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# THE UNIVERSAL SOFTWARE COMPLEX FOR THE PROCESSING OF ASTROMETRIC CCD OBSERVATIONS

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**Abstract.** For processing the images obtained with the new CCD camera at the Mykolayiv Astronomical Observatory, a universal software complex was created for a digital filtering of CCD images, identification of star-shaped objects and determination of their coordinates. The complex can be used for the processing of observations obtained on different telescopes.

**Key words:** astrometry – data processing

## 1. INTRODUCTION

Regular observations on the Axial meridian circle (AMC) of the Mykolayiv Astronomical Observatory (MAO) were started in 1996. For this automatic telescope, a computer control system for the preparation of observations and their realization in a self-acting mode was created, together with the processing of the data from the CCD camera to obtain coordinates of the observed objects (Protsyuk et al. 1996, Protsyuk 1999). Later on, (Kovalchuk et al. 1999), the need has appeared to select from the AMC program complex a certain universal part which could be used for processing of observations obtained on other telescopes. Since 1999, this universal software package was used to process observations carried out on various telescopes with CCD cameras.

## 2. UNIVERSAL SOFTWARE COMPLEX

The software complex allows to take into account a dark signal and make filtering of CCD images, to identify any star-shaped objects on the obtained images, to determine their coordinates and to make some other calculations. The package can be used to process the astrometric observations obtained with telescopes of any design with similar parameters equipped with a CCD camera working in different modes.

The dark signal account can be made by three various methods, and the operator may choose the method which is most suitable for his observing equipment. The image filtering is intended to improve the signal/noise ratio. The program uses up to eight various methods of filtering, including the flatfielding, the low-frequency non recursive numeral filters and the filters based on a Fourier transform. It is possible to combine various filters in the necessary sequence in the processing. The filtering of one 1024×1024 pixel frame takes about 2 min.

The program of star-shaped object identification uses the catalogues of stars in the electronic form. The number of the identified objects on a frame can be from 3 up to 1000. Two operational modes for the identification of frames and strips can be used. The operator selects three or more stars by mouse, and the further identification is performed automatically. The limiting magnitude of the identified objects depends on the used catalogues, telescopes and the image quality. For the identification one may use either the Guide Star Catalogue or the USNO-A2.0. The time of identification of one 1024×1024 pixel frame with 500 objects is 2–3 min. The identified objects are accepted for further determination of their coordinates.

The program for the coordinate determination uses six methods and a check of these methods on the interior accuracy. The mean interior accuracy of coordinate determination for stars in the middle of the dynamic range is about 0.01–0.02 pixel. The program can determine the coordinates by three different methods in parallel. Processing, depending on the operational mode, is performed with a speed of 20–100 stars/sec.

For the normal operation of all the software complex a computer with a rate of 200 MHz and a RAM of 32 Mb is sufficient. The complex was used with good results for the processing of observations obtained on the following telescopes: the AMC and the

Zone Astrograph at the Mykolaiv Observatory, the 70 cm telescope of Astronomical Observatory of the Kharkov University and the 1.56 m telescope of the Shankhai Observatory (China).

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