

ROLLEIFLEX 6008 METRIC - A NEW CAMERA FOR INDUSTRIAL PHOTOGRAMMETRY

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The product range regarding the recording systems for industrial photogrammetry of Rollei Fototechnic (Rollei Large Format Camera LFC, Rollei R_Metrika) has been extended by the Rolleiflex 6008 metric, a new model in the film format of 60 x 60 mm.

Also for this camera, the strict réseau technique is pursued by making use of a fixed, integrated grid plate with a mesh size of approx. 2 x 2 mm. The body of the camera with objective, ring flash and réseau preexposure being integrated in a rolling ring unit as well as the electronic camera control performed by a microcomputer are guaranteeing a simple handling of the recording system on the spot.

Efficiency and possible accuracy are presented by examples of measuring tasks. These tasks are aiming at precise point determination required for surface measuring or in the field of quality control.

1. INTRODUCTION

The application of close range photogrammetry to solve every day measurement tasks in industry is a technique that has already been introduced in practical work.

For highest requirements of accuracy the user has today at his disposal close range photogrammetric systems, which achieve the accuracy level of modern precise theodolite measurement systems in 3D point measurement /1990 Heister, H., Peipe, J.; 1991 Dold, J., Riechmann, W./.

The arguments for the application of a photogrammetric system are short the recording time of the object to be measured in combination with the short interruption of running production processes, a free choice of recording positions, temporary and spatial separation of recording and evaluation, as well as the possibility to automate the evaluation. These arguments led to the fact, that numerous systems are installed for solving industry measurement tasks.

The photogrammetric industrial measurement system developed by ROLLEI FOTOTECHNIC, GERMANY consists of the Large Format Camera LFC, the digital monocomparator RS1 for the high accuracy image point measurement as well as the driver and evaluation software of RolleiMetric /1990 W. Wester-Ebbinghaus /.

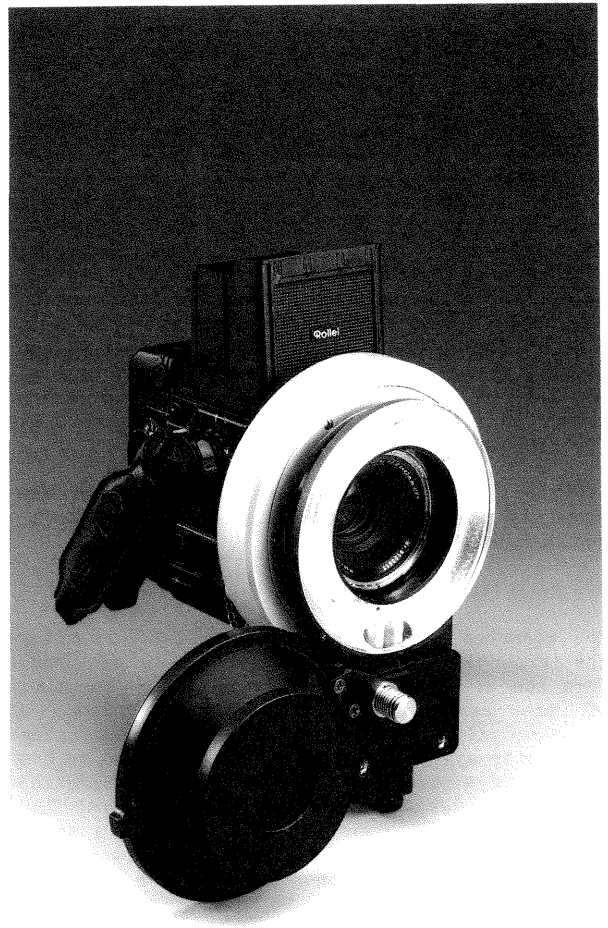


Fig.1: Rolleiflex 6008 metric

The new recording system Rolleiflex 6008 metric extends the product range based on the principle of strict réseau technique by a powerful metric camera system in the medium film format size (60 x 60 mm).

The Rolleiflex 6008, which was developed for professional photography, was modified for the application in photogrammetric measurement technique by introducing a réseau plate and a number of technical developments.

The réseau preillumination and the flash system allow the use of retroreflective points signals. An automatic image evaluation can be effected with the Rollei RS1 réseau scanner and the measurement software MIROS /1992 Knobloch, Rosenthal /.

Many tasks can be solved with this low cost and practical camera system. It is fully compatible with the existing system components RS1 réseau scanner and the RolleiMetric Software and therefore allows the extension and upgrading of these systems.

2. ROLLEIFLEX 6008 METRIC

For the application in the high accuracy 3D measurement technique, the photogrammetric measurement system has to meet with strict demands:

- reliable flattening of image surface,
- rigorous formulation of the camera model,
- simultaneous determination of the image space parameters /1990 Wester-Ebbinghaus /.

The medium format camera Rolleiflex 6008 metric as well as the Rolleiflex 6006 metric were developed out of the standard production for professional photographers and meet with the requirements of a photogrammetric measurement system.

The camera body is an exceptionally tough special aluminium casting.

The geometric image space is further assured by high precision adjustment of camera and lens.

The fixed film positioning together with the mechanic film flattening is not produced in the magazine but in the camera body. When opening the built in laminar drawslide, the film plate is pushed forward on the filmguidebar. The film is fixed with elastic clips at both sides. Mechanical film flatness in the Rolleiflex 6008 metric is simple, for it just has to hold the film sufficiently in the focal plane for sharp imaging.

The use of the réseau grid (mesh width 5 mm, 121 crosses) in the Rolleiflex 6006 metric makes possible a sufficient correction of the film plane by réseau transformation on the calibrated cross positions.

The Rolleiflex 6006 metric has been established in the photogrammetric recording technique for years. The user has at his disposal a electronical SLR Camera with the exposure control, motorised film transport and a large range of metric lenses for different tasks.

For the use of the medium format system of the 6000 series as a measurement camera in the RolleiMetric industrial measurement system, further requirements are:

- a flash system, which is adjusted around the lens, necessary for the use of retroreflecting point signals.
- for a perfect film plane, a fine réseau grid (app. 2 mm) is used, which is also applied for the sensor orientation of the réseau scanner /1991 Dold, Riechmann, 1988 Luhmann, Wester-Ebbinghaus/.
- a réseau preillumination assures a perfect measurement of the crosses in the image,
- for easy handling an electronic camera circle is important,
- there must be the possibility to tilt the camera by +/- 200 gon.

Furthermore, it is desirable that the camera can be used without flash and preillumination with all features.

In its present form, the Rolleiflex 6008 metric has a fine réseau plate (mesh width $x = 2.375$ mm, $y = 1.75$ mm, 23 x 31 crosses). The ring flash and the preillumination unit are fixed at the rotation ring as well as the recording system via a quick setting. A tilt of +/- 200 gon possible with the rotation ring. For the preillumination a reflector is moved in front of the lens. A definable quantity of the flash light is then given into the lens through the reflector. The essential camera circle for taking measurement pictures is the following:

1) main illumination

The first illumination of the film with flash light for recording the object points

2) réseau preillumination

The réseau preillumination is achieved by setting the reflector in front of the lens.

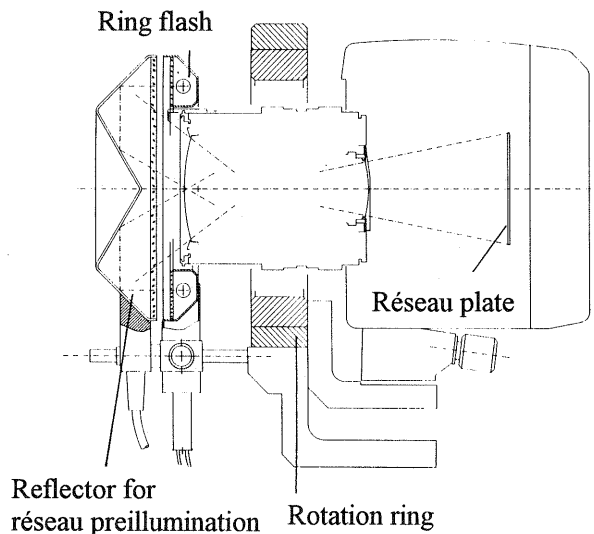


Fig. 2: Technical drawing

3) film transport

After the preillumination the film is then transported.

An integrated rechargeable power supply feeds the camera with electricity. An external power supply feeds the flash unit. For industrial application, the ZEISS lenses Distagon 4/40 mm metric, Distagon 4/50 mm metric and Planar 2.8/80 mm metric belong to the standard equipment.

To meet with all different requirements, the Rolleiflex 6008 metric system with its flash and preillumination unit offers the use with a tripod as well as the hand held recording. The camera can be used outside the preillumination and flash unit with all features for taking standard pictures.

3. APPLICATIONS

In the following, three measurement results are presented:

Surface measurement

For controlling the tension situation on a conveyer belt for coal, a surface of app. 1 x 1 m was signalled with retro target in regular intervals. A calibrated scale was used.

The bundle adjustment gives the following results:

(8 pictures, 659 unknowns, 3082 observations, 1 camera)

SIGMA0 = 0.0007 mm
 RMS x = 0.0006 mm
 RMS y = 0.0006 mm

The object points were determined with following accuracy (standard deviation):

SX = 0.01 mm
 SY = 0.08 mm
 SZ = 0.01 mm

Fitting check for plane parts

For quality control of plane parts, it is necessary to check certain parts before adjustment into the whole. In this case, a large format camera Rollei LFC (230 x 230 mm) or Rollei R_Metrika (120 x 95 mm) / 1992 Peipe, Suilmann, Wester-Ebbinghaus / is used to meet with the accuracy requirements. For testing purposes, the Rolleiflex 6008 metric was also used in this application.

In this test, the design of the retro target was developed for a use of a large format camera. For an automatic point determination with RS1 software the size in the 60 x 60 mm pictures was too small. The measurement had to be effected in the manual mode and a lower accuracy was accepted.

The bundle adjustment gave the following results:
 (14 images, 659 unknowns, 3082 observations, 1 camera)

SIGMA0 = 0.0023 mm
 RMS x = 0.0019 mm
 RMS y = 0.0022 mm

SIGMA0 = est. variance of unit weight
 RMS x, RMS y = mean square residuals of image coordinates

The object was determined with the following accuracy (standard deviation):

SX = 0.15 mm
 SY = 0.10 mm
 SZ = 0.09 mm

Technical data Rolleiflex 6008 metric	
Type	Single lens rollfilm camera system with electronic micro computer control, multi mode exposure control, multi function TTL metering, motorised film transport and action grip.
Picture size	6 x 6 cm (2.25 x 2.25 in.)
Shutter	Electronically controlled leaf shutter, 1/500, or 1/800 to 30 sec. and B with direct drive control by two linear motors built into each lens.
Lens mount	Rollei bayonet fitting with 10-pole terminal strip to transmit iris shutter drive pulses.
Réseau	number of crosses in x: 23 number of crosses in y: 31 mesh width in x: 2.375 mm mesh width in y: 1.750 mm Réseau preillumination with flash and reflector.
Lenses	40 mm Zeiss Distagon PQ f/4 HFT metric (angle of view: diagonal 88, horiz. 69 deg.). 50 mm Zeiss Distagon PQ f/4 HFT metric (angle of view: diagonal 75, horizontal 57 deg.). 80 mm Zeiss Planar PQ f/2 HFT metric (angle of view: diagonal 52, horizontal 38 deg.).
Weight	body with 80 mm lens 2060 g, preillumination and flash unit app. 2000 g, external accu for flash unit app. 500 g.

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Fig. 3: Technical data

A comparison with the results of the Rollei Large Format Camera LFC shows the following differences in the object points:

(mean values)

$$dX = 0.19 \text{ mm}$$

$$dY = 0.24 \text{ mm}$$

$$dZ = 0.27 \text{ mm}$$

Object size : approx. 6 x 6 x 2 meters.

Comparison to other measurement methods

Further comparison with other measurement methods are shown in /1992 Riechmann/.