

APPLICATION OF THE "SCANNER+MIDAS" COMPLEX FOR PROCESSING ASTROMETRIC PHOTOGRAPHIC PLATES

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ABSTRACT. Researches of an opportunity of use in the astrometric purposes of the photographic plates digital images received with the scanner ScanMaker-4 manufactured by Microtec were carried out by the authors. Photographic plates with the images of star fields received with different telescopes were used for researches. The processing of digital images of photoplates was made with the ESO-MIDAS and with the programs developed by one of the authors. The researches have shown, that this technology provides results with acceptable quality level. That makes possible use of the given scanner for mass processing of the stored photographic material.

A rich observational photographic material have been saved by many observatories for many years. The processing of this material by means of modern technology will allow to take the new astrometric and photometric data. As the special measuring machines for work with photographic plates are available only on several observatories, the opportunity of use for these purposes of the film-scanner essentially would simplify and quicken this work. The scanner in such case will carry out primary operation - scanning or digitizing of photographic plates. The digital images, received after such operation, can be processed by the same means, as CCD-images.

For our researches the scanner ScanMaker-4 manufactured by Microtek was used. According to the technical description it allows scanning with optical resolution 600x1200 dpi and color depth of 36 bits. The photographic plates received within the PIRS program (Gubanov et al., 1989) of Astronomical Observatory of Kyiv National University in 1991 and the plates received on the AGK-2 program at Pulkovo Astronomical Observatory (Beljavsky, 1947) in 1929 were used for our work. PIRS photographic plates were received with the astrograph ($F=426\text{mm}$, size of a field - $108'$, scale - $50''/\text{mm}$) of Astronomical Observatory at Kyiv. AGK-2 plates were received with the zone astrograph ($D=160\text{ mm}$, $F=2049\text{ mm}$, working field $5^\circ \times 5^\circ$, scale - $100''/\text{mm}$) of Pulkovo Observatory.

The analysis of the received images has shown, that the accuracy of 256-color scanning is enough to reproduce a color gradient of photographic emulsion. So for scanning the color mode with 8 bits color depth was chosen. The scanning were carried out in a mode $900^\circ \times 900^\circ\text{ dpi}$. These modes were chosen specially for the given plates proceeding from resolution ability of the scanner and received scale of the electronic image. After scanning the image was kept in the tiff format (Tagged Image File Format). For the subsequent processing the image was converted in

the fits (Flexible Image Transport System) format.

The processing of the received digital images was made as follows. A search of the images of stars on a field and determination of coordinates of the centers of the star images and their photometric characteristics were performed through the ESO-MIDAS package. TYCHO-2 catalogue was chosen as a reference. The calculation of spherical coordinates α , δ was carried out with the program developed by one of the authors. Under calculations different models for astrometric reduction were used.

In our case the process of scanning consists in moving the scanning device along a plate. It was found, that the errors of definition of coordinates in a direction of CCD ruler, that is across the movement of the scanning device, are less than errors in a direction along movement of the scanning device, which reaches 2 arcsec. It makes the scanner actually one-coordinate measuring device. Thus, in order to receive both coordinates it is necessary to execute two scanings with turn of a plate by 90 degrees. In turn the scanning device consists of some CCD-rules and the specific joint error in coordinate is risen. For definition of an optimum scanning technique the multiple scanings with turn of a plate by 90, 180 and 270 degrees were executed. Finally we have chosen four-multiple scanning with subsequent turn of a plate by 90, 180 and 270 degrees. Then tool coordinates were averaged to exclude non-uniformity of movement of the scanner and to compensate discrepancy coupling of CCD-rulers. That is for reception of each coordinate only two scans were used from four ones, which orientations differ by 180 degrees. For reduction of an error splitting the plate image into zones also was executed which were scanned only by one CCD-ruler. The results for a plate received within the PIRS program are given in Table 1.

Table 1: Dependence of mean error in spherical coordinates on numbers and methods of scans

Numbers of scans (orientation)	all plate σ (stars in solution)	zone of one CCD-rule σ (stars in solution)
1(0°)	247 (115)	205 (61)
4(2 × 0°, 2 × 180°)	205 (101)	159 (42)
8(4 × 0°, 4 × 180°)	160 (102)	120 (43)

From Table 1 it follows that mean errors decreases both with increasing of number of scans and under transition from all plate to one CCD-rule zone, reaching 120 mas. That is quite acceptable value for mass processing.

The carried out researches have shown, that use of the scanner for the astrometric purposes is quite possible. In conclusion we shall note, that it is possible to expect, that use of the scanner with the optical resolution up to 2400 × 2400 dpi will allow to reduce errors of definition of measured coordinates.

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