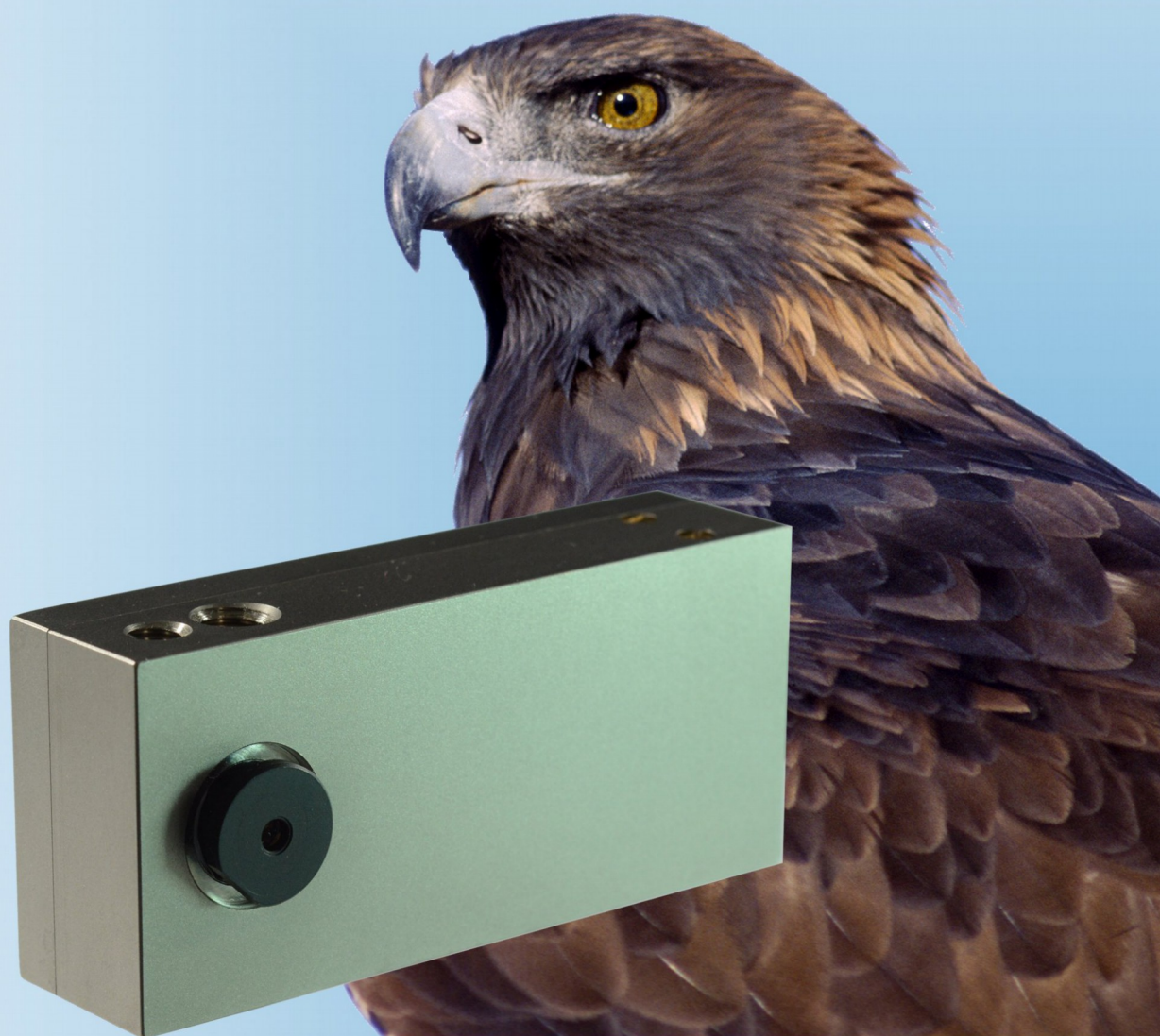


“MRC High Resolution”

MR-compatible digital HD video camera



User manual

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1. Intended use

Our MR compatible video cameras are designed to view and record video images of subjects in an MR scanner. They can also be used for the monitoring of objects and instruments. The cameras can be used inside the bore of scanners with field strengths of up to 3T. They can be equipped with different exchangeable lenses. The correct orientation of the cables, the correct installation of the filter box, and the correct grounding should be checked before the application. Respective descriptions can be found in this user manual.

The High Resolution video cameras provide video images with different resolutions. They are recommended whenever a high spatial resolution is desired.

The cameras are not equipped with an automatic alert in case of an interruption of the video stream. That is why they are not intended to identify critical states or situations.

2. System components

- Camera
- Filter box
- Camera connection cables:
 - Optical fibre (length: typical: 10 m, up to 30 m with gradient-index fiber)
 - Power cable (length: 10 m, 2 m at the camera + 8 m elongation cable)
- Power supply (length: 1.8 m)
- Earth ground cable for provisional installation
- Fibre converter (optical->electronic) + Ethernet cable (standard length: 10 cm)
- Optional: Gigabit Ethernet to display converter (“vDisplay HDI-Pro”)

Figure 1 shows a photo of the camera with equipment for powering and GigE signal transfer.

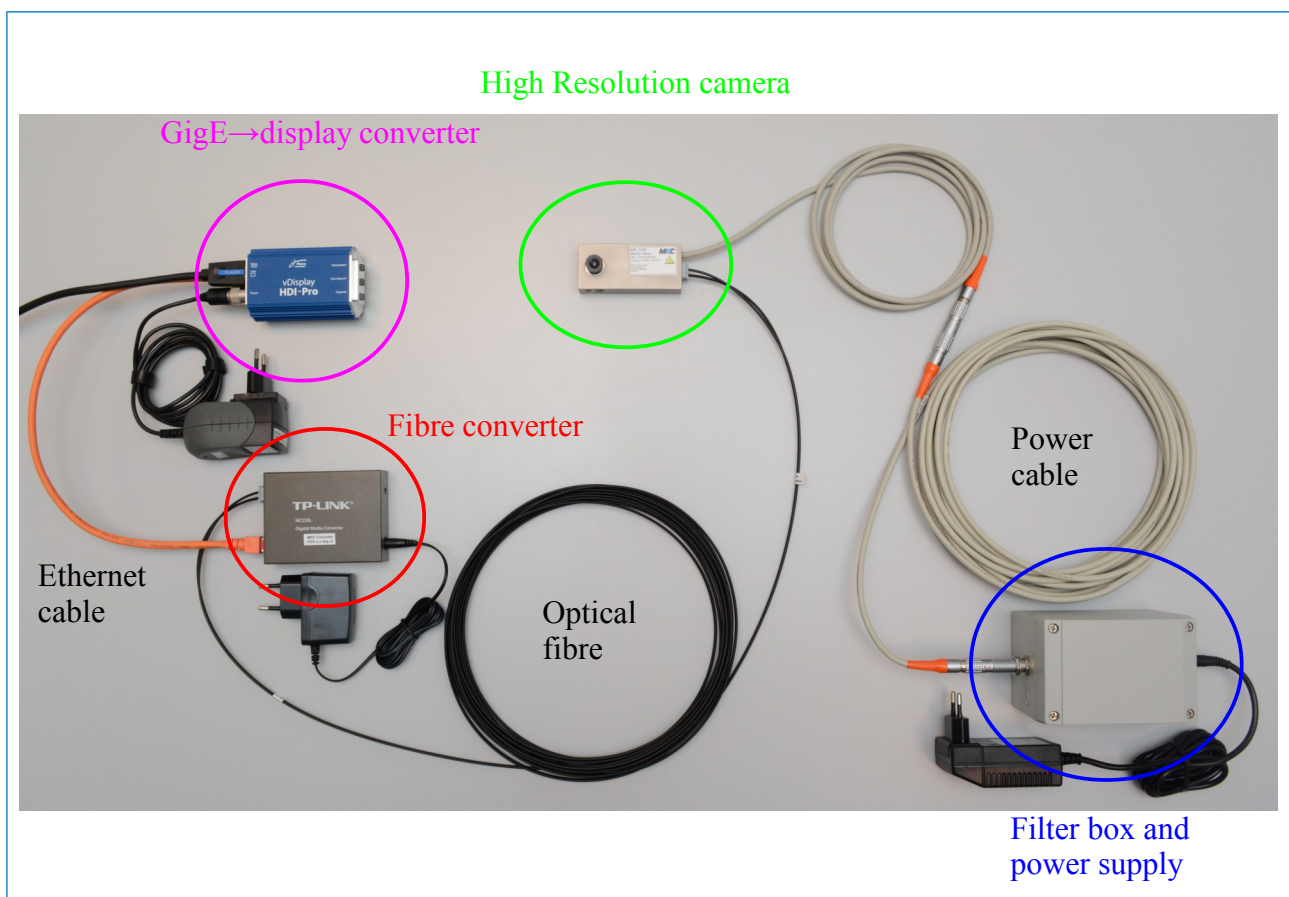


Figure 1: High Resolution video camera and accessories.

3. Video camera and lens

The video camera has a standard **M12 mount** and can be equipped with exchangeable lenses. A wide range of various lenses is available in order to optimize the field of view / magnification for different applications.

- The lenses can be exchanged easily by completely screwing out the connected lens and screwing in a new one.
- The **focus adjustment** is done by screwing the lens in and out. Care should be taken not to screw out the lens too far, as the lens may fall out of the thread.

Figure 2 shows the camera housing with a connected lens.

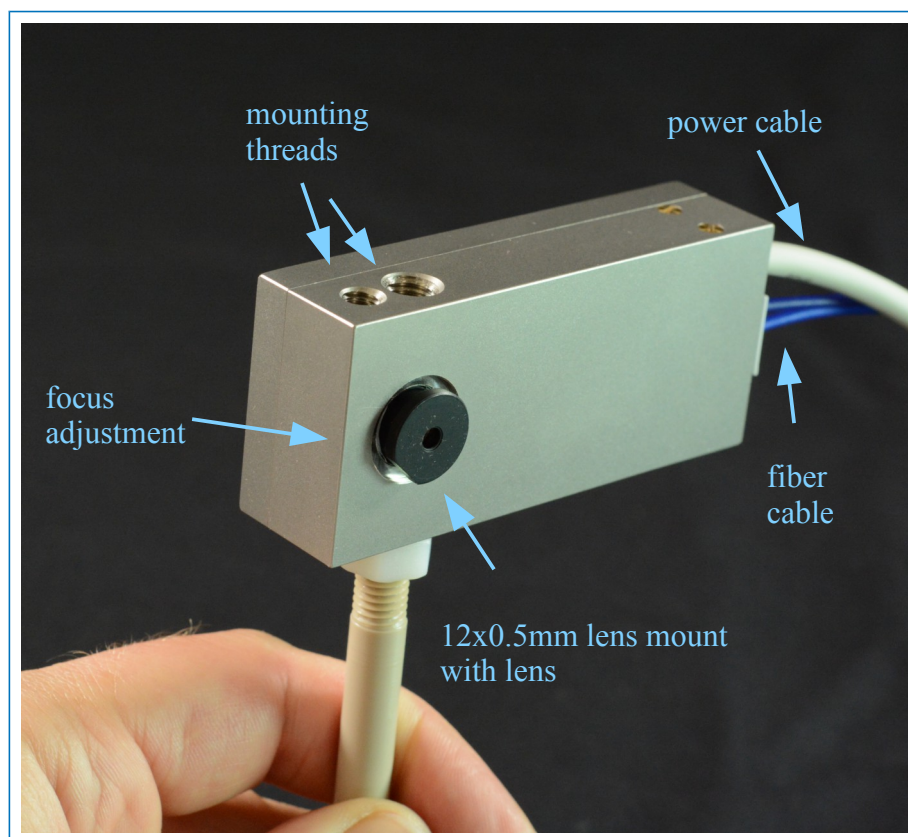


Figure 2: Video camera with lens

4. Interface

Due to the high resolution the camera produces a big data volume in short time. The signals are transferred via the standard Gigabit Ethernet protocol. You can use GigE Vision compatible image acquisition software to read and record the video stream.

As an option, we can provide software libraries for processing the high video frame rates of this digital camera. You can find further information in section 6.

As an option for simply viewing the video images we offer a GigE-Vision-to-display converter.

5. Installation

5.1. Overview

The installation of the camera system is rather easy. Figure 3 illustrates a typical arrangement. The video signals are transferred via an optical fibre (2), and the camera is powered via a specially shielded electronic cable (5). A signal converter (3) converts the optical signal to the Gigabit Ethernet protocol which is then physically available in a standard Ethernet cable (1000BaseT) (4).

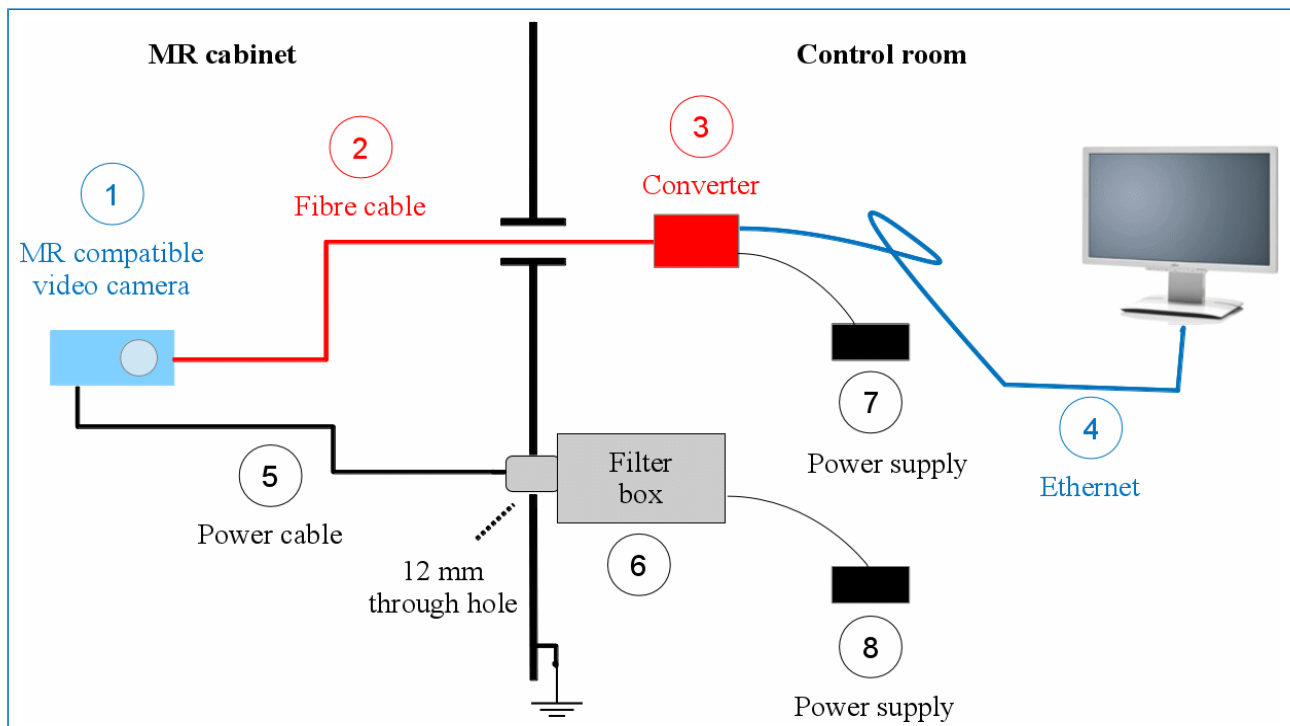


Figure 3: Overview of equipment in MR cabinet and control room

The main task during the installation is the connection of the filter box and the cables. All required steps are described in the following sections.

5.2. Powering of camera / Connection to filter box

The camera is powered by a wall-plug power supply via the filter box. The filter box prevents the transmission of disturbing signals into the MR cabinet. It includes a low pass filter that suppresses frequencies higher than 1 MHz with over 100 dB. This filter prevents damage and interferences caused by the high frequency signals of the MR scanner.

The camera is connected to the filter box via the power cable, which includes the power lines and shielding. Figure 4 shows the connector for the power cable at the filter box.



Figure 4: Filter box (front side)

5.3. Filter box installation and grounding

For a permanent installation, the filter box should be screwed onto the panel board by means of the feed through **power connector** (see figure 4). Figure 3 illustrates the recommended configuration:

- A 12 mm through hole in the panel board is required.
- The **power connector** is guided through this hole.
- The power connector provides the ground connection to the shielding of the MR cabinet.

For temporary use, the power cable can be brought into the MR cabinet by other means, e.g. through a service entry hole (“wave guide”).

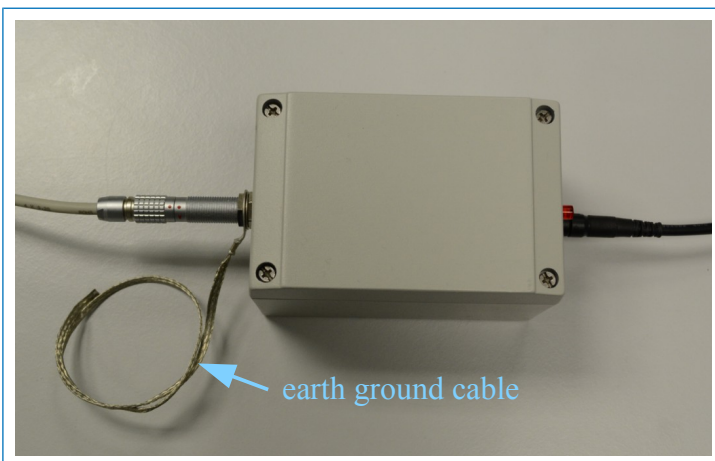


Figure 5: Earth ground cable at filter box

Notes:

- 1) Please make sure that the power cable is fully inside the MRI room. It should not protrude outward.
- 2) In case of the installation through a wave guide, an additional grounding cable has to be used to connect the power connector to the shield ground. The earth ground cable must be directly connected to the wave guide in order to avoid interference. The power connector must

completely protrude into the MR cabinet and the power cable must not jut out.

- 3) The camera should always be used with the elongation cable, as this cable is needed for thermal management of the camera.

5.4. Connection of power supply to filter box

The power supply is connected to the filter box. The connector is shown in figure 6.



Figure 6: Filter box (rear side) with connector for power supply

5.5. Fibre connection and signal transfer

The video signals are transferred via an optical fibre. The optical fibre can be guided through the wave guide or any other through-hole connection.

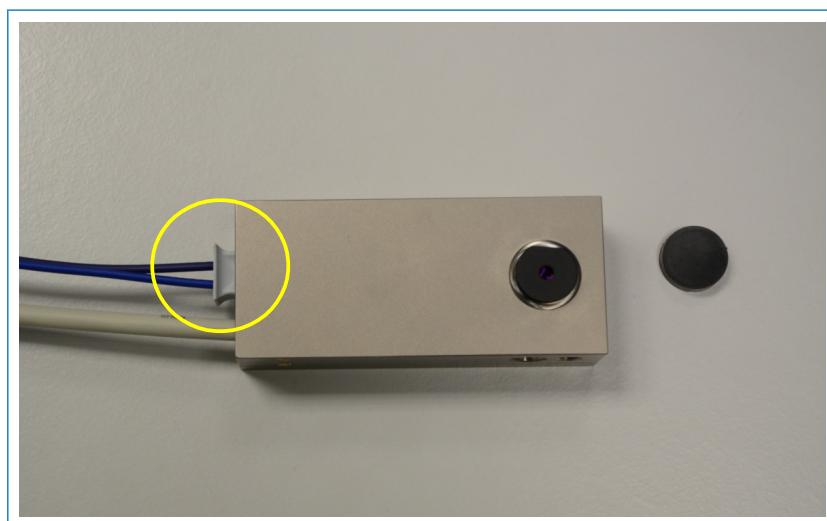


Figure 7: Fibre connection at camera

The optical fibre must be plugged into the fibre connector at the camera. Figure 7 shows a photo where the connection can be seen.

The opposite end of the optical fibre is connected to a signal converter which converts the optical signal to an electronic signal. Figure 8 shows a photo of this part. The converter should be placed outside the MR cabinet. It is powered by a wall-plug power supply.

After the converter the signal is available on an Ethernet cable which can be connected to a video device which is capable of reading the GigE Vision protocol.

We offer an optional GigE-Vision-to-display converter which converts the signal to a standard HDMI protocol. The HDMI signal can be connected to a usual display with DVI-D input by means of a HDMI to DVI-D cable.

Note:

The optical fibre is a sender/receiver cable with black and blue claddings. In another configuration we deliver two black fibres where one of the fibres has a white ring. Please take care that the fibres are connected as shown in the photos in figures 7 and 8. You can switch between black and blue, but if you do it, you have to do it on both connections (camera and fibre converter).

You can also carry out the following steps to make sure the correct fibre connection:

- 1) Pull out the rectangular fibre fixation.
- 2) If you switch on both devices, the camera and the fibre converter, you can connect the fibre pair at first on the camera side. On the opposite end you can place the red illuminated fibre into the dark hole of the fibre connector and the dark fibre into the red illuminated hole.
- 3) Push the fibre into the fixation in order to fix the fibre in its place.

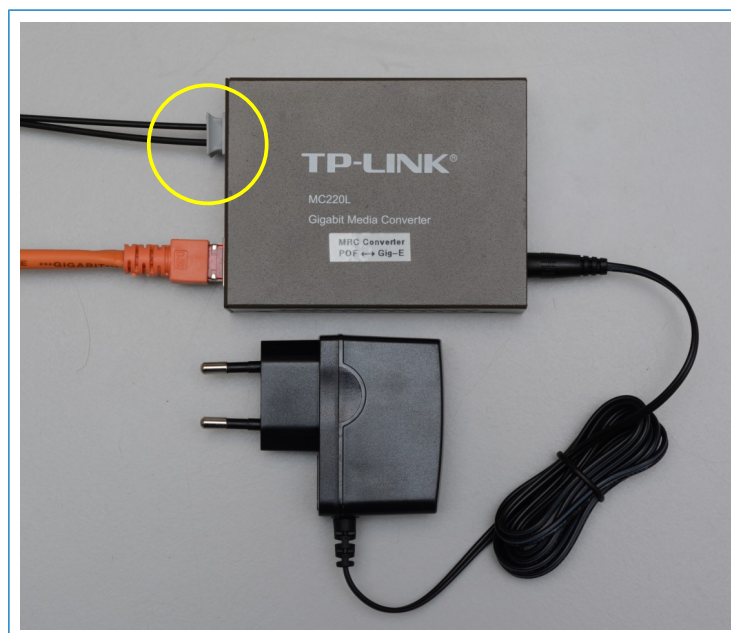


Figure 8: Fibre connection at converter

6. Viewing and recording of video images

The MRC High Resolution camera is a digital camera which operates with the GigE Vision standard. You can use GigE Vision compatible image acquisition software to read and record the video stream.

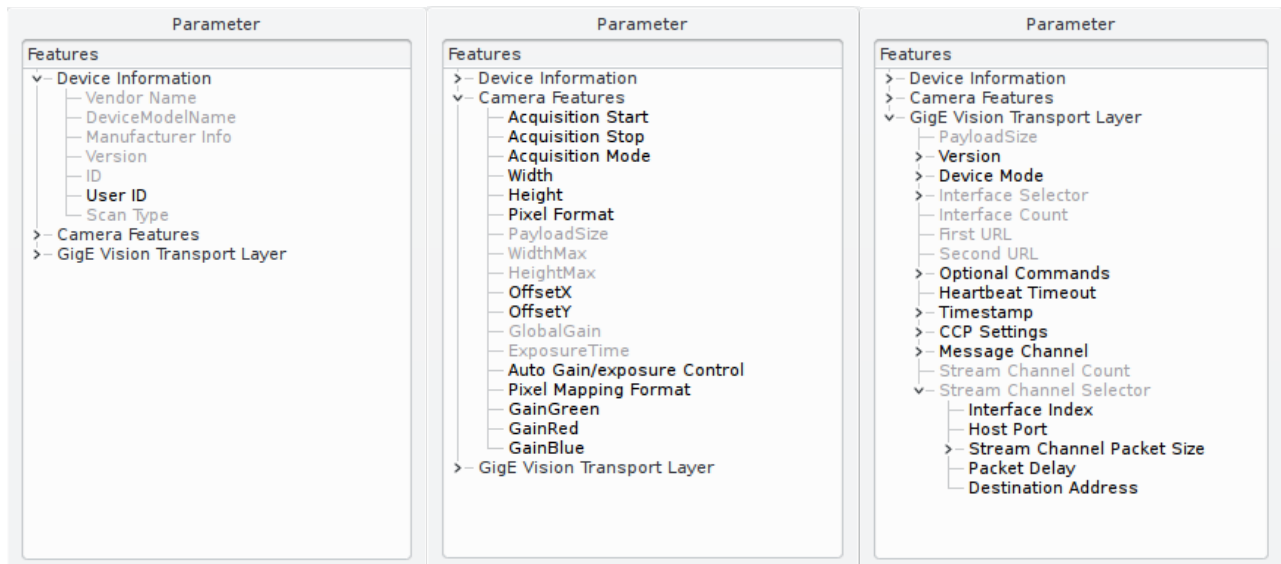


Figure 9: Typical parameters / features of the GigE Vision protocol

A typical image acquisition software enables you to read out and set various parameters of the video camera. The first step is usually a “discover” step where the software searches all GigE Vision devices. If the MRC High Resolution camera is connected, the software should find and display it. Then you should have access to the parameters as shown in figure 9.

6.1. Selection of frame rate and camera resolution

The main parameters you might wish to change are included in the **Camera Features** (see central box of figure 9). There are parameters for the *Width* and the *Height* of the camera's frame. If you modify these parameters, it can also make sense to change the *OffsetX* and *OffsetY* parameters in order to adjust the selected frame to the centre of the sensor.

The default setting of the MRC High Resolution camera is *AutoGain/Exposure Control* activated (or true). But you can also overwrite the *GlobalGain* and *ExposureTime* parameters by your own settings.

The parameter *Pixel Mapping Format* can be used to adjust the grey value range. Since the camera only uses 8 of the 12 bits of the sensor's resolution, the adjustment can be helpful for specific illumination conditions.

The parameters *GainGreen*, *GainRed*, and *GainBlue* can be used to optimize the color matching.

Please refer to the GigE Vision standard for more information about these and all other parameters.

Note:

Non-volatile memory: If you change the dimension values *OffsetX*, *OffsetY*, *Width*, *Height* and/or the colour gain values *GainGreen*, *GainRed*, *GainBlue*, the new values are stored in a non-volatile memory, so that they survive power cycling,. In the following table you can find safe default values:

OffsetX:	2	GainGreen:	32
OffsetY:	4	GainRed:	32
Width:	1280	GainBlue:	32
Height:	960		

7. Mounting

On two sides of the camera there are two different mounting threads (M8 and 1/4"), respectively. These threads can be used to mount the camera. A typical set-up, where the camera is connected to a mirror mount with a semi-transparent mirror is shown in figure 10.

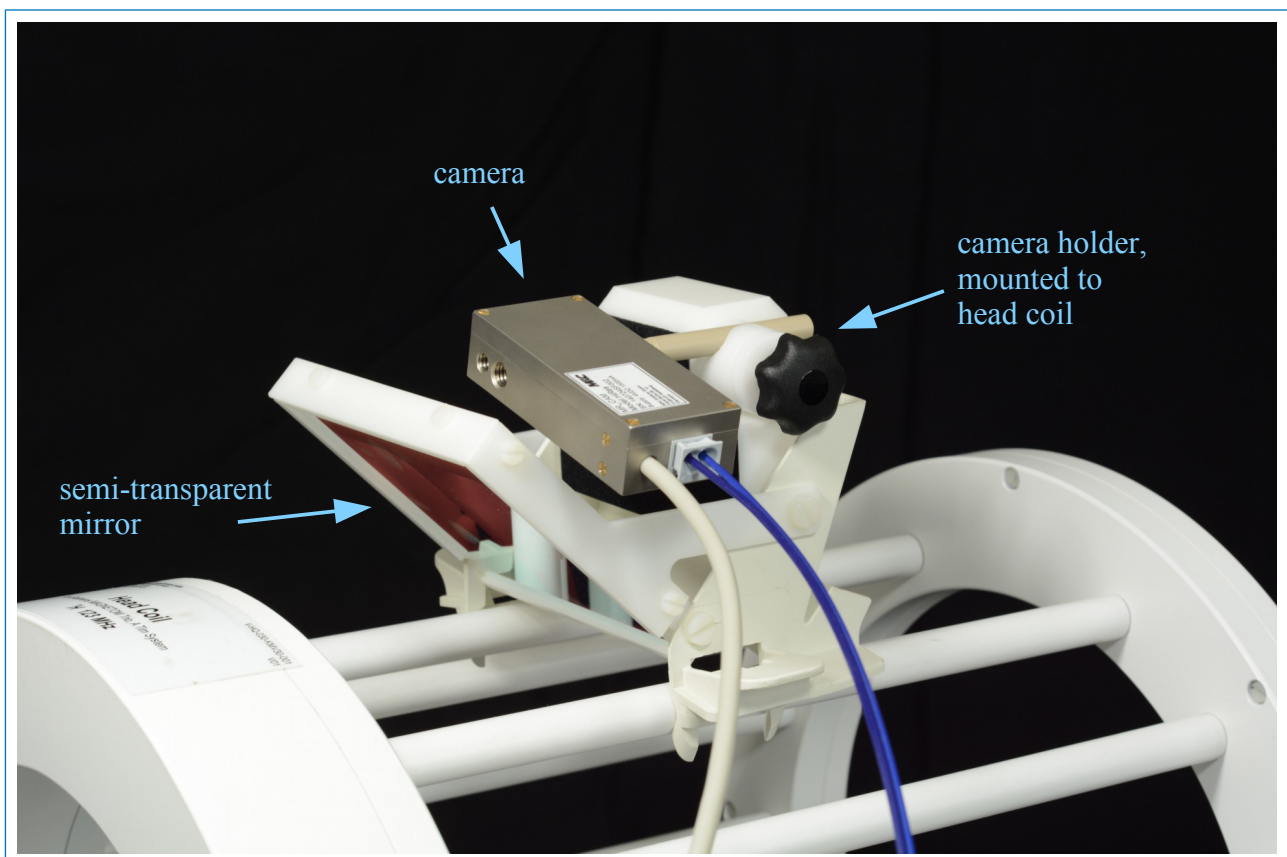


Figure 10: MRC's High Resolution camera and mirror mount in a typical setup for eye-tracking and face monitoring

8. Technical data

Sensor Type: 1/3" CMOS sensor, color, progressive scan, global shutter
 Resolution: 1,280x960 @43 Hz, 1,280x720 @60Hz, or ... (adjustable)

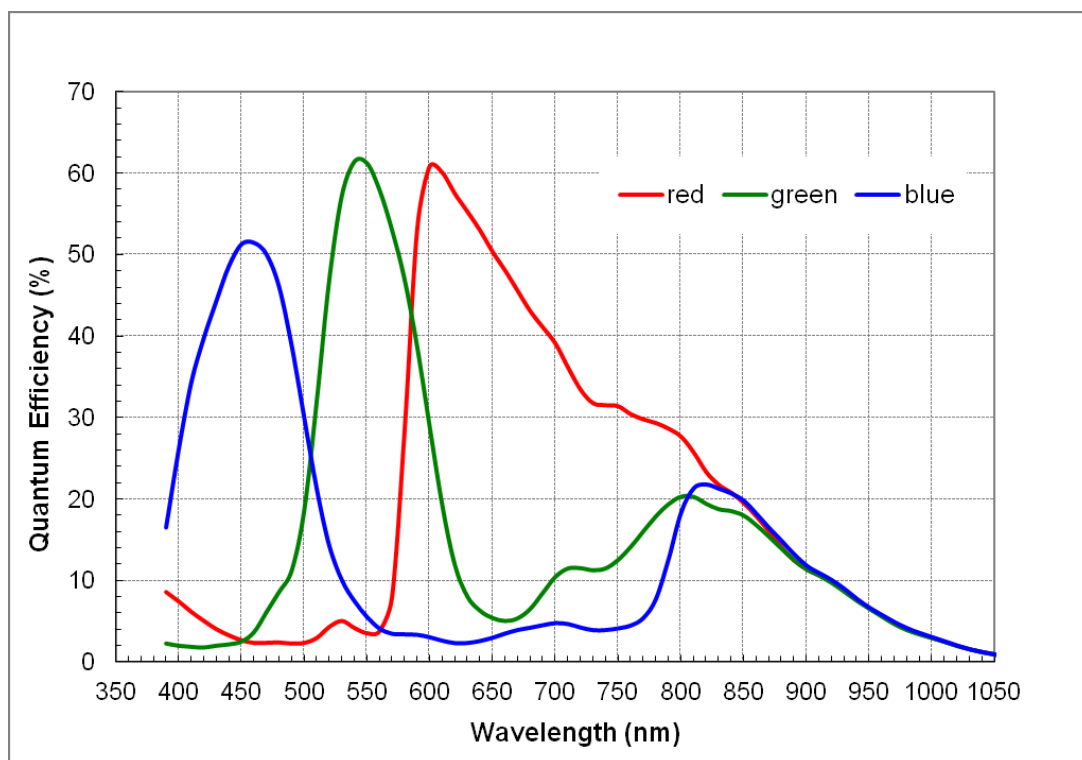
Housing dimensions

Dimensions: 83.5 mm x 37 mm; height \approx 21 mm + lens
 Connector for lens: 12x0.5mm mount
 Mounting thread: 2x M8, 2x 1/4"
 Weight: approx. 160 g

Lenses

Type: fixed focal length with fixed aperture, exchangeable
 Mount: M12 x 0.5
 Focal length: 9.6 mm (others on request)
 Aperture: e.g. 2.4
 Sensor format: 1/3 inch
 Minimal object distance: 50 mm (typical, depending on the chosen lens)

Spectral sensitivity (color camera)



Electronics

Power supply: 1 A, 5-12 V DC
 Type: Friwo FW7555M/06, 6 V 2.1A (medical power supply)

Filter box

Dimensions: 80 mm x 120 mm x 80 mm

Weight: approx. 700 g

9. Labelling

A label on the camera housing includes the information about the embedded video sensor and a serial number (SN) as shown in figure 11. There is also a label on the filter box.



Figure 11: Labels on camera (left) and filter box (right)

10. Contact

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