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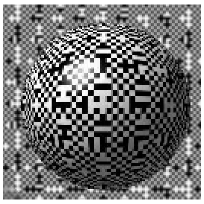

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# RasCaM
# The sensor for the RasNik alignment system.

**The RasCaM is the optical sensor of the RasNik alignment system. It converts the image into a standard video signal. The local pixel clock is also transmitted. This validates the sampling moments for the framegrabber, which is part of the total system.**

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## Introduction

The basic idea is to create an image of a coded mask on a optical sensor by means of a lens. The mask is lit by an infrared LED. In this set up the relative position in X and Y direction is measured along the line mask, optical center of the lens and the sensor. Also the (relative) rotation of the mask or the sensor can be measured. By calculating the actual image spotsize and comparing this with the mask spot size, the position of the lens along the Z-axis is calculated. Also the relative rotation around the X and Y-axis of the mask in respect to the CCD sensor can be calculated.

The system can be split into three major components

1. The optical system:
   - a coded mask
   - a lens
   - an optical sensor
2. The sensor and framegrabber combination (video):
   The optical sensor is a commercially available B&W observation camera, without a lens. This can be a CCD type or CMOS.
   The frame_grabber is a commercially available 8 bit grayvalue type E.G.Data Translation DT3152. The Ras_Mux connects a number of sensors to the framegrabber.
3. The reconstruction software ICARAS.

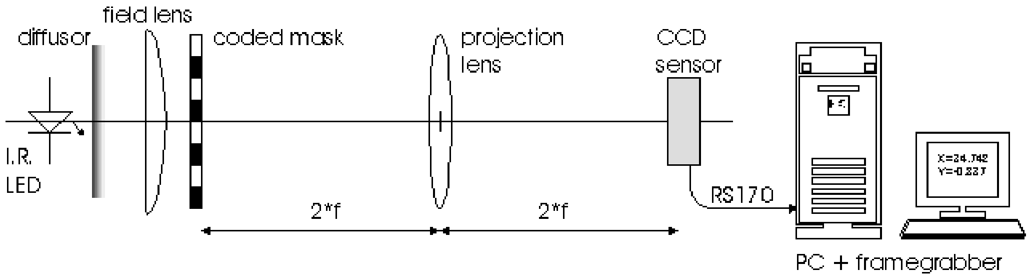



**Figure 1: RasNik system**

This paper describes the sensor (RasCam). Details of the coded mask can be found at: http://www.nikhef.nl/pub/departments/et/ccd_rasnik/restricted/code.pdf or printed as NIKHEF paper ETR 94-10.

For the sensor a CMOS type is chosen. These are less expensive than CCD types, require little power and all circuitry needed to generate the video signal and to control various settings on board of the chip are included.
The board described here also transmits the pixel clock. Compared with a system where the frame grabber generates it own clock (locking on the video signal), this gives a very stable and predictable result. Also oversampling becomes unnecessary which results in smaller raw data files to analyze (110 kbyte instead of the standard size of 390 kbyte).

## Specifications:

The sensor is a CMOS type, the VV5430 CMOS sensor from Vision[1].
The number of pixels is 384 times 287 (grabbing one field or half a frame)
Video standard: CCIR.
The gamma correction is switched off.
Auto gain and auto exposure are switched on.
Pixel size: 12 * 12 µm.
Array size 4.66 mm * 3.54 mm.
$I^2C$ bi-directional bus to control or monitor various settings. An $I^2C$ buffer is added to deal with long (20 m) cables. The $I^2C$ commands will not be described here, since the RasMux translates these into JTAG operations.
For a detailed description of the VV5430 chip see: http://www.vvl.co.uk

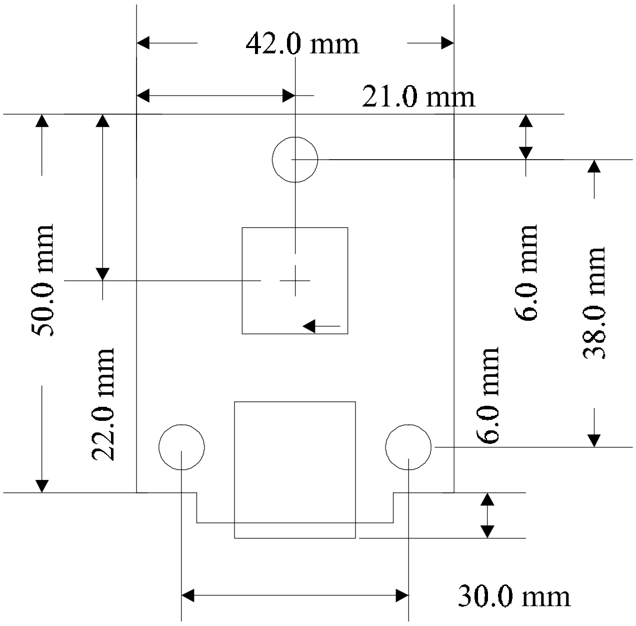
The sensor connects to the RasMux via a single standard FTP cable, the same type that is used in computer networks. This cable contains four wire pairs and carries the following signals:

- Power: A single power supply is required of 9 to 12 V. A cards draws app. 100 mA.
- Video: A semi differential video signal is transmitted by the board upon power up.
- Pixel clock: An LVDS (Low Voltage Differential Signalling) clock validates the sampling of the pixels transmitted. After power-up it runs continuously to simplify the interface to the frame grabber, currently in use at various institutes (Data Translation, DT3152). Please note that after addressing the camera via the $I^2C$ bus, the continuous clock output changes to a visible pixel clock. This can be corrected by the proper $I^2C$ instructions.
- $I^2C$ bus: Using two lines, a bi-directional bus is created. The current settings of the sensor can be read and its settings can be changed.

| PIN | Function |
|---|---|
| 1 | SDA: The data signal of the $I^2C$ bus. |
| 2 | 9 to 12 V power supply input. |
| 3 | +Video output. |
| 4 | +Pixel clock output. |
| 5 | -Pixel clock output. |
| 6 | -Video output. |
| 7 | Ground, 0 V |
| 8 | SCL: The clock signal of the $I^2C$ bus. |
| Case | The shield of the cable is connected to sensor housing.<br>Shield is connected to ground via 10 kΩ. |

[1] VLSI Vision Limited - A company of the ST Microelectronics group.

Board size is 42 times ~50 mm. The board is a little longer at the connector location to stick the connector through the housing.




The arrow indicates the read-out direction. When a lens is mounted on the board it should be mounted as drawn to obtain an upright picture. The mounting holes fit M3 or equivalent.

**Figure 2: Dimensions**

## Options

The board has been designed such that the standard lens –as used for the VV5430 demonstration board- can be mounted. Insulating washers should be used beneath the mounting screws.

The $I^2C$ bus sub-address is 0. It can be changed by means of two jumpers to individually address 4 cameras sharing the same $I^2C$ bus. In the standard RasNik system each camera will have it's own cable. A mounted jumper is a logical one.

The gamma correction is set to one (no gamma correction). This cannot be overruled via the $I^2C$ bus. Gamma correction can be switched on by scratching the line called *Lin*. In that case the correction can be switched on and of via the $I^2C$ bus.

Mounting the jumper *no_clk* will disable the pixel synchronous clock output.

Several signals are made available as solder terminals.

- Lst: Line start, indicates the start of an active video line.
- Fst: Field start.
- Odd: One for odd fields.
- Sync: Resets the video timing logic on the falling edge.

These signals can be used to synchronize variable scan frame grabbers. They can also be used to combine the video signals of maximum four cameras to a single video output. One of the cameras generates the synchronization for the other three in that case. If pixel synchronous clock output is desired, the crystals of the *slaves* should be removed. The clock signal from the master camera should be distributed. There are no special provisions on the board for this purpose.