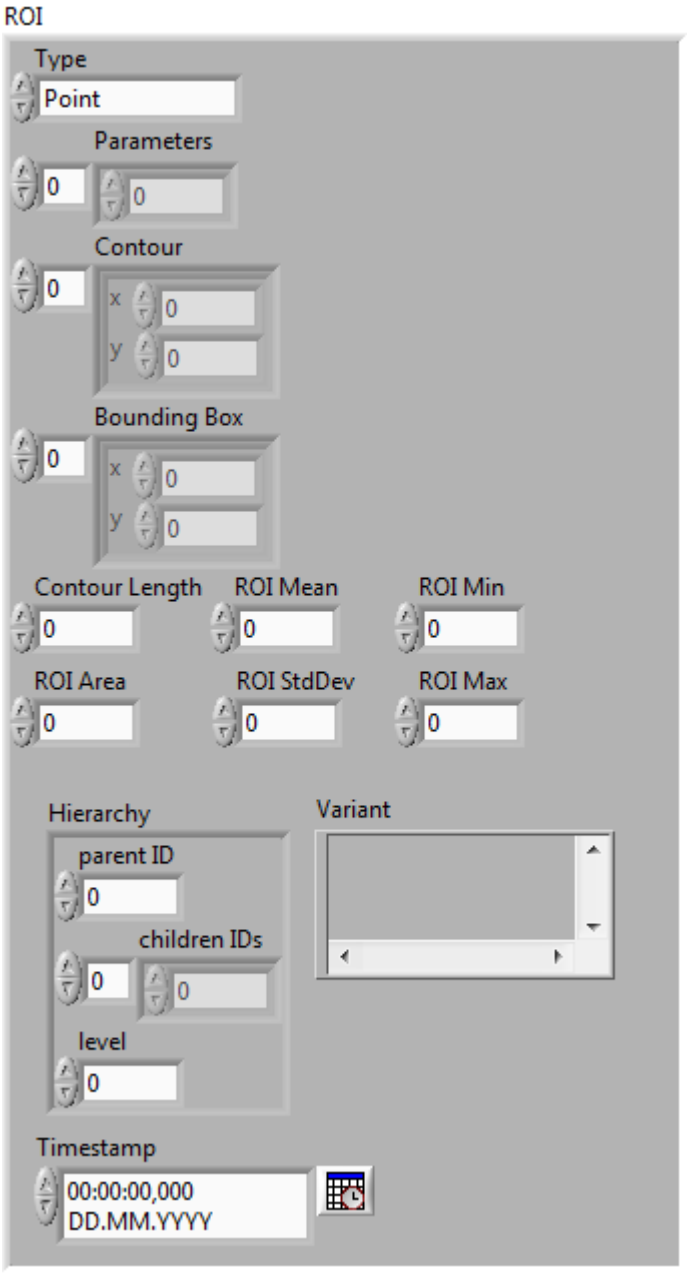

Figure 9: Structure of ROI

in the **R** egion **O** f **I** nterest Control are all information necessary for the descriptive region in the image.

- "Type"
  The type of the region. Currently, it is possible to point, line, rectangle, oval and freehand / Polygon to choose.

- "Parameters"
  These are the parameters of the IMAQ ROI. They are maintained Compatibility
- "Contour"
  The enclosing contour of the region
- "Bounding Box"
  bounding rectangle
- "Contour Length"
  Length of the contour in pixels
- "ROI Area"
  Area of the region in Pixel²
- "Statistical Values"
  Mean, standard deviation, minimum and maximum of the investigated region
- "Hierarchy"
  Hierarchy of the current region to other regions
- "Variant"
  Any additional information on ROI can be stored here.
- "Timestamp"
  Timestamp of the Region

ROI

The ROIs entered are analyzed and calculated.

Is "Crop" to True, the result will be tailored to the selected region. Additionally, it is possible to specify an ID with. It is then analyzed by the index, only the ROI. This is useful, for example, with the use of *ROI - Fill Tree,* which returns the ID of the selected ROI.

Are hierarchical data available, its child-ROIs is subtracted from each ROI. about *IMAQ ROI to ROI MSC Image* a IMAQ ROI can be converted into a MSC Image ROI. So you can make the user-friendly interface of IMAQ to Use. Note

	Please do not forget to dereference the images created here.

Apply Mask

Extracts image data of a mask image (U8) are marked. All pixels are considered to be non-zero marks. citation

 OpenCV http://docs.opencv.org/modules/core/doc/basic_structures.html#void%20Mat::copyTo% 28OutputArray% 20m, 20InputArray%%% 29% 20mask 20const

Calculate Contours

In the mask image (U8) are detected contours and returned as ROIs. In addition, the hierarchy is considered in this automatic determination. Thus, it is possible to determine which includes ROI other ROIs. The disclosures on *ROI - Fill Tree* this represents a tree view is. citation

 OpenCV http://docs.opencv.org/modules/imgproc/doc/structural_analysis_and_shape_descriptors.html#fi ndcontours

Note
 The hierarchy operates index controlled. Thus, the indexing of the ROI array can not be changed (zBElemente remove or reorder).

Threshold

Performs thresholding and extracts the corresponding image parts Is Low <High, pixels are extracted between two limits.
Is Low> High, the pixels are considered to be excluded from the limits. citation

 OpenCV http://docs.opencv.org/modules/core/doc/operations_on_arrays.html#inrange

Mask From Threshold

Creates a mask based on limits

Is Low <High, pixels are extracted between two limits.

Is Low> High, the pixels are considered to be excluded from the limits. citation

 OpenCV http://docs.opencv.org/modules/core/doc/operations_on_arrays.html#inrange

Mask From Contour

Creates a mask image (U8) by means of a contour. All pixels within this contour are set to the 255th

citation
 OpenCV http://docs.opencv.org/modules/imgproc/doc/structural_analysis_and_shape_descriptors.html#d rawcontours

6.5.8 Statistics

Get Type

Reads the image type.

Get Size

Reads the image size.

Get / Set Time Stamp

Reads or writes the timestamp. Is at *Set timestamp* the timestamp is not connected, the current system time is used.

Get / Set Variant

This Vis are access to the Variant functionality.

Histogram

Calculates a histogram of the current image for each channel. Note

 The image type Double (F64) can lead to an overflow here.

Statistics

Calculates statistical values of an image with optional mask. This VI is for example used for ROI calculation. Note

 The image type Double (F64) can lead to an overflow here.

7 Function Reference MSC Video

The function *Read Camera Snapshot* MSC Image class provides a fast implemented camera recording. However, here we come quickly to limits: For each function call the camera Stream opens, extracts an image and the camera Stream closed. Continuous recordings are not useful to solve. it is not possible to manually select a camera driver or change camera settings. Remedy the MSC Video class.

7.1 structure

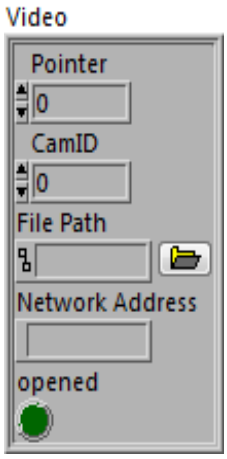

Figure 10: Structure of the MSC Videos

If you want to start a video stream, so you only need the camera ID. Once started, the stream is then referenced by a pointer and can thus also from other software appeal. The boolean element opened indicates whether the stream is started or not.

7.2 features

7.2.1 Understanding

Initialize

Initializes an instance for further operations.

Delete

Closes the stream and all references to the video instance.

7.2.2 Operations

Open Camera Stream

Starts a stream to the camera with the ID "CamID".
It automatically selects a driver. If more than one is available, the gewüschte can be selected via "API". citation

	OpenCV http://docs.opencv.org/modules/highgui/doc/reading_and_writing_images_and_video.html#vide ocapture-video capture

Open File Stream

Starts a stream to a stored video file.

Open Network Stream

Starts a stream to a network resource. Many network cameras use a h264 codec. In order to address this, it is necessary the file "opencv_ffmpeg * .dll" either in the application directory or the system directory (system32, syswow64) to copy.

close stream

Closes the previously opened stream.

ReadImage

Reads an image from an open stream and returns it as MSC Image.

Get / Set Property

Sets the property of an open camera streams. Depending on the camera type, driver and type of streams different properties are settable here.

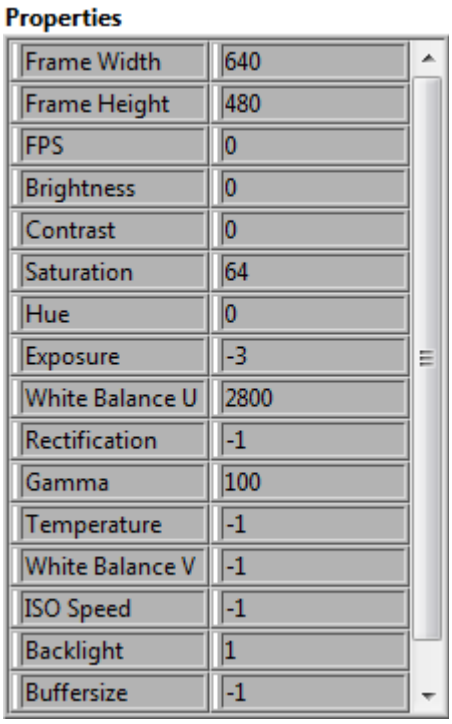

Figure 11: Some available camera settings

Get All properties

Reads all parameters and outputs it as a 2D array of strings.

Set resolution

Set the size of the video stream (user-friendly than on *Get Property)*.

8 Function Reference MSC Video Writer

To save a sequence of images as a video, you can use the MSC Video Writer.

8.1 functions

8.1.1 Understanding

Initialize

Initializes the Writer object. Already here the frame rate (FPS), path, size and type must be selected to prepare the file to your content. About the FourCC codec compression can be set. Here is indicated "0", the video is uncompressed, a "-1" opens a dialog for codec selection. citation

FourCC codec
http://www.fourcc.org/codecs.php

Delete

Delete the video ends Writer operation and deletes open references. This function does not delete the file on the hard disk.

8.1.2 Operations

Get Size / Type

the information specified reads back.

Write

Adds video file one frame added. The frame is to be passed in the format of the MSC Picture.

9 ETC

Some functions are not directly to do with image or video objects, but are helpful when programming image processing software.

9.1 Conversion

For the conversion or conversion of different data found in this folder a small selection.

only two Vis this folder are probably useful to you as an end user: *IMAQ ROI to ROI MSC Image* and *MSC Image ROI to ROI IMAQ*. Here,

the ROIs for use are converted. remark

The MSC Image ROI data type contains more information than the type IMAQ. Therefore, the conversion to IMAQ should be used only for display.

9.2 Tools

copyright

Is the copyright notice of the .dll file.
Please note that both the program extension (.dll), and the LabVIEW library and classes are protected. A transfer or copy requires written consent of the company MSC.

Ellipse Contour Points

Calculates the contour of an ellipse.

error handling

Here you will find information about the error codes. This VI will run automatically and can be used as a reference for possible errors.

ROI - Fill Tree

Filled a tree control with ROI data. The choice fell on the tree control, as the hierarchical relationships can be clearly displayed here.

In addition, this VI returns the index of the selected ROI back to match as displaying only this ROI (eg in combination with *ROI).*

ROI Max Bounding Box

Calculates the common bounding box of two rectangles.

Scale Intensity Graph

Intensity scales a graph based on the present image type.

spread Histogram

Spreads the values of the input array to the limits Min and Max ideal fill.

U8 Grayscale Color

Calculates the RGB value range of a U8 grayscale image.

uneven

Converts the number to an odd number.

Zoom Picture

Set the zoom parameters of a LabVIEW Picture Controls so that the current picture is maximized and is presented without distortion.

10 demo programs

These programs demonstrate the use of various functions. As an introduction to this library these are ideal. Please refer to the function reference, if technical terms or features are unclear.

10.1 MSC Image

Camera snapshot

The simplest demonstration of this library reads an image of a connected camera and displays it.

ReadImage

Reads an image from the hard disk and displays it.

ROI

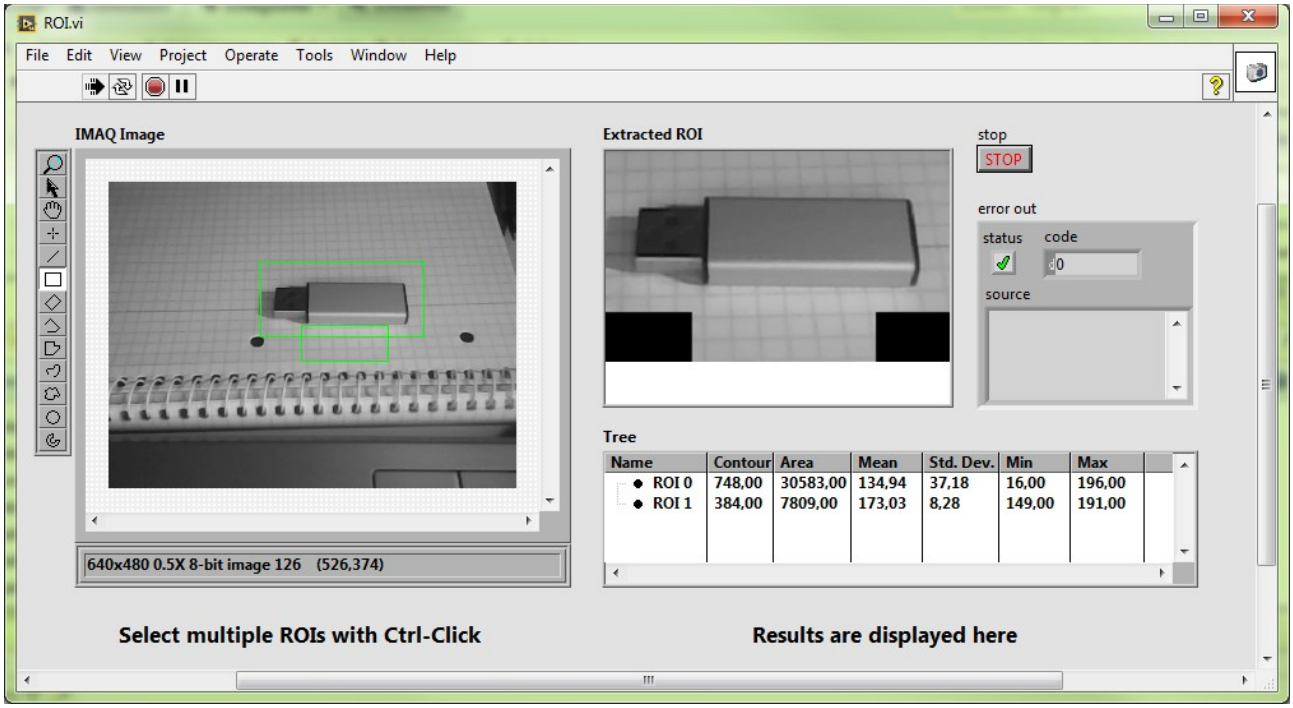

Figure 12: Demo ROI

This advanced example describes the use of ROI tools. The selected on the left side ROIs are analyzed on the right side.

10.2 MSC Video

Camera stream

In this demo, a live stream is opened and continuously extracted images.

Camera Stream Properties

The live stream can be adjusted via Properties.

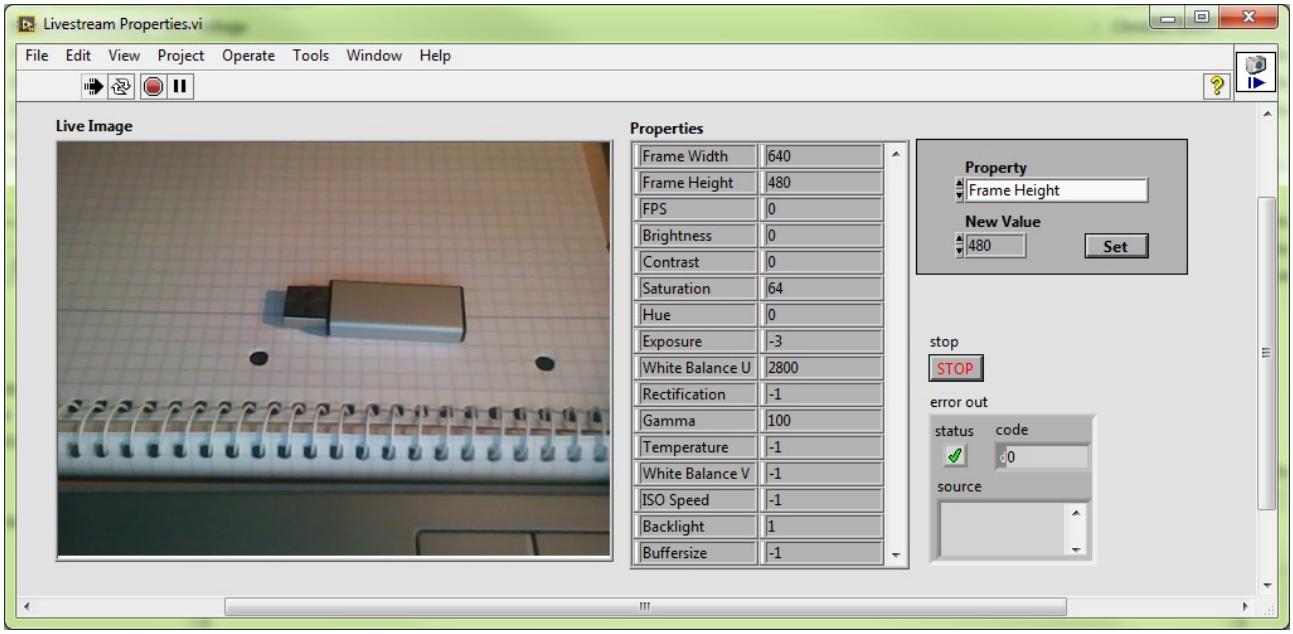

Figure 13: Demo Live Stream Properties

Camera Stream Video Writer

Saves the live stream as a video file on the hard disk.

FileStream

Reads a video file from the hard disk.

NetworkStream

Opens a network resource and displays.
As default an external URL is specified here, the content of which MSC's control. The provider or operator of the sites is always responsible for the content of linked pages. For the content, availability and accuracy of the third-party sites information provider is not guaranteed.

11 Appendix

11.1 Removing the link to IMAQ

If you have not installed on your PC NI vision or IMAQ, a warning can occur when opening.

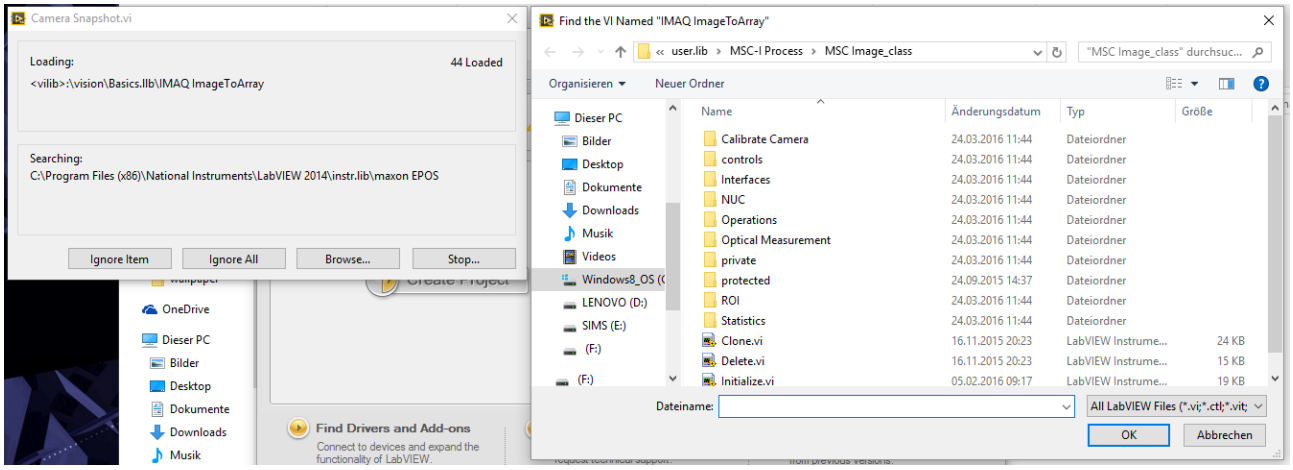

Figure 14: Warning IMAQ

To prevent this, please proceed as follows: Open the file user.lib / MSC's BPM / MSC Image_class / MSC Image.lvclass with LabVIEW.

There you will find interfaces file "Read IMAQ Image.vi" and "Write IMAQ Image.vi". Highlight them and remove them.

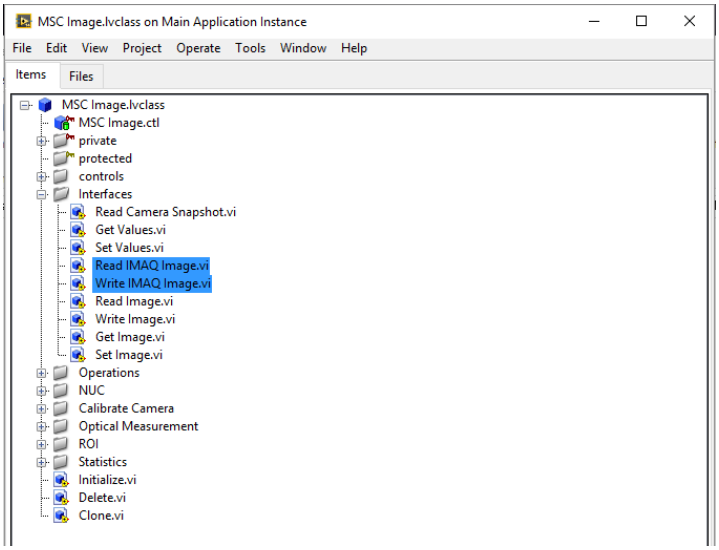

Figure 15: To remove files

Thereafter, the modified file is lvclass File - Save stored. The warning will no longer occur.

List of Figures