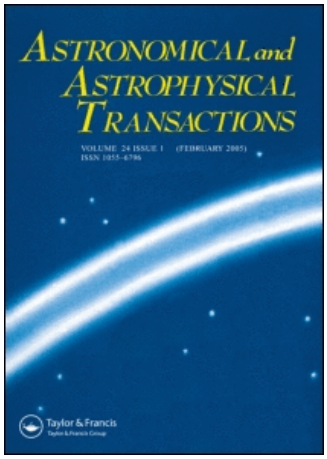

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Sergeev; Sergeeva

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FLAT-BED COMMERCIAL SCANNERS AS THE TOOL FOR THE CREATION OF VIRTUAL ARCHIVES OF ASTRONOMICAL PLATES

A. SERGEEV* and T. SERGEEVA

Main Astronomical Observatory, National Academy of Sciences of Ukraine,
27 Akademika Zabolotnoho, Kyiv 03680, Ukraine

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The astronomical plates that have been produced for more than 100 years may contain information on events or processes that have occurred in the sky at the moment of observation. The preservation of the unique information on the astronomical plates can be achieved by transforming it to a digital form and keeping it in an electronic data medium. This may be achieved with flat-bed commercial scanners equipped with a transparency extension. We have some experience of using such scanners as the tool for the creation of our observatory digital plate archive. To provide a high efficiency for the work with the digital plate archive a special database of about 2×10^4 plates is now being created at the Main Astronomical Observatory, National Academy of Sciences of Ukraine.

Keywords: Archives of photographic plates; Methods of digitization; Databases; Virtual observatory

1 INTRODUCTION

For more than 100 years observatories all over the world have accumulated 2×10^6 and possibly up to 3×10^6 astronomical plates (Hudec, 1999) which have been processed only partly according to the scientific task studied by the observer or which have not been processed at all. Therefore many of the plates contain unique astronomical information, recorded at the moment of observation but not required until now. This information cannot be obtained or restored, not even with the help of the newest facilities and technologies, but it may be useful for many astronomical tasks. Among the subjects for such investigations are the variables of diverse nature, asteroids, comets and other Solar System bodies, optical sources in the direction of γ-ray bursts and other interesting objects that have been missed or not discovered yet.

The threat of loss of astronomical plate archives caused by economical, technical or other reasons have resulted in a problem for the world astronomical community: how should historical information kept on the plates be preserved? The problem can be solved by

* Corresponding author. Centre of Astronomical and Medico-Ecological Investigations, 31 Akademika Zabolotnoho, Kyiv 03680, Ukraine.

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transforming this information to a digital form and keeping it in an electronic data medium. There are two approaches to the solution. The most widespread up to recent years was the scanning of plates with a high spatial resolution by specially designed measuring machines. The digitization of a single plate in that case takes several hours. The volume of received information can be up to 100 Gbytes for one plate. However, not all astronomical investigations require such image sampling. In the last decade, new digitizing technology based on the use of flat-bed commercial scanners equipped with transparency extension appeared (Kroll, 1999; Pollas and Bijaoui, 1999). There are many scanner models from different producers on the market with a rather wide range of parameters so that they can satisfy most astronomical scientific tasks.

2 SOME EXPERIENCE WITH FLAT-BED COMMERCIAL SCANNERS AS THE TOOL FOR THE CREATION OF A VIRTUAL ARCHIVE OF ASTRONOMICAL PLATES

This year we began to create a system for a quick information search in the astronomical plate archive (SQSAPA) of the Main Astronomical Observatory (MAO) of the National Academy of Sciences of Ukraine (NASU). The SQSAPA is intended to help researchers to look up quickly the digital plate archive, detection and analysis of astronomical events and objects. It assumes the creation of hardware and software environment for viewing of the archive fast and for carrying out research on this basis. We have already reported the system concept and main principles (Sergeev and Sergeeva, 2001). To restore historical astronomical information effectively, it is necessary to work with the whole digitized plate archive. In this case the sizes of plate image files become very crucial. They depend significantly on the parameters of digitization. So, if the plates are digitized with an optical resolution of 10–20 mkm and an amplitude resolution of 4096 grey levels, this will allow uncompresseed plate image files with sizes of hundreds and even tens of megabytes (depending on the plate size) to be received.

We have carried out some tests with small format scanners to determine the abilities to reveal details at various parameters and conditions of scanning, coordinates and photometric errors of scanners. A4 Agfa and Mustek scanners with an optical resolution of 40 mkm and an amplitude resolution of 256 grey levels have been used. For these scanner models it was found the difference between the X and Y pixel sizes caused by the difference in the mechanical and optical discretization step sizes, and the dependence of the pixel size on the distance between the plate and charge-coupled device line. The reproducibility of distances between objects was about ± 0.5 pixel. The photometric characteristics of the images of NGC 6913 cluster stars on two plates of the Goloseev double wide-angle astrograph have been determined. Very good conformity of the photometric characteristics obtained with external accuracies of magnitude 0.13 and 0.15 has been found.

One of scientific task of SQSAPA has also been checked. A selective analysis of a small part of the MAO NASU plate archive has been carried out and some hundreds of plates have been selected for search and rediscovery of asteroids. On six plates (produced in 1950–1970) that were scanned, several traces from asteroids, discovered for the first time in 1996–1998, have been found.

We came to the conclusion that, for our plates, image sampling with an optical resolution of 20 mkm and an amplitude resolution of 4096 grey levels will be enough to identify required objects and to determine their exact photometric characteristics; this will

TABLE I Some Characteristics of Plates of the MAO NASU Archive Suitable for SQSAPA.

Telescope[a]	Scale (arcsec mm^{-1})	Field (deg)	Colour system	Limiting magnitude	Number of plates
DLA	38	2×2	mpg, mpv	14–15.5	More then 8000
DWA	103	8×8	B	Up to 16.0	More then 10,000
DSA	295	6×6	B, V	Not defined	More then 2500
AMT-2	66	1×1	B, V	Up to 17.0	Several hundred
Zeiss-600	28	1×1	—	Up to 18.5	More then 350

[a]DLA, double long-focus astrograph (D/F = 40/550; refractor); DWA, double wide-angle astrograph (D/F = 40/200; refractor); DSA, double short-focus astrograph (D/F = 12/70; refractor); AMT, astronomical mirror telescope (D/F = 70/315; reflector); Zeiss-600 (D/F = 70/750; reflector).

permit us to carry out various astronomical investigations with the plate archive of the MAO NASU.

3 PLATE DATABASE OF THE MAIN ASTRONOMICAL OBSERVATORY, NATIONAL ACADEMY OF SCIENCES OF UKRAINE

The digital plate archive, planned within the framework of SQSAPA, will represent a set of plate image files received by completely scanning each plate as a whole with scanning parameters optimal for the given plate. The received files of plate images will not be modified or processed; only an estimation of the quality of a plate and a check of its conformity to the catalogue of plates will be made. The plate image files will be stored in duplicate on optical disks with the prospect of using more modern electronic carriers. On-line access to digital plate archive at the first stage will be provided on enquiry.

To provide high efficiency of the work with the digital plate archive a special database for plate collection (a list of the plates with all the available information about them and access software) is necessary. Now at MAO NASU the creation of the database of about 2×10^4 plates that are suitable for SQSAPA has begun. The database will be transformed to a standard format acceptable for the wide-field plate database, which represents the largest archives of the world's astronomical observatories. At MAO NASU the plate archive totals more than 3×10^4 plates containing unique information on the Universe, Sun, Moon, large and small planets of Solar System and other objects. Some data about the plates suitable for SQSAPA and telescopes with which they have been produced are given in Table I.

4 CONCLUSIONS

The development of a system for a quick information search of an astronomical plate archive based on an inexpensive commercial scanner with an optical resolution of 20 mkm and an amplitude resolution of 4096 grey levels gives us an opportunity to extract unique historical information from the astronomical plates of the MAO NASU archive. Such digitization parameters will allow us to receive uncompressed plate image files with sizes not exceeding hundreds and even tens of megabytes. These plate image files will be suitable for identifying required objects and determining their exact photometric characteristics, which permit us to realize various astronomical investigations. So each observatory will be capable of creating its own digital plate archives as a part of the common world virtual archive or virtual observatory.

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