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Presented Paper

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# 10 Years UMK 10/1318 Universal Measuring Camera

Abstract

In conjunction with a retrospection of the development of the UMK 10/1318 wide-angle camera produced since 1969 a report is given on two new units UMK 20/1318 and UMK 30/1318 long-focal-length measuring cameras efficiently supplementing the universal measuring camera system. Strictly following the modular design principle the camera itself is the only part that needs to be exchanged to obtain one of the new systems.

In 1969 JENOPTIK presented at the Leipzig Spring Fair an instrument system for industrial photogrammetry. It consisted of a well-matched range of cameras and plotters; it had been designed specifically for use in industrial metrology, which was then becoming increasingly prominent as an application area, everywhere. Thus a new camera took the interest of the community of experts and gave an important impulse to near-zone photogrammetry in the world- the Universal Measuring Camera type UMK 10/1318.

The functional principles that went into the design of this unit were unlike those normally used in terrestrial cameras; others had not been applied before because, technically, it could not be done. A comparison with the Photheo 10/1318 topographic phototheodolite clearly shows this. For many years part of the manufacturing programme it had been used until then even for architectural surveys and similar jobs. By the following new funtional principles we were to tailor the UMK 10/1318 to the needs of the very mixed field of near-zone photogrammetry:

. Camera and mount are separate units now. This was essential for extending the unit into a modular system as it gives a wide range of choice in camera-object arrangement.

. Use of a true wide-angle lens with the standard photoplate size of the Photheo.

. Continuous focussing by axial shift of the lens which does away with exension tubes and accessory lenses.

. The shutter can be released mechanically or by an electromagnet, which also lights up the collimating marks and additional data registrations. In this way it is possible to trigger two cameras at the same time from one control.

The mount used for the instrument introduced in 1969 was the orientation system for controlled single-camera arrangement (Fig. 1) / 1 /. The camera lens had a focussing range from 3.6 m to ∞ and photographs could be taken from a distance of at least 2.5 m.

A second version of the camera came out in 1971; it was called IMK 10/1318 industrial photogrammetric camera (Fig. 2) / 2 / and configured for close-range conditions. It consists of two cameras mounted on one support. The main concern was to allow for a widely variable adjustment of space orientation. Because of the design of the mount it was used mainly as a stationary camera, providing the object was carried to the camera and not the other way round. The fact that the camera could be separated from the base was found to be very useful in designing the IMK. The radius of action of the camera was limited to a maximal camera-to-subject distance of about 10 metres, since the base length obtainable with the IMK 10/1318 was 1.6 metres maximally. This meant in terms of distortion behaviour that the Lamegon

8/100 lens (with a distortion of ≈0 µm at a distance of y = ∞ and about 10 µm at y = 3.6 m), which had been with the UMK 10/1318, had to be replaced by another type of lens with maximum distortion in the near zone. This was Lamegon 8/100 N with $\Delta r' \approx 0$ µm at a distance of y = 2.3m. The overall focussing range of the IKM cameras was 1.5 to 4.4 m. Thus, with the camera lens fully stopped down photographs could be taken from a distance as close as 1 m.

Many aspects of the UMK/IMK complex were modified later on the basis of practical data and the international trend in industrial photogrammetry. The result - the UMK 10/1318 Universal Photogrammetric Camera System - hit the market in 1973 / 3/. Improvements were made in three main areas:
. lenses were given a wider focussing range;
. another three versions were added to the range of mounts;
. roll film as an alternative to plates also with fully automatic camera cycles.

The basic parameters have remained unchanged.

In the field of mounts we now have in addition to the orientation system a single-camera mount without azimuthal aligning system (single mount) and a single-camera mount for shooting in vertically downward position (vertical mount) (Fig. 3). Two single mounts may be combined on one support beam to give a double mount (Fig. 4). The tripod of the IMK 10/1318 was adapted and included in the system as the measuring stand. These redesigns advanced us a long way towards.
The IMK had not been designed for transport over long distances. Now, with the double mount, stereo close-up shots at the site of the object are easier to take as one can set up three different symmetrical stereo bases.

The vertical mount has filled the need for a suitable assembly to shoot immobile objects spreading in the horizontal, such as crane runways, etc. .

The need for distortion-free lenses in industrial photogrammetry is going down since analytical plotting based on image coordinates obtained by stereocomparator is becoming increasingly the practice.
And it is no problem at all to include into the computer program numerical correction for distortion, at least for rotation-symmetrical radial distortion, and for systematic errors such as asymmetry and affinity.

In the new modular system both types of lens (Lamegon 8/100 and 8/100 N) were given the same focussing range of 1.4 m to ∞ , thus reducing the need to choose a suitable type of camera to a few special cases. One such case being subsequent evaluation by an analogue stereoplotter which requires great accuracy; therefore one cannot put up with the deformations of the model caused by the rather high degree of distortion of more than 20 µm "at the other end"

of the lens. Otherwise the instrument's useful range was extended to camera-to subject distances between ∞ and about 1 m. So, instead of having to make a number of complicated changes on the camera body there is one camera for large objects, detail shots and pin-points.

The system's service value has been greatly improved by several functional units for shooting on 19-cm wide roll film (Fig. 5). Apart from the fact that some emulsions are simply not available today on plates (Color, for an example), roll film as compared to plates is far less weight to carry if the job requires that many photographs are taken at or from, a particular place or point. Its main advantage, however, is the following: roll film and an automatic time sequence of consecutive photographs have enabled us to measure even moving or changing objects in their consecutive, defined states.

All modifications to the UMK universal photogrammetric camera were based on the use of Lamegon wide-angle lenses. Two things were considered at the design stage: a diagonal field angle of 100 gon is optimal for most conditions of shooting - a fact practice has proved to be true many times over; accuracy, on the other hand, demands that the focal length be as long as possible.

The wide-angle camera seems to be as much a standard type in near-zone photogrammetry as the aerial survey camera type 15/2323 is in aerial photogrammetry.

It has turned out, however, that a 10/1318 system will not always fill the format as it should; that is, objects are not in every case recorded at the largest possible image scale and with maximum accuracy; add to this that wide-angular coverage involves the risk of dead space in very relived objects.

For these reasons the Photheo 19/1318 with its long focal length of about 195 mm will still be the instrument of choice in many instances where the object is farther away from the camera. However, as we said before, this instrument is tailored entirely to topographic purposes; thus it lacks many of the functional elements essential to industrial photogrammetric and closs-range work. Some of these are: shutter, large relative aperture, focussing, film magazine.

We, therefore, aimed our redesigning efforts at combining the Photheo's long focal length with the functional parameters of the UMK system. The outcome of these efforts was the UMK 20/1318 universal photogrammetric camera and the UMK 30/1318 (Fig. 6) first presented in 1979 at the Leipzig Spring Fair.

Table 1 compares the parameters of the three types of camera.

The modular design principle was strictly followed:

the only part that needs to be exchanged to obtain one of the new systems is the camera itself; the remaining units can be used as they are (mounts, magazines, electronic shutter release). All cameras are equipped for automatic camera cycles. Generally speaking, the various types of camera differ only insofar as their parameters are changed according to prevailing conditions of shooting. Such parameters are angular coverage, focussing distance and, concerning UMK 10/1318, maximum aperture. Lametar 8/200 and Lametar 11/300 / 4 / are high-performance lenses of recent design with excellent optical properties. The Lametar 8/200 is continuosly focusable like the Lamegon 8/100.

The focusable distance range in the usual field of use is 5.8 m to ∞ which can be stepped to record the relevant P.D. allowance. The rotation-symmetrical radial standard distortion is less than ± 4 µm throughout the focussing range. The shortest focussing distance is given as roughly 4 m, since the camera lens can be stopped down to f/32. With a diagonal angle of coverage of 56 gon the Lametar 8/200 is a true normal-angle lens.

The Lametar 11/300 narrow-angle lens (diagonal angle of coverage 39 gon) can not be focussed continuosly. The fixed adjustment to a camera distance of 50 m gives a depth of focus range with the lens stopped down of ∞ to about 25 m. A special-purpose camera the UMK 30/1318 is configured for long-distance work and insufficiently featured objects; that is for those instances where even the focal length of a normal-angle camera is too short. The focal lengths mentioned above are rarely used for close-ups. When required, the camera can be permanently focussed to distances other than the ones mentioned. The amount of distortion (standard) at a distance of $y_o$ = 50 m is ± 2 µm; distortion is never more than ± 5 µm even if the camera is focussed to distances as short as 5 m.

The possibility of choosing any combination of camera and mount, magazine and electronic controls makes for considerable variation in the applicability of the system thus obtained. The UMK 1318 Universal Photogrammetric Camera System accommodates more than any system before the diversity of conditions in terrestrial photogrammetry, industrial metrology, architectural photogrammetry and other areas. As focal distances increases, single mounts will be preferred because of the greater distance between camera and subject.

A new type of plate magazine, which can take photoplates of up to 6 mm thickness, was developed along with the new cameras. This helped us to meet a situation where the flatness of such plates as are available on the market sometimes fails to be good enough for the kind of precision expected nowadays of industrial photogrammetry. For instance, only glass plates that are more than 5 mm thick are reasonably safe to give a flatness of ± 5 µm. Further, to reduce the number of parts to be carried we housed the

electronic trigger units of the UMK film camera (trigger unit and control unit) in one module, now called control unit B. It contains the intervalometer and the trigger unit proper; without intervalometer it converts to the trigger unit B when there is no need for automatic cycling.

References

/ 1 / VOSS, G.: UMK 10/1318 Universal Photogrammetric Camera System. Jena Review 14 (1969) 2, 107 - 110.

/ 2 / IMK 10/1318. Publication No. 14-323a-1 (1972).

/ 3 / VOSS, G.: The UMK 10/1318 Universal Photogrammetric Camera System of the JENA Optical Works. Jena Review 18 (1973) Special Issue Spring Fair 1973, Leipzig, p. 63-67

/ 4 / WÜRTZ, G.: New aerial camera lenses from JENA, Vermessungstechnik (in print)

Table 1: Parameters of three types of camera

| Camera | 10/1318 F | 10/1318 N | 20/1318 | 30/1318 |
|---|---|---|---|---|
| Lens | Lamegon 8/100 | Lamegon 8/100N | Lametar 8/200 | Lametar 11/300 |
| Focal length | 99 mm | | 200 mm | 300 mm |
| Max.standard distortion (up to r'= 90mm) for focusing distance | ± 1/um | | ± 4/um | ± 2/um |
| | 25m | 2.1m | full range | 50m |
| | ± 10/um | | | ± 5/um |
| | 3.6m... ∞ | 1.4 ...4.2m | | 5/m |
| Shutter Exposure time | T,B,1 ..... 1/400 s | | | |
| f-stop | f/8 ..... f/32 | | | f/11...f/32 |
| Focussing | ∞;25;12;8;6;5;4.2;3.6;3.2; 2.8;2.6;2.3;2.1;2.0;1.8;1.7; 1.6;1.5;1.4m | | ∞;67;34;22;17 14;11;9.5;8.5 7.5;7;6.3; 5.8m | 50 m (Standard) |
| Useful frame size | 120 mm x 166 mm | | | |
| Useful angle of coverage | | | | |
| Long side of the format,max. | 88gon. (79°) | | 50gon(45°) | 34gon(31°) |
| Short side of the format,max. | 68gon (61°) | | 37gon(33°) | 25gon(22°) |
| Max. diagonal | 97gon (87°) | | 56gon(51°) | 39gon(35°) |
| Degrees of tilt of camera axis | +100gon(+90°) | +66 2/3gon(+60°) | +16 2/3 gon (+15°) | -16 2/3 gon (-15°) |
| | +83 1/3gon (+75°) | +33 1/3 gon(+30°) | 0 gon | -33 1/3 gon (-30°) |
| | (broadside and with film magazine only between +33 1/3 gon and - 33 1/3gon) | | | |
| Additional data registrations | P.D. for ∞ | | | P.D. for focussing distance |
| | P.D. allowance for individual steps of focussing | | | |
| | Frame No. 1 ... 72 ; | | | |
| | camera station and occasion A,AL,AR,B,BL,BR | | | |

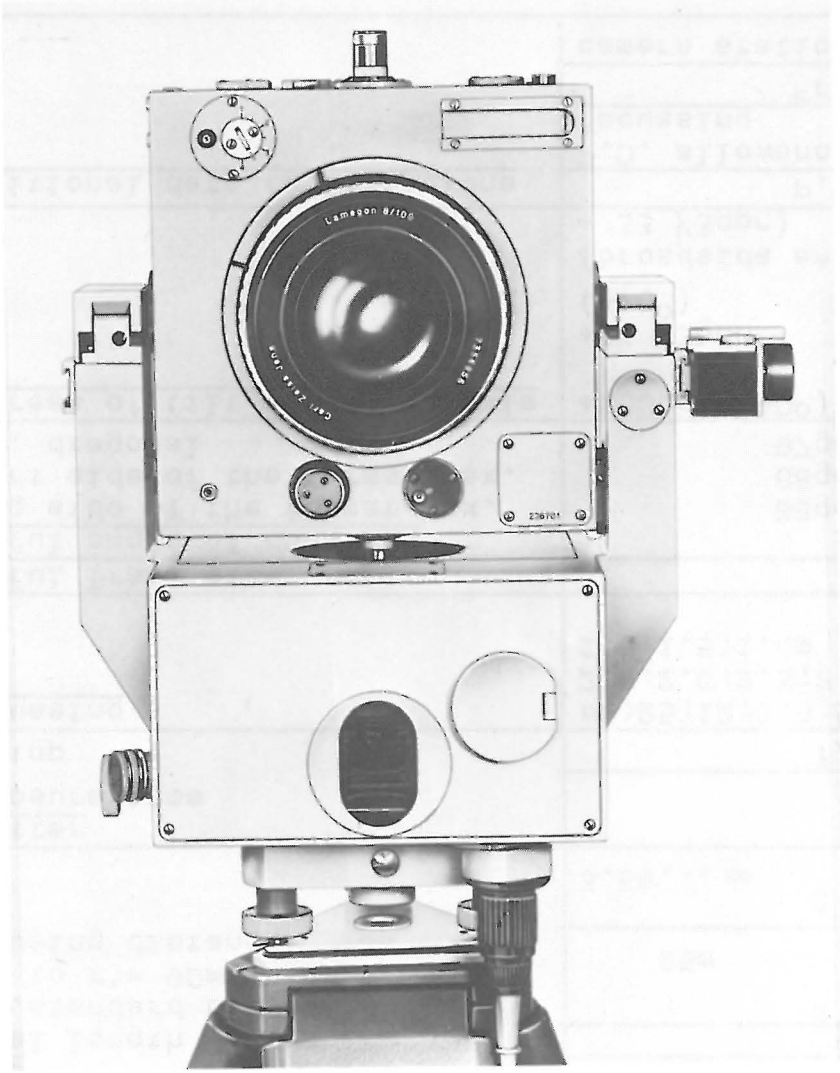


Fig. 1 UMK 10/1318 Universal Measuring Camera (1969)

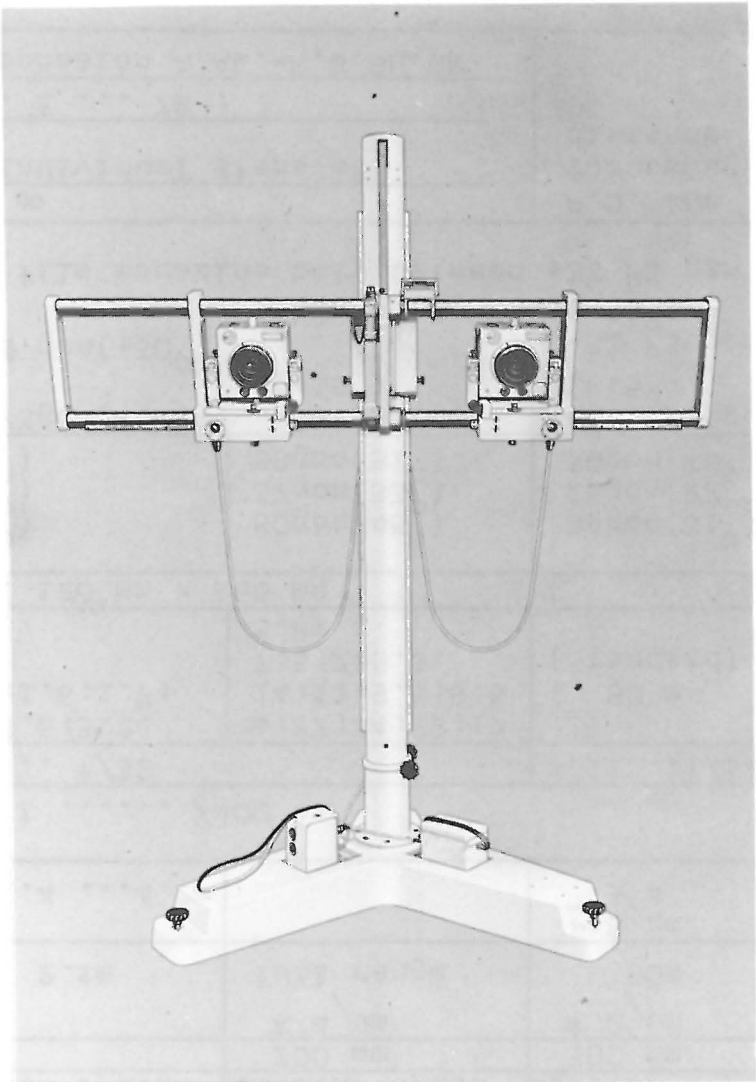

Fig. 2 IMK 10/1318 Industrial Measuring Camera (1971)

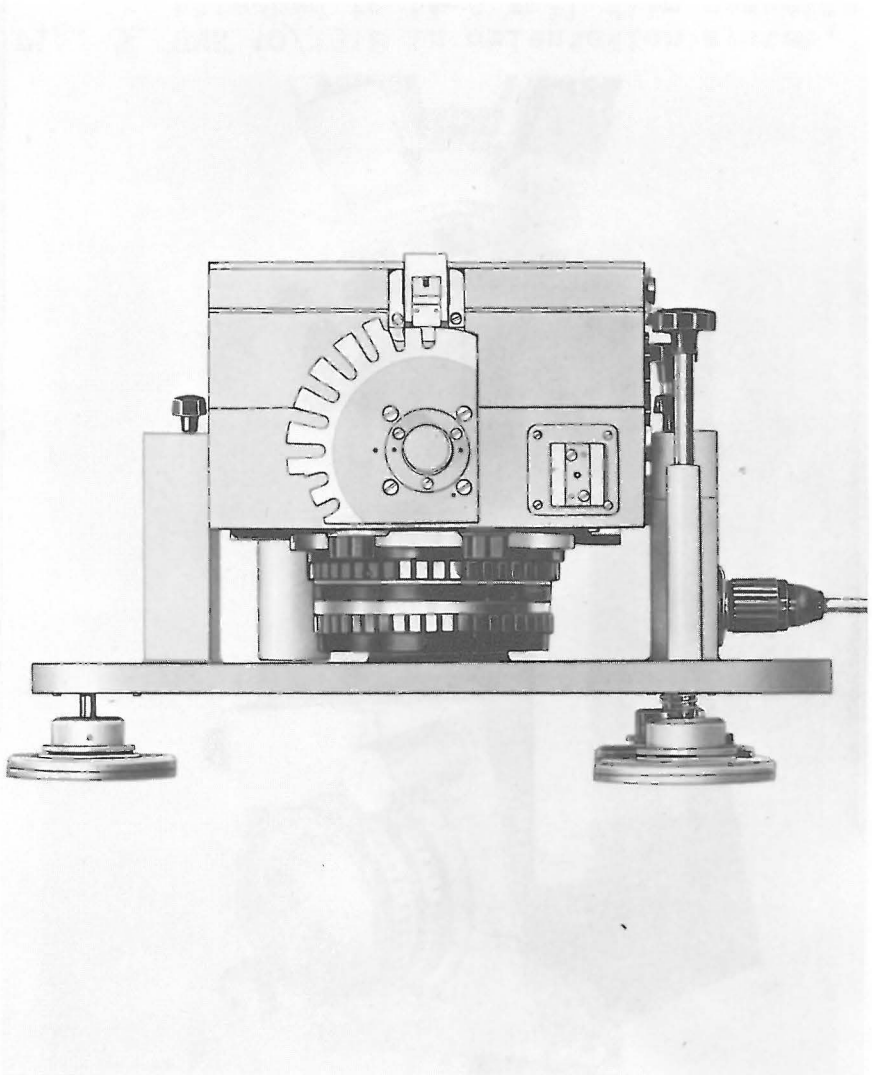

Fig. 3 UMK 10/1318 Universal Measuring Camera in vertical mount(1973)

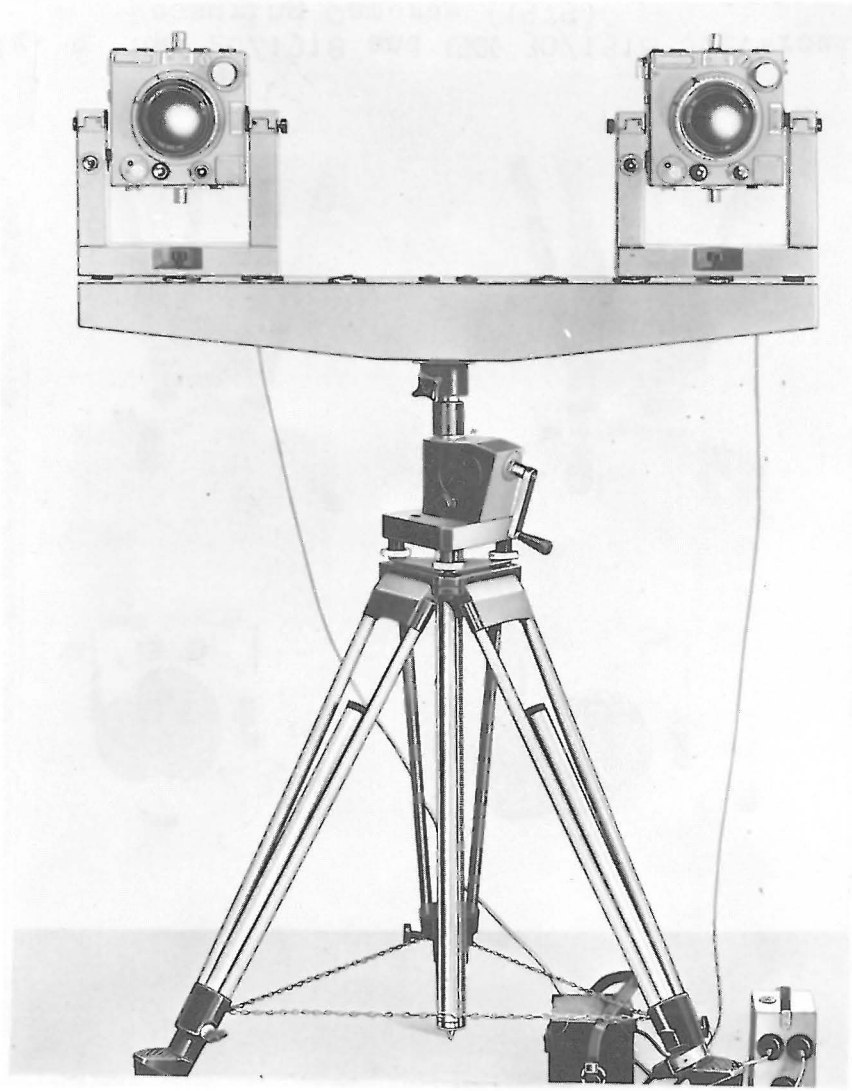

Fig. 4 UMK 10/1318 Universal Measuring Camera in double mount (1973)

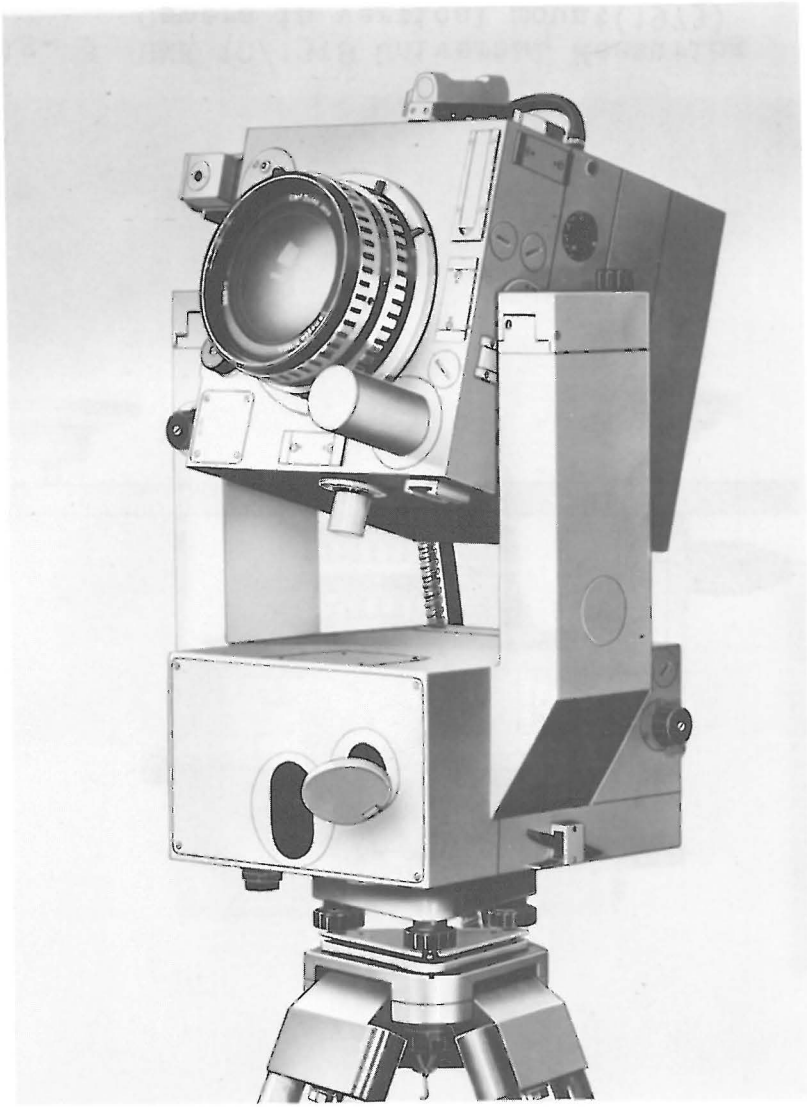

Fig. 5 UMK 10/1318 in orientation system, attached to it a roll film cassette (1973)

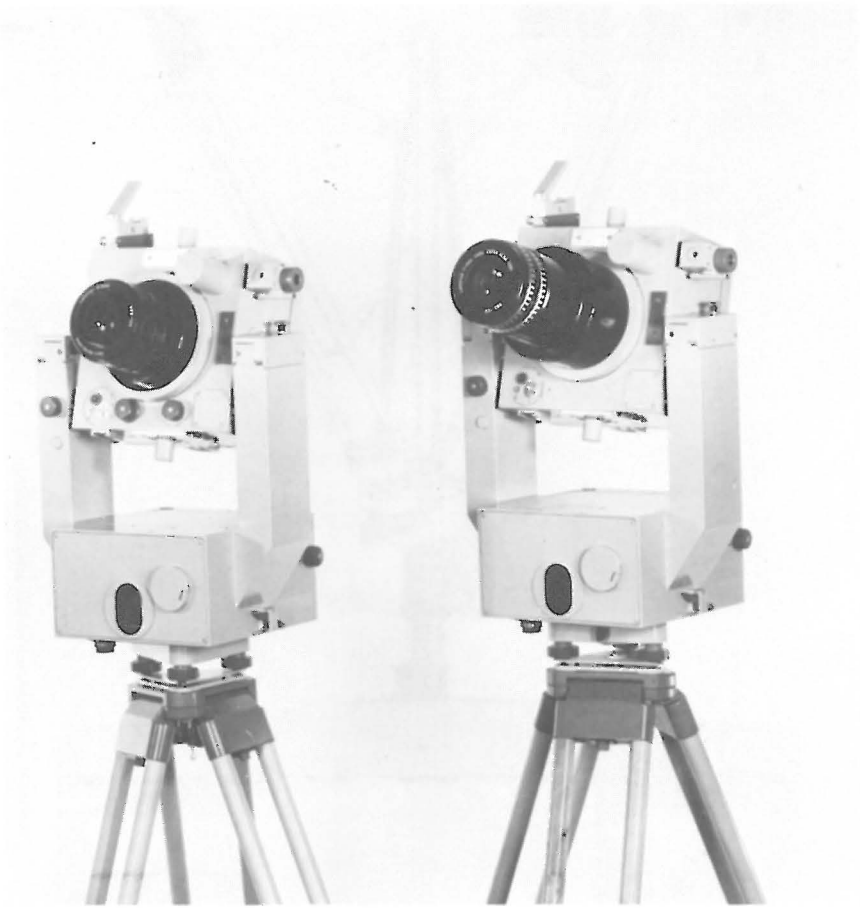

Fig. 6 UMK 20/1318 and UMK 30/1318 Universal Measuring Cameras (1979)