

Image processing system VisionSystem⁺



Operating instructions

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1. Use for Intended Purpose

This wenglor product shall be used in accordance with the following function principle: The wenglor image processing system is an optical system and is used for contact-free control of objects.

2. Safety Precautions

These instructions are part of the product and should be maintained during its entire life. Carefully read the operating instruction before using the product. The “Intelligence Pro” image processing system is simply called Intelligence Pro in this manual. Intelligence Pro is not suitable for safety applications. When using Intelligence Pro, follow the corresponding electrical and mechanical regulations, standards and safety rules. Interventions and changes to the device are not permissible. Components must be protected against mechanical impacts. Mounting, start-up and servicing of this product should be done solely by trained personnel. Mount the Intelligence Pro so that the ventilation slots are not covered. Always observe the safety precautions to avoid injuries and accidents.

3. EC Declaration of Conformity

3.1. EC Declaration of Conformity for the Image Processing System

The EC declaration of conformity can be found on our website at www.wenglor.com in download area.



RoHS

Warning: This is equipment of class A. It can cause radio interference in residential areas; in this case, the operator can be required to carry out appropriate measures.

3.2. Declaration of Conformity for the Cameras

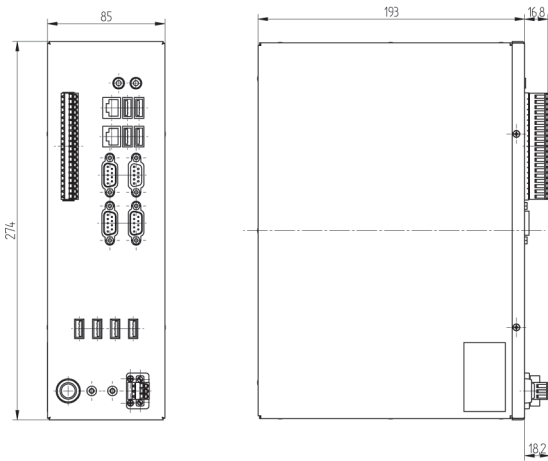
The EC declaration of conformity can be found on our website at www.wenglor.com in download area.



4. Hardware Design

This chapter gives you an overview of the hardware of the individual components of the Intelligence Pro.

4.1. System Overview



Electrical	
Supply voltage	18...30 V DC
Current consumption (Ub = 24 V)	< 3 A
Temperature range	0...40 °C
Processor	1.8 GHz
RAM	512 MB
Number of switching outputs	8
Switching output voltage drop	< 2.5 V
PNP switching output/switching current	700 mA
Electrical isolation	Yes
Short-circuit protection	Yes
Reverse-polarity protection	Yes
Number of digital inputs	8
Number of RS-232 interfaces	1
Number of USB interfaces	4
Number of Gigabit Ethernet RJ45	3
Mechanical	
Housing material	Metal
Protection class	IP20

4.2. Intelligence Pro

The Intelligence Pro evaluation unit, which is suited for industrial use, is delivered with user-friendly, Linux-based user software. The Intelligence Pro is galvanically separated from the power supply and the inputs and outputs. So a secure operation is assured in any industrial environment. The following illustration shows the front view of the Intelligence Pro.

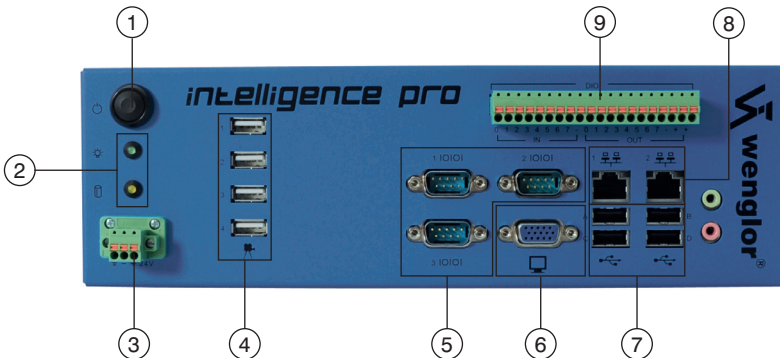
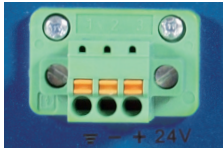


Figure 1: Intelligence Pro front view

No.	Description	Information
1	Multifunction button	On/off
2	Status LEDs	Memory access, operating status display
3	Supply voltage	18...36 V DC
4	USB	Connection possibility for the wenglor camera BKS0x0A30
5	RS-232	Serial interface for external devices
6	Monitor socket	Monitor (min. 1280 × 1024 pixel resolution)
7	Without function	
8	Camera interfaces	Two free USB sockets are available
9	Network interface	Network interface 10/100/1000 MBit
10	Key pad socket	Connection possibility for a PS/2 keyboard
11	Mouse socket	Connection possibility for a PS/2 mouse
12	Digital Inputs/Outputs	

4.2.1. Supply voltage

Please connect the supply voltage to the plug no. 3 (see “4.2. Intelligence Pro” on page 8).



Pin	Description
1	Protective ground conductor
2	– Chassis / GND
3	18...36 V DC

Figure 2: Supply voltage

4.2.2. Interface Description

The Intelligence Pro is equipped with a number of interfaces. Besides the standard interfaces, the device has a digital I/O card.

4.2.2.1. D-IO

The wenglor D-IO 1.0 interface has 8 optoisolated inputs (digital inputs) and 8 optoisolated outputs (digital outputs). The inputs work with a low level 0...3 V and a high level of 3...50 V. The 8 optoisolated outputs work with a voltage of 10.5...45 V. The maximum output current is 700 mA per channel. The outputs are short-circuit protected and equipped with one current limiter per channel. The optoisolated digital inputs and digital outputs refer to separate grounds. The insulation voltage between input part and output part as well as against the housing ground is 500 VAC_{eff}. The combination of current limitation, thermal switch-off and automatic reconnection effectively protects switching circuits from overload. In case of overload, the applicable channel switches off and switches back on again. Meanwhile, channels without overload can be used normally.

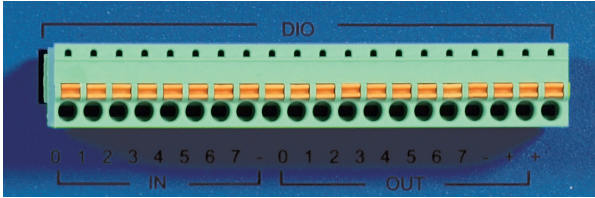


Figure 3: Intelligence Pro digital inputs/outputs

The 8th output is used by the Intelligence Pro to signal readiness. As a result, 7 outputs can be freely used.

4.2.2.2. Output Switch

The inputs or outputs of the Intelligence Pro are built up as follows:

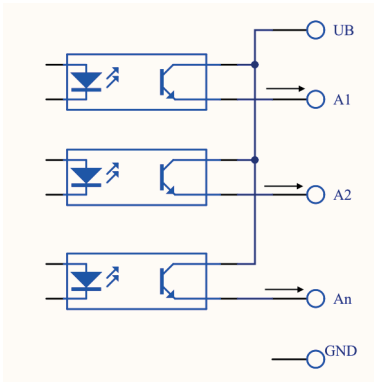


Figure 4: Wiring of the optoisolated outputs

The outputs must have a ground connection to the external wiring.

4.2.2.3. Input Switch

The inputs of the Intelligence Pro are built up as follows:

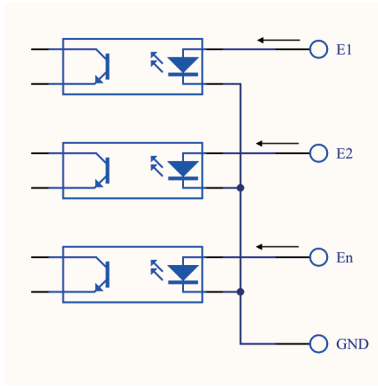


Figure 5: Wiring of the optoisolated inputs

4.2.2.4. Note

In order to assure flawless operation of the Intelligence Pro, it must be assured that it's not used under the following ambient conditions or where the following substances occur:

4.2.3. Mounting Instructions

In order to assure flawless operation of the Intelligence Pro, it must be assured that it's not used under the following ambient conditions or where the following substances occur:

- Strong temperature fluctuations that can result in condensation
- Dust, gas or salt in the air
- Direct sunshine
- Contact with oil, water and chemicals

4.2.3.1. Table Operation

When operating the Intelligence Pro on a flat surface, such as a tabletop, use the supplied rubber feet.

4.2.3.2. Rear Panel Mounting

The Intelligence Pro can be mounted on a wall using the mounting bracket BEF-SET 35, which is included.

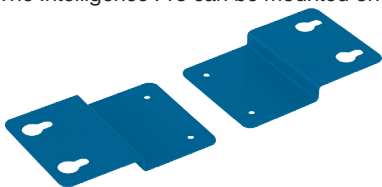


Figure 6: Mounting bracket BEF-SET 35

4.2.3.3. DIN Rail Mounting

To fasten the Intelligence Pro to a DIN rail, wenglor offers a mounting system (article no.: ZMBBV0001).

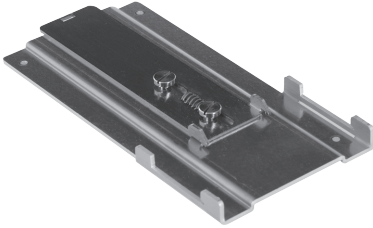


Figure 7: Mounting system ZMBBV0001

4.3. Cameras

With their compact housing, the wenglor digital cameras are highly versatile, and can be used even in tight spaces. For extreme environmental conditions, wenglor offers special camera solutions with a protection class of up to IP67. The small, compact CMOS cameras can be combined for various applications with different lenses.

4.3.1. BKS0x0A40 Digital Camera

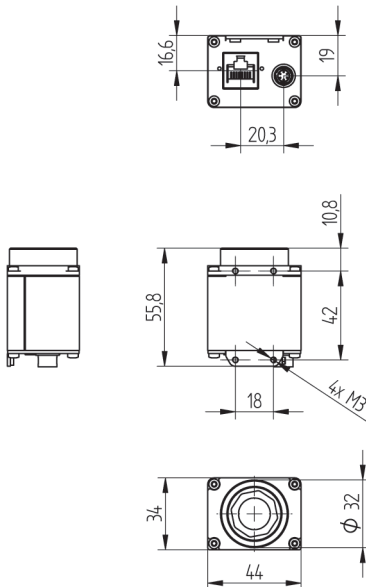
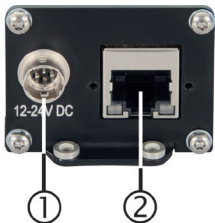


Figure 8: Engineering Drawing of BKS0x0A40 Digital Cameras

Optical Characteristics	
Optical Characteristics	1280 × 1024 pixels
Pixel size	5,3 μm × 5,3 μm
Image chip	Color/monochrom
Image chip size	1/1,8"
Refresh rate	50 fps
Electrical Characteristics	
Supply power	18...26 V DC
Power consumption	(UB = 24 V) < 200 mA
Electrical isolation	yes
Temperature range	-5...50 °C
Number of flash outputs	1
Flash output	Optocoupler
Number of trigger inputs	1
Trigger input	Optocoupler
Protection Class	III
Mechanical Characteristics	
Lens thread	C mount
Housing material	Aluminium
Weight	108 g
Degree of Protection	IP30
Connection type	HR10; 6-pin
Functions	
Global Shutter	yes
Subsampling	yes

The following figure shows a rear view of the camera:



Number	Description	Information
1	Supply power	Supply power, inputs and outputs
2	Interface	GigE

Figure 9: Rear View of BKS0x0A40 Digital Camera

4.3.1.1. BKS0x0A40 Power Supply



Pin	Signal
1	GND
2	Supply power: 12 to 26 V DC
3	Digital input (-)
4	Digital input (+)
5	Digital output (+)
6	Digital output (-)

In combination with the ZAV84R901 Adapter Cable, the following pin assignments result:

Pin	Signal
1	Supply power: 12 to 26 V DC
2	
3	GND
4	Digital input (+), trigger
5	Digital input (-), trigger
6	
7	Digital output (+)
8	Digital output (-)

4.3.1.2. Interfaces

4.3.1.2.1. GigE Interface

wenglor BKS0x0A40 Cameras are equipped with a Gigabit Ethernet interface (GigE). This interface allows for image transmission with a maximum cable length of up to 100 meters. The GigE interface uses the following pin assignments:



87654321

Pin	Signal
1	D1+
2	D1-
3	D2+
4	D3+
5	D3-
6	D2-
7	D4+
8	D4-

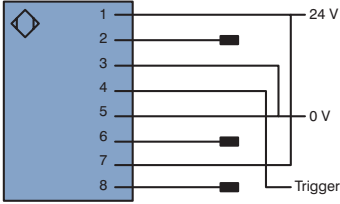
The RJ45 port at the BKS0x0A40 complies with the IEC 60603-7 standard.

Several wenglor Connection Cables are available for connection. Suitable Connection Cables can be found at www.wenglor.com.

4.3.1.2.2. Trigger Input at the BKS0x0A40 Digital Camera

wenglor Digital Cameras are equipped with a trigger input. With the help of a trigger sensor, image processing can be synchronized with the application. Having the trigger input directly on the camera makes it possible to minimize time delays between the trigger pulse and image recording.

The following example shows how an external trigger sensor can be connected to the BKS0x0A40 Digital Camera using the ZAV84R901 Connection Cable:



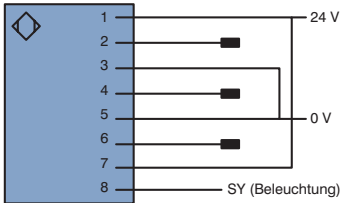
	Min.	Max	
Low threshold	0	2	V
High threshold	5	24	V
Voltage range	0	30	V
Trigger pulse width (edge)	100	—	μ s
Trigger edge steepness	35		V/ms
Breakdown voltage		50	V
Input current	10	—	mA

The trigger signal can be evaluated either on the rising or the falling edge. The digital input is electrically isolated by means of an optocoupler, in order to protect the Camera and the PC from overvoltage. Only direct voltage may be applied to the digital input.

4.3.1.2.3. Illumination Control

Illumination can be directly controlled by the BKS0x0A40 Digital Camera. Various types of illumination are available. The following wiring diagram shows how a Digital Camera can be connected to a light source. A Connection Cable is available for easy connection.

The wiring diagram shows a BKS0x0A40 Digital Camera with interconnected ZAV84R901 Connection Cable.



Digital Output Specifications

Pin	Max.
Output current, momentary	500 mA
Output current, continuous	150 mA
Output voltage	30 V
Breakdown voltage	50 V
Transistor power loss	125 mW

The digital output is electrically isolated by means of an optocoupler, in order to protect the Camera and the PC from overvoltage. Only direct voltage may be applied to the digital output.

The output can be used as either a PNP or an NPN output.

4.3.1.3. Installation Tips

In order to assure flawless operation of the Camera, it should be assured that it is not used under the following ambient conditions:

- Temperature outside of a range of -5 to 50° C
- Excessive temperature fluctuation which might lead to condensation
- Dust, gas or salt in the air
- Exposure to direct sunlight
- Mixtures containing oil, water and chemicals

Do not touch the image chip!

The danger of static charging exists in static environments. Before touching the Camera, it must be assured that any static charging is discharged by means of contact with a grounded object.

4.3.1.3.1. Mounting Options

The Digital Camera can be mounted with the help of a wenglor ZMBID1202 Mounting System.

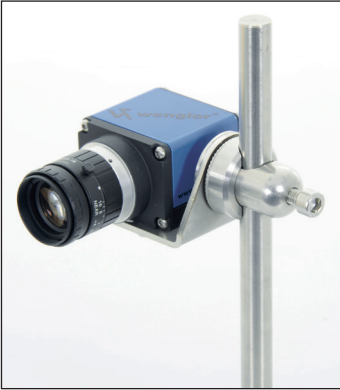


Figure 10: ZMBID1202 Camera Mounting System

4.4. Complementary Products

wenglor offers a comprehensive portfolio of accessories for operating the Intelligence Pro. The exact specifications and order numbers can be taken from the current catalog or the homepage www.wenglor.com. The following describes the most frequently used accessory parts.

4.4.1. Lenses

Available for selection are three C-Mount lenses, each with different focal distances. The recording range depends solely on the camera's distance from the object. The depth of focus depends both on the camera's distance from the object and the focal distance of the lens. The following diagrams illustrate these relationships. In addition to the lenses offered by wenglor, any commercially available c-mount lens can also be used.

Lens selection

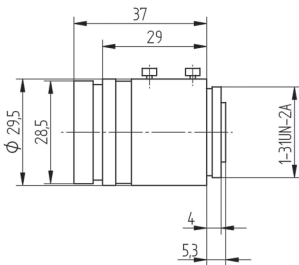


Figure 11: Lens LAC9-14K01

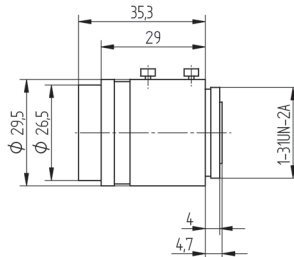


Figure 12: Lens LAC25-14-K02

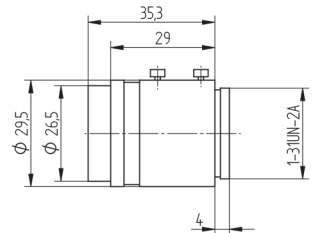


Figure 13: Lens LAC35-16-K02

The choice of lens changes the image detail and the depth of focus, among other things.

Focus depth

The focus depth (also depth of field) is the range in front of and behind the object which is still imaged with adequate sharpness. The focus depth can be influenced by changing the aperture, focal distance and working distance.

4.4.2. Lights

Four ultra-modern LED lighting systems that can be mounted quickly and easily with the wenglor mounting system are available for selection.

Spotlights

The wenglor spotlight illuminates the application evenly. It can be easily mounted even in tight spaces. Flash mode is possible.

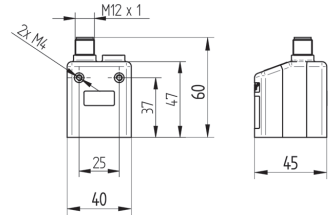


Figure 14: Spotlights

Spotlights

The wenglor spotlight illuminates the application evenly. Edges, contours and drill holes can be reliably recognized. If mounted angularly, even reflecting objects can be well illuminated. Flash mode is possible.

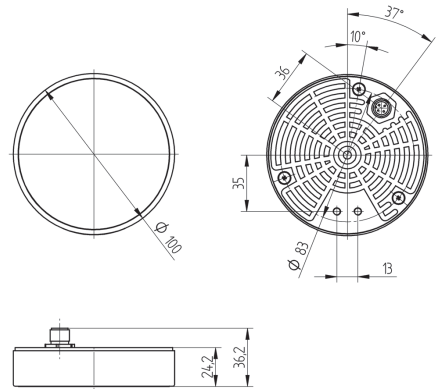


Figure 15: Spotlights

Floodlight

The wenglor floodlight can be used both in transmitted light and reflected light mode. Transparent and reflecting objects as well as object contours are illuminated well.

Flash mode is possible.

The floodlight is available in different sizes.

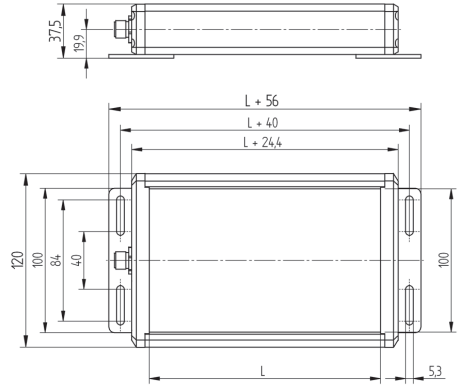


Figure 16: Floodlight

Ring light

The wenglor ring light illuminates the application with even brightness due to its positioning around the camera. It is especially well suited for detection of colors and prints.

Even contrasts on matte surfaces are detected well. Flash mode is possible.

Illumination strength max.: 2500 Lx

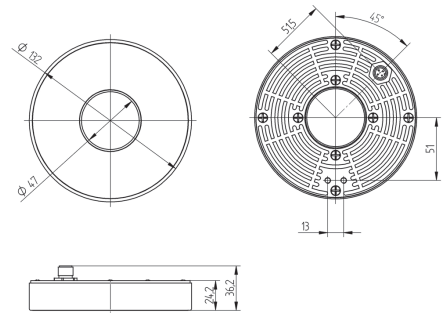


Figure 17: Ring light

You can get exact details on the individual lights on our homepage www.wenglor.com.

Light 1...4:

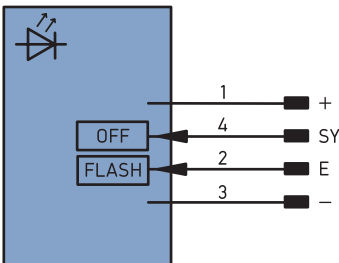


Figure 18: Connection diagram, light 1...4

Pin	Description
1	Voltage supply 18...30 V DC
2	Synchronization line
3	Ground
4	Lighting control

4.4.3. wVision Windows®

There's a Windows® version of wVision image processing software for the VisionSystem+. This makes it additionally possible to process projects and Teach+ files at a Windows® PC.

wVision software for Windows® is compatible with the following operating systems:

- Windows 7®
- Windows 8®
- Windows 10®

wVision software for Windows® can be ordered under order number BVZ2002. A USB stick with a license file is included in the scope of delivery. The most recent version of wVision software for Windows® can be downloaded from our website.



Please proceed as follows in order to use the Windows® version of wVision software:

1. Plug the USB stick included with the software into the PC. Make sure that the USB stick is detected by the PC and that its device driver is installed.
2. Download and install the most recent version of wVision software for Windows® from the wenglor website.
3. Start wVision software for Windows®.

Projects and Teach+ Files can then be processed at the Windows® PC.

Caution: It is not allowed to format the USB stick. By formatting, the licence file on the USB stick is deleted and the software wVision Windows can no longer be used.

As opposed to the full version of wVision, the Windows® version is limited with regard to the following functions:

- User administration (see also section “5.3.5. User Administration” on page 33) is deactivated in the Windows® version of wVision.
- The network settings (see also section “5.3.6. Network Connections” on page 35) are deactivated in the Windows® version of wVision.
- The functions provided by the communication module (see also section “5.8. Communication” on page 111) are deactivated in the Windows® version of wVision.
- The functions provided by the serial port (see also section “5.3.4. Serial Interface” on page 32) are deactivated in the Windows® version of wVision.
- Only one virtual image source, and no real image source, can be selected in the camera module (see also section “5.4. Camera” on page 37).

5. Software

The following chapter gives you an overview of the Intelligence Pro software wVision.

5.1. User Interface

The user interface consists of various elements.

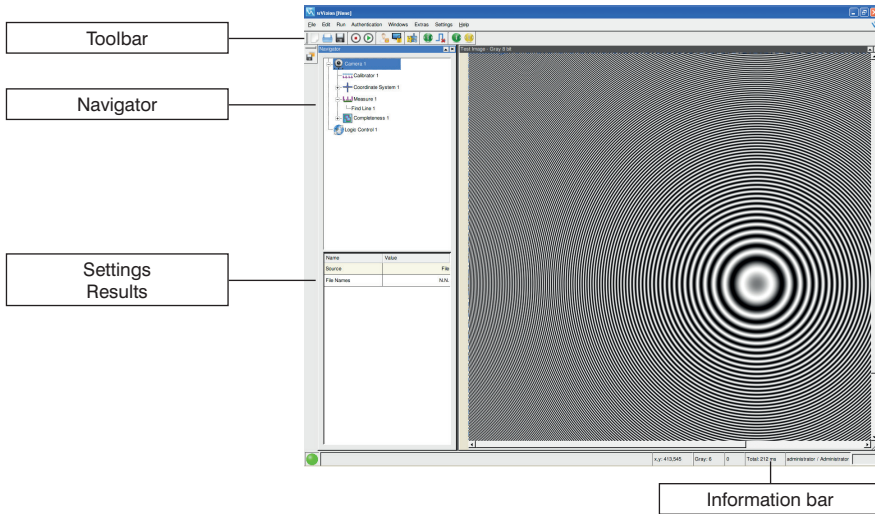















Figure 19: User interface

5.1.1. Toolbar



Figure 20: Toolbar

-  New project
-  Open
-  Save
-  Recording mode of an image sequence, incl. all functions (Teach⁺)
-  Play mode of an image sequence, incl. all functions (Teach⁺)
-  Log out user
-  Block screen
-  Add image processing module
-  Start
-  Continuous operation without trigger impulses
-  Snapshot forward
-  Snapshot backward
-  Live image (without evaluation)

Additional symbols can be displayed, depending on the currently used image processing module. These additional symbols are discussed more closely in the respective chapters on the image processing modules.

Save Project

The project is saved under the current filename.

Save Project As

A dialog box appear to which a filename, as well as additional information regarding the project, can be entered. In addition to the project name, it's also possible to specify the wVision version. Furthermore, projects can also be saved for older wVision versions. Saving of projects with functions which were unavailable in older wVision versions is not possible.

Open Project

After opening a project, the last saved reference image is displayed. This is not a live image. The image is not updated until after a single shot or operation in the run mode. Immediately after loading a project, the displayed values are initially invalid. The displayed values are not correct until after a single shot or operation in the run mode.

Navigator

The entire signal path is depicted in the Navigation window. These are worked off in the order that the individual image processing modules are listed in the navigation tree. Here, all user interfaces can be called up by mouse click. If an additional image processing module is added, it is automatically attached to the navigation tree. If an error occurs in one of the modules, this module is marked in red and shows the user where the error occurred.

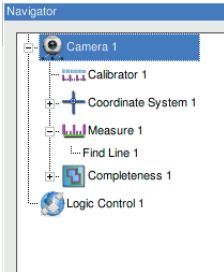



Figure 21: Navigator

Clicking on the symbol  permits a more detailed look into the selected image processing module. All other tasks and components of the image processing modules are then depicted in additional branches.

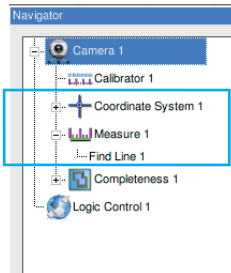


Figure 22: Extended signal path

5.1.2. Results/Settings

The module-specific settings or events can be set or called up below the Navigator window.

The following example shows various settings or result fields:

Name	Value
Scan Direction	Default
Scan Length	30 pix
Scan Interval	5 pix
Edge Polarity	Either
Edge Find By	Best Score
Edge Sensibility	30 GrM
Edge Width	5 pix
Regression Iterations	2
Outlier Threshold	3.0 pix
Center Point X	354.1 pix
Center Point Y	-425.7 pix
Angle	-37.8 °

Figure 23: Settings/results

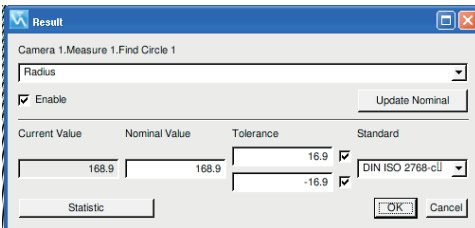
5.1.2.1. Result Field

Result fields can be recognized by the colored indicators below the description text. The colored result indicator changes its color to the same degree as the current result changes with regard to the preset tolerances.

Distance	4.895 mm
----------	----------

Figure 24: Result Field

The tolerances can be set through a click on the result fields. A window opens, which can appear as follows or similar.



Current Value	Nominal Value	Tolerance	Standard
168.9	168.9	16.9	DIN ISO 2768-ctl
		-16.9	

Figure 25: Result window

5.1.2.2. Statistics of the Results

Through the menu option **Settings** → **Options** → **History**, the number of results used for statistical calculation is determined.

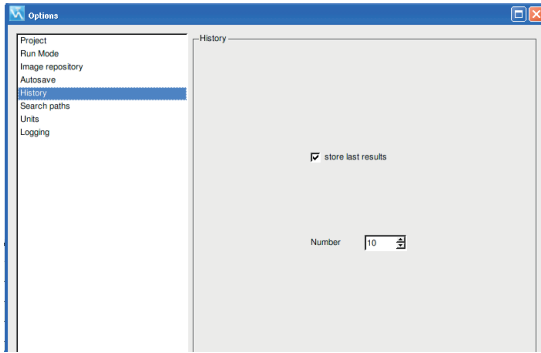


Figure 26: Statistics setting

If the minimum number of evaluations has taken place, the button causes the statistics of the last results to be depicted graphically in the result window.

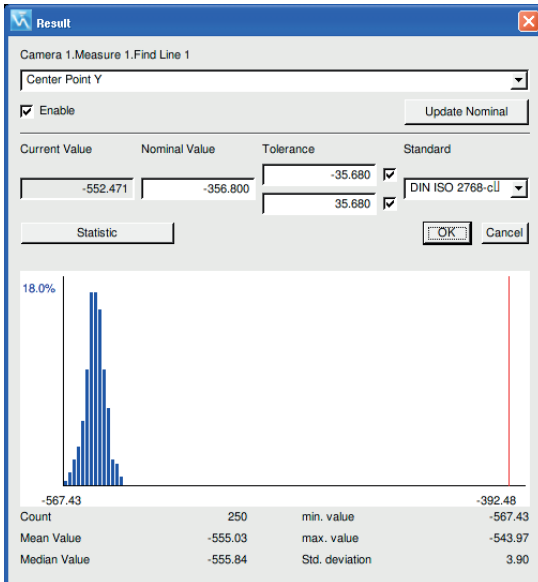


Figure 27: Sample result with statistics graphic

In the statistics graphic, the measurement results are depicted as individual bars. The height of the bars provides information about the frequency of the measured values. The red lines on the left and right side display the tolerances. The green line in the middle of the graphic provides information about the set point of the measurement result.

5.1.2.3. Results by Standards/Tolerances

In Intelligence Pro, common standards/tolerances are stored for evaluation of results. Additional standards can be stored in the directory /usr/local/conf_wVision and used for evaluating results.

All available standards/tolerances are displayed in the result window:

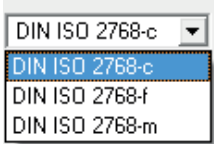


Figure 28: Available standards/tolerances

5.1.2.4. Settings

There are two possibilities for making settings. One way to make a setting is by movement of a sliding controller or direct input of the numerical value.



Figure 29: Setting option - slider

Alternatively, a setting list with various possibilities is available for selection:

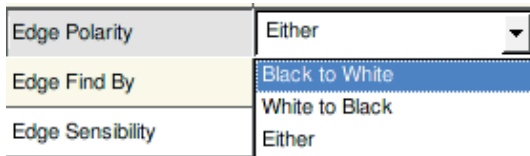


Figure 30: Settings – pull down

5.1.3. Status Bar

The status bar located on the lower edge of the user interface informs the user about the user status, the time taken for the last evaluation, the number of evaluations and the gray value or color value of the pixel that the cursor is currently pointing to. The x and y coordinates of the cursor in the image are available as additional information. Before the green or red status message on the far left forms the end of the information bar, next to it to the right is a field that displays current information on the next action or event. The green status LED signals that the system is working correctly. If the red status message appears, an error has occurred.



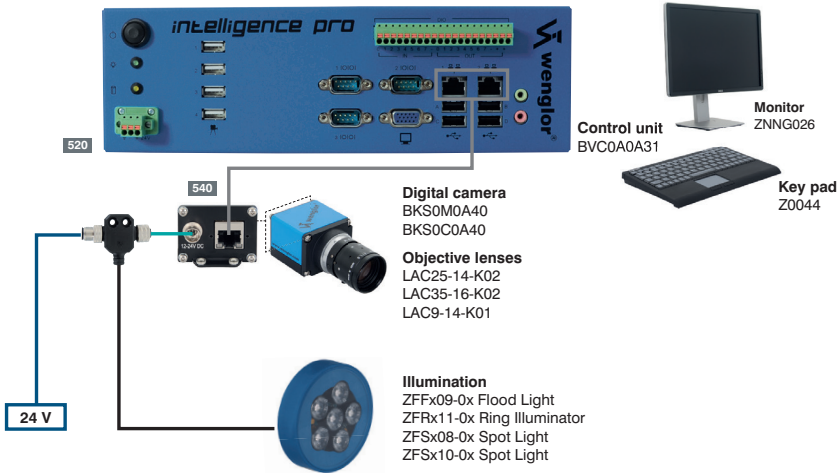
Figure 31: Status bar

5.1.4. Taskbar

The taskbar appears when the mouse pointer is moved to the edge of the screen. Information regarding currently available memory space within the various hard disk partitions can be queried via the taskbar. The US and German national flags indicate which keyboard layout is currently being used.

5.2. Quick Start

5.2.1. Overview



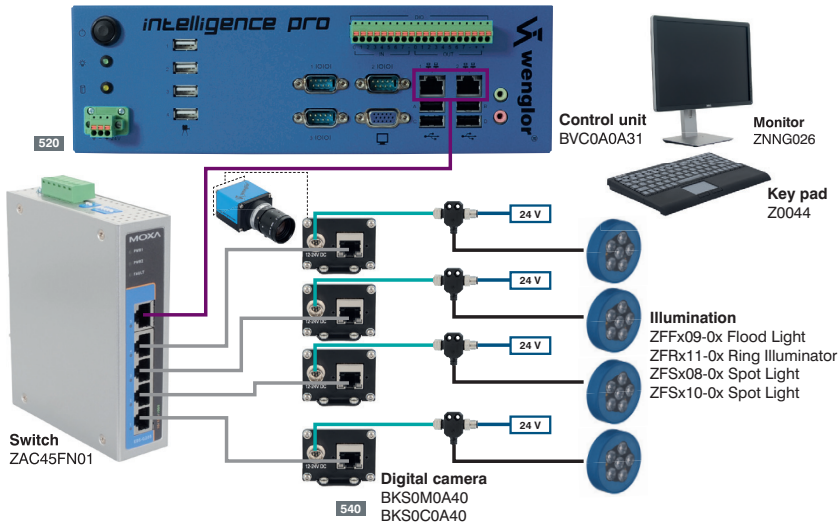
	Order number	Description	Cable length	Plug picture
	ZAV84R901	Connection cable; M12×1 Socket; Hirose HR10	0,3 m	

	Order number	Description	Cable length	Plug picture
	ZAV89V901	Connection cable; M12×1 docket; 8-pins, M12×1 plug; 8-pins; M12×1 socket; 4-pins	80 cm	

	Order number	Description	Cable length	Plug picture
	Standard Cable	Connection cable and connection lines, M12×1; 8-pins	Various lengths available	

	Order number	Description	Cable length	Plug picture
	ZAV47V501	Connection cable; RJ45 plug, with screw connector on one end	5 m	
	ZAV47V601	Connection cable; RJ45 plug, with screw connector on one end	10 m	
	ZAV47V801	Connection cable; RJ45 plug, with screw connector on one end	25 m	
	ZAV47R601	Connection cable; RJ45 plug, with screw connector on one end, drag chain suitability	10 m	

	Order number	Description	Included in delivery
520	BEF-SET-35	Mountingset for wall mounting	yes
	ZMBBV0001	Mounting System for DIN rail mounting	no
540	ZMBID1202	Mounting System camera Ø 12 mm VA	no
470	WFW07S12AL	Mounting System for Illumination, Ø 12 mm, Aluminum	no
	WFW07S12VA	Mounting System for Illumination, Ø 12 mm, VA	no
	WFW07S30KU	Mounting System for Illumination, Ø 30 mm, Plastic	no
480	ZMWZF0001	Mounting Brackets for Illumination	no
360	WMS12AL	Mounting System for Illumination, Ø 12 mm, Aluminum	no
	WMS12VA	Mounting System for Illumination, Ø 12 mm, VA	no
	WMS30KU	Mounting System for Illumination, Ø 30 mm, Plastic	no



	Order number	Description	Cable length	Plug picture
	ZAV84R901	Connection cable; M12x1 socket; Hirose HR10	0,3 m	
	ZAV89V901	Connection cable; M12x1 socket; 8-pins, M12x1 plug; 8-pins; M12x1 socket; 4-pins	80 cm	
	Standard cable	Connection cable and connection lines, M12x1; 8-pins	Various lengths available	
	ZAV47V501	Connection cable; RJ45 plug, with screw connector on one end	5 m	
	ZAV47V601	Connection cable; RJ45 plug, with screw connector on one end	10 m	
	ZAV47V801	Connection cable; RJ45 plug, with screw connector on one end	25 m	
	ZAV47R601	Connection cable; RJ45 plug, with screw connector on one end, drag chain suitability, Drag Chain Suitable	10 m	
	ZAV45V501	Connection cable; both sides RJ45 plug	5 m	
	Order number	Description	Included in delivery	
520	BEF-SET-35	Mountingset for wall mounting	yes	
	ZMBBV0001	Mounting System for DIN rail mounting	no	
540	ZMBID1202	Mounting System camera Ø 12 mm VA	no	
	WFW07S12AL	Mounting System for Illumination, Ø 12 mm Aluminum	no	
470	WFW07S12VA	Mounting System for Illumination, Ø 12 mm VA	no	
	WFW07S30KU	Mounting System for Illumination, Ø 30 mm Plastic	no	
480	ZMWZF0001	Mounting Brackets for Illumination	no	
	WMS12AL	Mounting System for Illumination, Ø 12 mm, Aluminum	no	
360	WMS12VA	Mounting System for Illumination, Ø 12 mm, VA	no	
	WMS30KU	Mounting System for Illumination, Ø 30 mm, Plastic	no	

The system has to be restarted after changing the hardware configuration.
 Connection information for voltage supply see "4.2.1. Supply voltage" on page 9.

5.2.2. Camera Mounting

Mount the camera at the desired position using the various fastening options (wenglor fastening systems). Connect the camera using the connection cable to the Intelligence Pro. For power supply, connect the connecting line likewise to the digital camera. Connection information for voltage supply see “4.2.1. Supply voltage” on page 9.

5.3. System Settings

The system settings are in the menu bar, in the submenu **Settings**.

5.3.1. Key Pad/Language

The key pad and language can be set in the menu option **Settings → Keyboard/Language**.

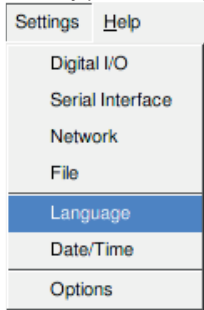


Figure 32: Menu option Key Pad/Language

English is the default value upon shipment from the factory. The keyboard layout can be changed by clicking the flag icon in the taskbar.

5.3.2. Date/Time

Under the menu option **Settings → Date/Time**, a window opens in which the current region and the related time zone can be defined.

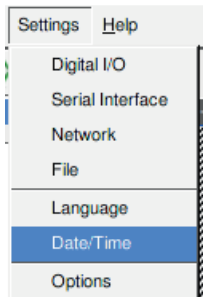


Figure 33: Menu option Date/Time

The window is divided into two groups. In the upper part of the window, both the region and the time zone are set.

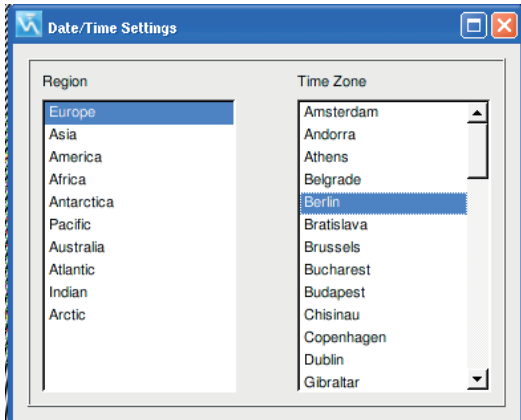


Figure 34: Setting for region & time zone

In the lower part, there is the possibility to enter the date and time manually.

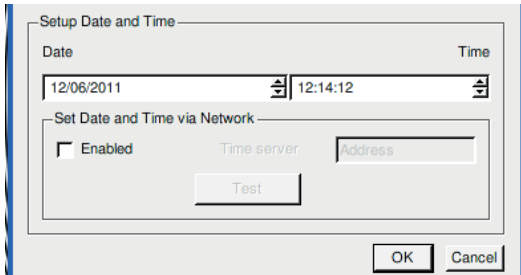


Figure 35: Manual setting, date & time

It is possible to set the current date and time on the network automatically. To do this, an NTP server must be present in your network.

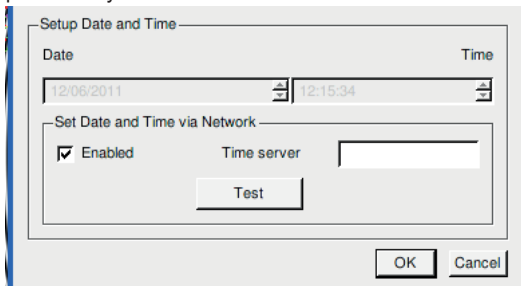


Figure 36: NTP server activated

5.3.3. Digital Inputs/Outputs

The system has eight optoisolated inputs and eight outputs. These inputs and outputs can be activated in the menu **Settings → Digital I/O**.

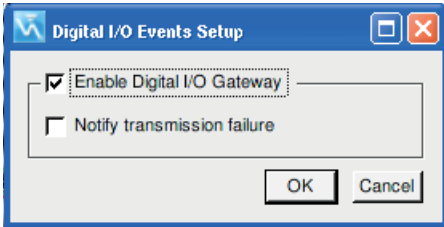


Figure 37: Settings, digital inputs/outputs

When **transmission monitoring** is active, errors are displayed in the event that transmission discrepancies occur.

5.3.4. Serial Interface

The settings for the serial RS-232 interface are located in the menu **Settings → Serial Interface**. All relevant settings can be made.

Three serial ports are available. The data communication direction can be selected.

If the “Transmit module data” setting is selected, the serial port is used to transmit data. The “Listen to commands” setting configures the port as a receiver. Commands can be transmitted to the Control Unit as well.

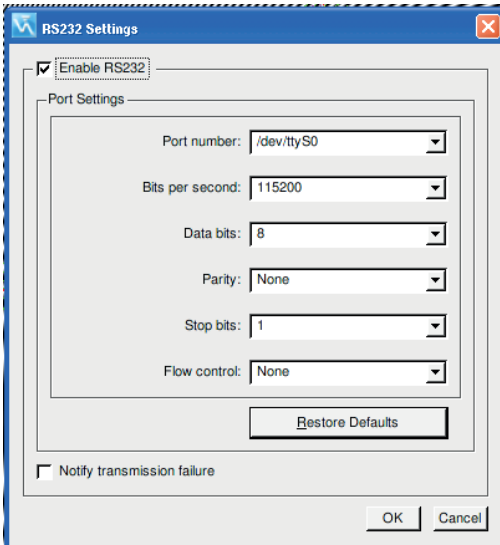


Figure 38: Settings, serial interface

The interface parameters can be defined in this window. With active **transfer monitoring**, an error is reported if there is a discrepancy in the transfer.

5.3.5. User Administration

The system supports several user roles. User administration can be called up via the menu bar **Authentication**.

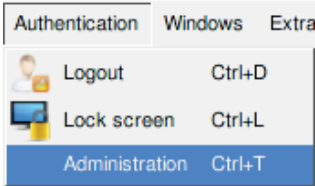


Figure 39: Menu option User Administration

The user administration window opens:

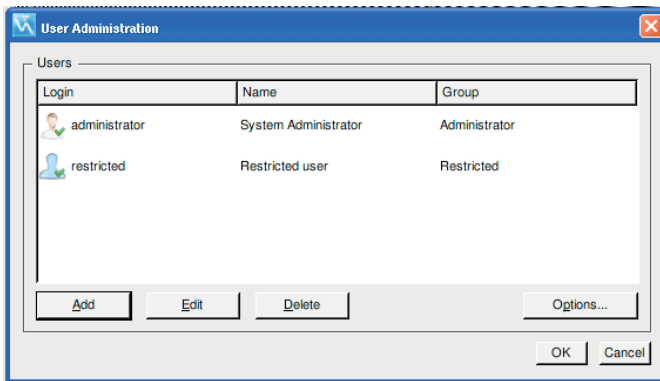
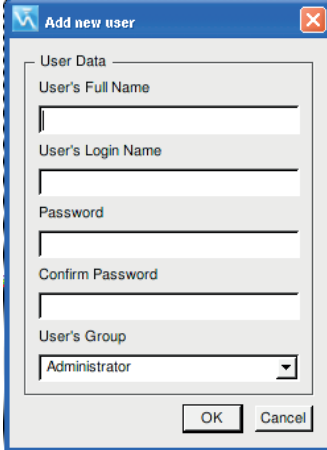


Figure 40: User administration

Selection is made between four different user roles:

	Administrator	Setter	Operator
Create user	x	x	x
Delete user	x	x	x
Change passwords	x	x	x
Activate auto login	x	x	x
Activate auto logout	x	x	x
Create projects	x	x	
Change projects	x	x	
System settings	x	x	x
Start/stop	x	x	x

A new user can be created using the “Add” button. Only users with administrator rights have the right to create new users.



After determining the user data, the user’s role can finally be determined with the “Group” field.

Figure 41: Add new user

The “Options” button determines how users are logged into the system. You can choose between:

- **Automatic login:** The selected user is logged in during system start.
- **Automatic logout:** The user is automatically logged out from the system after a specified time period.
- **Show user list during login:** The entire user list is displayed during system start. During system start, the desired user can be selected.

Default settings for passwords:

In the default setting, the system automatically starts as administrator. The following password is stored in the default settings:

User name	Password
Administrator	admin
Restricted	restricted

5.3.6. Network Connections

The system has three network adapters. These network connections are configured through the network settings. The necessary settings can be made in the menu **Settings → Network**.

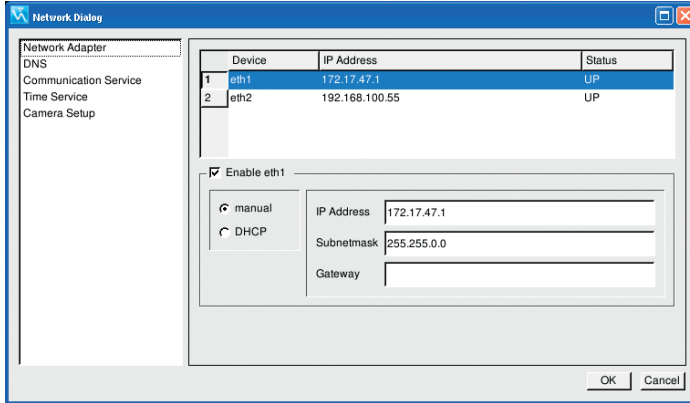


Figure 42: Overview of network settings

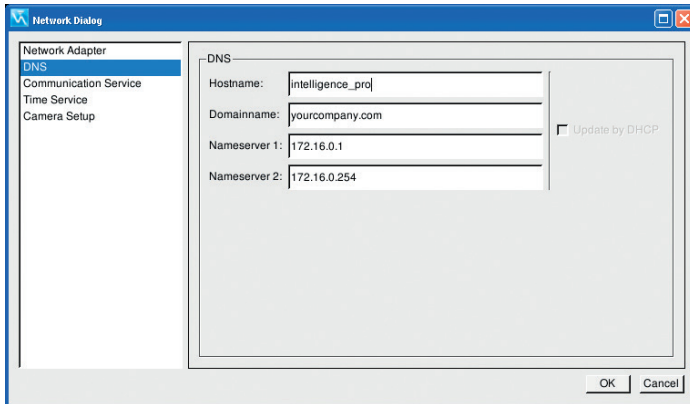


Figure 43: Network DNS settings

IP addresses can be automatically assigned if the network supports this function (DHCP). Contact the network administrator to obtain the correct network settings, if necessary.

The **host name** determines how Intelligence Pro logs into the network. This name is globally identical for all gigabit Ethernet interfaces. The **DNS** server addresses are listed by IP addresses that the system queries for resolution of DNS domain names. DNS servers are queried here in the displayed order. It is possible to obtain DNS information automatically. For this, **Update via DHCP** must be activated.

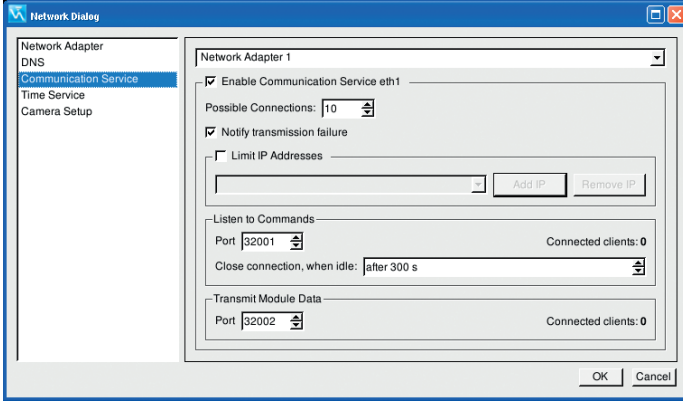


Figure 44: Network communication services

Under **communication service**, the various settings, such as input and output ports, are defined for a connection via sockets. The settings can be made for each network adapter individually.

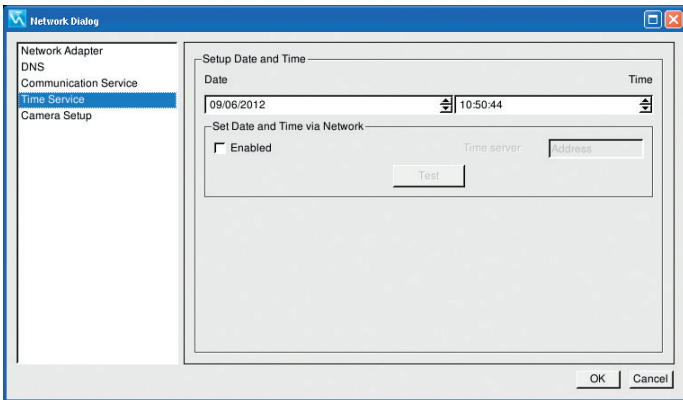
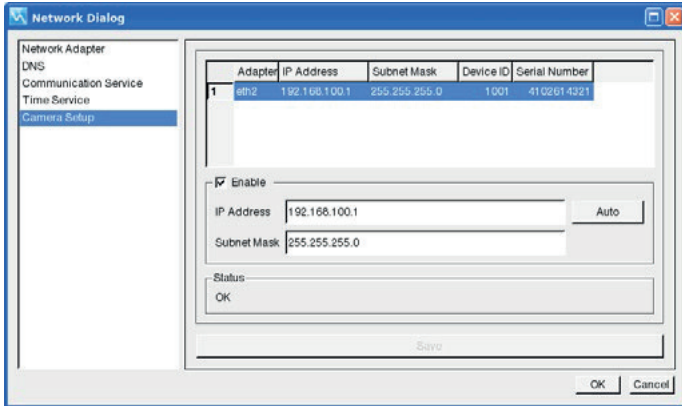


Figure 45: Settings, network time

It is possible to obtain the current date and time through the network. To do this, an NTP server must be present in your network.



Communication with wenglor BKS0x0A40 Digital Cameras is based on an Gigabit Ethernet interface. A valid IP address must be assigned to the Camera in order to log it on to the Control Unit as an Ethernet user. All Cameras within the network are listed in the menu under Communication. A unique, correct IP address must be assigned to each Camera. If a camera with faulty configuration is detected, the **Status** appears red. The system suggests a possible IP address space. After clicking the **Auto** button, the next available, correct IP address, including subnet mask, is assigned to the camera. After subsequently clicking **Save**, the settings are stored to the camera.

Caution: If an incorrect IP address is assigned to the Camera, it might not be recognized within the network.

5.4. Camera

The camera module supports two different image sources that serve as a foundation for the following image processing functions. There is a virtual and a real image source.

If the virtual image source is selected, one or more previously saved pictures are used for the image processing functions. The wenglor digital cameras serve as a second image source.

An outstanding image is the best foundation for a process-secure image processing application. To obtain a good image, there are some influencing factors, such as camera resolution, the right optics, contrast or calibration. These setting options are in the camera settings.

5.4.1. Virtual Image Source Settings

First, the desired camera module must be selected before the virtual image source can be set.

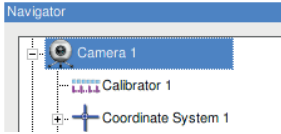


Figure 46: Camera

Name	Value
Source	File
File Names	N.N.

Figure 47: Virtual image source

If “File” is selected as the image source, an image, or several images through multiple selection with the SHIFT key, can be selected in a dialog window. These selected images are then used for evaluation of the following image processing modules.

Clicking on the field next to **File Names** (N.N.) opens the dialog window for selection of the desired images. Images of type bmp, png, xpm, jpg and gif can be loaded into the system. Only JPEG files in the RGB format can be processed.

5.4.2. Camera Settings

First, the desired camera module must be selected before the virtual image source can be set.

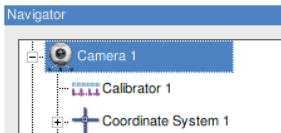


Figure 48: Camera

The setting parameters appear in the lower area of the Navigator.

Name	Value
Source	File
File Names	File
	BKS0M0A40-4002909480

Figure 49: Camera selection

If a connected camera should serve as an image source, click on the menu **Source**. All connected cameras are displayed.

After a camera has been selected, the setting parameters expand. The following setting parameters appear, depending on the camera variant:

Sensor Window	1280x1024
----------------------	------------------

Digital cameras have a maximum image chip resolution of 1280×1024 pixels. By setting the Sensor resolution, the resolution can be reduced or the window section optimally adapted to the requirements.

A window opens in which the **Sensor resolution** can be reduced to 640×512 pixels. The surface that is recorded does not change, only the resolution is reduced. In the **window section** area, the area to be used for the additional tasks is specified. The area can optionally be typed in with numbers in the dialog or defined directly in the camera image by moving the window section.

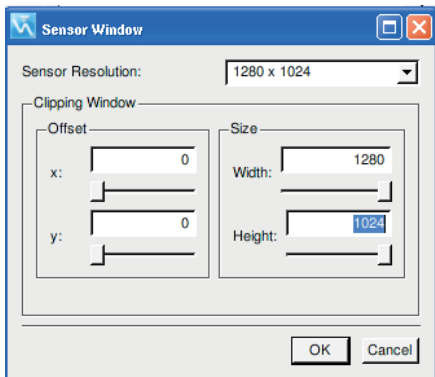


Figure 50: Camera window settings

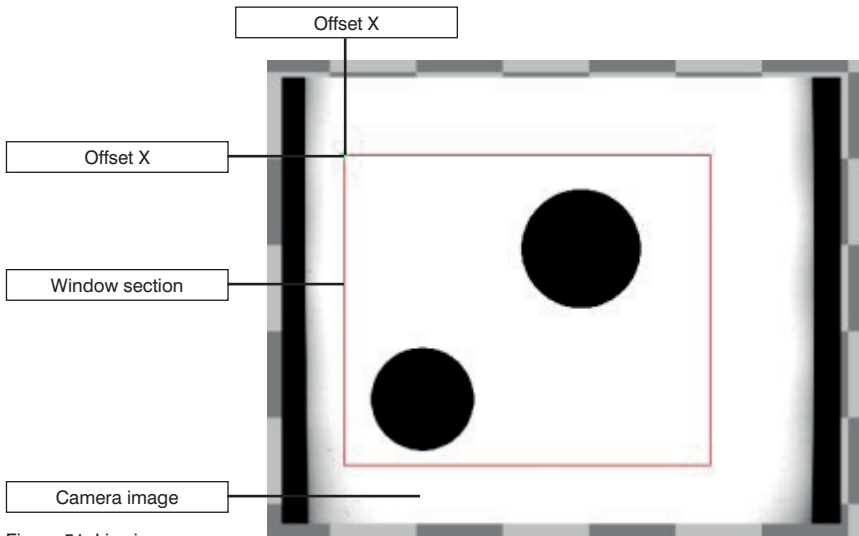


Figure 51: Live image

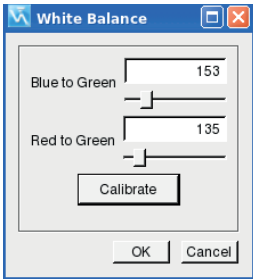
The following parameters are available. Depending on the respective camera model, some of the parameters may not be visible.

Exposure Time	28549
---------------	-------

The following parameter is only possible with color cameras:

White Balance	153/135
---------------	---------

The following window appears:




Place a white object within the camera's imaging field. Press the calibration button. White balancing is executed automatically. If the results do not fulfill your expectations, color values can be manually adjusted. The corresponding color values can be changed with the two sliders to this end.

Setting **Exposure Time** optimally prepares the image for subsequent further processing.

Invert Illumination	<input type="checkbox"/>
---------------------	--------------------------

The camera is equipped with an **illumination output** whose polarity can be inverted.

Trigger	<input type="checkbox"/>
---------	--------------------------

With the **Trigger** button, the camera is placed in trigger mode. When the box is activated, the camera is in trigger mode  additionally „start“ must be activated

Trigger Delay	0
---------------	---

Triggering image reception after a trigger slope is set via the **Trigger Delay**. The time is specified in μs .

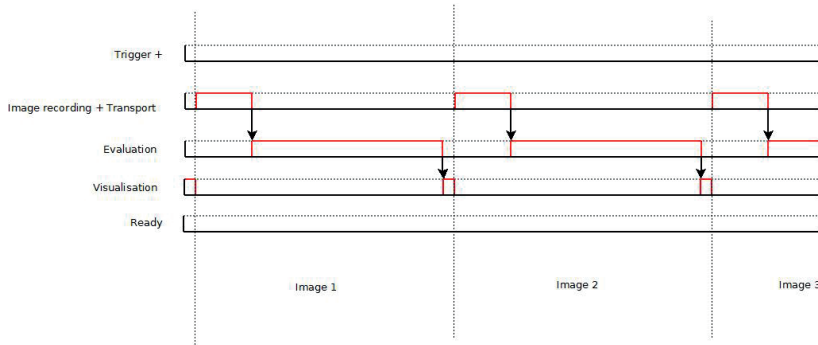
Invert Trigger	<input type="checkbox"/>
----------------	--------------------------

In the standard case, the system reacts to a rising trigger slope. If the **Invert Trigger** function is activated, the image processing system reacts to falling trigger slopes.

5.4.2.1. Live Mode

In the live operating mode, image recording takes place as follows without trigger or ready output.

Image recording in Live Mode

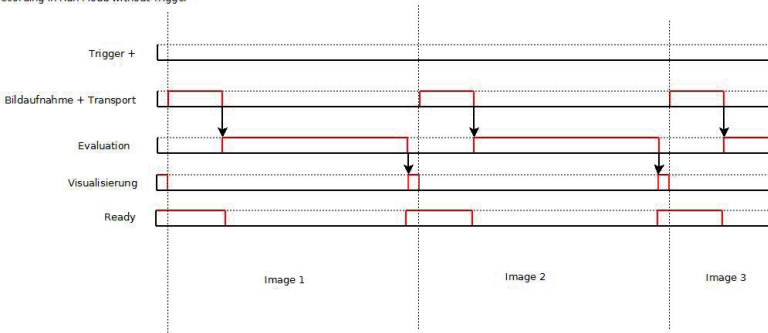


As soon as visualization of the last image has been completed, image recording is immediately triggered. After the data have been transmitted to the processor, evaluation of the recorded image takes place. The results are then displayed and depicted during the visualization phase. As soon as visualization has been completed, recording of the next image is started.

5.4.2.2. Run Mode Without Trigger

Image recording can also be started in the run mode without trigger, using a ready signal instead.

Image recording in Run Modu without Trigger

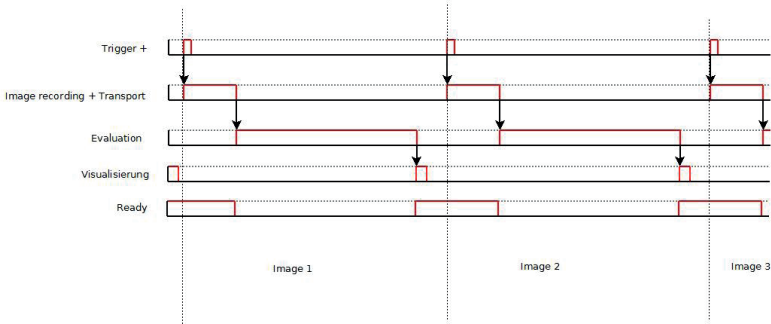


As soon as the ready signal is activated and visualization of the last image recording has been completed, image recording is immediately triggered. After the data have been transmitted to the processor, evaluation of the recorded image takes place. The ready signal is subsequently activated and the results are displayed during the visualization phase. As soon as visualization has been completed, recording of the next image is started and the ready output is deactivated.

5.4.2.3. Run Mode with Positive Trigger Edge

Image recording is triggered in the run mode by the positive trigger edge.

Image recording in Run Mode with Positive Trigger Edge

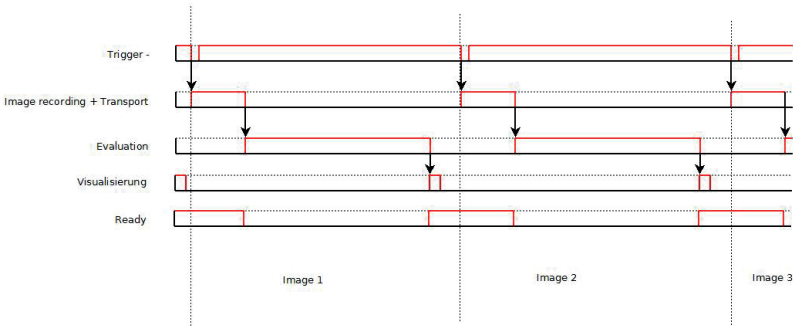


As soon as the ready signal is activated and a rising trigger edge is launched by the application, image recording is immediately triggered. After the data have been transmitted to the processor, the ready signal is deactivated and evaluation of the recorded image takes place. The ready signal is subsequently reactivated and the results are displayed during the visualization phase. As soon as the next positive trigger edge occurs, recording of the next image is started.

5.4.2.4. Run Mode with Negative Trigger Edge

Image recording can also be triggered in the run mode by the negative trigger edge.

Image recording in Run Mode with Negative Trigger Edge

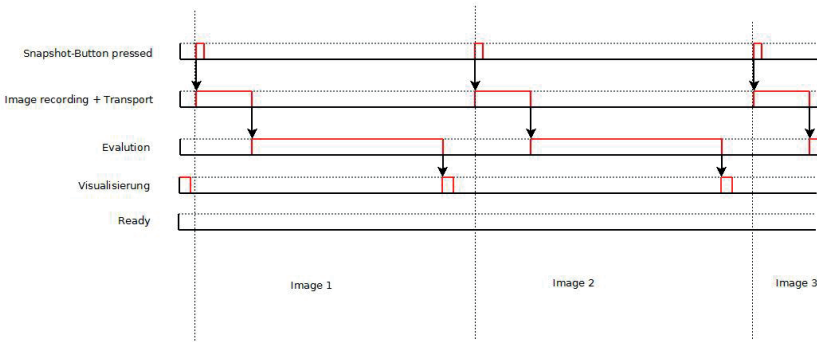


As soon as the ready signal is activated and a falling trigger edge is launched by the application, image recording is immediately triggered. After the data have been transmitted to the processor, the ready signal is deactivated and evaluation of the recorded image takes place. The ready signal is subsequently activated and the results are displayed during the visualization phase. As soon as the next negative trigger edge occurs, recording of the next image is started.

5.4.2.5. Snapshot Mode

Image recording can be triggered by clicking the snapshot button.

Image recording Snapshot



As soon as the snapshot button is clicked or a rising edge is launched by clicking the button, image recording is immediately triggered. After the data have been transmitted to the processor, evaluation of the recorded image takes place. The results are then displayed during the visualization phase. As soon as the snapshot button is clicked once again, recording of the next image is started.

5.4.3. Camera Modes for Image Recording

There are various ways of triggering image recording and processing. The rising or falling edge of a trigger pulse can be used to start image recording, or the snapshot button can be clicked. However, as an alternative, image recording in the live mode can be executed by the software as frequently as possible by allowing the end of the visualization to trigger the next recording.

5.4.4. Color Spaces

Various color spaces are available, depending on the selected camera design.

For a monochrome digital camera, only the monochrome channel can be selected. For a color camera RGB and HSV color spaces are still available.

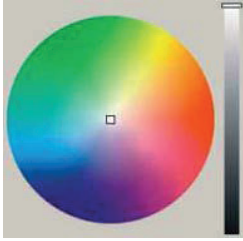
These various channels are based on different color spaces that can be processed in the camera. In the following, the various color spaces are described in more detail.

5.4.4.1. Monochrome

Monochrome or also monochromatic stands for single color. Simply expressed, a monochrome image consists of pixels with gray values of 0...255.

5.4.4.2. HSV

In the HSV color space, a color is partitioned into 3 channels.



H (hue = coloring)

S (saturation = chroma)

V (value = brightness value)

The **hue H** can take values between 0° and 360° and is generally depicted as a circle. All colors are presented on this circle. At 0° is the color red, at 120° the color green, and at 240° the color blue. All hues lie between these colors. Black and white are not listed as hues. They are achieved through saturation and brightness.

The **saturation S** depicts the luminosity of a color. If saturation is at its maximum, a pure color appears. If saturation is at its minimum, a gray value appears, which in turn depends on the current V value (brightness value). Between this maximum and minimum lie all colors between gray and the **pure color**.

The **brightness value V** depicts the brightness of a color, between black and a maximum. The achievable maximum is determined by the saturation.

A color with V value of 0 appears black regardless of H and S.

A color with V value at its maximum appears, dependent on H and S, as the brightest variant of the combination of H and S.

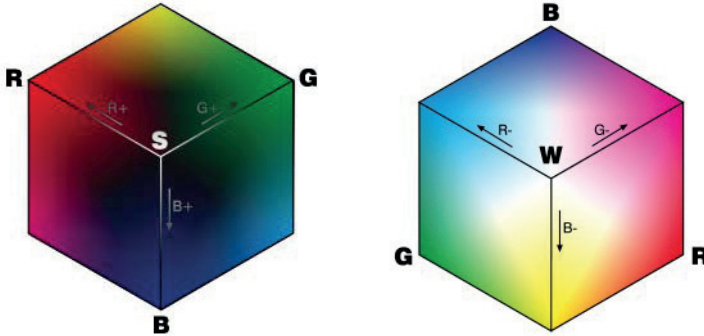
Advantages for digital image processing

For digital image processing, this brings a decisive advantage. A hue can be recognized independently of its brightness. A blue tone, for example, can be recognized independently of the surrounding brightness.

This is not possible in the RGB color space.

5.4.4.3. RGB

In the RGB color space, any color desired can be described with three values: the red, green and blue component. Each color component can vary between 0 and 100 %. The basic colors add up to white. The RGB color space has the form of a cube.



5.4.5. Calibration of the Camera

In order to deal very flexibly with the various image sources, each individual image source has the possibility to calibrate a coordinate system. The image processing system calculates in pixels. It is easier for the user to deal with a metric-system unit, such as mm, than with a pixel value.

Calibration thus has several advantages. One advantage is that it permits automatic conversion of all pixel values into a different unit, such as pixels \rightarrow mm. Through the use of various lenses and installation arrangements, there may be differences between the depiction in the image and the real application. This discrepancy can also be counteracted through a calibration process.

If possible, calibration should always be the first step in creating a new test process. Only then can it also be ensured that the subsequent test procedures deliver an exact result. To calibrate the system, calibration must first be selected in the navigation tree.

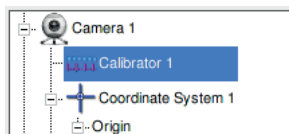


Figure 52: Navigator – Calibrator

The system offers the user three different possibilities for calibration.

5.4.5.1. Linear Calibration

With linear calibration, an object with known size is used for calibration. If the system has been calibrated, distances or measurement results are displayed in the selected unit.

With linear calibration, a fixed conversion factor is determined for the entire image. No image distortion is considered.

The user must assign a value to a previously established segment. The segment is defined by two points in the image.

In the symbol bar, through a click on the calibration symbol,  the calibration process is started.

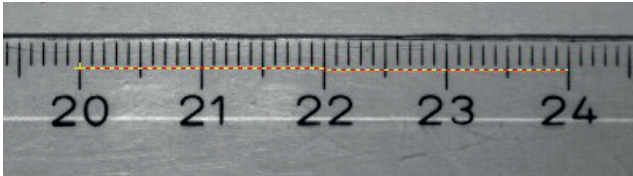


Figure 53: Linear Calibration

If you use an object for which the lengths are known, process as follows: The starting point of the known segment is marked with the first click. The second click on the end point defines the segment.

After the second click, a dialog window opens in which the distance must be entered.

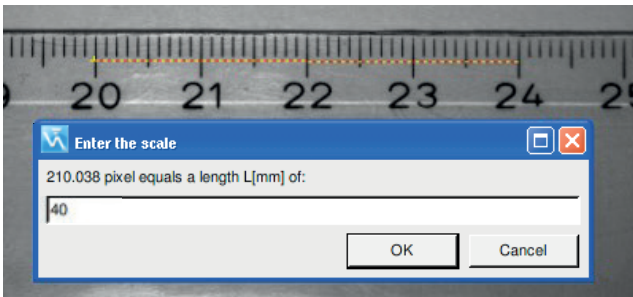


Figure 54: Linear Calibration

After successful calibration, the conversion factor between pixels and mm appears in the result field.

Unit Per Pixel	0.566
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5.4.5.2. Matrix Calibration

Matrix calibration is a much more exact calibration method than linear calibration. With matrix calibration, optical distortions can be eliminated. As a result, precise dimensional accuracy tests and evaluations are possible over the entire sequence of images.

This calibration method uses a calibration aid with round marks that lie exactly next to each other horizontally and vertically.

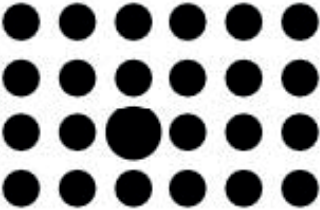



Figure 55: Example, calibration matrix

This calibration pattern must be visible over the entire window section. Only in this way can it be ensured that calibration can be performed successfully.

In the symbol bar, through a click on the calibration symbol,  the calibration process is started. A context menu opens, in which the distance between the individual points must be defined.

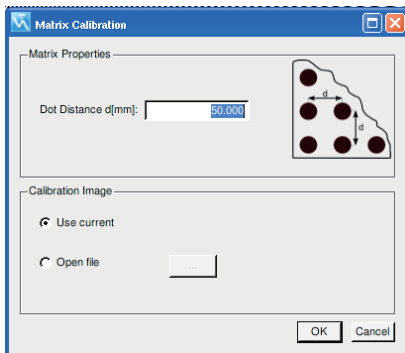


Figure 56: Matrix Calibration

Various sources for the calibration images can be selected in the lower area of the window. Selection can be made between the current camera image and a previously saved image.

A click on OK starts the calibration process. If calibration has been performed successfully, it is acknowledged with a green signal in the information bar.

The calibration method has the possibility of repeating the calibration for every image recording and saving the calibration in a file (.bin).

Name	Value
Unit	mm

If the calibration has been successfully performed, a window appears that depicts the calibration result.

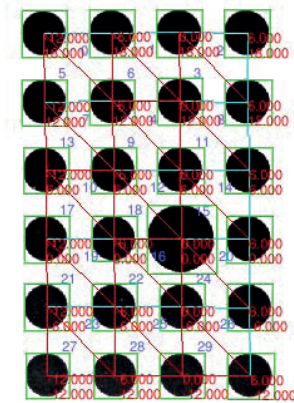



Figure 57: Sample result, matrix calibration

5.4.5.3. Existing Calibration

If a previously saved calibration should be loaded into the system, this process is started with a click on the calibration symbol  in the menu bar. Select the desired calibration file (.bin).

5.4.6. Coordinate System

Another important step toward a secure-process image processing solution is the coordinate system. The coordinate system is an aid in finding objects in an image. Static applications, in which the object is always at exactly the same place, are very rare. In reality, objects are usually guided relatively exactly. But to obtain a secure-process application with very high precision, it is necessary to localize the object in the image. The coordinate system is available to localize an object securely. If the object is localized using the coordinate system, all further functions are based on this coordinate system.

The coordinate system is independent of the location and rotational position, i.e. the subsequent image processing modules also orient their location and rotational position on the coordinate system. For many applications, it is important that the coordinate system be tracked.

5.4.6.1. Basic Settings

In the basic settings of the coordinate system, the following setting options exist.

Name	Value
Input Image	1280 pix * 1024 pix
Construction Method	2 Pt. X-axis, 1 Pt. Y-axis
Tracking	Yes
Tracking Point	3. Pt.

In the **input image** category, all available image sources, e.g. several cameras or filtered camera images, can be selected as output image.

The coordinate system can be tracked through four different methods. These methods can be optionally selected via the icons or the settings of the **design method**. How the various methods differ is described in more detail in the following:

1. A fixed point, which can be defined as desired

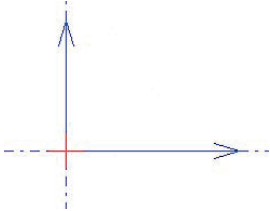


Figure 58: Coordinate system 1 fixed point

2. A point on the x-axis and a point on the y-axis

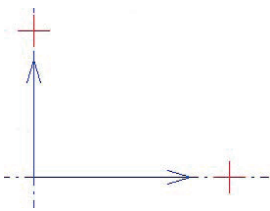


Figure 59: Coordinate system 2 fixed points

3. A point that defines the origin and an angle-independent point on the x-axis

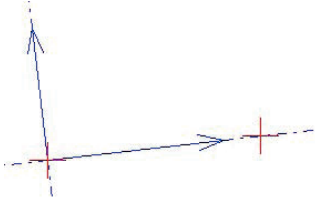


Figure 60: Coordinate system 1 fixed point 1 variable point

4. Any two points on the x-axis and any point on the y-axis

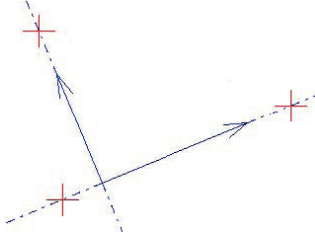



Figure 61: Example of a coordinate system

In these examples, fixed points (red crosses) were used to orient the coordinate system. A coordinate system independent of location and rotational position has not yet been implemented. There are several options for determining the points that represent the foundation of the coordinate system.


In the following, the individual search functions are explained in more detail.

5.4.6.2. Fixed Point

Through the symbol  the function is activated. The fixed point can be freely moved in the image to the desired location.

5.4.6.3. Focus

In the **focus** function, the calculated focus of an object is determined within a square ROI.


If the function is activated through the symbol  a square appears in the image window. The size and location of the square can be freely selected. The system detects an object according to established parameters. The focus of the found object then provides a point of the coordinate system.

Name	Value
Object Type	Largest Dark Object
Object Completely Inside	No
Threshold	128

The following parameters must be differentiated:

- **Object type:** It must be determined whether a search is made for the largest bright object or the largest dark object in the recording range.
- **Object completely within** determines whether the object has to be completely in the recording range to be recognized.
- **Threshold settings** determine from what gray value a pixel is considered present or not present.

5.4.6.4. Edge on a Line

The foundation of this function is a search beam. In edge detection, a transition from black to white pixels or vice versa is searched for on the search beam. If such a transition is found, it is defined as an edge point. Through the symbol  in the symbol bar, the function is activated.

The following example shows a search line (red) and the detected edge (red circle):

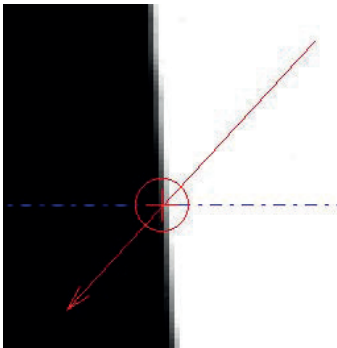


Figure 62: Line detection

Various options are offered for searching for an edge transition on the search beam.

Name	Value
Edge Type	First Edge
Threshold	128 ...

Figure 63: Search circle parameter


The following edge detection modes are available:

Name	Value
Edge Type	First Edge
Threshold	First Edge Bright -> Dark Dark -> Bright Largest Bright Segment Smallest Bright Segment Largest Dark Segment Smallest Dark Segment

Figure 64: Opportunity for edge detection

Threshold settings determine from what gray value a pixel is considered present or not present.

5.4.6.5. Edge on Circular Line

The foundation of this function is a search circle in which a segment is searched for. Through the symbol  in the symbol bar, the function is activated.

The following example shows a circle (red) and the detected segment (red circle):

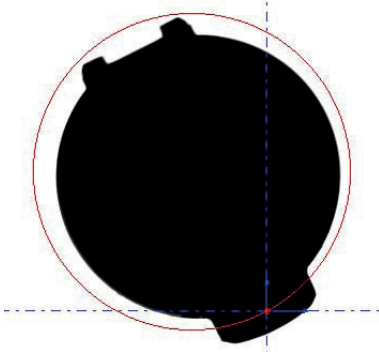


Figure 65: Edge on circular line

Various options are offered for searching for a segment on the search circle.

Name	Value
Edge Type	Largest Bright Segment
Threshold	128

Figure 66: Circle parameter

The following edge detection modes are available:

Name	Value
Edge Type	Largest Bright Segment ▾
Threshold	Largest Bright Segment
	Smallest Bright Segment
	Largest Dark Segment
	Smallest Dark Segment

Figure 67: Edge detection modes

In each case, the center of the segment to be recorded is detected. If, for example, the **largest bright segment** is selected, the center of the circle sector that includes the largest bright segment will appear. Threshold settings determine from what gray value a pixel is considered present or not present.

5.4.6.6. Edge of Circular Arc

Various options are offered for searching for an edge transition on the circular arc.

Through the symbol  in the symbol bar, the function is activated.

The following example shows a circular arc (red) and the detected edge (red circle).

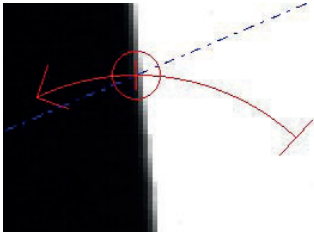


Figure 68: Circular line detection

Name	Value
Edge Type	First Edge
Threshold	128

Figure 69: Circular arc parameter

Various options are offered for searching for a segment on the circular arc.

The following edge documentation modes are available for selection:

Name	Value
Edge Type	First Edge
Threshold	<ul style="list-style-type: none"> First Edge Bright -> Dark Dark -> Bright Largest Bright Segment Smallest Bright Segment Largest Dark Segment Smallest Dark Segment

Figure 70: Edge detection modes

Threshold settings determine from what gray value a pixel is considered present or not present.

5.4.6.7. Edge on a Line (Subpixel)

For an image recording, the size and number of pixels are determined through the image chip, optics and additional physical influences. The actual resolution of an image is limited by this. Through a mathematical procedure, it is possible to depict parts of an image more exactly in order to achieve a more exact result in the subsequent process. Such a procedure is used in subpixel-precise edge detection.

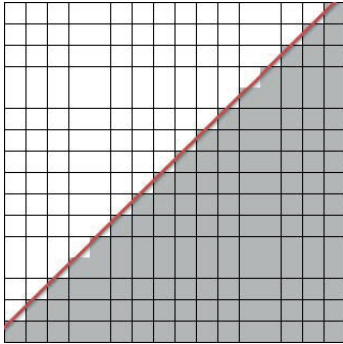



Figure 71: Subpixel-precise line

This example shows a subpixel-precise line that was applied at the transition between the two objects. If the line was not applied subpixel-precisely, a stair-shaped line would result.

Through the symbol  in the symbol bar, the function is activated. The procedure is identical to that for detection with a standard line (see “5.4.6.4. Edge on a Line” on page 51). There are various options available to recognize the line robustly.

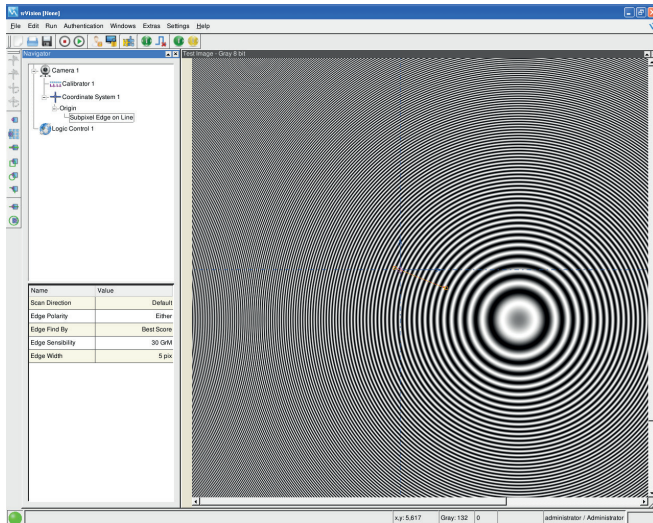


Figure 72: Line parameter

The **Scan Direction** can be changed between **default** and **swap**. The initial search-beam direction results from the direction from which the search beam was drawn. The parameter turns this direction around.

The parameter **edge polarity** describes the transition that is searched for on the search beam. Differentiation can be made between the search directions black to white, white to black or both.


Setting the **Edge Find By** establishes which edge transition should be taken as the coordinate system point. **First Score**, **Last Score** or **Best Score** can be used.

The **Edge Sensibility** value describes the minimum difference in brightness between two neighboring pixels that must be reached to be recognized as an edge.

The **Edge Width** determines the expected width of the edge to suppress point malfunctions in the edge transition.

5.4.6.8. Center of a Circle (Subpixel)

To determine a point for the coordinate system, a subpixel-precise circle center is determined in this function. Several search lines are arrayed circularly to find a subpixel-precise circle center.

Through the symbol  in the symbol bar, the function is activated.

The following example shows a subpixel-precise circle (red) and the circle center (red circle):

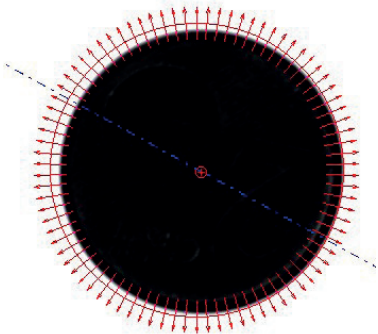


Figure 73: Center of a circle

There are various options available to recognize the circle robustly.

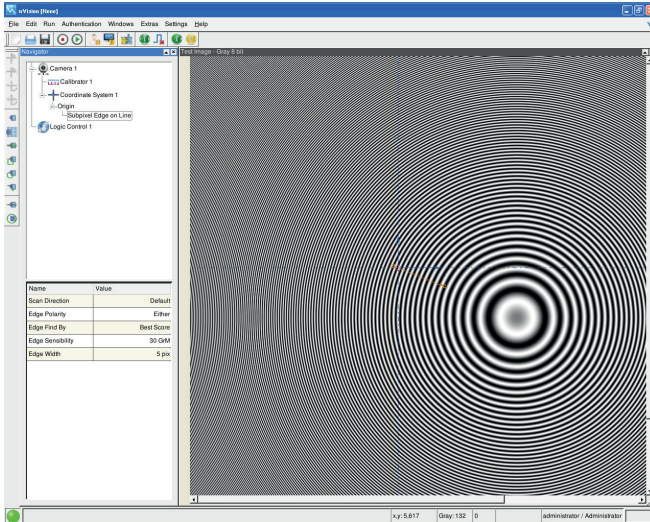


Figure 74: Circle center parameter (subpixel)

The **Scan Direction** can be changed between **default** and **swap**. The initial search-beam direction results from the direction from which the search beam was drawn. The parameter turns this direction around.

The parameter **edge polarity** describes the transition that is searched for on the search beam. Differentiation can be made between the search directions black to white, white to black or both.

Setting the **edge search type** establishes which edge transition should be taken as the coordinate system point. First value, last value or best value can be used.

The **edge sensitivity** value describes the minimum difference in brightness between two neighboring pixels that must be reached to be recognized as an edge.

The **edge width** determines the expected width of the edge to suppress point malfunctions in the edge transition.

An edge is detected through calculation of a line between all edge transitions found. But if an edge transition is disproportionately far from the expected edge, this can falsify the result. The regression evaluates the connection between focal lines and the distance of the edge transitions to these focal lines. If the edge transitions continue as established under **outlier threshold**, these edge transitions are no longer considered in the new calculation of the focal lines. The **regression steps** value specifies how often this procedure should be applied.

5.4.6.9. Variable Design of the Coordinate System

If we assume that we do not know exactly where the object edges are located, correct recording of the object is difficult. If the coordinate system is defined by two or three variable edges, it is possible to track one or two points depending on the others. The selected point becomes the reference point. Based on this, the further search geometries can be placed.

The example should clarify the connection:

A coordinate system is constructed of three points. Two points for the x-axis and one point for the y-axis

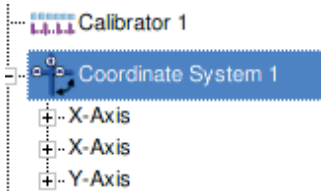


Figure 75: Navigator window – coordinate system

The function of variable tracking of cohesive design points can be activated in the **tracking** category in the settings for the coordinate system.


Name	Value
Input Image	1280 pix * 1024 pix
Construction Method	2 Pt. X-axis, 1 Pt. Y-axis
Tracking	Yes
Tracking Point	3. Pt.

Figure 76: Coordinate system parameters

The tracking reference point determines which point of the coordinate system should be taken as reference point. In this example, design point 3 was selected, that is, the design point of the y-axis. The two other design points of the x-axis are tracked dependent on the reference point of the y-axis.

5.5. Image Processing Modules

Any number of image processing modules can be used in a project. The individual image processing modules are described in the following. Some settings repeat themselves with all image processing modules. These functions are described more precisely in the **general functions** subpoint.

To insert an image processing module into a project, the symbol  in the menu bar must be clicked on.

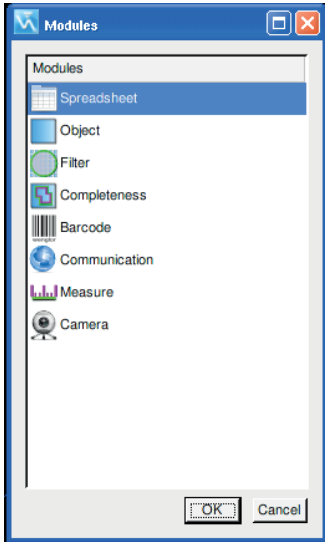


Figure 77: Image Processing Modules

The image processing module window appears, in which the individual image processing modules and other cameras and components of a project can be selected.

5.5.1. General Functions

At the start of every image processing module are always that basic settings. The parameters for the basic settings can be found in the lower part of the navigator window. The process in making the settings for an image processing module is divided into the following steps.

5.5.2. Selection of the Image Source

An image source must first be selected as the foundation of every image processing module. All physically connected image sources and the image sources that run through a filter stage are available.

A click on the button for input image opens the selection dialog, in which the various image sources can be selected.

Name	Value
Input Image	1280x1024 ...

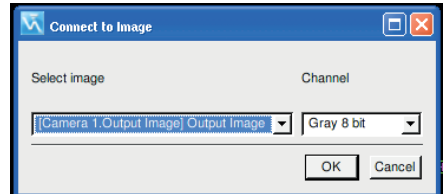
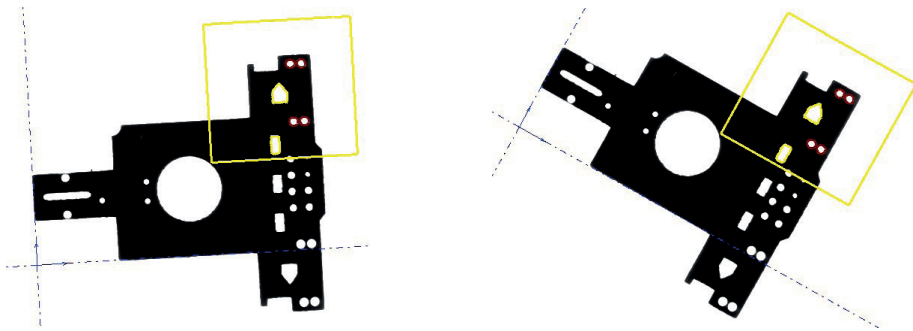


Figure 78: Select image source

If a color camera is connected, selection can additionally be made between the individual color channels or saturation, brightness, etc.

If a coordinate system has been defined, the image processing task is linked to the coordinate system. If the object to be evaluated moves in the image window, the image processing tool moves to the same extent with the help of the coordinate system. As a result, a successful evaluation is possible for moving parts as well.

The following images show how an image processing tool turns together with the object:




5.5.3. Threshold Calculation

The threshold establishes the value from which a pixel/symbol is detected. The pixel/symbol is not detected until the threshold is exceeded.

There are various possibilities for establishing the threshold. The simplest method is to set the threshold as a fixed value. To do this, the value can be entered directly in the field.



Through a click of the button  in the setting field, a window opens in which further opportunities for threshold calculation can be activated.

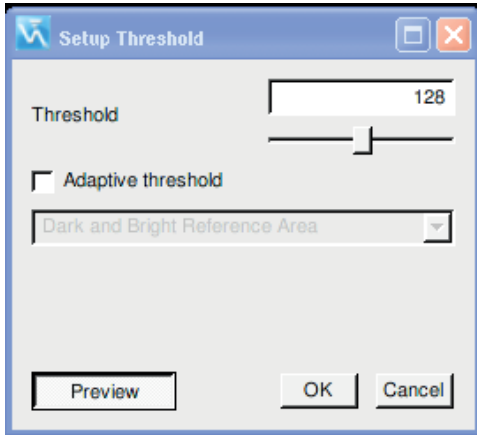


Figure 79: Threshold calculation

With an activated **preview** button, the threshold settings are applied to the image and the binary effect can be recognized.

While the application is running, brightness variations can occur due to environmental influences. One option to counteract them is to track the threshold dynamically.

Examples with changing brightness conditions:



Brightness 1

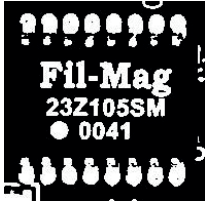


Brightness 2

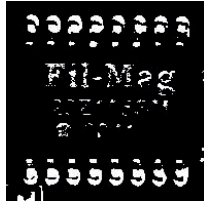


Brightness 3

The related binary images appear as follows:



Binary image 1



Binary image 2



Binary image 3

One possibility to counteract changing environmental conditions it to recalculate the threshold with every image acquisition. If the threshold should be recalculated with each image acquisition, the function **adaptive threshold** must first be activated.

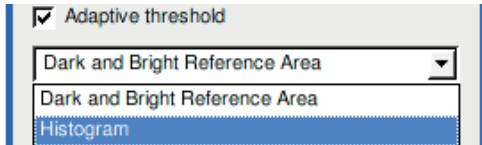


Figure 80: Adaptive threshold parameter

After activation of the function, two options for threshold calculation are available.

- **Dark and Bright Reference Area**

With this threshold calculation, the maximum brightest and maximum darkest range are selected using two reference ranges in the ROI. To select the ranges, these can be shifted in size and position.

- **Histogram**

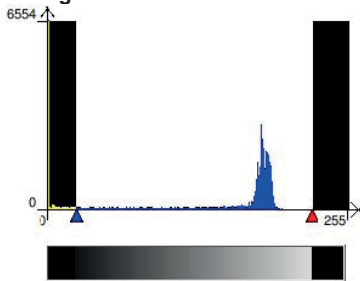


Figure 81: Histogram threshold

If the histogram is used, the window expands by an additional histogram, which can, for example, appear as follows: The histogram shows the distribution of the pixels with their gray values. By moving the arrows in the histogram, the threshold can be set optimally.



Figure 82: Offset threshold






With the help of the **offset**, the settings of the 1st and 2nd quantile are shifted in the positive or negative direction by the value established in the offset. A quantile defines a specific part of a data set, that is, a quantile establishes how many values of a distribution are above or below a specific limit.






5.5.4. Selection of the work range (ROI)




The work range, or region of interest (ROI), determines which range of the entire camera image should be used for the following image processing module.

It is normally not necessary to apply the image processing module to the entire image. The processing time of the image processing module can be reduced by limiting the ROI and simultaneously also the image information to be processed.

An ROI can consist of one or more geometries. Rectangles, circles or polygons are available for selection. An ROI can consist of several geometries; how the geometries are combined together is established with the following functions.


Function	Display in the image	Icon
Add new ROI		
Copy ROI		
Addition of ROIs	Red line	
Subtraction of ROIs	Green line	
Intersection of the ROIs	Blue line	

Geometries	Procedure	Icon
Rectangle from two points	Start and end point	
Rectangles from three points	Start and end point, rotary position	
Circle from two points	Center and radius	
Circle from three points	Start point, radius and rotational angle	
Polygon	Geometries from any number of points	

General	Functions result	Icon
Rotate	Turn individual ROIs	
Delete	Delete individual ROIs	
Delete everything	Delete all ROIs together	

5.5.5. Filters

Filters are digital filters that are used to emphasize or suppress features of an image or image section or improve the image quality. A filter should be understood as an operator that is used on a recorded image and thus generates a new, filtered target image. Filters are used for image preprocessing.

The **Filter** image processing module is received into the project structure through the symbol , which is located in the navigation bar.

5.5.5.1. Basic settings

At the beginning, the following subpoints are inserted into the project structure.



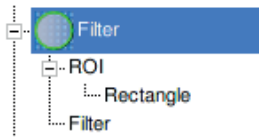
The highest level defines the basic settings of the module. These parameters establish the filter module.

Name	Value
Input Image	1280 pix * 1024 pix
Coordinate System	*+423.1 pix -497.8 pix 15.4 °
Scale factor	1.0

Figure 83: Filter parameters

Selection of the **input image** of the **coordinate system** to be used is defined in the basic settings.

With the **scaling factor** value, the results/effects of the filters can be increased or reduced by the scaling factor. If, for example, the scaling factor is set to the value 2.0, the results/effects of the filters are doubled. This happens analogously in the negative direction. The scaling factor 0.5 means that the results/effects are only half as strong as in the basic setting.



The ROI is determined in the second level. Here, at first a rectangle is selected, but it can be freely changed. How the geometries can be changed is described in more detail under “5.5.4. Selection of the work range (ROI)” on page 62.



The image filters are determined in the third level.

5.5.5.2. Erosion

Erosion belongs to the morphological filter functions. These image processing functions are used to emphasize or reduce objects of a specific shape and/or size

- (black portions are strengthened)
- or deleted
- To smooth edges
- To remove errors or “noise”
- To “fill up” specific segments in an image.

Effects of an erosion:

- Adds points to the edges of the objects according to the form and color of the neighboring point.
- Small distortions and gaps are closed and disappear irrevocably.
- Closes objects.

The filter can be set via the following parameters:

Name	Value
Type	Erosion
Kernel size	3x3

Besides selection of the filter **type**, setting of the **size** of the filter kernel is offered. The size of the **filter kernel** specifies how large of a pixel area should be selected for a filter step. The larger the filter kernel, the larger the influence of the surrounding pixels. It should be noted that a larger filter kernel also entails greater processing time.

The following example should clarify how an erosion filter works.



Figure 84: Original before erosion filter



Figure 85: With erosion filter

We assume that the background was bright and the object dark in this example. In case of an erosion, the object, here meaning the share of the dark portion, is strengthened. An erosion is the exact opposite of dilatation. The effect of the dilatation and erosion reverses when the foreground and background (black/white) are reversed.

5.5.5.3. Dilatation

Dilatation belongs to the morphological filter functions. These image processing functions are used to emphasize or increase objects of a specific shape and/or size

- (white portions are strengthened)
- or deleted
- To smooth edges
- To remove errors or “noise”
- To “fill up” specific segments in an image

Effects of a dilatation:

- Adds points to the edges of the objects according to the form and color of the neighboring point.
- Small distortions and gaps are closed and disappear irrevocably.
- Objects that are close to each other can be connected to each other.

The filter can be set via the following parameters:

Name	Value
Type	Dilatation
Kernel size	3x3

Besides selection of the filter **type**, setting of the **size** of the filter kernel is offered. The size of the **filter kernel** specifies how large of a pixel area should be selected for a filter step. The larger the filter kernel, the larger the influence of the surrounding pixels. It should be noted that a larger filter kernel also entails greater processing time.

The following example should clarify how a dilatation filter works.



Figure 86: Original before dilatation

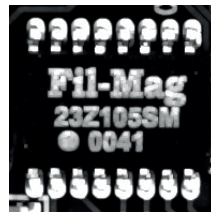


Figure 87: With dilatation filter

We assume that the background was bright and the object dark in this example. In the case of a dilatation, the background is strengthened, here the share of the bright portions.

A dilatation is the exact opposite of erosion.

5.5.5.4. Opening

The opening filter is the succession of an erosion and a dilatation. Erosion closes gaps of dark structures while dilatation reverses thickening of the dark objects. The increase in the surface of the dark objects that occurs in erosion is removed again through dilatation.

Effects of the opening:

- Contours are markedly emphasized even with relatively low gray value transitions.

The filter can be set via the following parameters:

Name	Value
Type	Opening
Kernel size	3x3



Figure 88: Original image, opening



Figure 89: Opening filter

Besides selection of the filter **type**, setting of the size of the filter kernel is offered. The size of the filter kernel specifies how large of a pixel area should be selected for a filter step.

5.5.5.5. Closing

Analogously to the opening filter, the closing filter is the succession of a dilatation and an erosion. Erosion closes gaps of bright structures while dilatation reverses thickening of the bright objects. The increase in the surface of the bright objects that occurs in dilatation is removed again through erosion.

Effects of the closing:

- Contours are markedly emphasized even with relatively low gray value transitions.

The filter can be set via the following parameters:

Name	Value
Type	Closing
Kernel size	3x3



Figure 90: Original image, closing



Figure 91: Closing filter

Besides the **type** of filter selected, setting of the **size** of the filter kernel is offered. The size of the **filter kernel** specifies how large of a pixel area should be selected for a filter step.

5.5.5.6. Median

The median filter is a diffuser. In median filtering, the gray value of a pixel is replaced by the median of all gray values of the surrounding pixels. This results from all pixels of the gathered environment being brought into a sorted sequence and replacement of the current pixel by the middle value of the sequence (the median). The median filter suppresses noise and is simultaneously an edge-retaining operator. The result is a lightly smoothed image of the original, whereby strongly deviating “noise pixels” are much more strongly dampened than sharp edges, for example.

Effects of the median filter:

- Causes smoothing of the image with retention of the edge slope.
- The edges are not smudged – the image does not lose sharpness.
- The filter eliminates small, sporadic image disturbances.

The filter can be set via the following parameters:

Name	Value
Type	Median
Kernel size	3x3

Besides selection of the filter **type**, setting of the **size** of the filter kernel is offered. The size of the **filter kernel** specifies how large of a pixel area should be selected for a filter step. The larger the filter kernel, the more homogeneous the filtering.



Figure 92: Original image, median filter



Figure 93: Median filter

5.5.5.7. Sobel

The Sobel filter is a combination of edge filter and smoothing filter. Homogeneous surfaces are shown black, edges white.

Effects of the Sobel filter:

- Edges are markedly emphasized even with relatively low gray value transitions.

The filter can be set via the following parameters:

Name	Value
Type	Sobel
Kernel size	3x3

Besides selection of the filter **type**, setting of the **size** of the filter kernel is offered. The size of the **filter kernel** specifies how large of a pixel area should be selected for a filter step.

The following example should clarify how a Sobel filter works:



Figure 94: Original image, Sobel filter



Figure 95: Sobel filter

5.5.5.8. Gaussian

With this procedure, the image is shown softer. This filter can reduce image noise or non-homogeneous surfaces can be shown more homogeneously.

Effects of the Gaussian filter:

- Edges are markedly emphasized even with relatively low gray value transitions.

The filter can be set via the following parameters:

Name	Value
Type	Gauss
Kernel size	3x3

Besides the **type** of filter selected, setting of the **size** of the filter kernel is offered. The size of the **filter kernel** specifies how large of a pixel area should be selected for a filter step.

The following example should clarify how a Gaussian filter works:



Figure 96: Original image



Figure 97: With Gaussian filter

5.5.5.9. Laplace

The Laplace filter is a direction-independent edge filter that works in the horizontal and vertical as well as diagonal directions. With the Laplace filter, each edge results in a double contour.

Effects of the Laplace filter:

- Only edge transitions are strongly emphasized.
- Homogeneous image areas are shown black.

The filter can be set via the following parameters:

Name	Value
Type	Laplace
Kernel size	3x3

Besides selection of the filter **type**, setting of the **size** of the filter kernel is offered. The size of the **filter kernel** specifies how large of a pixel area should be selected for a filter step.

The following example should clarify how a Laplace filter works:



Figure 98: Original image, without Laplace filter



Figure 99: Laplace filter

5.5.5.10. Canny

The Canny image filter is different from the image filters looked at so far. The filter delivers binary rather than gray-scale images (i.e. each pixel can merely take the values 0 = "no edge" or 1 = "edge"). To reach this result, the initial image runs through several image filters linked one after another.

Effects of the Canny filter:

- A binary image is created that shows only edges.

The filter can be set via the following parameters:

Name	Value
Type	Canny
Kernel size	Fix
Lower threshold	50
Upper threshold	200

Besides the **type** that the Canny filter establishes, the **size of the filter kernel** is set to **Fix**. The binary threshold is determined through definition of the **lower** and **upper threshold**.

The following example should clarify how a Canny filter works:



Figure 100: Original image Canny



Figure 101: Canny filter

5.5.5.11. Laplace of Gaussian

The Laplace of Gaussian filter combines a Laplace filter with a Gaussian filter. The Laplace filter is very sensitive to (often undesired and not relevant) disturbances in the image. For that reason, the image is usually first washed with the Gaussian filter and then the edges emphasized with the Laplace filter.

No additional settings are necessary with this filter. It can merely be switched on.

Name	Value
Type	LoG
Kernel size	Fix



Figure 102: Original image, Laplace of Gaussian filter



Figure 103: Laplace of Gaussian filter

5.5.5.12. Binarization

The binarization filter creates a pure black/white image from an image consisting of several gray levels. The threshold parameter determines from which gray value a pixel should be depicted as black or white.

Effects of the binarization filter:

- A black/white image is created.

The filter can be set via the following parameters:

Name	Value
Type	Binarization
Threshold	128



Figure 104: Original image



Figure 105: Binarization filter


The threshold parameter establishes the binarization threshold. How the various binarization methods work is described in more detail in chapter "5.5.3. Threshold Calculation" on page 60.

5.5.6. Dimensional Accuracy

The Measurement Module image processing module offers measurement functions based on finding rays, circles, arcs, and line, arc, and ring segments in the image. The characteristics of the named geometries, like the radius of a circle or the position of the center, can be documented with permitted tolerances.

Additionally, the image processing module offers links of geometries with distance or angle calculations. For example, the smallest angle between two rays or the intersection of the lines can be calculated.

A further example is the measurement of distance between two parallel lines. The distance from center to center of the two rays and the projection from the center of the first lines to the second line are determined.

The Measurement Module image processing module is received into the project structure through the symbol , which is located in the toolbar.


After the Measurement Module is inserted into the project structure, the basic settings of the module must first be made.

Input Image	1280 pix * 1024 pix
Coordinate System	*+423.1 pix -497.8 pix 15.4 °


Selection of the **Input Image** of the **Coordinate System** to be used is defined in the basic settings.

Intelligence Pro contains the following edge detection methods, which also contain dimensional accuracy functions. The functions and measurements associated with the individual tools are described in more detail in the following.

The individual functions can be deleted globally or as individual elements from the measurement arrangement.

With the symbol  individual elements can be deleted from the measurement arrangement.

After the delete function is activated, elements can be deleted from the measurement arrangement by clicking on them.

If the entire measurement arrangement should be deleted, this must be done by activating the function with the  symbol.

5.5.6.1. Basic Settings

Search beam

The line consists of several search beams. The distances between the search beams and their lengths can be defined. The parameter Search Beam Interval is available for this purpose.

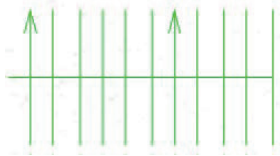


Figure 106: Search beam

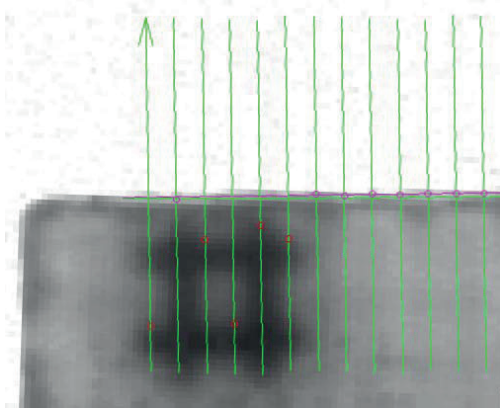


Figure 107: Search beam with edge detection.

The search beam consists of green arrows. The direction of the arrow shows the direction in which a search is made after a transition from bright to dark or vice versa. The purple circles on the green search beams show the transitions found. If several search beams find a transition, the software calculates the course of the edge. The red circles show found bright-dark transitions that are not used for edge detection.

There are several options to adapt the function optimally to the task:

Name	Value
Scan Direction	Default
Scan Length	30 pix
Scan Interval	5 pix
Edge Polarity	Either
Edge Find By	Best Score
Edge Sensibility	30 GrM
Edge Width	5 pix
Regression Iterations	2
Outlier Threshold	3.0 pix
Center Point X	354.1 pix
Center Point Y	-425.7 pix
Angle	-37.8 °

Figure 108: Line parameters

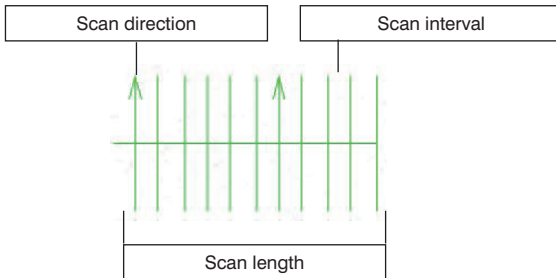
The direction of the search beam can be switched between **default** and **inverted**.

Scan Direction	Default
----------------	---------

The length of the search beam is specified in pixel values.

Scan Length	30 pix
-------------	--------

The **search beam interval** determines the distance between the search beams on the search line.



How the edge transition is located on the search beam is determined: **black to white**, **white to black** or **both**.

Edge Polarity	Black to White
---------------	----------------

If several edge transitions occur on one search beam, which edge to be detected is established. Differentiation is made between **first score**, **last score** and **best score**.

Edge Find By	First Score
--------------	-------------

The **edge sensibility** value specifies the minimum difference in brightness between two neighboring pixels that must be achieved to be detected as an edge.

Edge Sensibility	30 GrM
------------------	--------

The expected **edge width** helps smooth brightness peak points in a broad edge.

Edge Width	5 pix
------------	-------

An edge is detected by calculating a focus line between all found edge transitions. But if an edge transition is disproportionately far from the expected edge, this can falsify the result. The regression evaluates the connection between focal lines and the distance of the edge transitions to these focal lines. If the edge transitions are further than established under **Outlier Threshold**, these edge transitions are no longer considered in the new calculation of the focus lines. The **regression iterations** value specifies how often this procedure should be applied.

Regression Iterations	2
Outlier Threshold	3.0 pix

The software tries to calculate a **focus line** from the found edge transitions. The **outlier threshold** value establishes the threshold for the maximum distance that the found edge transitions can be from the focus lines to still be used in the calculation of the focus lines.

The basic settings are selected so that as large a number as possible of different edge types can be detected. But to achieve a stable evaluation, it is possible to adapt the settings perfectly to the conditions. To do this, the Scan Direction, edge polarity and edge search type should be set for the evaluation.

5.5.6.2. Lines

To detect a straight edge in an object, use the function "Find Line".

Proceed as follows:

- Activate the function by clicking on the symbol in the toolbar.
- Click on the first point of the search line to be created.
- Click on the end point of the search line.

A search beam results, which can look like the following, for example:

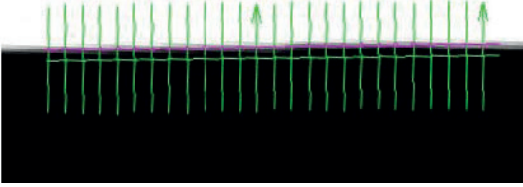


Figure 109: Search beam example

The result values specify the distance in the **X**- and **Y**-direction and the **angle** to the 0 point of the coordinate system. The individual result values can be documented with specifications and tolerances. The color visualizes the actual value to the target value.

Center Point X	354.1 pix
Center Point Y	-425.7 pix
Angle	-37.8 °



The result **straightness** describes the largest distance of an edge transition to the regression line. The result describes the fluctuations of the lines in pixels or mm.

Straightness	9.3 pix
--------------	---------

5.5.6.3. Circle

To detect a circular edge of an object, there is the possibility to choose a circular detection arrangement. There are two ways to create the circle.

Proceed as follows:

- Activate the function by clicking on the symbol  or  in the toolbar.
- The first click establishes the center of the circle to be drawn.
- The second click sets the radius of the circle.
- Through a third click, which may still be necessary, the position of the circle is established.

A circle results, which can look like the following, for example:



Figure 110: Example, circle measurement

The result values specify the distance of the circle in the **X**- and **Y**-direction to the 0 point of the coordinate system. The individual result values can be documented with specifications and tolerances. The color visualizes the actual value to the target value.

Center Point X	496.492 mm
Center Point Y	-401.676 mm

The individual result values for the **radius** are specified. Radius stands for the average radius from the smallest possible radius (**Radius Min**) and the largest possible radius (**Radius Max**). The individual result values can be documented with specifications and tolerances.

Radius	169.134 mm
Radius Min	149.213 mm
Radius Max	179.339 mm



The result **Roundness** is the largest distance of an edge transition to the found circle.

Roundness	30.126 mm
-----------	-----------

5.5.6.4. Arc of a circle

To detect a circular edge of an object, there is the possibility to choose a circular detection arrangement. There are two ways to create the arc of a circle.

Proceed as follows:

- Activate the function by clicking on the symbol  or  in the toolbar.
- The first click establishes the starting point of the arc to be drawn.
- The second click sets the size of the arc.
- The third click defines the radius of the arc.

An arc results, which can look like the following, for example:

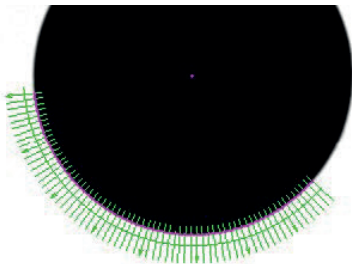


Figure 111: Example for measurement of an arc

The result values specify the distance in the **X**- and **Y**-direction and the **angle** to the 0 point of the coordinate system. The individual result values can be documented with specifications and tolerances. The color visualizes the actual value to the target value.

Center Point X	354.1 pix
Center Point Y	-425.7 pix
Angle	-37.8 °

The individual result values for the **radius** are specified. Radius stands for the average radius from the smallest possible radius (**Radius Min**) and the largest possible radius (**Radius Max**). The individual result values can be documented with specifications and tolerances. The color visualizes the actual value to the target value.

Radius	168.9 pix
Radius Min	160.2 pix
Radius Max	185.2 pix


The result **Roundness** is the largest distance of an edge transition to the found circle.

Roundness	25.0 pix
-----------	----------

5.5.6.5. Line segment

The function of the line segment is a special type of line detection. In this function, segments are detected on the individual search beams.

Proceed as follows:

- Activate the function by clicking on the symbol  in the toolbar.
- Click on the first point of the search line to be created.
- Click on the end point of the search line.

A search beam results, which can look like the following, for example:

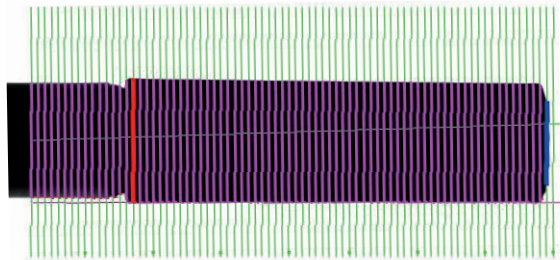


Figure 112: Example, line segments

Several different-colored search lines are depicted in the graphic. The green lines are the search lines on which searches are made for cohesive black or white segments. If a segment is found, it is depicted in **pink**. The **red line** visualizes the largest segment and the **blue line** the smallest segment in the search area.

The **segment color** button establishes what kind of segments are detected.

Segment Color	Black
---------------	-------

The following results of the segment calculation are provided:



Segment Number	38
Segment Length Mean	11.036 mm
Segment Length Min	10.216 mm
Segment Length Max	12.835 mm
Segment Length Deviation	1.977 mm

The **Segment Number** result counts the found segments on the search line. The individual results for the **Segment Length Min** and **Segment Length Max** segment length as well as their **Segment Length Mean** and the **Deviation** between the longest and shortest segment piece are output as well. All of these values can be equipped with variances.

5.5.6.6. Segment of a circle

The segment of a circle function is a special form of circle measurement. In contrast to the circle measurement, the size of the circle is not calculated here. Segments are searched for on a circular search line.

Proceed as follows:

- Activate the function by clicking on the symbol  or  in the toolbar.
- The first click establishes the center of the circle to be drawn.
- The second click sets the radius of the circle.
- Through a third click, which may still be necessary, the position of the circle is established.

A circle results, which can look like the following, for example:

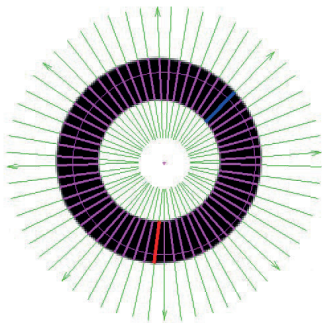


Figure 113: Example, segments of a circle

Several different-colored search lines are depicted in the graphic. The green lines are the search lines on which searches are made for cohesive black or white segments. If a segment is found, it is depicted in **pink**. The **red line** visualizes the largest segment and the **blue line** the smallest segment in the search area.

The **Segment Color** button establishes what kind of segments are detected.

Segment Color	Black
---------------	-------

The following results of the segment calculation are provided:



Segment Number	38
Segment Length Mean	11.036 mm
Segment Length Min	10.216 mm
Segment Length Max	12.835 mm
Segment Length Deviation	1.977 mm

The **Segment Number** result counts the found segments on the search line. The individual results for the **Segment Length Min** and **Segment Length Max** segment length as well as their **Segment Length Mean** and the **Deviation** between the longest and shortest segment piece are output as well. All of these values can be equipped with variances.

5.5.6.7. Arc of a circle segment

The function is comparable with the measurement of the segment of a circle. The function works according to the same principle, but only an arc is evaluated, not the entire circle.

Proceed as follows:

- Activate the function by clicking on the symbol  or  in the toolbar.
- The first click establishes the starting point of the arc to be drawn.
- The second click sets the size of the arc.
- The third click defines the radius of the arc.

An arc results, which can look like the following, for example:

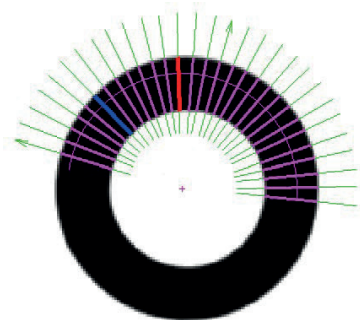


Figure 114: Example, segment of an arc

Several different-colored search lines are depicted in the graphic. The green lines are the search lines on which searches are made for cohesive black or white segments. If a segment is found, it is depicted in **pink**. The **red line** visualizes the largest segment and the **blue line** the smallest segment in the search area.

The **Segment Color** button establishes what kind of segments are detected.

Segment Color	Black
---------------	-------

The following results of the segment calculation are provided:


Segment Number	38
Segment Length Mean	11.036 mm
Segment Length Min	10.216 mm
Segment Length Max	12.835 mm
Segment Length Deviation	1.977 mm

The **Segment Number** result counts the found segments on the search line. The individual results for the **Segment Length Min** and **Segment Length Max** segment length as well as their **Segment Length Mean** and the **Deviation** between the longest and shortest segment piece are output as well. All of these values can be equipped with variances.

5.5.6.8. Angle measurement between two lines

The angle measurement measures the angle between two previously found lines. Besides the angle, the intersection of the lines is also determined. This intersection can be used for additional measurements. For example, the intersection of the two lines can be set to refer to the center of a circle.

Proceed as follows:

- Activate the function by clicking on the symbol  in the toolbar.
- Click on the first line.
- Click on the second line.

The angle between the two lines is drawn.

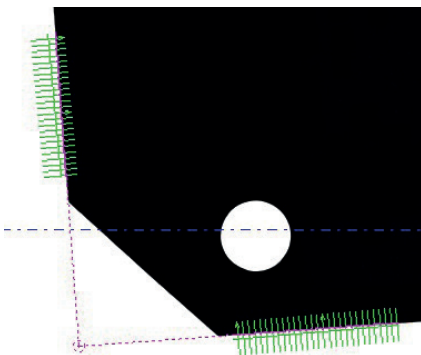


Figure 115: Example, angle measurement

The intersection of the two lines is visualized as a circle.



If the interface is used as a starting point for a further measurement, the following constellation can result, for example:

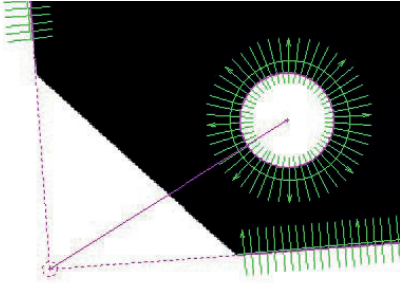


Figure 116: Linking of several measurements

The result of the angle measurement is depicted here in degrees:


Angle Line to Line	57.3 °
--------------------	--------

The unit of angle calculations can be converted to rad. Conversion from ° to **rad** can be done under the menu option **Options** in the Units category.

5.5.6.9. Distance between two lines

With this function, the distance between two previously found lines is calculated. Three different results are differentiated. The distance between the centers of the two lines and the minimum and maximum distance are calculated. The result between the two centers is visualized as a line that can be used for additional measurements.

Proceed as follows:

- Activate the function by clicking on the symbol  in the toolbar.
- Click on the first line.
- Click on the second line.

↓ Three distance values are displayed.

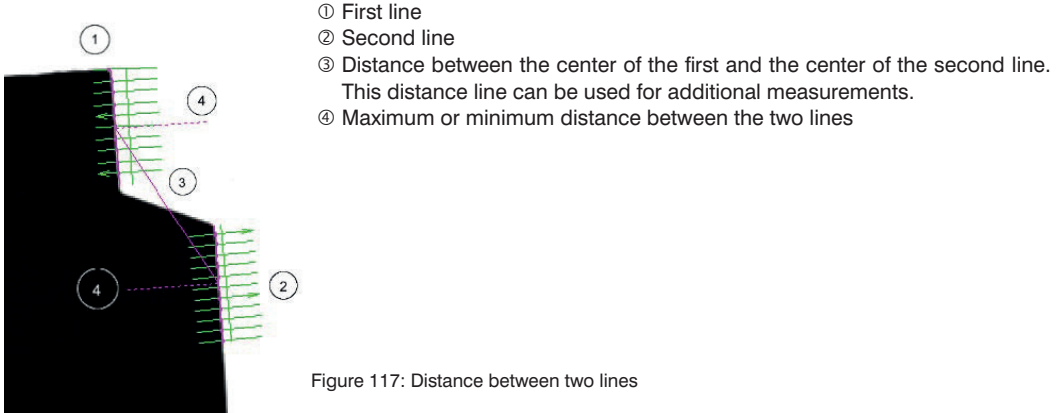


Figure 117: Distance between two lines


The following results are generated:

Distance Center to Center	8.425 mm
Distance Min	8.413 mm
Distance Max	8.424 mm

5.5.6.10. Distance between a line and a point

With this function, the distance between a previously found line and a point is calculated. Lines can arise not only through edge detection, but also with other distance measurements, for example. Points to which the measurement should refer are created, for example, with circle or arc detection and with angle measurements. The line resulting from the distance measurement between a line and a point can be used again for further measurements.

Proceed as follows:

Activate the function by clicking on the symbol  in the toolbar.

- Click first on the point or the line.
- In the second step, now click on the line or the point.

↓ The distance between the line and the point is displayed.

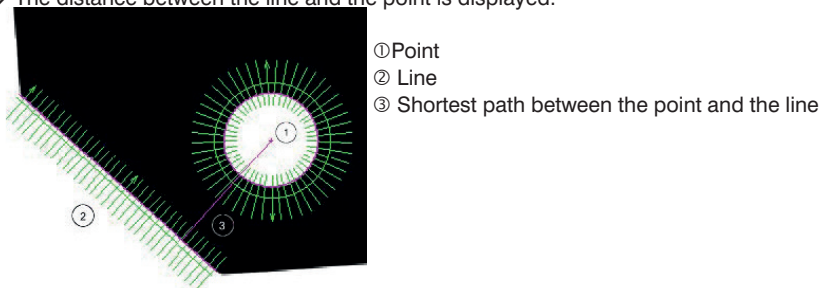


Figure 118: Distance line – point


The current distance between the chosen point and the shortest connection to the chosen line is displayed.

Distance	4.895 mm
----------	----------

5.5.6.11. Distance between two points

With this function, the distance between two points is calculated. Points to which the measurement should refer are created, for example, with circle or arc detection and with angle measurements. The line resulting from the distance measurement between two points can be used again for further measurements.

Proceed as follows:

- Activate the function by clicking on the symbol  in the toolbar.
- Click on one of the two desired points.
- Click on the second of the desired points.

↓ The distance between the points is displayed.

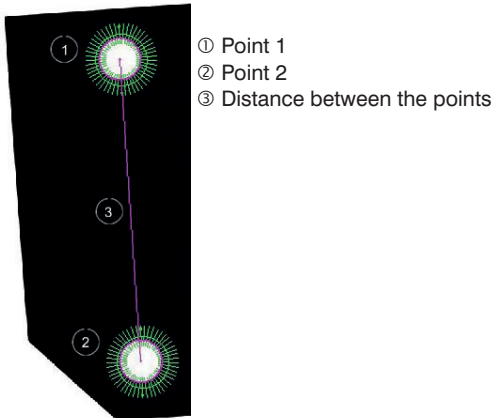



Figure 119: Distance, point – point

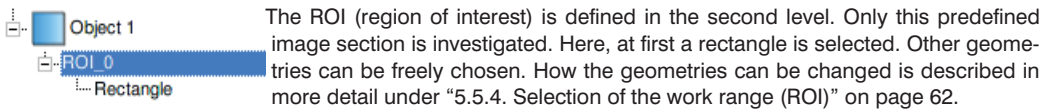
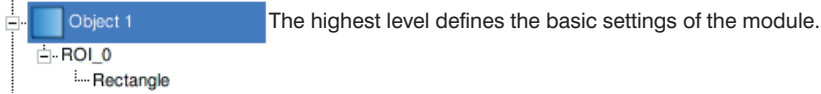
The distance between the two points is specified.

Distance	4.895 mm
----------	----------

5.5.7. Object recognition

The object recognition module analyzes statistical characteristics of objects and assigns them to classes. The Object Recognition image processing module is received into the project structure through the symbol , which is located in the navigation bar.

5.5.7.1. Basic settings



After the Object Measurement module is inserted into the project structure, the basic settings of the module must first be made.

Input Image	1280 pix * 1024 pix
Coordinate System	*+423.1 pix -497.8 pix 15.4 °

Selection of the **Input Image** of the **Coordinate System** to be used is defined in the basic settings.

Threshold	128
-----------	-----

The **Threshold** establishes the value from which a pixel/symbol is detected. The pixel/object is not detected until the threshold is exceeded. More information on the threshold settings is described in chapter “5.5.3. Threshold Calculation” on page 60 .

Object type	White
-------------	-------

The **Object type** is used to decide whether white or black objects should be recorded.

Objects fit completely in ROI	Yes
-------------------------------	-----

Must the **Object fit completely in ROI**, or should parts of an object that is not completely in the ROI be recorded as well?

5.5.7.2. Class definitions

Objects can be defined using a number of characteristics or characteristic combinations.

If the system recognizes several objects that are still not assigned to a class, they are displayed together with their number under the point **Unclassified Objects**.

Unclassified Objects	11
----------------------	----

The **Class Definitions** button opens the following window:

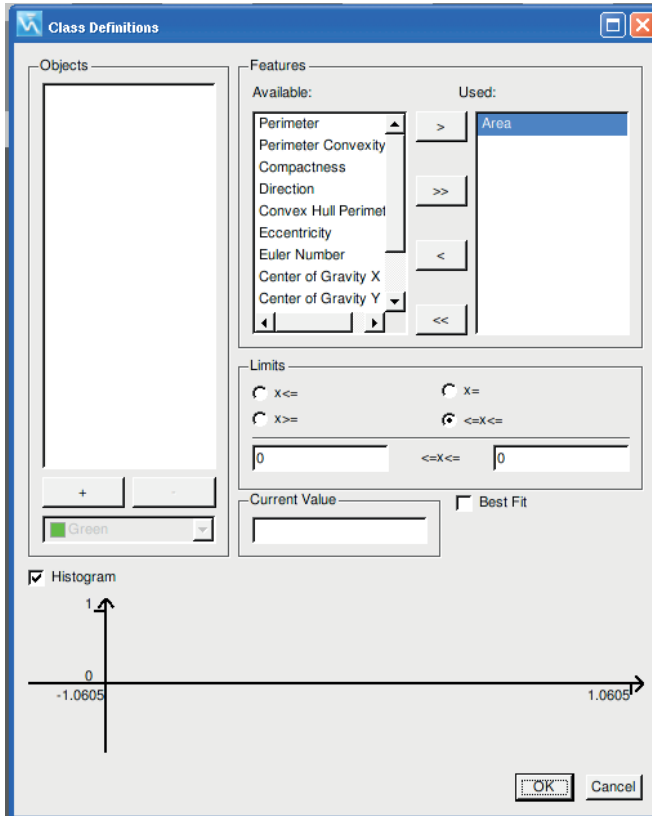


Figure 120: Class definition

The **objects** field serves to create and name new class definitions.

Actuating the button or adds a new class or deletes the marked class.

The section **available characteristics** defines the characteristics that a class can contain. The following characteristics are available.

- **Area**

The area of the object is calculated.

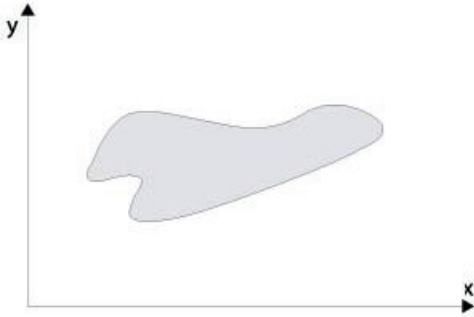


Figure 121: Area

- **Perimeter**

The Perimeter of the object is calculated.

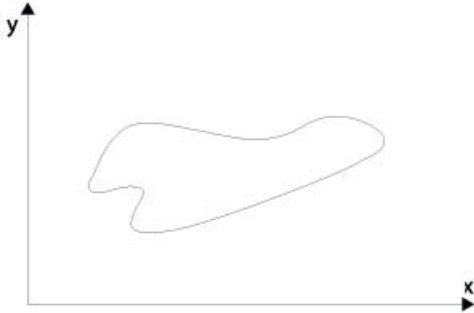


Figure 122: Perimeter

- **Perimeter Convexity**

The Perimeter Convexity is calculated by dividing the convexity by the actual Perimeter of the object. The Perimeter can be visually best depicted by placing an imaginary elastic band around the object. A round object, regardless of its shape, has a convexity of “one”, while a strongly jagged or irregular object has a convexity closer to “zero”.

- **Compactness**

Compactness specifies whether an object is more circular (compactness = 1) or oblong (compactness < 1). Compactness is calculated from:

$$\frac{\text{Surface area}}{\text{Circumference}^2} \times 4\pi$$

- **Direction**

The Direction of an object specifies the angle (rad) between the x-axis of the coordinate system and the main axis x' of the object.

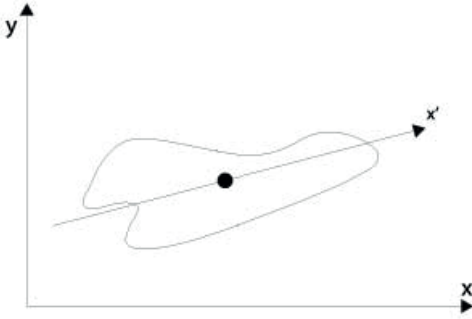


Figure 123: Direction

- **Convex Hull Perimeter**

The Convex Hull Perimeter can be visually best depicted by placing an imaginary elastic band around the object. A round object, regardless of its shape, has a convexity of “one”, while a strongly jagged or irregular object has a convexity closer to “zero”.

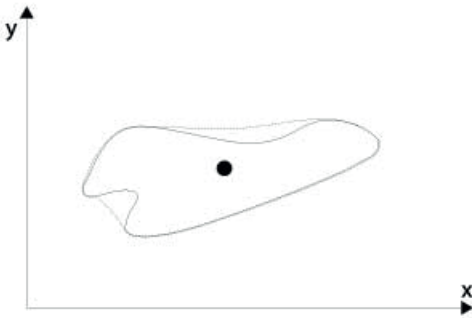


Figure 124: Convex Hull

- **Eccentricity**

Eccentricity describes the ratio between length and width of an object and is a dimension for determining roundness, range (0...1). An eccentricity of 1 describes a circular object. If an object has a value < 1 , it is a line-shaped object.

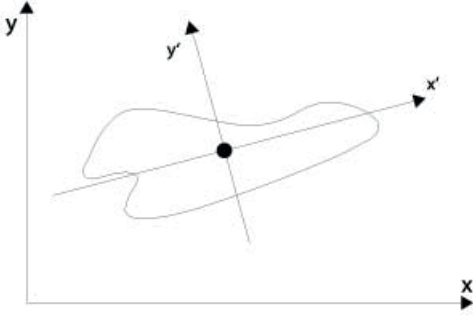


Figure 125: Eccentricity

- **Euler number**

The Euler number describes the number of holes that occur in an object.

- **Center of Gravity X**

The focus of an object is the object's center in the X-direction. The value of Center of Gravity X specifies the calculated object focus in the X-direction with regard to the origin of the coordinate system.

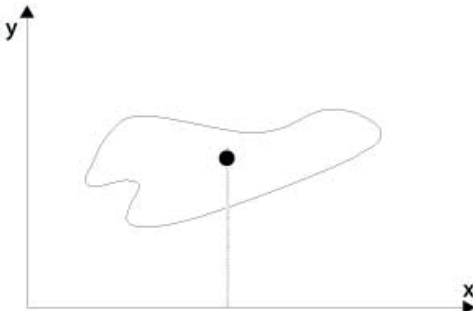


Figure 126: Center of Gravity with regard to the x-axis

- **Center of Gravity Y**

The Center of Gravity of an object is the object's center in the Y-direction. The value of Center of Gravity Y specifies the calculated object focus in the Y-direction with regard to the origin of the coordinate system.

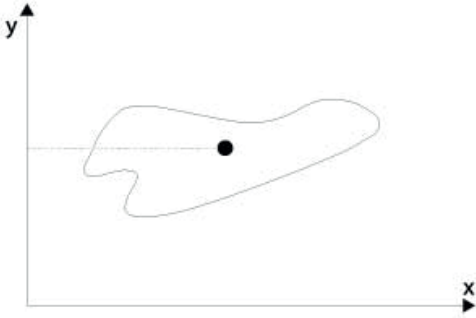


Figure 127: Center of Gravity with regard to the y-axis

- **Maximum width**

The characteristic **maximum width** determines the widest position of the object. An imagined vertical line is laid on the focus axis to calculate the widest position of the object.

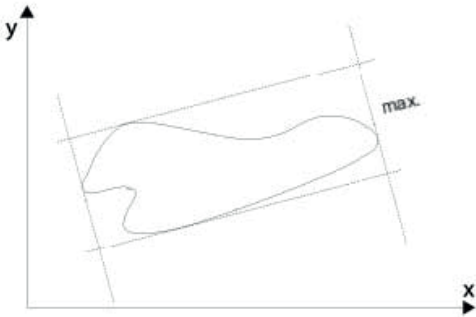


Figure 128: Maximum width

- **Maximum length**

The characteristic **maximum length** determines the longest position of the object. An imagined horizontal line is laid on the focus axis to calculate the longest position of the object.

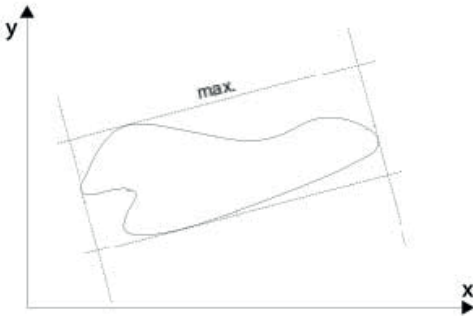


Figure 129: Maximum length

- **Euclidean Distance**

The Euclidean distance is the distance between two points that one would measure with a ruler, for example.

Listed under **characteristics used** are the characteristics in a class that are currently used. With the various buttons, characteristics can be moved between the windows **available** and **used**. With the button or one characteristic each is moved. With the button or all characteristics are moved.

The **Limits** establishes the point at which a characteristic should be considered fulfilled.

Limits

<input type="radio"/> $x <=$	<input type="radio"/> $x =$
<input type="radio"/> $x >=$	<input type="radio"/> $<=x <=$
5.243	$<=x <=$
	5.587

$x <=$ = The measured value must be smaller than or equal to the specified threshold value.

$x =$ = The measured value must be exactly the specified threshold value.

$x >=$ = The measured value must be greater than or equal to the specified threshold value.

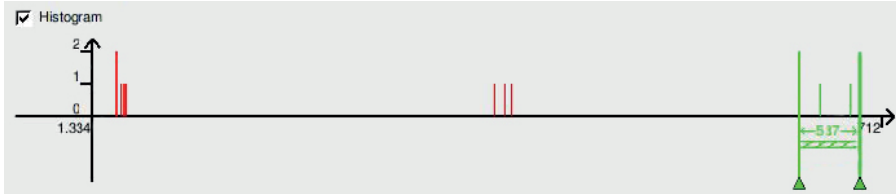
$<=x <=$ = The measured value must lie exactly between the specified threshold values.

In the image, the individual objects are marked with color. With a click on an object in the image, you receive the actual **Current Value** of the characteristic that was selected.

Current Value	<input checked="" type="checkbox"/> Best Fit
88.000000	103

Through the function **Best Fit**, the objects can be sorted by a fixed threshold. In the above example the best fit was established at 103. If we assume there are several objects that lie between the previously set limit values, the object that lies closest to the best fit is selected. If, for example, the objects have a distribution of values between 75.00 and 130.00, the object is calculated that lies closest to the best fit value (here in the example, 120).

If the **Histogram** is activated, a graphic aid for limit setting appears. All objects are displayed in the shape of a bar. Red bars represent objects that have not yet been assigned to a class. Green bars show objects that have already been assigned to a class. The limit values can be adjusted by moving the green triangles.



5.5.7.3. Class definition result fields

The object module delivers several values as a result. The number of objects not yet classified is depicted and another result field shows the class in which the class definition was created.

Unclassified Objects	16
New Class	16

All results can be equipped with various limit values. A click on the result makes a button appear, which opens the following result window.

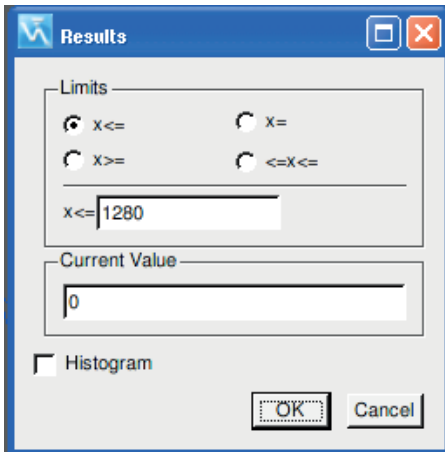



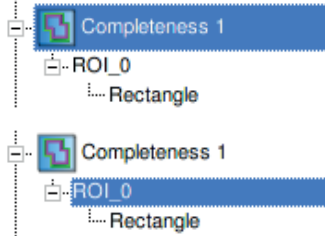
Figure 130: Class definition result field

5.5.8. Completeness check

The completeness control compares learned statistical reference values with the current values in a freely definable image window (ROI).

The Completeness Control image processing module is received into the project structure through the symbol , which is located in the navigation bar.

5.5.8.1. Basic settings



The highest level defines the basic settings of the module. The ROI (region of interest) is defined in the second level. Only this predefined image section is investigated. Here, at first a rectangle is selected. Other geometries can be freely chosen. How the geometries can be changed is described in more detail under “5.5.4. Selection of the work range (ROI)” on page 62.

After the Completeness Control module is inserted into the project structure, the basic settings of the module must first be made.

Input Image	1280 pix * 1024 pix
Coordinate System	*+423.1 pix -497.8 pix 15.4 °

The selection of the **Input Image** and the **Coordinate System** to be used are defined in the basic settings.

Threshold	128
-----------	-----

The **Threshold** establishes the value from which a pixel/symbol is detected. The pixel/object is not detected until the threshold is exceeded. More information on the threshold settings is described in chapter “5.5.3. Threshold Calculation” on page 60.

The image processing module calculates not only static values but also has the function of pixel counting. The pixel type selection field establishes whether the module counts black or white pixels.

Pixel Type	Black
------------	-------

5.5.8.2. Results

Various statistical values are calculated. The following values are calculated by the system. The result fields can vary; various result fields are displayed, depending on the connected camera type or selected color channel. In the following example, we assume an image with only one gray channel. If an RGB image were the foundation, the results for red, green and blue would be output.

In the **Pixel Counting** result field, the current number of pixels in the ROI is displayed. The type of pixels that are counted is established in the pixel type selection field.

Pixel Counting	162492
----------------	--------

The pixels in the ROI are investigated for their gray values. The darkest pixel value, that is, the **gray minimum**, is output.

Gray minimum	0
--------------	---

Under **gray maximum**, the brightest pixel value that occurs in the ROI is output.

Gray maximum	255
--------------	-----

The average of all gray values of the entire ROI is output in the **gray mean** result field.

Gray mean	128.24
-----------	--------

Quartiles divide a quantity into 4 parts. The distribution of the individual pixels is looked at in the completion control area. The **lower quartile** is the first quarter of the distribution. The value designates the value that is reached in the first quarter.

Gray lower quartile	37
---------------------	----

The **gray median** is output in the result field of that name.

Gray median	129
-------------	-----


The **gray upper quartile** shows the value corresponding to the upper quarter of the pixel value distribution.

Gray upper quartile	219
---------------------	-----

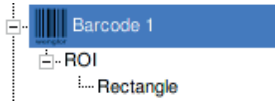
Entropy is a statistical value for the disorder of an area. The more randomness in an area, the higher the entropy is. The higher the entropy, the more evenly and randomly something is distributed. An entropy value of 0 describes a homogeneously bright image. As soon as the homogeneity of the area is disturbed through gray pixels, the entropy value rises.

Gray entropy	5.05
--------------	------

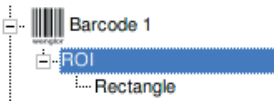
5.5.9. Barcode



The **Barcode** module searches for a barcode in the defined image section (ROI). The Barcode image processing module is received into the project structure through the symbol , which is located in the navigation bar.

5.5.9.1. Basic settings



The highest level defines the basic settings of the module.



The ROI (region of interest) is defined in the second level. Only this predefined image section is investigated. Here, at first, the complete image window is selected. You can select between a rectangular surface  and an individual line  as additional ROI geometries.

After the Barcode module is inserted into the project structure, the basic settings of the module must first be made.

Input Image	1280 pix * 1024 pix
Coordinate System	*+423.1 pix -497.8 pix 15.4 °

Selection of the **Input Image** of the **Coordinate System** to be used is defined in the basic settings.

Threshold	128
-----------	-----

The **Threshold** establishes the value from which a pixel/symbol is detected. The pixel/symbol is not detected until the threshold is exceeded. More information on the threshold settings is described in chapter “5.5.3. Threshold Calculation” on page 60.

5.5.9.2. Barcode scanner settings

Scan Type	Pharma Code
-----------	-------------

The **Barcode** module can read many different code types. The **Scan Type** setting field displays what decoding algorithms are currently activated. Clicking on the scanner type setting field opens another window in which the settings for the decoding algorithms can be made.

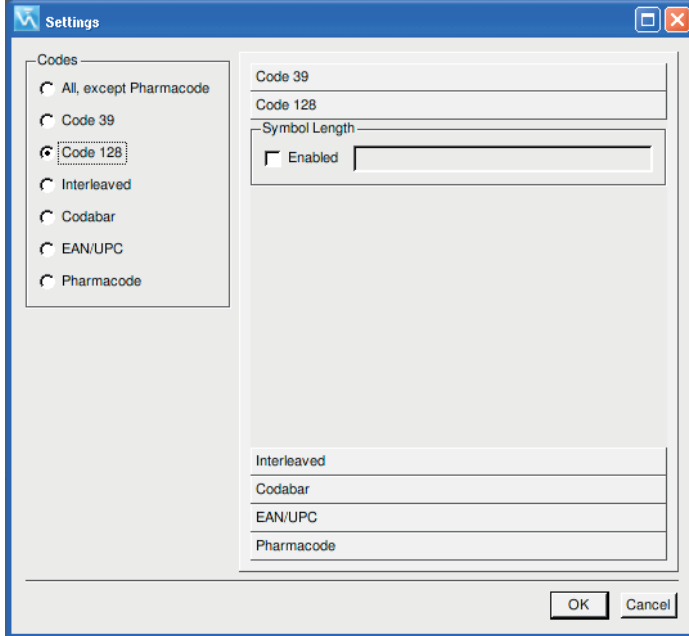
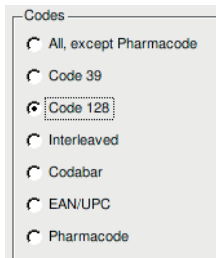


Figure 131: Barcode settings

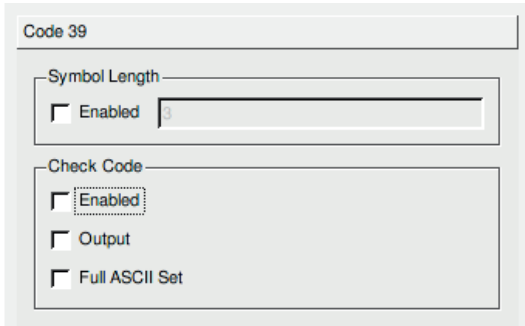
The available codes are offered for selection on the left side.



Special settings for the respective codes can be made on the right side of the window.

- **Code 39**

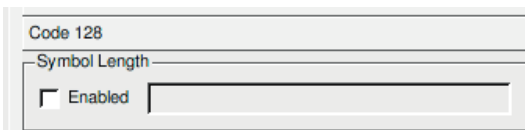
Code 39 is considered a standard code outside of retail. It can depict alphanumeric symbols. The code has a unique start and stop character and is made up of 9 black and white elements per character, of which 3 are wide.



When **symbol length** is activated, the code is read only if it has the specified length (excluding start, stop and check characters). The standard code 39 supports 43 characters: 0 to 9, capital letters A to Z, minus sign, plus sign, diagonal slash, blank, decimal point, dollar sign and percentage sign. If **Full ASCII Set** is activated, the scan module can read the entire ASCII character set from 0 to 255.

- **Code 128**

Code 128 is a smaller code intended for applications with a high information density and high security requirements. It is a very dense alphanumeric barcode. It codes all 128 ASCII characters, is continuous, has a variable length and uses four different element widths.



When **Symbol Length** is activated, the code is read only if it has the specified length (excluding start, stop and check characters).

• Interleaved

The interleaved code is very popular, as it is the densest code for printing numerical characters with a length of less than 10 characters. It is a dense, continuous, self-checking numerical code. The characters are summarized in pairs, so that each character consists of five elements (two wide and three narrow), which in turn can take on values between 0 and 9. The bars represent the first character and the spaces between them the second character.

The screenshot shows a configuration window titled "Interleaved". It contains two main sections: "Symbol Length" and "Check Code". The "Symbol Length" section has a checkbox labeled "Enabled" and an adjacent empty text input field. The "Check Code" section has two checkboxes: "Enabled" and "Output".

When **Symbol Length** is activated, the code is read only if it has the specified length.

• Codabar

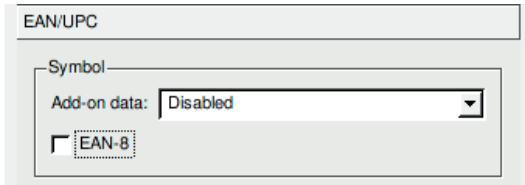
Codabar is a 16-bit character set (0 to 9 as well as the characters \$, :, /, ., + and -). This code type has start/stop characters and at least two bar widths that differ strongly from each other. The Codabar barcode is mainly used in libraries and health care, but is being replaced more and more by more modern codes due to the high frequency of errors.

The screenshot shows a configuration window titled "Codabar". It contains two main sections: "Symbol Length" and "Check Code". The "Symbol Length" section has a checkbox labeled "Enabled" and an adjacent empty text input field. The "Check Code" section has two checkboxes: "Enabled" and "Output".

When **Symbol Length** is activated, the code is read only if it has the specified length.

• **EAN/UPC**

EAN (European Article Number) is a product designation for wholesale and retail trade. An EAN code consists of 13 or 8 numerical characters, is centrally administered by the GS-1 organization and is issued to manufacturers on request. The EAN code is also known under the name GTIN (Global Trade Item Number). **UPC** (Universal Product Code) is a compatible code type that is mainly used in America and Canada. The last character is the checksum character.

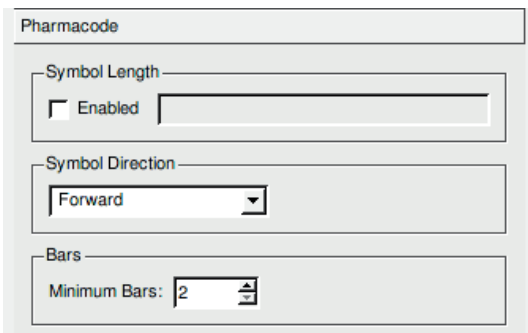


The screenshot shows a configuration window titled "EAN/UPC". Inside, there is a "Symbol" section with an "Add-on data:" dropdown menu currently set to "Disabled". Below this, there is a checkbox labeled "EAN-8" which is currently unchecked.

AddOn data is an extension of the existing EAN code. This extension is separated from the actual EAN code through a “rest area”. An AddOn code can consist of either two or five characters. EAN-8 has 8 characters, of which one character is a check character.

• **Pharmacode**

The Pharmacode is used mostly in packaging processes in the pharmaceutical industry. This barcode supports up to five different numerical characters, whereby each has its own color. The characters can be entered in decimal or binary format; a wide bar stands for 1, a narrow bar for 0. The bar width is independent of the height. In the decimal format, each entry can take on a value of up to 99,999.



The screenshot shows a configuration window titled "Pharmacode". It contains three main sections: "Symbol Length" with an "Enabled" checkbox and an empty text input field; "Symbol Direction" with a dropdown menu set to "Forward"; and "Bars" with a "Minimum Bars:" label and a dropdown menu set to "2".

When **Symbol Length** is activated, the code is read only if it has the specified length. A Pharmacode is not built up omnidirectionally. For this reason, the reading direction must be established. This can be done under the **Symbol Direction** option. The **Minimum Bars** number establishes how many bars the Pharmacode must consist of.

5.5.9.3. Barcode results

Code Type	None
-----------	------

In the **code type** result field, the type of the last read barcode is displayed.

Symbol Identifier	No
-------------------	----

In each code, one or more characters are used as prefixes, with which the type of code can be identified. If the **symbol identification** function is deactivated, the prefixed characters are suppressed and not output. If the function is activated, the identification symbols are output as well.

Message	1234567890123
---------	---------------

The field **Message** outputs the result of the last reading.

Match	Disabled	...
-------	----------	-----

Activation of the **Match** function opens a dialog window with which the settings of the comparison cases can be defined:

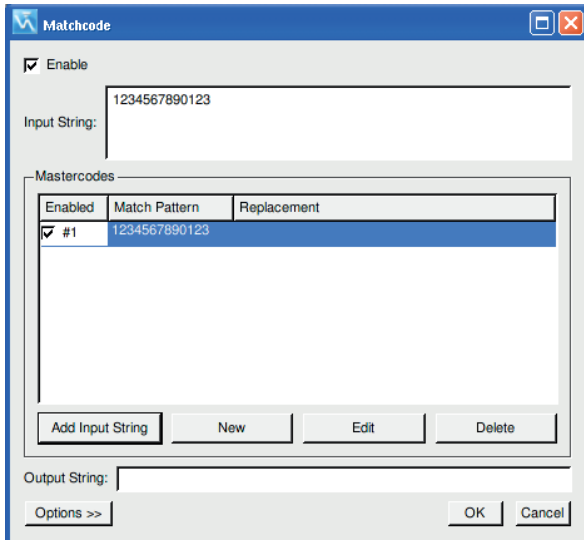
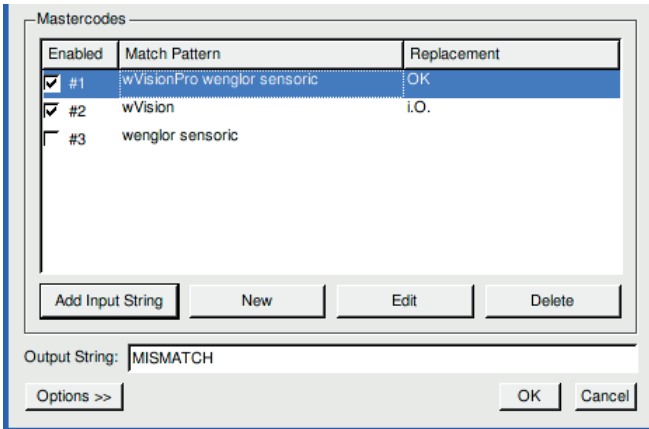


Figure 132: Matchcode

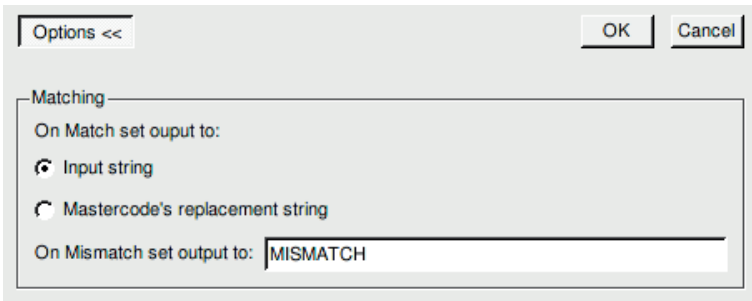
A click on the **activate** button switches the code comparison function to active. The initial character chain is compared with all active master codes. In the following example, several master codes are stored that the system compares against.



The first column first differentiates between activated and deactivated master codes. The second column depicts the search sample that the chain is compared against. If there is agreement between the search sample and the initial character chain, the status of the code comparison function is set to **true** and, in addition, the read-in code can be replaced by any desired text.

Actuating the button **Add Input String** adds the last read code as master code.

Through the menu option **Options >>** it is decided which character chain should be output in case of agreement.



If the read-in text should be changed in case of agreement, the necessary settings can be made with a click on **Edit** in a new dialog window.

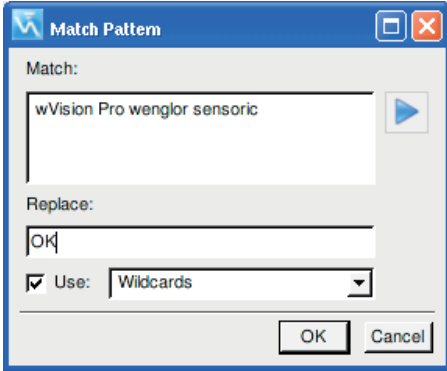



Figure 133: Master code – search & replace

The search sample can be made variable through different placeholders (wildcards). If a code should be queried in which a number sequence was stored but that differs in one character, this character must be equipped with a placeholder (wildcard) in the search sample.

If **use** of the placeholder (wildcard) is activated, the symbol  selects the individual placeholders.

<u>Wildcards</u>	
?	any single character
*	multiple occurrence of any character
[...]	any character in a set of characters

Use of placeholders (wildcards) is only possible when this function was also activated. If a placeholder is inserted without the activated function, the placeholder is recognized as a character.

Besides placeholders, **regular printouts** can also be used.

<u>Regular Expression</u>
Characters
A single character specified in a range
Repeated content
Alternatives
Assertions

If the **code comparison** function is activated, an additional result appears in the result list.

Overall Match Rate	85.1 %
--------------------	--------

The **overall match rate** value describes the ratio between the read result and the match code that should be compared against.

Overall Read Rate	85.1 %
-------------------	--------

The **overall read rate** result describes the ratio of good to bad readings since the start of the evaluation.

5.6. Spreadsheet


The spreadsheet module is used for further processing of all data and results present in the system. The spreadsheet module makes it possible to perform mathematical calculations with the data and generate new data and results from this. The newly gained data and results can then, in turn, be used as output value. The spreadsheet module is only run if no errors have occurred during previous evaluation. It is thus only run if the values are valid.

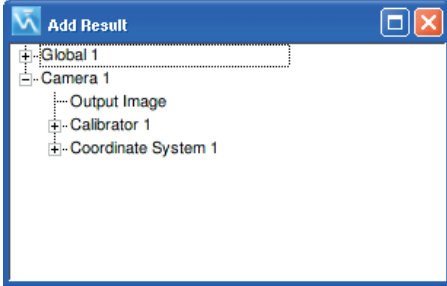
Caution: As of version 2.2.0, validity of the values is no longer checked. If you want to check the processed input values for validity, they have to be linked to the validity flag of the respective camera.

Spreadsheet 1					
	A	B	C	D	E
1					
2					
3					
4					
5					
6	Distance	19.8182			
7	Angle	0.0831593			
8					
9					
10					
11					
12					

5.6.1. Insert Data

Place the cursor on the desired cell.

Clicking on the icon  in the menu bar opens the following window in which all available data or results can be selected.



For better presentation of the table, it is possible to write text as well as data in the individual cells.

Through the following syntax, it is possible to enter freely defined numbers that are not generated by the system.

5.6.2. Scope of function

All data can be calculated against each other using the following mathematical functions.

- **Sine** syntax: $\sin(\text{number})$
Calculates the (trigonometric) sine of **number**, the angle in radians.
- **Cosine** syntax: $\cos(\text{number})$
Supplies the (trigonometric) cosine of **number**, the angle in radians.
- **Tangent** syntax: $\tan(\text{number})$
Calculates the (trigonometric) tangent of **number**, the angle in radians.
- **Arcsine**
Syntax: $\text{asin}(\text{number})$
This function calculates the arcsine of **number**. The returned angle lies between $-\pi/2$ and $+\pi/2$.
- **Arccosine**
Syntax: $\text{acos}(\text{number})$
This function returns the arccosine of **number**, that is, the angle (in radians) whose cosine is **number**. The returned angle lies between 0 and π .

- **Arctangent**

Syntax: atan(number)

This function returns the arctangent of **number**, that is, the angle (in radians) whose tangent is **number**. The returned angle lies between $-\pi/2$ and $\pi/2$.

- **Arctangent 2**

Syntax: atan2(numberX; numberY)

ARCTAN2 returns the arctangent, that is, the angle (in radians) between the X-axis and a line from the point numberX, numberY to the initial point. The returned angle lies between $-\pi$ and π .

- **Minimum**

Syntax: min(number1; number2; ...)

Calculates the **number** that is the smallest of the numbers transferred as arguments.

- **Maximum**

Syntax: max(number1; number2; ...)

Calculates the **number** that is the largest of the numbers transferred as arguments.

- **Sum**

Syntax: sum(number1; number2; ...)

The sum of the numbers or number series is generated.

- **Root**

Syntax: sqrt(number)

Calculates the positive square root of **number**. **Number** must be positive.

- **LN**

Syntax: ln(number)

The natural logarithm of base e is calculated from the specified value. The constant e has the approximate value 2.71828182845904.

- **Logarithm**

Syntax: log(number)

Number is the value whose logarithm is to be calculated.

- **PI**

Syntax: pi()

Returns the value of pi.

- **And**

Syntax: and(argument1; argument2)

Returns 1 when all are **arguments1**. If one of the arguments has the value 0, this function returns 0.

- **Or**

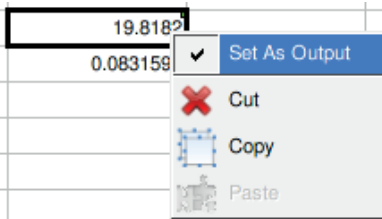
Syntax: or(argument1; argument2)

Returns 1 when at least one is **argument1**. If all arguments have the value 0, this function returns 0.

- **If**
Syntax: `if(argument1 logical function argument2; result1)`
Example: `if(3=3;1)`
Returns the **result1** when the logical function is true.
- **Inversion of a logical result.**
Syntax: `not(cell)`
Inverts the logical result that is in the cell.
- **Logical function smaller than or equal to**
Syntax: `<=`
The logical function **smaller than or equal to** can be used in connection with logical calculations.
- **Logical function greater than or equal to**
Syntax: `>=`
The logical function **greater that or equal to** can be used in connection with logical calculations.



5.6.3. Use of results

All cells can be provided back to the system as results. These results can then be used again as input for the logic control or for the communication module. A value of 0 corresponds to logic 0, and all values not equal to 0 correspond to logic 1. A click on the right mouse button in the corresponding cell opens the following context menu:



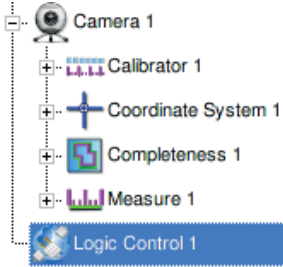
If the cell is used as an output, this is symbolized through a small, green square in the upper right corner. The results can be equipped with limits, as usual. For more information, see “5.1.2. Results/Settings” on page 25.

5.6.4. Format cells

In the menu bar are the icons for changing the background color  and the font color  of the respective marked line.

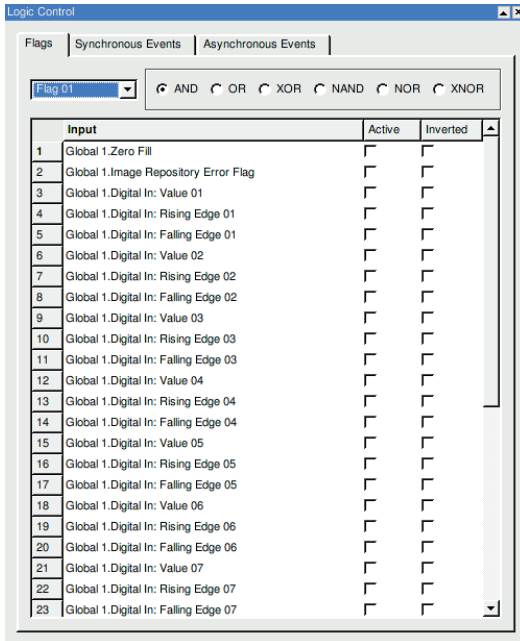
5.7. Logic control

Every image processing project includes the point logic control as the last branch in the project tree. Under this point, all results and events occurring in the system can be freely combined with each other or linked with outputs, or other results can be defined from them. These outputs, in turn, can then become switching outputs.



Through the  symbol in the navigation bar, the function can be assigned to the individual outputs. A setting dialog opens.

5.7.1. Output setting

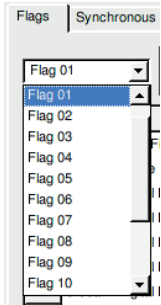


The screenshot shows the 'Logic Control' dialog box with the 'Asynchronous Events' tab selected. A dropdown menu shows 'Flag 01'. Below the menu are logical operators: AND, OR, XOR, NAND, NOR, and XNOR. A table lists 23 input flags with checkboxes for 'Active' and 'Inverted'.

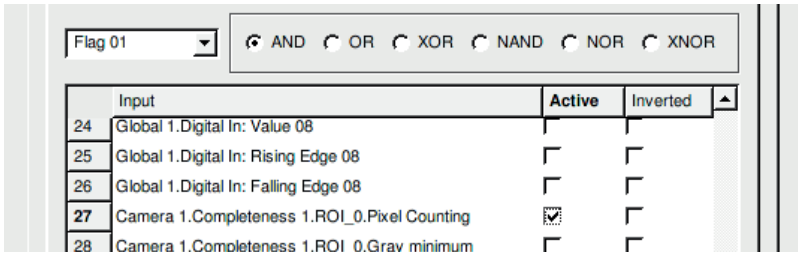
Input	Active	Inverted
1 Global 1.Zero Fill	<input type="checkbox"/>	<input type="checkbox"/>
2 Global 1.Image Repository Error Flag	<input type="checkbox"/>	<input type="checkbox"/>
3 Global 1.Digital In: Value 01	<input type="checkbox"/>	<input type="checkbox"/>
4 Global 1.Digital In: Rising Edge 01	<input type="checkbox"/>	<input type="checkbox"/>
5 Global 1.Digital In: Falling Edge 01	<input type="checkbox"/>	<input type="checkbox"/>
6 Global 1.Digital In: Value 02	<input type="checkbox"/>	<input type="checkbox"/>
7 Global 1.Digital In: Rising Edge 02	<input type="checkbox"/>	<input type="checkbox"/>
8 Global 1.Digital In: Falling Edge 02	<input type="checkbox"/>	<input type="checkbox"/>
9 Global 1.Digital In: Value 03	<input type="checkbox"/>	<input type="checkbox"/>
10 Global 1.Digital In: Rising Edge 03	<input type="checkbox"/>	<input type="checkbox"/>
11 Global 1.Digital In: Falling Edge 03	<input type="checkbox"/>	<input type="checkbox"/>
12 Global 1.Digital In: Value 04	<input type="checkbox"/>	<input type="checkbox"/>
13 Global 1.Digital In: Rising Edge 04	<input type="checkbox"/>	<input type="checkbox"/>
14 Global 1.Digital In: Falling Edge 04	<input type="checkbox"/>	<input type="checkbox"/>
15 Global 1.Digital In: Value 05	<input type="checkbox"/>	<input type="checkbox"/>
16 Global 1.Digital In: Rising Edge 05	<input type="checkbox"/>	<input type="checkbox"/>
17 Global 1.Digital In: Falling Edge 05	<input type="checkbox"/>	<input type="checkbox"/>
18 Global 1.Digital In: Value 06	<input type="checkbox"/>	<input type="checkbox"/>
19 Global 1.Digital In: Rising Edge 06	<input type="checkbox"/>	<input type="checkbox"/>
20 Global 1.Digital In: Falling Edge 06	<input type="checkbox"/>	<input type="checkbox"/>
21 Global 1.Digital In: Value 07	<input type="checkbox"/>	<input type="checkbox"/>
22 Global 1.Digital In: Rising Edge 07	<input type="checkbox"/>	<input type="checkbox"/>
23 Global 1.Digital In: Falling Edge 07	<input type="checkbox"/>	<input type="checkbox"/>

The system has 16 logical Flags. A value or event can be assigned to each Flag. These can be logically linked to each other.

First, the desired flag, which should be set, has to be chosen.



Through activation of the selected value or event, the status is transferred to the flag. An example for this: The results of the modules can be equipped with tolerances. In the example, the number of pixels is monitored. If the result is within the tolerance, the evaluation of the result returns a “true” status, which here sets the flag 01 to “1”. If the result is outside the tolerance, the evaluation of the result returns a “false” status, which here sets the flag 01 to “0”.

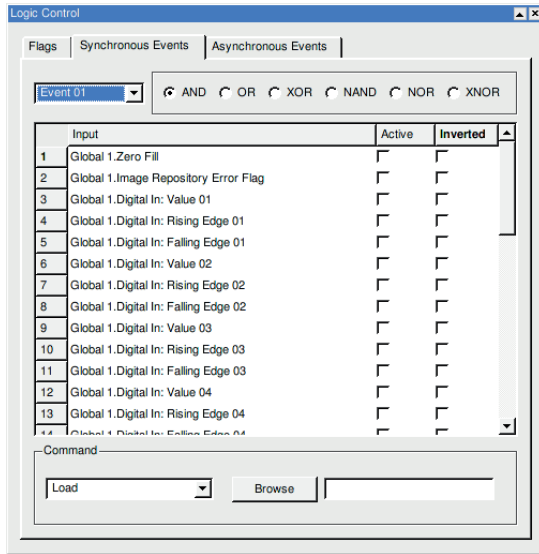


If several values or events are activated, these are connected with each other via the logic functions.

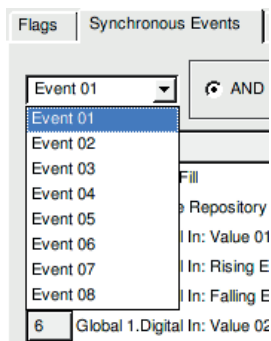


5.7.2. Synchronous Events

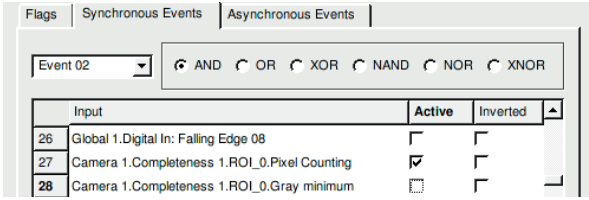
Synchronous events can be compared to the function of flags, as described in the previous section. But the difference from flags is that no flags are switched, but events are triggered synchronously with the occurrence of the event.



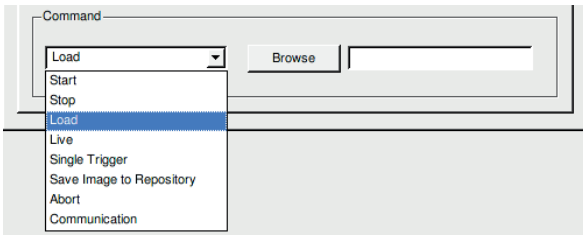
The Intelligence Pro can work off 8 different events, one after another. First, the event must be selected. This is done via the **Synchronous Events** menu.



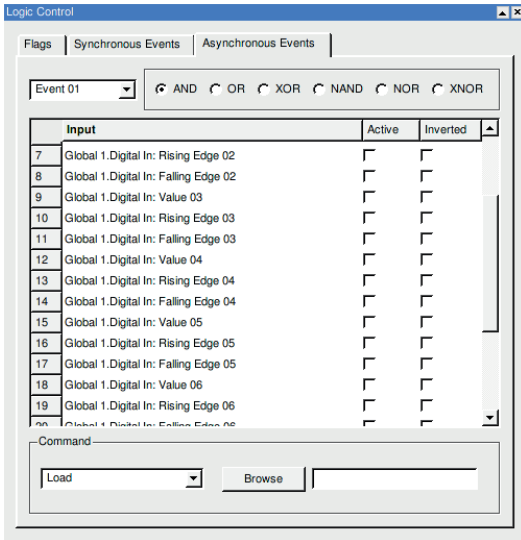
A value or event in the image processing application must be assigned to the events to be carried out. For this, the desired value or event must be activated.



If an event occurs, the following commands can be carried out. Depending on the type of command, another storage location, camera type or communication module must be selected.



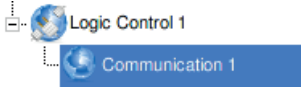
5.7.3. Asynchronous Events



The asynchronous events behave comparably to the asynchronous events. To process asynchronous events, the software must be in "evaluation mode" or visualization must be active. The commands are carried out as soon as the event occurs.

5.8. Communication

The Communication module can send events (test events that the system is processing) to various targets.



The **Communication** module is taken over into the project structure via the symbol  in the navigation bar.

Through the symbol  individual interfaces can be configured. A setting dialog opens.

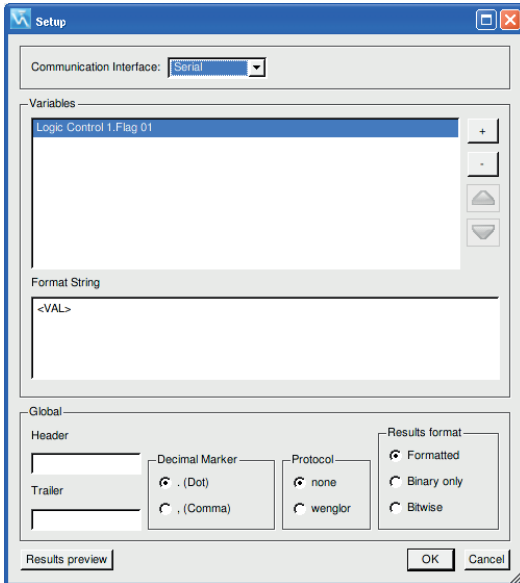



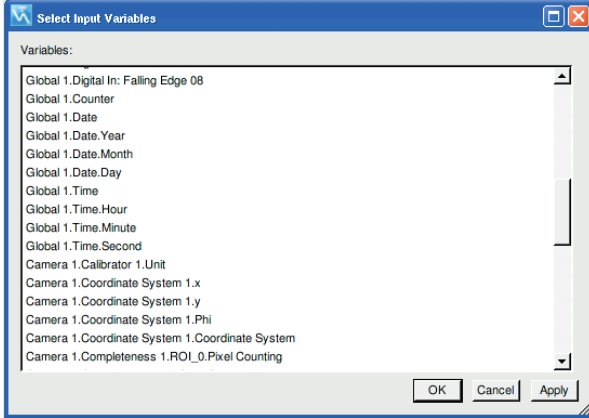




Figure 134: Communication settings

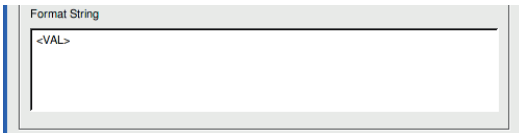
The selected results are displayed in the **Variables** area. Through the buttons  and  on the side, new variables can added or existing ones deleted.

After actuation of the button  a list opens with all available variables that can be output.



If several variables are selected for transfer, these are output in the same order as presented in the window. Through the arrow symbols  and  the sequence can be changed.

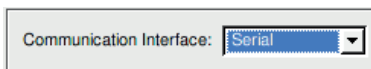
Besides establishment of the sequence, the format of the transmission package can be freely defined. In the **format string** field, the orientation of the individual variables can be defined.



Moving the variables in the **format string** window also changes the position in the transmission package. How the variables are sent to the target can first be displayed in a result preview.

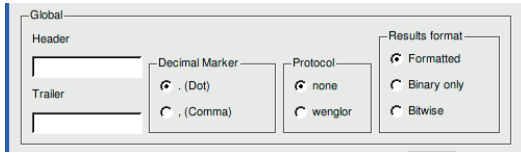
The following targets can be used for the variables:

1. Serial interface ("5.3.4. Serial Interface" on page 32)
2. Digital inputs and outputs (must be activated, see "5.3.3. Digital Inputs/Outputs" on page 32)
3. File system
4. Network adapter ("5.3.6. Network Connections" on page 35)



Establishes which **interface** is used. Through the **configure** button, configuration of the interface can be accessed directly.

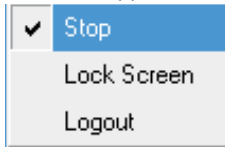
Through the global settings, test results can be processed variably.



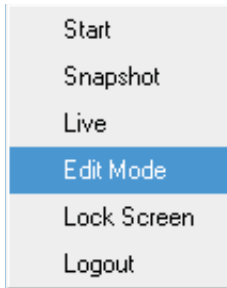
5.9. Teach⁺

Under Teach⁺, two functions of wVision are listed that can help the user store settings and image sequences. Both functions **record** and **play** are located in the menu bar under the option **File**.

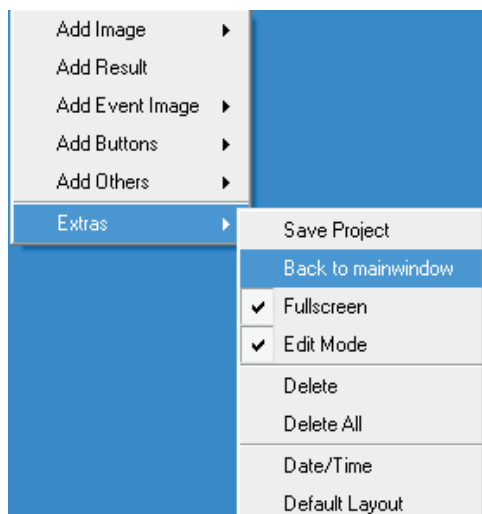
If the visualization interface has been activated, it must first be exited. If the application is in the run mode, it must be stopped. The following context menu can be accessed by right clicking:



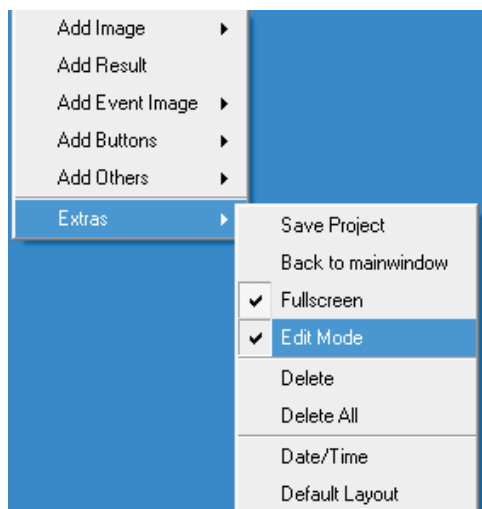
The context menu has to be accessed once again in order to switch to the **editing mode**.



In the **editing mode**, the **Extras** menu item is listed in the contact menu which can again be accessed by right clicking. A submenu is included under this menu item with a **Return to Main Window** entry, by means of which the setup interface can be accessed where the Teach⁺ function is available.



After successfully incorporating the Teach⁺ file, the display can be returned to the visualization interface via the **Window** ↓ **Visualization menu** items. Right click in order to return the system to the run mode. A context menu appears in which Editing Mode has to be clicked under the Extras menu item. After the inspection program has been started either via the context menu or by clicking a start button, the system starts once again with the inspection program.

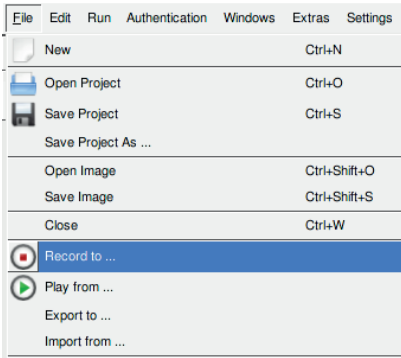


5.9.1. Record


With the **record** function, it is possible to store complete image sequences, including all of the settings belonging to the current project, such as interface settings, calibration data, etc., in a compressed file.

An additional storage medium, e.g. USB flash drive or network drive, must be connected to the image processing system.


The function can be found either in the toolbar with the symbol  or in the menu bar under **File**:



A window opens, which establishes the storage location of the file. All files are first copied into the target directory and then a compressed file is generated. The file is named automatically. The file name consists of the project name and the appendix.

Clicking on the symbol  activates the recording function. All images that are recorded from this time forward are now stored. If the record button is clicked on again, the recording phase is ended.


Recording is stopped by clicking the stop button.

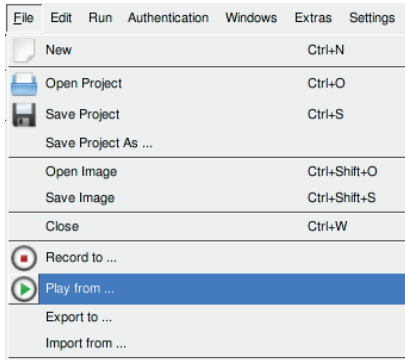
After the symbol  is clicked on, all recorded images are compressed, brought together into a file and stored in the previously established target directory. The target directory must be large enough to store all images. If there's already a Teach+ file with the same name on the target medium, a prompt appears asking whether or not the file should be overwritten. If this is acknowledged by clicking yes, all newly recorded images, including the project file, are saved to the Teach+ file.

5.9.2. Play

With the play function, it is possible to load and play recorded image sequences, including all related project and interface settings.


The previously recorded file with the **.gz** can be reloaded into the system through the **play** function.


The function is activated through the toolbar with the symbol  or in the menu bar under **File**.




A window opens, in which the compressed file can be selected. The file is then decompressed again at the storage location and brought into the original structure.

It can take several seconds until the file is decompressed, depending on the size of the file and the number of images stored in it. All previously recorded images and project settings are now available. The images can be automatically played as image sequences.

For this, the symbol  must be actuated. Now all stored images are worked off, one after another.

Actuating the symbol  causes all stored images to be worked off as individual images.

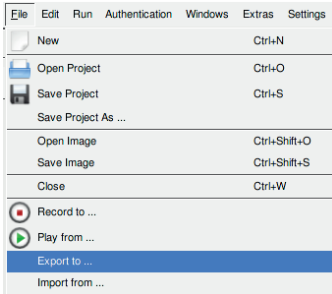
Click the  symbol in order to return to the previous image.

Through repeated pressing of the symbol  or the menu entry, the play mode is left again.

5.9.3. Export

The export function is comparable to the record function. But in contrast to the record function, no images are stored in the export function. Here in export, all project settings are stored, including all settings for logic control and interface settings.

The function can be called up through the menu bar under **File**.

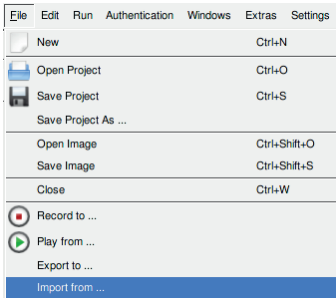


A window opens, which establishes the storage location of the file. All project-specific files are placed in a compressed file. This file contains all files located in the project directory at the time of export.

5.9.4. Import

Previously exported projects can be loaded into the system through the **import function**.

The function can be called up through the menu bar under File.



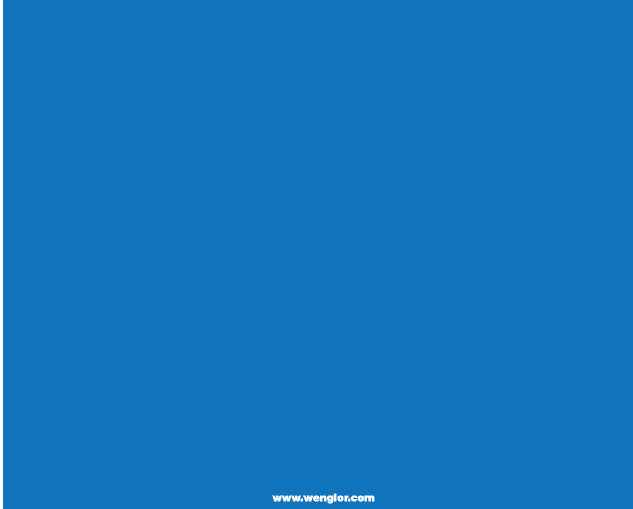
Besides exported projects, recorded Teach⁺ files can also be imported. Through the import of a recorded Teach⁺ file, it is possible to change the project settings. It is also possible to write the changes made in a Teach⁺ file back to the same Teach⁺ file.

In general, Teach⁺ files recorded with various version of wVision can be played back and imported. Previously saved Teach⁺ files can be edited and saved. If the loaded or saved Teach⁺ file originates from a wVision version other than the one currently in use, only those functions can be saved which are available in the older version.

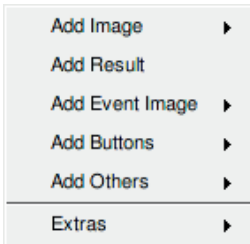
5.10. Visualization

Under the menu option **Window → Visualization**, a freely definable user screen can be created. Users can put together their own screen interface, with the images, events, text fields and buttons they select.

At the start, the user screen is empty.



A right click of the mouse opens a context menu, through which various images, events, event images, buttons and other functions can be added.



5.10.1. Basic Settings

Under the **extras** category the date/time can be inserted.

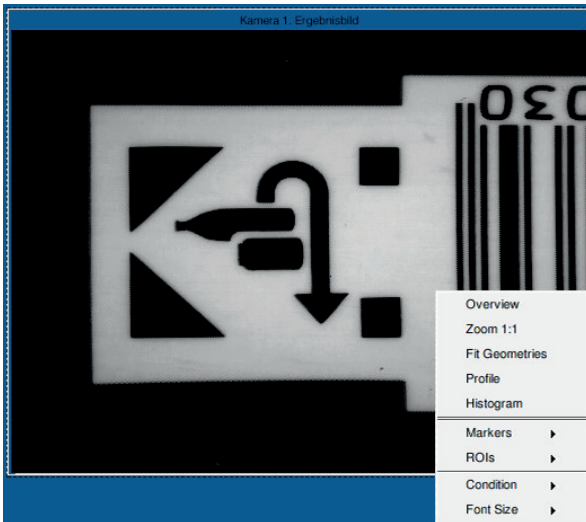
At their first appearance in the visualization interface, all images, events or buttons receive their own name from the system. This name can be changed through a double-click on the text.

5.10.2. Image

All connected cameras are available under the **Add Image** menu option. Clicking on the desired camera inserts the related image window into the interface.



The newly inserted image can be changed in size as desired. If the camera image is anchored in its position, the image can be moved or presented zoomed. Additional functions for the image are accessible via a context menu through a right click in the camera image.



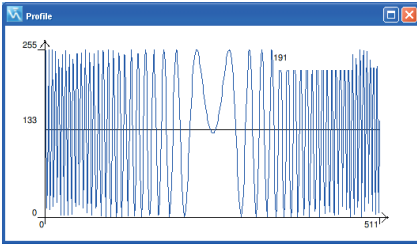
The **overview** function calls up a small overview window of the entire camera image. This function improves orientation in the overall image.



The green frame displays the current selection.

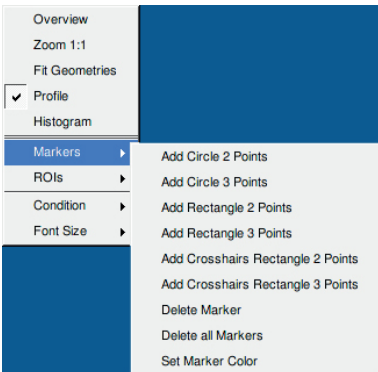
Adapt to geometries changes the zoom factor so that the image is depicted completely in the specified size.

The **profile** function places a line in the camera image. Using the line, the gray value pattern is displayed in an additional window.



The **histogram** function calculates the distribution of the frequency of various gray values in a freely definable image section. The result is depicted as a graphic in a separate window.

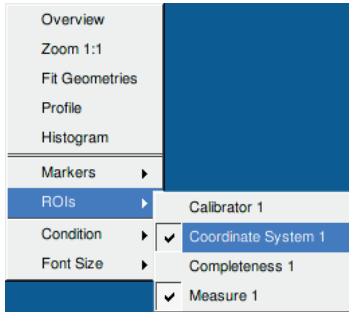
The most varied of marking geometries can be added to the camera image. This function places fixed markings in the camera image. Such **markings** are helpful, for example, when the object to be evaluated is held by hand under the camera. The markings can also be seen as orientation aids.



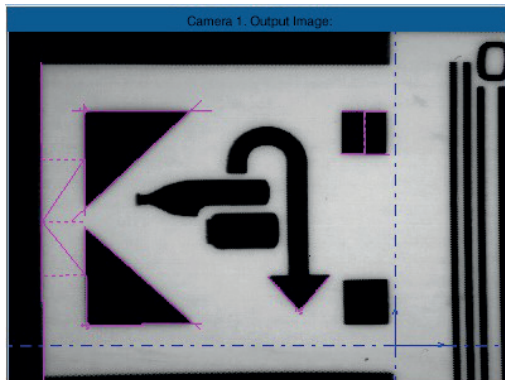
Besides different geometries, the color of the geometries can also be adapted optimally to the user requirements.

In the main window different overlays are drawn into the live image, depending on the module. These graphic aids can also be drawn into the live image in the visualization interface.

Under the category ROIs, all available graphic aids are displayed for selection.

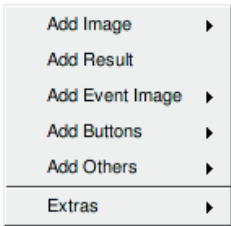
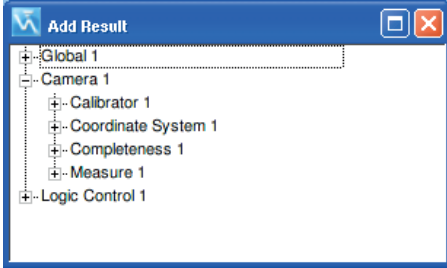


The following image shows a live image with drawn-in coordinate system and measurement functions.

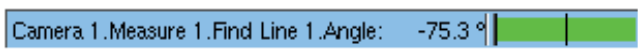
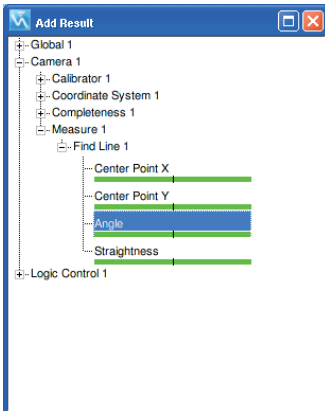


5.10.3. Add Results

Through the **Add Results** submenu, a window opens in which all events, statuses and events in the system can be brought onto the visualization interface.



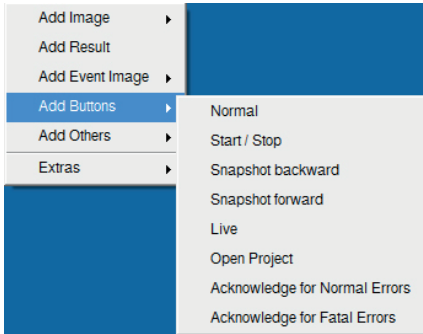
The desired result field can be placed in the visualization by drag and drop.



After insertion, the result appears in the interface. The labeling can be freely changed. With a double-click, the labeling can be edited and with a right-click the font size changed.

5.10.4. Add Buttons

Through the submenu **Add Buttons**, different buttons can be added, such as to start/stop the application or an actuation button.



Normal: A button is generated whose function can be freely defined. If this button is inserted, an additional event is created simultaneously, which in turn can be queried through the logic control.

Start/Stop: The application is started or ended.

Snapshot Forward: A single image is recorded using a camera used as the image source. In the case of Teach⁺, it's possible to advance to the next image. This function can also be executed with the "Ctrl + E" key combination..

Snapshot Back: In the case of Teach⁺, this button can be used to return to the previous image. This function can also be executed with the "Ctrl + R" key combination..

Live: The application is started without an evaluation taking place.

Open Project: A button that opens a dialog window to load projects.

Confirmation

Acknowledge for

Normal Errors: Confirmation field to restart the system at standstill after an error.

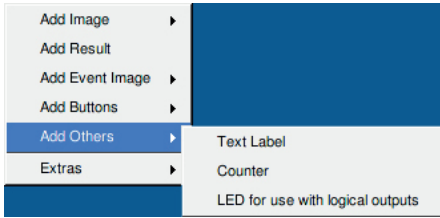
Confirmation

Acknowledge for

Fatal Errors: Confirmation field to restart the system after a serious error.

5.10.5. Add Others

The submenu **Add Others** makes available freely definable text fields, counters and LED displays.



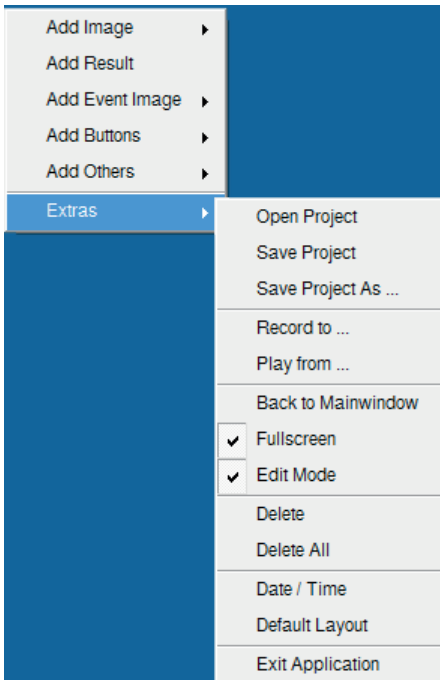
Text Label: A freely definable text field is generated.

Counter: Displays the current number of evaluations.

LED for use with logical outputs: A text field + LED is inserted into the interface. The function that the LED should represent is established through a click with the right mouse. Available as functions are, for example, inputs, outputs and the logic control.

5.10.6. Extras

The submenu **Extras** contains overarching functions:



A project can be opened directly from the visualization by clicking **Open Project**. The project is then started in the visualization.

Save Project saves the entire project.

After clicking **Save Project As**, a dialog box appears to which the filename, as well as additional information (description, author, project number, project ID) can be entered.

After clicking **Record to Play from**, Teach⁺ files can be recorded or played back directly in the visualization (see also section “5.9. Teach⁺” on page 113).

Back to Mainwindow closes the visualization interface and opens the main window.

Fullscreen is activated as standard. If full screen is deactivated, a menu bar appears on the upper edge of the image.

Deactivation of the **Edit Mode** means the interface can no longer be changed. The system can only be operated through the previously defined buttons. If the processing mode is deactivated, the individual basic functions can be called up with a click of the right mouse button.

The F9 hotkey can be used to switch back and forth between the editing mode and the operating mode.

Activation of the **Delete** function permits removal of all or specific elements from the interface. If the menu option **Options → Run Mode → Start**, the visualization interface must be saved last so that visualization automatically starts when the system starts.

5.11. Other settings

Under the menu option **Extras** can be found various additional programs and functions that support users in their work with the system and communication with other network components.

5.11.1. File Manager

Through the menu option **Extras → File Manager**, a file manager can be called up with which data can be processed as usual.

5.11.2. Remote Control

The system can be remotely serviced through an integrated VNC server. The VNC server is switched on via the menu option **Extras → Remote Control**. If there is a hook in front of the menu option, the VNC server is active. The password for the VNC server is „vision“.

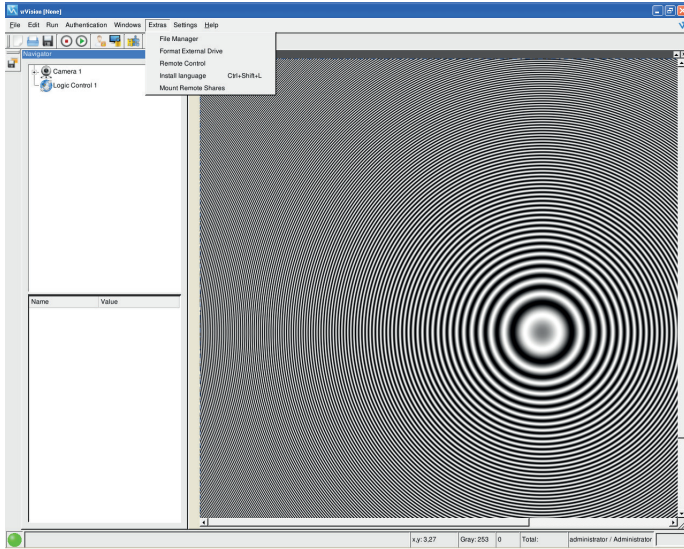
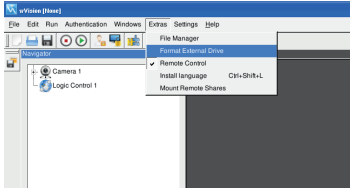


Figure 135: Remote Control activated

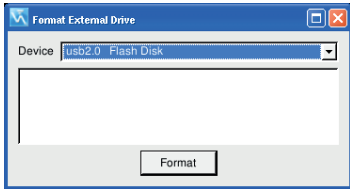
Please note that the image transmitted by the VNC server corresponds to the actual image at any interconnected monitor screen. If the Control Unit will be operated without a monitor screen, the display resolution of the VNC client must first be specified in the boot menu under "Setup Display Resolution".

5.11.3. Formatting an External Disk Drive

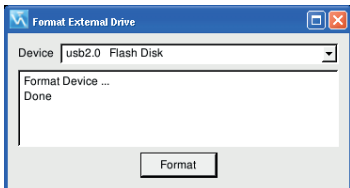
Commercially available storage media can be operated at the Control Unit, for example USB sticks, external disk drives etc. wenglor offers a suitable USB stick as an accessory (order number: Z0074). External disk drives can be formatted with the help of the Format external drive command in the Extras menu. Storage media are formatted to the FAT32 file format, and can thus be used with any commercially available PC.



First select the desired drive:



The drive has been formatted.



5.11.4. Install languages

Additional languages can also be added later via the menu option **Extras → Install Languages**.

5.11.5. Status, inputs/outputs

The current status of the inputs and outputs can be displayed through a context menu.

The current status is displayed in the menu **Window → Digital I/O Service**.

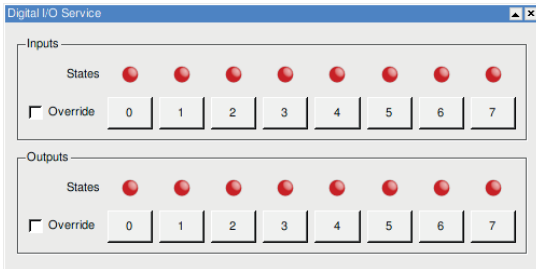


Figure 136: Display, inputs/outputs

A red LED visualizes the unswitched status and a green LED the switched-on status of the output. If the overwrite function is activated, clicking on the respective input/output can change it manually.

5.11.6. Connect network drives

If you often have to access the same directories from other computers in your network, it can help to connect them permanently as network drives.

Through the menu option **Extras → Mount Remote Shares**, the following window opens:

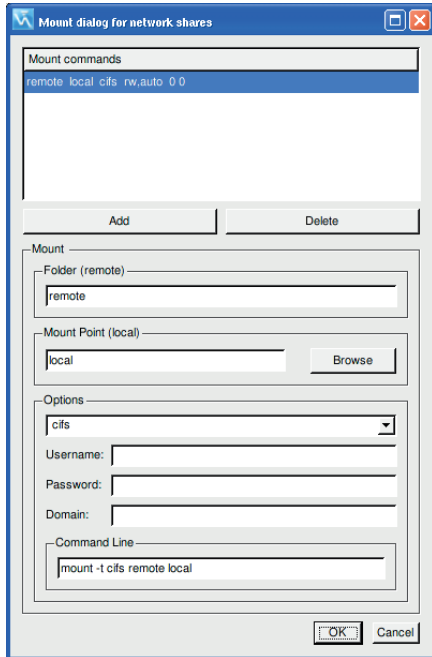


Figure 137: Connect network shares

Network shares can be added, changed and deleted in this window.

The IP-address and the released folder must be entered in the **folder (remote)** field. The entry should look as follows, for example: //192.168.0.1/public

If the Intelligence Pro is in a network in which the IP-address is assigned by a DHCP server, it is advisable to use the computer name of the target computer instead of the IP-address. To find the target computer in the network using its name, a DNS server must be specified in the network settings.

The **mount point (local)** establishes where the connected folder should be displayed in the file structure.

In the fields under **Options**, the login information of the connected target system is specified.

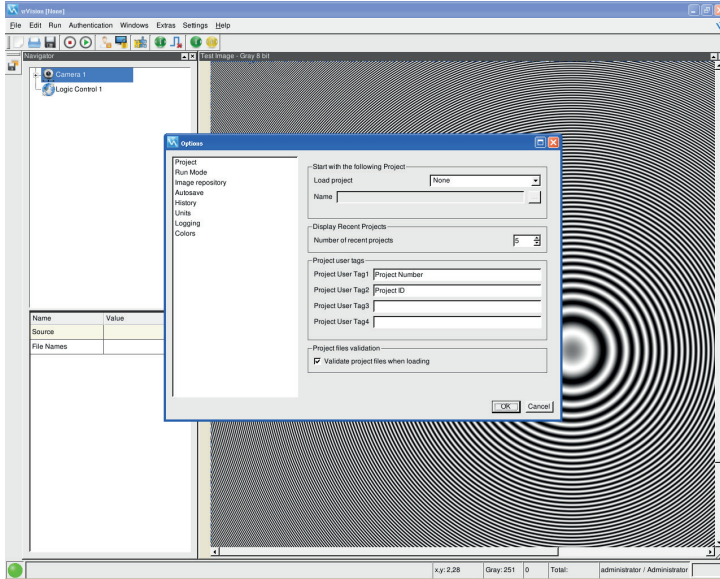
5.11.7. Options

General settings can be made under **Options**.

5.11.7.1. Project

Project settings can be accessed via **Settings → Options → Project**.

The following window opens:



Load project defines whether a project or which project is loaded during a system. In the menu option **File**, the **recent projects** are displayed. How many projects are displayed is also established here.

Additional information is added to each project when saved, such as the last change date, user, a reference image, etc. Through the category **Project user tags**, up to four additional columns can be attached to a project for information.

5.11.7.2. Run mode

This determines how the system should behave after a system start. The following possibilities exist:

Teach: The system starts in the parameterization interface.

Pause: The project previously loaded under the category **Project** is loaded but not started. The pause remains in place, and a manual start is awaited.

Live: The system starts in the live mode.

Start: The project previously loaded under the category **Project** is automatically started as soon as the system starts.

The last saved project: With this option, the last saved project is loaded and immediately executed.

5.11.7.3. Image Repository

The function is activated through **Settings → Options → Image Repository**. This setting establishes the system folder or network drive in which error images are saved. The storage medium must be formatted to FAT32. Besides the storage location, the maximum number of images that should be saved is established. If the maximum number of images is reached, the oldest image in the memory is overwritten. Images in bmp or png format can be saved. In order to save an image to the ring buffer, Write Image to Ring Buffer must be activated as a condition under **Communication → Synchronous Events**.

5.11.7.4. Autosave

The function is activated through **Settings → Options → Autosave** and switches on automatic saving of the project file. The project is automatically saved in the specified time interval.

5.11.7.5. History

The function is activated through **Settings → Options → History**.

It determines how many results should be used for calculating statistics.

5.11.7.6. Units

The function is activated through **Settings → Options → Units**.

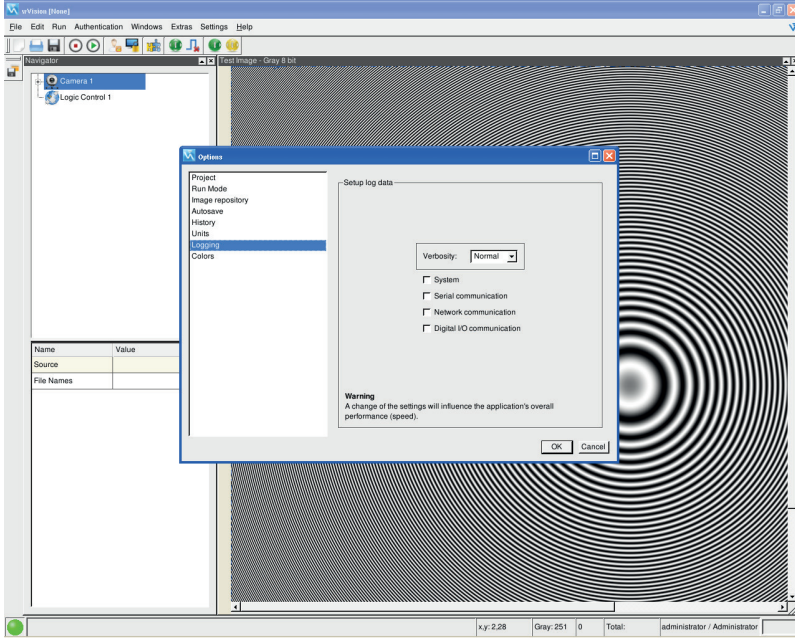
Individual results are output with units. You can select between ° and rad.



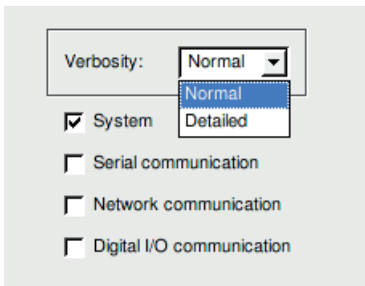
5.11.7.7. Event Protocol

The function is activated through **Settings → Options → Logging**.

The system has the possibility to log the most varied of events. Which events should be logged is established in the following window:



The degree of detail establishes whether only “normal” results should be recorded or all events that occur. The protocol can optionally be activated for the following categories:

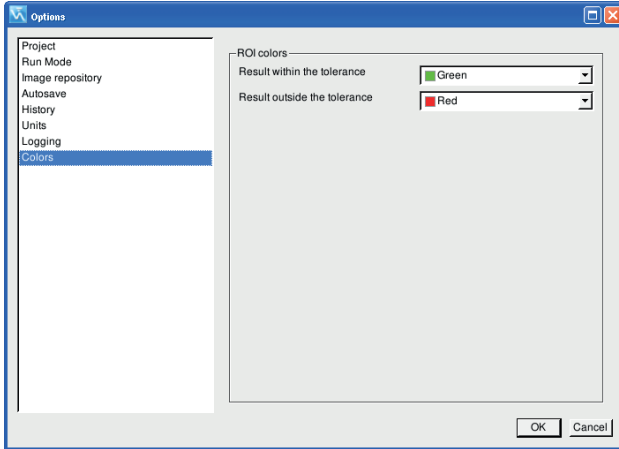


It must be noted that activation of the event protocol can influence system performance.

The protocol can be displayed and saved via the menu bar **Window → Log Info**. The selected categories appear in this window again.

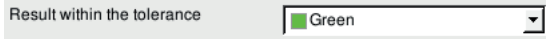
5.11.7.8. Colors

Under the Colors menu item which is accessible via Settings → Options → Colors, the different ROI colors are set. The settings are global, i.e. they are applied to the parameterization mode and the visualization.



The ROI changes its color if the status of the results received in the ROI changes.

Determines the color of the ROI if the results are within the tolerance range.

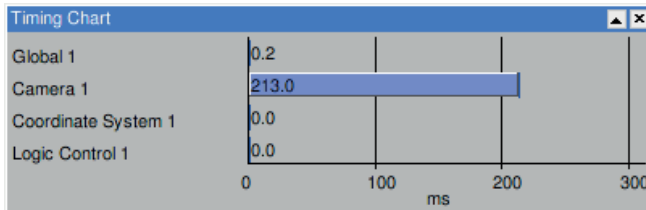


Determines the color of the ROI if the results are outside the tolerance range.



5.11.8. Timing Chart

In the menu option **Windows** → **Timing Chart** is a time monitor that provides information about the processing time of the individual image processing modules. You can observe in real time how much time an evaluation processing step takes.



The sum of the processing times in the time monitor gives the times for pure calculation time of the modules. The total time of evaluation is displayed in the status bar.

6. Communication over the RS-232 and Ethernet interface

The Intelligence Pro has an RS-232 interface for communication with a communication partner, such as a PC or a controller. The interface works in the software handshake procedure (type of protocol, see below).

The system must first be connected to the RS-232 interface and the communication partner with a zero modem cable.

6.1. Data format used

6.1.1. Long/short

In this protocol, the Little Endian data format is used.

Explanation:

Little Endian refers to the arrangement of the least significant byte (LSB) of a data structure in the memory. If the LSB is the first byte of the structure in the memory, we have the Little Endian presentation.

Examples:

16-bit (short) value: DE45

Address	n-1	n	n+1	n+2
Little Endian	xx	45	DE	xx

32-bit (long) value: FF01DE45

Address	n-1	n	n+1	n+2	n+3	n+4
Little Endian	xx	45	DE	01	FF	xx

6.1.2. Float

The float variables are built up according to the IEEE Standard for Binary Floating Point Arithmetic (ANSI/IEEE Std 754-1985).

6.2. Control character

Character	ASCII value (decimal)	ASCII value (hexadecimal)	Significance
\$	36	0x24	Start character
.	46	0x2E	Stop character 1
;	59	0x3B	Stop character 2

6.3. Telegram set-up for data transmission

	Length	Telegram area
Start character	1 byte	Telegram header (header) 12 byte
Frame type	1 byte	
MSG_ID	1 byte	
Repeat	1 byte	
ProtocolLen	2 bytes	
MsgType	2 bytes	
Address	4 bytes	
CMD0: Command type 0	1 byte	Data header (Data header) 16 bytes
CMD1: Command type 1	1 byte	
Parameter 1	2 bytes	
Parameter 2	2 bytes	
Parameter 3	2 bytes	
Parameter 4	4 bytes	
Data length:	4 bytes	
1st data byte	1 byte	User data
2nd data byte	1 byte	
...		
nth data byte	1 byte	
Checksum	2 bytes	Telegram end 4 bytes
Stop character_0	1 byte	
Stop character_1	1 byte	

6.3.1. Telegram header

- **Start character (1 byte):**

The **start character** <\$> signals the start of a protocol.

- **Frame type (1 byte):**

The **frame type** is always set to 0.

- **MSG_ID (1 byte):**

The **message identification** is a serial number that can be selected as desired. The Sensor answers with the same number in the answer protocol.

- **Repeat (1 byte):**

Repeat is the identifier for a protocol repetition.

- **ProtocolLen (2 bytes):**

ProtocolLen describes the entire length in bytes of the telegram to be sent.

- **MsgType (2 bytes):**

MsgType describes the type of message (see chapter “6.4.2. Acknowledge” on page 140)

- **Address (4 bytes):**

Address describes the address of the device.

6.3.2. Data header

- **CMD0 (1 byte) and CMD1 (1 byte):**

The **CMD0** combines commands hierarchically into groups. For example, all data packages related to Teach begin with the same **CMD0** identifier. Within this group, the **CMD1** clearly differentiates the commands from each other. (See chapter “6.6. Commands” on page 141).

- **Parameter 1...4 (10 bytes):**

The (transfer) **parameters 1...4** can be used for the respectively required parameters, depending on the command or data header.

- **Data length (4 bytes):**

In the **data length** parameter, the lengths of the following user data are entered (max. 900 bytes).

6.3.3. User data

The user data field contains user data that may be necessary for the respective command. This user data field can be max. 900 bytes long. There are also commands that work without user data field. The length is described in the data header in the data length parameter.

6.3.4. Telegram end

- **Checksum (2 bytes):**

The checksum must be recalculated for each send telegram (see “6.3.4.1. Calculation of the Checksum BCC (Block Check Character)” on page 136)

- **Stop character (2 bytes):**

The stop character signals the end of the protocol.

Stop character_0 <.>

Stop character_1 <.>

6.3.4.1. Calculation of the Checksum BCC (Block Check Character)

The checksum is calculated by XOR-linking all characters of the telegram header + data header + user data.

6.3.5. Protocol example

This chapter presents an example for an interface protocol and describes it in more detail. This example is fundamental for further chapters, that is, the next chapter describes only those protocol components that change and are relevant for the respective function.

Example: Read out distance from chapter “6.3.4.1. Calculation of the Checksum BCC (Block Check Character)” on page 136.

Character sequence PC => Intelligence Pro:

Telegram header							
	Start character	Frame type	MSG_ID	Repeat	Protocol Len	Msg type	Address
Value (hexadecimal presentation)	24	00	01	00	20 00	00 00	00 00 00 00



Data header							User data	Telegram end		
CMD 0	CMD1	Param 1	Param 2	Param 3	Param 4	Data length	Data	Checksum	Stop character_0	Stop character_1
0A	00	00 00	00 00	00 00	00 00 00 00	00 00 00 00		0F 00	2E	3B



Intelligence Pro answer:

Telegram header							
	Start character	Frame type	MSG_ID	Repeat	Protocol Len	Msg type	Address
Value (hexadecimal presentation)	24	00	01	00	40 00	01 00	00 00 00 00



Data header						
CMD 0	CMD1	Param 1	Param 2	Param 3	Param 4	Data length
0A	00	00 00	00 00	00 00	00 00 00 00	20 00 00 00



User data				Telegram end		
Data				Checksum	Stop character_0	Stop character_1
92 05 00 00 10 27 00 00 <u>F6 05 00 00</u> E 02 00 00 E 02 00 00 E 02 00 00 00 00 00 00 00 00 00 00 00				11 00	2E	3B

The absolute position of the current distance in the stream is 36 and has a length of 4 bytes. The distance is depicted underlined in the stream and, due to the use of the Little Endian data format, corresponds to the hexadecimal number 00 00 05 F6. This corresponds to a distance of 1526 mm.

6.4. Communication process

6.4.1. Example

The module transmission of data is possible with each Run or Snapshot in the application if the communication module is configured to use network interface and the modules results are added.

The client then receive the data which can be surrounded with wenglor protocol or as it is previewed in the „Results preview“ from communication module setup dialog.

Please read the chapter “5.8. Communication” on page 111.

The application commands can take place in the following circumstances:

1. Device Identification (interogation), anytime.
2. Project Load (control), from application main window only when the state is „Run“, from visualization if not in „Edit Mode“.
3. Project Run (control), from visualization if not in „Edit Mode“. The stop running works also from application main window when the state is „Run“.
4. Project query (interogation), anytime, as long as a project is loaded.
5. Results query (interogation), anytime, as long as the communication module is configured properly, the last run result will be send.

Commands have to be according the protocol mentioned in the manual chapter 6.3 on page 135.

Module Data can either use the same protocol or are transmitted as they are (with no protocol overhead). If unsure, you can use protocol analyzer tools i.e. Wireshark.

Example:

Device Identification

HEX	DECIMAL	ASCII											
[NETWORK]--> [TX][1]:32 [bytes]													
24	31	01	00	20	00	00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00	00	00	00	00	00	00
34	00	2e	3b										
[NETWORK]--> [RX][2]: 65 [bytes]													
24	31	01	00	41	00	01	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00	00	00	21	00	00	00
42	56	43	30	41	30	41	33	31	20	31	30	30	31
20	32	2e	32	2e	31	2e	73	76	6e	32	39	33	31
31	00	00	00	00	6c	00	2e	3b					

6.4.2. Acknowledge

Each command sent by the PC to the Intelligence Pro is confirmed by an acknowledge package. The ACK flag of the Msg_Type parameter is set for each data package that the PC receives from the Intelligence Pro.

Header example:

Request (PC → Intelligence Pro)

Telegram header

Start	Frame type	MSG_ID	Repeat	ProtocolLen	MsgType	Gap	Address
\$	0	0x10	0	0x20 (+data length)	0	0	0

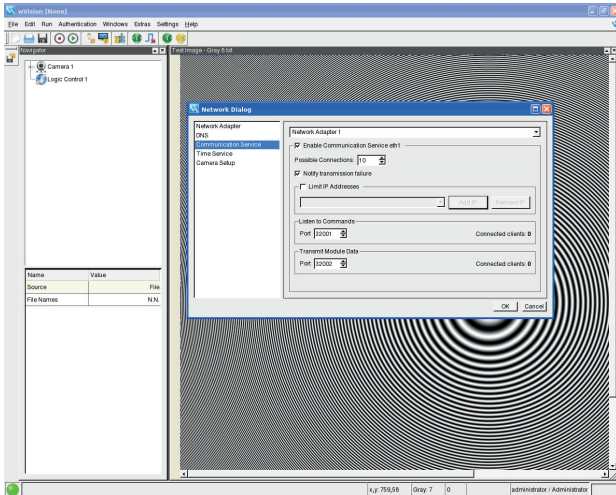
Answer (PC → Intelligence Pro)

Telegram header

Start	Frame type	MSG_ID	Repeat	ProtocolLen	MsgType	Gap	Address
\$	0	0x10	0	0x20 (+data length)	0x01	0	0



6.5. Configuration for Network communication



Both network adapters have as default the communication service enabled.

In order to use the communication the system must be connected into a network, first the Network adapter 1 or/ and 2 need to be configured properly that the system can communicate with external devices.

The client can communicate with the application by setting the IP address of system network adapter and port. There are two possible type of connections:

- „Listen to Commands“ which can be used by clients as default on port 32001. The client can send commands to the application for interrogation or project control. If after a configurable number of seconds there is no activity from the client the connection will be closed, but this can be set to never close.
- „Transmit Module Data“ which can be used by clients as default on port 32002. By using this port the connected client can only receive data from application. The data consist of the formatted results from the Communication module.

The ports are user configurable.

The number of possible configurable connections is 10, each port accepts this number of clients to be connected in the same time.

The errors can be displayed into dialogs if the „Notify transmission failure“ is active, if not only the „Log Info“ will show them.

To restrict the connections there is the possibility to „Limit IP addresses“ which allows only the defined IP address to access the network communication, default is no restriction.

All used network protocols are based on TCP/IP!

6.6. Commands

The following contains an overview of the command groups (CMD0). Differentiation of these command groups takes place through CMD1 and is described in the respective chapters.

CMD0	CMD1	Param 1	Param 2	Param 3	Param 4	DataLen
0x00 CMD0_IDENTIFICATION	0x00 CMD1_GET_IDENTIFICATION	Default 0				56 bytes
0x50 CMD0_PROJECT	0x4C CMD1_PROJECT_LOAD	0x0 or 0x1				
0x50 CMD0_PROJECT	0x4D CMD1_PROJECT_RUN	0x0 (pause) 0x1 (run)				0
0x50 CMD0_PROJECT	0x3F CMD1_PROJECT_QUERY					
0x52 CMD0_RESULT	0x3F CMD1_QUERY					
0x52 CMD0_RESULT	0x59 CMD1_SYNC					

6.6.1. Device Identification

CMD0	CMD1	Param1	Param2	Param3	Param4	DataLen
0x00 CMD0_IDENTIFICATION	0x00 CMD1_GET_IDENTIFICATION	Default 0				56 bytes

CMD1_GET_IDENTIFICATION

Name	Stream Pos.	Type	Default value
Device Id	28	Unsigned char [26]	e.g. "BVC0A0A31 1004 2.0.3.12345"
Reserved	54	Unsigned char [4]	Normally 0

6.6.2. Load project

CMD0	CMD1	Param1	Param2	Param3	Param4	DataLen
0x50 CMD0_PROJECT	0x4C CMD1_PROJECT_LOAD	0x1				

CMD1_PROJECT_LOAD

Param1: 0x01 Selection of the project by project name.

Return value:

Param1: 0x01,

0xFF → If project could not be loaded.

DataLen: Name of the project

6.6.3. Start project

CMD0	CMD1	Param1	Param2	Param3	Param4	DataLen
0x50 CMD0_PROJECT	0x4D CMD1_PROJECT_RUN	0x0 (pause) 0x1 (run) 0x2 (MODE_TRIGGER- LESS_SINGLE)				0

Param1: 0x00, 0x01, 0x02

Return value:

Param1: 0x00, 0x01,

0xFF → If project could not be loaded.

6.6.4. Query project

CMD0	CMD1	Param1	Param2	Param3	Param4	DataLen
0x50 CMD0_PROJECT	0x3F CMD1_PROJECT_QUERY					0

CMD1_PROJECT_QUERY

Return values

Param1: Run mode, or 0xFF

DataLen: Length of the data block that contains the name of the project

6.6.5. Query results

CMD0	CMD1	Param1	Param2	Param3	Param4	DataLen
0x52 CMD0_PROJECT	0x3F CMD1_QUERY					0

With this command, the data of the communication module can be called up asynchronously.

Return value:

Param1: 0x00,

0xFF → If result could not be loaded.

DataLen + block with data

6.7. Results

CMD0	CMD1	Param1	Param2	Param3	Param4	DataLen
0x52 CMD0_RESULT	0x59 CMD1_SYNC					0

No command is sent; only the data of the communication module is received synchronously.

7. Boot menu

The Intelligence Pro has a boot menu with which various actions can be started. The following actions are offered in the boot menu:

- Start of the “Intelligence Pro” system
- Setup Display Resolution
- Create Service Report to USB
- Backup to USB, the following selection is available: complete system, projects, images
- Restore from USB, the following selection is available: complete system, projects
- Reset to factory defaults
- Install updates from USB
- Run scripts from USB, which were prepared in consultation with wenglor

In installation or update through USB, the USB flash drive must be located in a USB port before the system is started. Only then can it be ensured that the USB flash drive is recognized correctly and can be used for installation. In addition, attention should be paid that enough free memory space is available on the flash drive.

USB-Stick Article number Z0074

Minimum requirements:

4 GB memory capacity
FAT32 format

If the USB stick is not correctly detected by the system, it must first be formatted by the system.

8. Environmentally responsible disposal

The image processing system and cameras contain and emit no environmentally hazardous substances. They use a minimum of energy and resources.

Disposal

For unusable devices, the respectively valid country-specific waste disposal regulations apply. All electronic components must be disposed of as controlled waste. wenglor sensoric gmbh does not take back unusable or irreparable devices.

9. Exclusion of liability

wenglor sensoric gmbh, hereafter called wenglor for short, points out that notes and information in this operating manual may be subject to constant development and technical changes. This operating manual does not represent a promise by wenglor with regard to the described processes or specific product characteristics.

wenglor accepts no liability with regard to printing errors or other inaccuracies contained in this operating manual, unless wenglor can be shown to have known about the errors at the time the operating manual was made. In addition, wenglor hereby informs users that this operating manual is only a general description of technical processes, whose implementation may not make sense in this form in every individual case.

The information in this operating manual can be changed without advance announcement. No part of this document may be copied, reproduced or translated into another language without the prior written permission of wenglor sensoric gmbh, regardless of the manner or with what means this takes place.

Liability – regardless of the legal foundation – is excluded to the extent this is legally permissible. In particular, no liability is accepted for material and legal defects of the software and hardware as well as the related documentation and information – especially with regard to their correctness, freedom from error, freedom from industrial rights and copyrights of third parties, completeness and/or usability – except in the case of intentional damage or malice.

10. Software Update

Product version	Release Date	Changes / Eliminated Errors
V2.0.0	24.09.2012	New features: <ul style="list-style-type: none"> • Support for Network Cameras • Project file format enhanced by version numbers, backward compatible • Support for BVC0A0A31 board (3 serial ports, 2 Gigabit Ethernet interfaces) • Snapshot button on the visualisation • xml project file validated
V2.0.1	23.10.2012	Bugfixes: <ul style="list-style-type: none"> • Hardware Trigger not working, when no trigger signal for more than one minute
V2.0.2	06.11.2012	New features: <ul style="list-style-type: none"> • Format USB sticks Bugfixes: <ul style="list-style-type: none"> • Hardware Trigger not working, when no trigger signal for more than one minute • Pressing „OK“ in Modules dialog without selecting a module and mouse double-click in the same Modules dialog • Refactoring of Network settings dialog • Save and Load of Projects with Spreadsheet module and Communication module

Product version	Release Date	Changes / Eliminated Errors
V2.0.3	14.02.2013	<p>Major issues:</p> <ul style="list-style-type: none"> • Visualisation changes for Objectmodul and Completness <p>Bugfixes:</p> <ul style="list-style-type: none"> • Global Teach Record doesn't work in visualisation Ethernet Ports Control Unit BVC0A0A31 • Copy warning pops up If we change the modules names and put only digits in their names, the application will crash • GigE camera's not found after crash Serial RS232 interface selection in gateway settings is lost after saving and reloading the project in version 1! • Application crashes when we go up one directory in /favorites • Invert Illumination is not set correctly during load • Error, if you add an camera Modul into the global teach file • MeasureModule crashes when adding a circle with radius zero • GlobalTeach file gets corrupted • Load time increased to more than 30 seconds with debug messages on • Project doesn't load, when validation is on • ProjectManagerDialog fails to open on Import • Serial interface in Production Test environment hangs randomly • Coordinate System Nodes reordered randomly in the Navigator • When we add an Object Module, the bar under the Unclassified Objects is red. After we go to Results and only press Ok, the bar turn green • The histogram goes wrong when we overlay the rectangle • Switching a project by Ethernet command can result in not triggering the camera or invalid calculation results • Read block for network command thread can read partial commands for high network traffic • Handling of Serial numbers need to be changed • Measure Modul – Bug if the module name is changed. • core dumps in write partion • Delete project modules does not remove the xml files • Setting date and time causes a popup like „Prozess wurde getötet“ • Xml schema for V2.0 project files • Import V11 project and the camera is not connected • Loading of Projects when using interfaces • A valid result could be handled as invalid at the logic module if ranges are swapped
V2.1.0	06.05.13	<p>New features:</p> <ul style="list-style-type: none"> • Any camera branch needs its own set of camera flags • Serial RS232 interface settings will not be stored by closing the dialog by OK button • 1071 wVision app crashes on startup, when USB stick is connected 776 GigE camera – Sensor window now available • 918 Global Teach Record doesn't work in visualisation QN-2012-024 <p>Minor issues: 678, 1024</p>

Product version	Release Date	Changes / Eliminated Errors
V2.1.1	15.05.13	<ul style="list-style-type: none"> • Communication Module with Digital IO has wrong default values • Global Teach Record stops after some execution cycles • Manual has updated chapter about camera.
V2.2.0	18.10.13	<ul style="list-style-type: none"> • GigE Camera: Auto White Balance for color cameras • Linux OS Upgrade (includes improved GigE camera query) • Bitwise formatted output in any Gateway • Spreadsheet Module should calculate, even if error flag of result is set <p>Bugfixes:</p> <ul style="list-style-type: none"> • Undefined crash • Random Freeze of the System after an error • App crashes or hangs when changing projects over network interface
V2.2.1	22.11.13	<p>Default hostname is intelligence-pro</p> <p>Bugfixes</p>
V2.2.2	22.04.2014	<p>Network keepalives according now the wenglor standard</p> <p>Changes in the IP-Config for the cameras</p> <p>Bugfixes</p> <ul style="list-style-type: none"> • If project name contains an & the loading of the visualization file fails • Crash when importing a project from a V2.0 Teach⁺ file on a V2.2.1 system which was updated from V2.0.2 or before • Configuration File for Network Camera may be deleted • Global Teach Files in Folders with spaces and Umlauts • Logout via Panel lead to error in Application starter • Bug in the ROI Colors • The default hostname cannot be "intelligence_pro" • Keyboard setting need to be saved • App crashes, when projects are switched with network interface • wVision crashes after app. 7 days • Failure in Communication module • Dark Image after camera hardware trigger
V2.2.4	09.07.14	Bugfixes
V2.2.5	12.11.14	<ul style="list-style-type: none"> • wVision Windows-software available • Open and save projects in visualisation • Record and play Teach⁺-Files in visualisation • Update compact flash from 4 to 8 GB <p>Bugfixes</p>
V2.2.6	28.11.14	<p>Bugfix:</p> <ul style="list-style-type: none"> • Create system backups
V2.3.0	08.04.15	<ul style="list-style-type: none"> • Bugfixes • Snapshot back button • Hotkey (F9) for switching from the operating mode to the editing mode

Product version	Release Date	Changes / Eliminated Errors
V2.3.1	22.04.15	Update of camera library
V2.3.4	27.06.16	Bugfixes: <ul style="list-style-type: none">• Two Communication Modules cannot be used simultaneously• Visualisation moves if you open it a few times• System restarts when using chained project• Saving visualisation settings in account exchange

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