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Professional paper

MODERNIZATION OF THE BELGRADE MERIDIAN CIRCLE

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SUMMARY: The purpose of the modernization of the Belgrade Meridian Circle is laid out. The description of the technical elements of the planned undertaking is also presented. The modernization includes the CCD micrometer, automatic circle reading system (CRS) and the telescope setting system (TSS).

1. INTRODUCTION

Not long ago all observations with the Belgrade fundamental meridian instruments – Large Transit Instrument, Meridian Circle and Vertical Circle, all of them optically equivalent ($\phi = 190$ mm, $f = 2578$ mm) – have been suspended. These opservations had to be suspended due to the fact that they were visual, non-automatic and as such antiquated, yielding results much below the modern standards of accuracy and efficiency. There is also the problem of magnitude limitation. The Belgrade Observatory is very much interested in complete modernization of at least one of these instruments. We believe that the selection of the Meridian Circle would be the best solution under the present circumstances (Protić-Benišek 1997).

It is these authors' opinion that our Meridian Circle (BMC) should be modernized in the way the Nikolaev Axial Meridian Circle (AMC) was automated (Kovalchuk *et al.* 1996; Kovalchuk *et al.* 1997).

2. TECHNICAL DESCRIPTION

1. CCD micrometer will consist of the following main functional parts:

a. CCD chip - ISD O17A with cooler and vacuum camera;
b. CCD controller and computer interface;
c. adjusting mechanical unit;
d. software.

CCD chip has the following parameters: number of pixels 1040 × 1160, pixel size (mkm) 16 × 16, sensitive area (mm × mm) 16.6 × 18.6, full well (e) 130, two-stage on-chip preamp. readout noise (e) 15, single-stage on-chip preamp. readout noise (e) 10, dark signal under -40° C (e/pix/s) 10, output amplifier responsitivity (mkv/e) 3.5, optical response non-uniformity %3, sampled optical response non-uniformity %1, quantum efficiency %250 (nm) 12; 400 (nm) 25; 750 (nm) 60. The cooler and vacuum camera must provide the working temperature at CCD chip not higher than -60° C (under temperature of the ambient air +20° C). The cooler must be equipped with automatic gauge for temperature control.

CCD controller must provide the operation of the micrometer in two modes, namely: drift-scan mode and statical exposition mode. The computer interface must provide the transmission of control signals from computer to the micrometer, and the reception of the video signal from CCD controller.

The adjusting unit must provide the proper orientation of CCD chip in the focal plane and connection between telescope flange and the micrometer.

The software consists of the support programs for all electronic modules which have program access, and also the procedures for data transmission from the micrometer to the computer.

The expected limiting magnitude for MC with $\phi = 190$ mm, $F = 2578$ mm is 16 m under exposition 100 sec. The accuracy of determination of the photometrical center of the star-like objects is not worse than 0.05 pixel.

2. The automatic circle reading system (CRS) consists of the following main functional parts:

a. divided circle, optical systems and mechanical devices;
b. electronic modules and control computer;
c. software;

Divided circle (diameter 800 mm, division interval $2'$) with the CRS includes 4 reading microscopes with expected mean error $0''.02$. There are two additional microscopes for automatic determination of graduation errors and for checking of their stability.

The electronic modules consists of CCD chips, commutator for CCDs and illuminators, connection line, ADC, buffer memory, computer interface. CCD monochrome image sensors of any firm could be used in the capacity of CCD chips operating without cooling.

The software is to be written on Pascal, and will provide proper operation of all electronic modules.

3. The telescope setting system (TSS) consists of the following main functional parts:

a. mechanical unit;
b. photoelectrical microscope;
c. electronic module and control computer;
d. software.

The mechanical unit consists of reduction gear and stepper motor.

The photoelectrical microscope is intended for counting of limb division during rotation.

The electronic module consists of switching unit and counting unit.

The accuracy of the TSS will be mainly determined by residual eccentricity and instability of rotational axis. Rotation speed is about 1.5 degree/sec.

The TSS software is to be written in Pascal and will provide proper hardware operation.

The CCD micrometer, CRS and TSS with the aid of computer control system (CSS) provide observations with modernized BMC in automatic and manual modes. For this aims the observer integrated environmental (IE) is elaborated and used. The CCS software in the form of IE would provide the following possibilities:

- testing of different devices and units;
- determination of the instrumental parameters;
- preparation of the input data for observations;
- observations in automatic or manual modes with handling and storing of the observed data;
- initial data processing.

These possibilities can be realized in the following forms:

- executive program;
- program library;
- source code.

3. CONCLUSION

The modernization of the BMC involving the above mentioned devices (CCD camera, automatic circle reading system and the telescope setting system together with corresponding software) is really possible. Nearly the same equipment mounted on Nikolaev AMC was used successfully during three years of drift-scan observations (1995-1998). It permits Belgrade Meridian Circle to join the IAU ground based observation programs in which Belgrade Observatory seeks to participate.

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МОДЕРНИЗАЦИЈА БЕОГРАДСКОГ МЕРИДИЈАНСКОГ КРУГА

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Стручни рад

Објашњен је разлог за модернизацију Београдског Меридијанског круга. Такође је дат пројектовани технички опис радова. Модернизација садржи монтажу новог CCD микрометра, система за аутоматско очитавање круга и система за аутоматско навођење инструмента.