FIRST EXPERIENCES WITH THE NEW DIGITAL CAMERA ROLLEI D7 METRIC

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Abstract:

Numerous digital cameras with megapixel resolution are available today. The requirements to a metric camera are a fixed focus and focal length, known lens distortion and known position of the principle point relative to the sensor elements. Application software has to provide correction of those deformations. Image quality can be very important when using correlation procedures. Focusing on new presentation technologies like texture mapping, panoramic images, digital stereo pictures and internet presentation is a legitimation for those kind of cameras. Rollei Fototechnic has introduced a new digital camera with SLR technique, fixed focus and focal length and a sensor with 1.4 million pixels. Images are stored in a raw data format and can be corrected under respect of the factory calibration parameters. Details of camera construction and handling are discussed. Some applications best suited for digital camera recording are presented.

1. OPTICAL AND MECHANICAL COMPONENTS OF THE CAMERA

The camera is designed in separate groups all assembled in a sturdy metal body. Lens, mirror, viewfinder and sensor are connected to the front plate of the body, while monitor, storage media, electronic elements and interfaces are fixed at the back of the camera housing. Figure 1 displays a principle construction drawing, here with a zoom lens.

The SLR single lens reflection principle displays the image in the viewfinder exactly as it will be on the CCD-sensor. Since view finding is possible without use of the integrated monitor, power is saved signifcantly at field works. The viewfinder image is projected through the lens and the mirror onto a ground glass. It can be viewed there with a 10 times enlargement through the viewfinder optics.

A carrier plate is used for fixing the CCD chip. The carrier plate itself is assembled at the mirror box with three screws braced with springs. This technique enables precise adjustment relative to the lens position.

In front of the mirror unit the lens system including aperture, shutter and motor drives, is connected. On top the view finder is mounted. This units together are independent assembled from the others and fixed at the front plate of the metal housing. Due to this design a sturdy interior orientation over a long term is guaranteed.

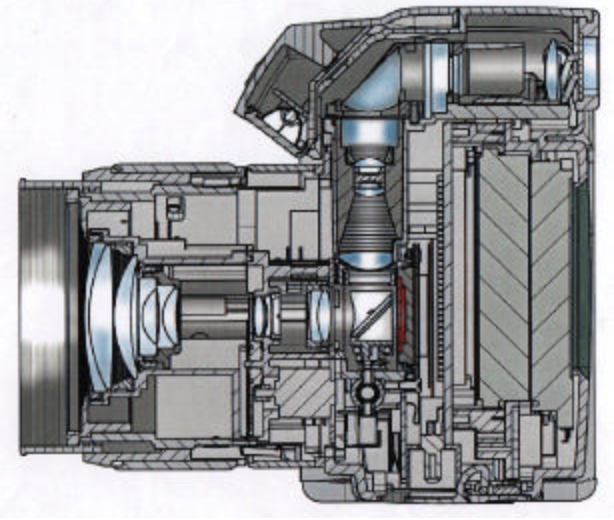

Figure 1: Principle construction drawing of the Rollei d7 metric camera.

The optic, a Rollei APOGON HFT lens, consits of 6 components resulting in a focal length of 7.3 mm which corresponds to a 28 mm lens compared with a 35 mm format. Light intensity is 2.8. Due to the metric requirements the focus is fixed. The field of depth ranges from 0.50 m to infinity. See figure 2 for arrangement of the lens components, parts of the viewfinder system and the image surface. A mechanical shutter is used additional to the electronic one for eliminating blooming. Taking an exposure by pushing the release button

initializes the following procedure: The shutter closes and reset of the sensor elements will be done. Afterwards the shutter opens and the sensor is taking the light. Finishing exposure by the sensor closes the mechanical shutter as well. The mirror is moved sideways before and after taking the picture. Range of shutter time is from 1/8 to 1/10.000 of a second.

Since the fixed focal length lens is not changeable, the focus is fixed and due to the construction principle of grouping the elements in the described arrangement, the Rollei d7 metric camera is best suited for metric applications.

The interfaces of the camera are a standard PCMCIA card adapter for using all storage media available on the market. With one plug in SCSI, parallel and serial interfacing is carried out. The video interface can be switched from PAL to NTSC. Power is provided by six rechargeable mignon accus. For stationary use a net device can be used. Buffering the data is carried out with a 3V lithium battery.

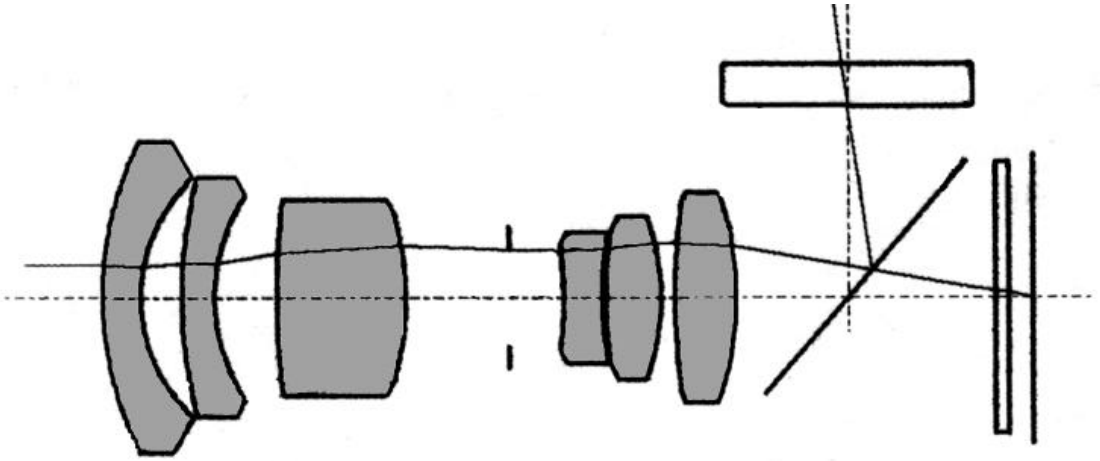

Figure 2: Arrangement of the six componentes of the Rollei APOGON HFT lens 2,8 / 7.3 mm focal length. Other drawing elements are the aperture, the mirror, the ground glass displaying the viewfinder image, the glass coverage of the sensor and the sensor surface.

A 2,5´´ LCD -monitor provides previewing of images and comprehensive information about cmera settings, exposure data such as frame number, flash mode, exposure functions, battery status, date and time. From the LCD you can check an erase individual shots from the memory card. An integrated flash with guide number 12 and external apater for SCA flash units as well as powerful studio flash units completes the funcionallity of the camera.

2. ELECTRONIC ELEMENTS AND SOFTWARE FUNCTIONS

The block diagramm of figure 3 gives an overview about the electronic components in a digital camera system.

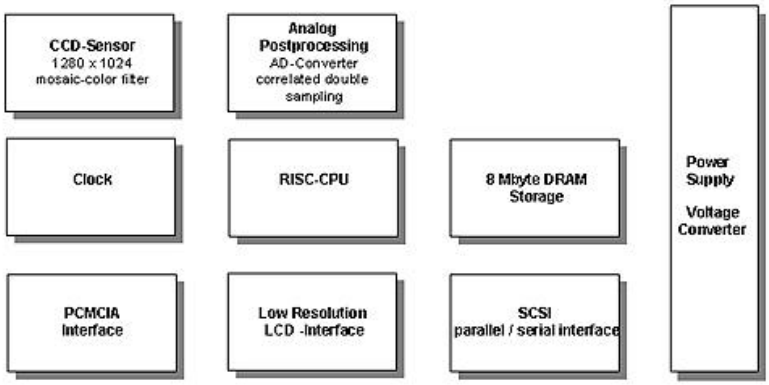

Figure 3: Block diagram of the electronic components of a digital camera

The element a photographer focuses first on is the sensor, in combination with the lens the most important component for image quality.

The Sony ICX085AK, used for the Rollei camera, is a 2/3-inch interline CCD solid-state image sensor with a square pixel array. Progressive scan allows all pixel signals to be output independently within approximately 1/12 second. This chip features an electronic shutter which makes it possible to realize full-frame still image without a mechanical shutter. Despite that, Rollei added a mechanical shutter for eliminating blooming effects. High resolution and high color reproductivity are achieved through the use of R, G, B primary color mosaic filters. The primary color filters of the sensor are given as shown in figure 3 where Gr and Gb denote the signals on the same line as the R or B signal (Bayer arrangement) . Due to this filter arrangement the chip collects 50% green filtered pixel, 25% blue and 25 % red filtered signals. From this information interpolation has to be done to transform the raw data into a bitmap image. The total number of pixels is 1360x1034. Rollei uses a resolution of 1280*1024 for a complete image. The cell size is 6.7 x 6.7 microns.

A digital camera is equipped with a CPU including an operating system. An analog postprocessing unit is responsible for converting the analog signal into a digital signal. Correlated double sampling is performed to reduce noise. The image in raw data format is transported into the 8MByte DRAM, this is done in approx. 160 micro seconds. Storing the image onto the external memory media is dependend from the media type and needs about 3 to 10 seconds. The CPU has to control this write process. Furthermore the low resolution screen has to be driven for showing images from DRAM or external media and the control parameter used for the photo have to be added to the image header. A second micro controller is used for controlling lens functions, shutter an the settings from the keyboard. A sophisticated power supply must provide different voltages

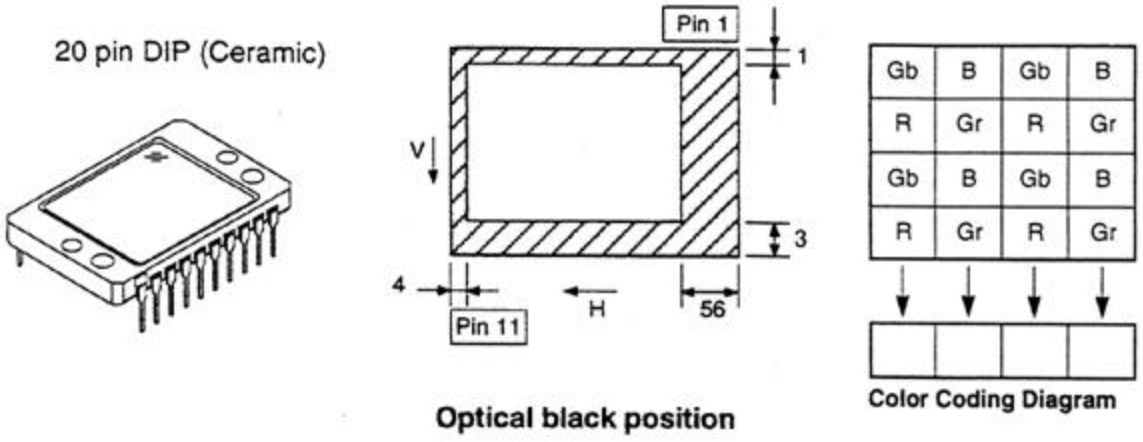

Figure 4: The CCD line transfer sensor and its color coding system

As mentioned above any memory media with a PCMCIA interface can be used for storing images. An image in raw data format needs 1.8 Mbyte storage space. Inside the camera thumbnails are generated and stored together with the raw data format. The software for processing the images on an external computer displays the thumbnails. By selecting one of the images, the raw data will be interpolated and converted to a bitmap file in RGB mode. Some image processing software functions enable image improvement like gray value adjustment or sharpening. Images than can be saved to the harddisc in common image formats like BMP, JPG or others.

For photogrammetric purposes the camera is calibrated. Rollei takes several shots from a flat calibration field in oblique and inverted order. Image measurement of points is done automatically. The parameters for position of principle point, principle distance, radial lens distortion, decentering distortion and orthogonaltiy and affinity are determinated by bundle adjustment. All values are written to the memory of the processor of the camera and added to any image file stored with a Rollei d7 metric camera. The application software can do image refinement upon user request. Every pixel is corrected about the principle point shift and the distortion values, before writing the image file. This function is necessary for furtherprocessing the images with software packages which are not capable of those transformations.

3. APPLICATIONS FOR MEGAPIXEL CAMERAS IN CLOSE_RANGE PHOTOGRAMMETRY

Why should one use a digital megapixel camera in close-range photogrammetry ? This question has to be answered under consideration of the available equipment and the application. Alternative to the use of a digital camera is film scanning. The disadvantage of a standard camera is that film flattening and definition of a reference for the image co-ordinate system needs modifying the camera. Modifying a camera includes high effort and is connected to some investment of money. A digital camera with a fixed focus and focal length meets the

requirements to a metric camera without any modification. While using digital images from film scanning the calibration should be given for the system camera - scanner. Using a 35 mm réseau camera or a medium format camera like the Rolleiflex 6008 metric has its benefits in the image format. The following table compares image format, resolution, and image scale for common types of metric cameras. The image scale is assumed from an object size of 15 m projected into the full frame. Cell size of 2000ppi scanning is approx. microns. New type of „of-the-shelf“ scanners provide an optical resolution of 4000 ppi.

camera type	**image format** [mm]	**resolution / mio pix** [film scan 2000ppi]	**image scale** [object size 15 m]
digital d7 metric	8,6 x 6,9	1280 x 1024 / 1,3	1:1700
35 mm réseau	24 x 36	1890 x 2830 / 5,3	1:400
Rolleiflex 6008	55 x 55	4330 x 4330 / 18,7	1:270

Table 1: Comparing image format, resolution and image scale of different types of cameras.

If one can accept the smaller image scale, a digital megapixel camera is a useful tool in close-range photogrammetic applications, especially for architecture, archaeology or event documentation.

New applications coming with the development of digital image processing and internet publication facilities simply request digital photography.

Digital panoramas are popular for complete scene descriptions and interactive viewing. A precise panorama can be taken if the camera is leveled and rotates around the perspective center. The segmented images must have all exactly the same resolution for stitching the images together.
Interactive viewing of the panorama within a Web browser is performed by plug-ins like QTVR or LivePicture Viewer. Figure 6 shows the Rollei d7 metric on a panoramic head from Kaidan. A panorama is displayed in figure 5 The panorama can be viewed interactively by visiting http://www.imagefact.com. Under gallery one can beside others find this publication. Clicking figure 5 opens a window for interactiv viewing of this panorama with a JAVA applet, so that no plug-in has to be installed. A photo object and stereo images are presented on that Web-site as well. Viewing the spin photo object needs QTVR.

Figure 5 : 360 degree panorama taken with a digital camera

Figure 6: Rollei d7 metric fixed on a panoramic head for taking segmented 360 degree panoramas

Figure 7: Rollei d7 metric assembled on a stereo bar recording a photo object.

Virtual reality models are based upon geometry and texture. Image based objects can be interactively viewed as well. The above described panaroma is one. Another technique is provided by a spin photo object. In the following sample the marble head of the goddess Hygeia from Epidaurus , 4th cent. B.C. is presented by an object model consisting of 36 photos taken form a fixed position while rotation the object on a turntable. Using QTVR enables interactive viewing with rotation and zooming. Figure 7 displays the exposure arrangement with the Rollei d7 metric on a stereo bar.

CONCLUDING REMARKS

The advantages of digital photogrammetry cover a long list. In the above mentioned application image control on site and direct further processing is most important. The requirements to a metric camera are fulfilled by a megapixel camera if the focus and focal length is fixed and the camera itself is stable constructed for use in the field works. A digital metric camera is best suited for new applications like photo objects or panoramas, stereo images or evaluation by means of correlation, production of digital image maps or orthopotos. With the production of the d7 metric digital camera Rollei has taken into account all the requirements a photogrammetrist has.

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