Standards and Software Tools for Digitization of Astronomical Photographic Plates

N. Kirov[1,2] K. Tsvetkova[1] M. Tsvetkov[3]

[1]Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

[2]Department Informatics, New Bulgarian University

[3]Institute of Astronomy and National Astronomical Observatory, Bulgarian Academy of Sciences

X KONFERENCIJA NOVE TEHNOLOGIJE I STANDARDI:
DIGITALIZACIJA NACIONALNE BAŠTINE
22-23.09.2011, Matematički fakultet, Beograd

Outline

1. Introduction
   - Wide-Field Plate Database
   - Plate Digitization – World-wide Current Status
   - FITS Format File
2. FITS Header Creator
3. Tif to FITS Converter
4. Practice and Conclusions

Astronomical Photographic Plates

The astronomical photographic plates constitute glass coated on one side by silver bromide dry emulsion. As light detectors and media for information storage they replaced the visual astronomical observations and marked the epoch of photographic astronomy began in the 70's of 19-th century, lasted more than 130 years. A lot of astronomical discoveries were done on the basis of photographic plates used in the observations. More, the stored astronomical photographic plates in the observatories or relevant institutions continue to be used at different astronomical tasks especially in those needed long time series analysis. The astronomical photographic plates are typical examples of scientific heritage needing to be preserved and used in future.

Astronomical Photographic Plates

The plate digitization is a needed undertaking and the only way giving plate preservation – against careless manipulation and emulsion aging. The plate digitization enables as a quick access to the plate image information through on-line preview, as well as and reuse of the astronomical data through high-resolution plate image scans.

Wide-Field Plate Database

The basic source of data for the wide-field (larger or equal of 1 square degree) astronomical photographic plates obtained with professional telescopes world-wide is the Wide-Field Plate Database (WFPDB). It consists of four parts:

- Catalogue of plate archives (data for observatories, telescopes, cameras), over 400 archives, containing about 2.1 million plates
- Catalogue of plate indexes (meta-data for plates), about 370 000 plates, on-line accessible (`wfpdb.org`)
- Data bank of digitized plate images (previews and FITS files)
- Links to on-line services and cross-correlation with other needed existing catalogues and journals.

EUROPEAN plate archives digitization last 5-7 years

Place	TNP	Scanner	SNP	Res.
Sonneberg	300000	FB 4xHP	215000	20
Pulkovo	50000	FB 1xUMAX	30000	20
Tautenburg	9000	TLSW Scanner	4058	10
Asiago	20000	2xEPSON1640XL	3000	16
Byurakan	20000	EPSON1680	≈1874	16
Bamberg	25000	EPSON1640,V750	1000	16
Heidelberg (ARI)	400	EPSON10000XL	344	10
Heidelberg (LSW)	20000	NEXSCAN F4100	200	
Potsdam (AIP)	20000	Epson10000VL/V700	1420	
Hamburg (HAO)	30000	EPSON1000XL	≈8000	

TNT – Total Number of Plates
SNP – Scanned Number of Plates
Res. – Resolution in microns/pixel

EUROPEAN plate archives digitization last 5-7 years

Place	TNP	Scanner	SNP	Res.
Konkoly	13000	UMAX PL3000	500/500	8/20
Brussels	20000	ROB Agfa DUOSCAN	≈600	250
Sofia	10000	EPSON1640XL/V700	1035/500	16/10
Moscow	20000	GAISH CREO	≈400	10
Moscow INASAN	4000	2xEPSON1640XL	200	16
Bucharest	12000	Umax AlfaVista II	100	10
Cluj	5000	HP	200	250
Vatican	10000	EPSON1640XL	3000	16
Belgrade	12000	EPSON V700	3000	test

TNT – Total Number of Plates
SNP – Scanned Number of Plates
Res. – Resolution in microns/pixel

Totally: more than 250 000 scanned for last 5-7 years.

The new US plate digitization projects

- Harvard College Observatory: 500 000 plates
  - 2004 NSF granted 0.5 million USD for special scanner construction (in 2007 ready).
  - For plate digitization Harvard asked more 5 million USD for the next 5 years.
  - Estimated amount of plate digitization – 75 000-150 000 per year.
  - Now they have 18 000 scanned plates in 5 selected areas.

The new US plate digitization projects

- Mt. Wilson: NSF grant of 0.5 million USD for digitization the Solar observatory plate archive using FB scanners.
- Maria Mitchell Observatory: 8000 plates
  - Needed about 250 000 USD
  - Using AgfaScan T5000Plus scanner
  - Scanned for 2 years in TIFF format 10 mic/pix.

FITS Format File

- FITS or Flexible Image Transport System is a digital file format used to store, transmit, and manipulate scientific and other images.
- A major feature of the FITS format is that image meta-data is stored in a human-readable ASCII header.
- Each FITS file consists of a header containing ASCII card images (80 character fixed-length strings) that carry keyword/value pairs and an image data block.
- The official reference document that defines the requirements for FITS format data files for 3.0 version is published in Astronomy and Astrophysics, Volume 524 (December 2010).

FITS Header Standard

Till now there is no

- *Demonstration*

The abbreviations in the first column of the table mean:

- `fixed`: the value is fixed in case of plates
- `tif2fits`: the value will be placed by **tif2fits**
- `md`: the value is copied from **maindata** file
- `not`: the value is copied from the **notes** file
- `obser`: the value is copied from the **observers** file
- `cat`: the value is copied from the CWFPAs file
- `calc`: the value is obtained by calculation
- `man`: this value must be inserted manually

FITS Header Tool

The FITS header is an important part for processing of plates images. It contains meta-data for the plate. In parallel of scanning plates, we have to create the FITS header. This software tool uses the data stored in WFPDB.

- *Demonstration*

tif2fits

This software is designed for converting row-tif files (16-bits gray-scale), produced by VueScan, to FITS files. The input data for a plate consist of

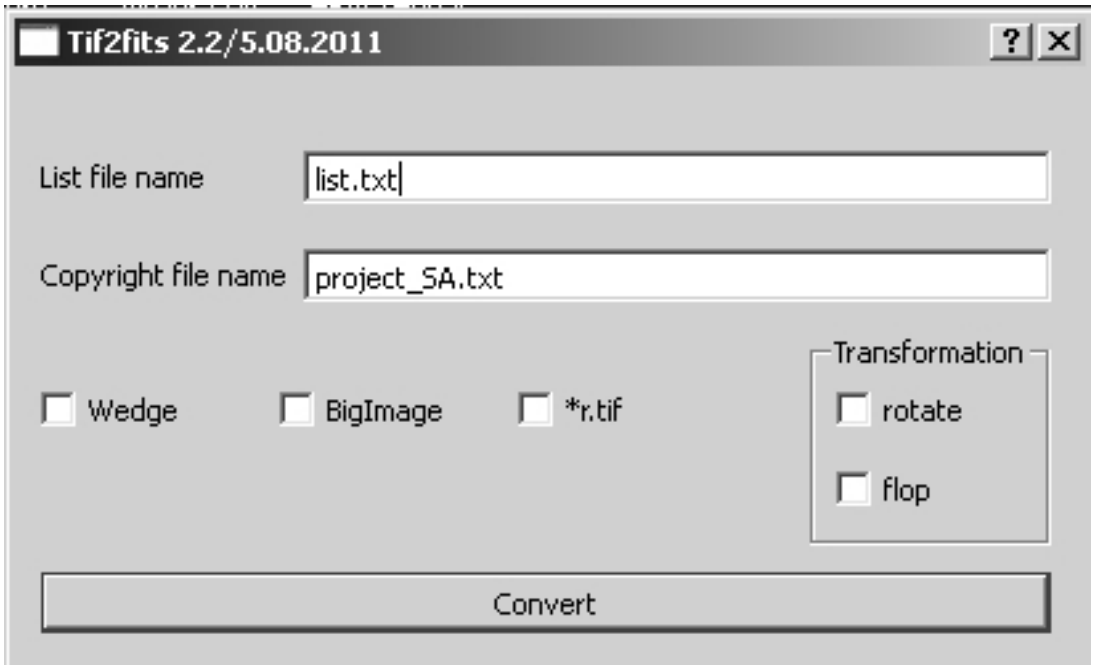
- image file (row-tif format) and
- header file (plain text).

Also the values of the following fields are updated:

- DATE-SCN (the scan date and time),
- DATE (last change of file),
- NAXIS1 and NAXIS2 (image size).

In case of scanning with a step wedge, the program separates wedge part of the image and produces two FITS files – one for the plate and one for the wedge.

tif2fits



The user interface of tif2fits converter.

Practice

Telescope	scale (arcsec/mm)	plate size (cmxcm)	resolution (dpi)	file size (MB)
POT015	138	20x20	2400	681
POT080	17	16x16	1600	193
BAM010C	338	16x16	2400	430
BON030	138	16x16	2400	386
HAR025C	167	20x25	1600	430
ROZ050	120	16x16	2400	430
ROZ200	13	16x16	2400	430

Conclusions

The presented here software is a part of a technology (full pipe-line) for digitization of astronomical photographic plates. It speeds up the processing time and decreases the possibility of errors in FITS header. Separating image with wedge is a new feature in such type of software. Improvements may go in several directions:

- to conform the FITS header to requirements of new FITS standard 3.0 (2010);
- to include validation rules for some fields in header software, especially for coordinates, numerical values, etc.;
- to add the algorithm for calculating the coefficients for converting local plate coordinates to World Coordinate System.

Acknowledgments

:(10k U 4 Ur attention! :)

This work is supported by:

- German DFG grant STE: 710/6-1/2009;
- Bilateral Agreements for Scientific Cooperation: *Serbian Academy of Sciences and Arts* and *Bulgarian Academy of Sciences* – joint research project: DIGITAL DATA BASES AND IMAGE PROCESSING;
- Bulgarian Ministry of Education, Science and Youth grant: DO-02-275/2009.