AUTOMATIC HORIZONTAL MERIDIAN CIRCLE AT PULKOVO

R.I.Gumerov,V.B.Kapkov
Engelhardt Astronomical Observatory,Kazan,USSR
G.I.Pinigin
Main Astronomical Observatory of the USSR Academy of Sciences at Pulkovo,Leningrad,USSR

The goal of the new design and modernization of transit circles is complete automation (Pinigin and Shornikov,1983; Hughes,1982; Requieme and Mazurier,1982). For example, all the essential steps of star observations and the determination of the instrument parameters have been automatized at the Tokyo and Brorfelde Observatories (Yoshizawa and Yasuda, 1982; Fogh Olsen and Helmer, 1978). Computer control was introduced for the automation of all the major operations of the Pulkovo horizontal meridian circle (HMC). This involves an automatic setting system (mirror setting), a circle reading system, two photoelectric eyepiece micrometers, meteorological data sensors and a rotating drive of the pendulum horizon (Figure 1). All these are controlled by a microcomputer of the "Electronica C5-12" type.

The automatic circle reading system was put into operation in 1980. It is intended for highly precise measurements of the angular positions of the mirror in declination determinations (Gumerov et al.,1982). The automatic circle reading system consists of 4 microscopes with illumination and glass annulus 420 mm diameter; and two additional microscopes can be mounted for a study of division errors. The reading microscope determines the positions of circle divisions with respect to the zero point of the microscope by use of the scanning device whose position is measured by the optical grid sensor.

The precision of a single circle reading using four microscopes corresponds to a standard error of the order 0".02 and takes 12 seconds. The automatic setting system of the HMC mirror consists of the coarse and fine mirror setting, the photoelectric microscope and the electronics (Gumerov et al., 1983). The microcomputer calculates the slew angle of the mirror using precalculated star coordinates corrected for atmospheric refraction and the zero point of

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the graduated circle. The coarse motion motor is used to move the mirror within integer multiples of 5' and a rate of the speed about 10° secs. Smooth deceleration is used to prevent the somewhat massive metal mirror from overshooting its goal.

The fine setting of the mirror within the 5' interval is accomplished by a stepping motor. The mirror setting for a given zenith distance is completed by the slow motion in one direction only in order to keep the mirror in its bearings and to avoid any azimuth change.

Elastic deformations and slacks in the mirror rotation are corrected for by a software setting algorithm. The final check on the mirror setting is performed by the circle reading system. If the mirror position deviates too much from that given, the setting may be repeated. With this setting we were able to reach a setting precision corresponding to a standard error in the order of ±2" in 15 seconds.

Until 1983 a photoelectric eyepiece micrometer with a fixed system of lambda-like slits (Kirian et al.,1982) was used on the HMC. At present a new micrometer with mechanical field scanning by a grating consisting of a slit system is being tested successfully. The oscillating motion of the scanning slit system is performed by the motor; the position of the slit system is determined by the optical grid sensor. Unlike on the Tokyo transit circle (Yoshizawa and Yasuda,1982), where the photons and corresponding slit positions are recorded every 50 miliseconds, the photomultiplier readings are given by the signal of the grid sensor. Moreover, the time intervals between the readings are also recorded, thus taking into account the instability of the motion of the slit system and plotting the time scale of the recording plot. The plot obtained is independent of variations in the scanning system rate. Finally, the plot is averaged over the slits of the analyzer grating, and star coordinates are determined in the micrometer system (Lindegren,1978). The control,obtaining and processing of the plots is performed by the microcomputer.

In order to restrict the sky background the star is accompanied by a stepping motor. The micrometer can use different filters for the work in various parts of the spectrum.

The test of the automatic eyepiece micrometer showed that the precision of the recording of the autocollimation mark, of 6^m, corresponds to a standard error of the order 1 mkm (0".05). The recording of one passage requires 30 sec. Stars down to 11^m can be observed with the micrometer.

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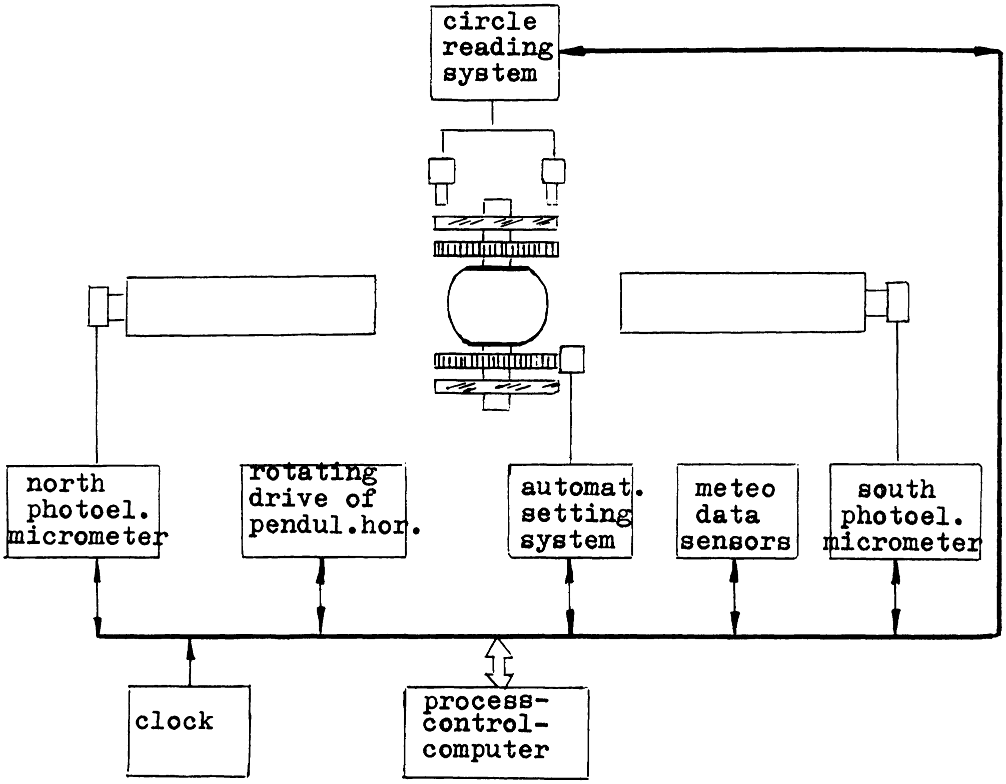

Figure 1. Computer control of the Pulkovo HMC

Star observations and the determination of the instrument parameters are computer controlled on the HMC. The EC computer makes the preparations for the observations, which are the computation of the apparent places, refraction, the setting coordinates in the mirror. The microcomputer operates the recording system, taking into account the observing conditions, the instrument behaviour and the change of the regime during the observations (when necessary). It also controls all the major steps of the observations and the determination of instrument parameters, performs a necessary intermediate check, and analyses the data obtained.

Processing and outputting the information for one star does not require more than 2 minutes. At present, test observations of FK4 stars are carried out. The preliminary results demonstrate the stability of the declination system and the slight instrument flexure, which has been the main source of systematic errors in declination determina-

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tions with meridian instruments (Kirian et al., 1983). The most suitable algorithm of the HMC control for various astrometric programs is being determined. The meteorological data collection and reversal of the artificial horizon is also being automated.

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