Proceedings of the IX Bulgarian-Serbian Astronomical Conference: Astroinformatics (IX BSACA) Sofia, Bulgaria, July 2-4, 2014,
Editors: M. K. Tsvetkov, M. S. Dimitrijević, O. Kounchev, D. Jevremović and K. Tsvetkova
Publl. Astron. Soc. "Rudjer Bošković" No 15, 2015, 43-48

WFPDB: SOFTWARE FOR TIME AND COORDINATES CONVERSIONS

NIKOLAY KIROV[1,2], MILCHO TSVETKOV[2] and KATYA TSVETKOVA[2]

[1]*New Bulgarian University*
E-mail: nkirov@nbu.bg
[2]*Institute of Mathematics and Informatics, Bulgarian Academy of Sciences*
E-mail: nkirov@math.bas.bg, milcho.tsvetkov@gmail.com,
katya.tsvetkova09@gmail.com

Abstract. The article consists of a detailed description of two software tools for time and coordinates conversions. The digitization of astronomical photographic plates has to start with collection of data for the plates. Wide Field Plate Database (WFPDB) is the most popular WEB-based database that contains data for more than 600 thousand plates. To add new data in WFPDB, it has to obey the requirements of content and data structure. The time of observation is UT and the coordinates are in J2000. The presented software can convert the time from the Local Sidereal Time or Local Time to Universal Time, and the equatorial coordinates from any equinox to J2000. The input and output files of the programs are in data format of WFPDB.

1. INTRODUCTION

The technology for digitization of astronomical photographic plates assumes that the data for digitized plates is already collected (see Kirov et. al (2012a,b), Tsvetkov et al. (2012)). Wide-Field Plate Database (WFPDB – `www.skyarchive.org` or `wfpdb.org`) is WEB-based database that contains data for more than 600 thousand astronomical photographic plates. Over two million and half plates are identified and collected in this database. The database structure is shown in Figure 1.

To add new plates in WFPDB, the data has to obey the requirements of content and data structure for WFPDB. The time of observation has to be Universal Time (UT) and the coordinates have to be J2000 (the currently used standard equinox). The software can convert the time from Local Sidereal Time (LST) or Local Time (LT) to UT; the equatorial coordinates (RA and DEC) from any equinox to J2000.

The input and output files are in data format of WFPDB.

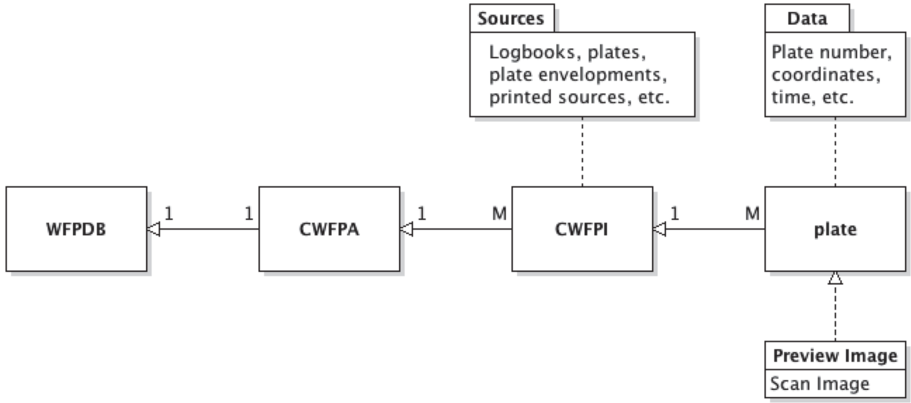

Figure 1: Main elements of WFPDB.

2. WIDE-FIELD PLATE DATABASE

The Catalogue of Wide-Field Plate Archives (CWFPA – `wfpdb.org/catalogue.html`) contains data for plate archives – the set of plates which are obtained with one instrument. The instrument means one telescope or camera at one place for observation (location). In the actual version 7.0 (February 2014) of CWFPA 495 archive descriptions are collected (Kalaglarski et al. 2014). The following example represents one line from the catalogue table containing the data for the archive with identifier ROB033.

```
ROB033 CdC Astrograph Brussels Belgium Royal Obs.Belgium Brussels Obs. Uccle
Belgium 12 1 04 21.5 50 47.9 105 0.33 3.43 60 Ast 2.6 1908 1950 1160 T T.Pauwels
```

Table 1 explains some fields of the example.

Table 1. Part of the content of the Catalogue of Wide-Field Plate Archives

No	Description	Format	Example
1a	Instrument Identifier (observatory code and instrument aperture)	`[LLLDDD]`	`ROB033`
1b	Original Name of the Instrument	text	`CdC Astrograph`
2-3	Location of the Archive	text	`Brussels Belgium`
8	Time Zone (main)	hours	`1`
9	Observatory Longitude	deg min	`04 21.5`
10	Observatory Latitude	deg min	`50 47.9`

Remark: `L` denotes a capital letter; `D` denotes a digit.

The Catalogue of Wide-Field Plate Indexes (CWFPI) contains data for plates. The following fields store data for the plates: the coordinates of the plate center, the date and time of the observation, object name and type, method of observation, duration of exposures, type of emulsion, the size of the plate, the quality of the plate, the name of the observer, etc.

All the data are distributed in 6 plain text files with names: maindata, quality, observer, availability, digitization and notes. For the instrument `ROB033` they are: `ROB033maindata.txt`, `ROB033quality.txt`, `ROB033observer.txt`, etc.

The example below represents a line form the file `ROB033maindata.txt` containing the data about plates obtained by the instrument with the identifier `ROB033`.

Example: `ROB033 000008 233256+333308 19081019214619`

Some important field from maindata file are given in the Table 2.

Table 2. Part of maindata file

Positions		Description	Format	Example	
1-6	6	Instrument Identifier	[LLLDDD]	ROB033	
7	1	Suffix	[ ] or [L]		
8-13	6	Plate Number	[DDDDDD]	000008	8
14	1	Suffix for Duplicates	[ ] or [L]		
15-20	6	Right Ascension (RA)	[hhmmss]	233256	$23^h32^m56^s$
21-27	6	Declination (DEC)	[±ggmmss]	+333308	+33°33'8"
28	1	Missing Data	[ ] or M		
29-36	8	Date	[yyyymmdd]	19081019	19.10.1908
37-42	6	Time	[hhmmss]	214619	21:46:19
43	1	Missing Data	[ ] or M		

Remark: `L` denotes a capital letter; `D` denotes a digit.

3. SOURCES AND CONVERSIONS

The data for plates are collected from various sources: telescope logbooks, photographic plates, plate envelopes, printed sources (books, plates' copies, etc.). The most important data are the coordinates of the plate center and the time of observation. Usually in the sources the time is given as LST or LT. `timetool` software transforms the time from LST or LT or local Daylight Saving Time (DST) to UT. The coordinates originally are given in Besselian Equinoxes (BE: B1875.0, B1900.0, B1925.0 and B1950.0) or in the Time of Observation (TO). `epochtool` software transforms equatorial coordinates (RA and DEC) from arbitrary equinox to J2000.

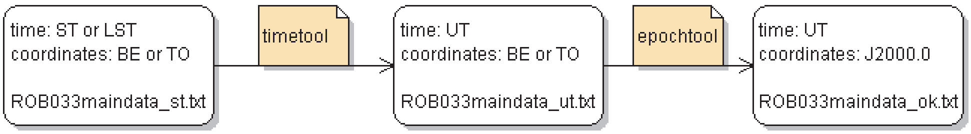

Figure 2: The conversion diagram.

4. TIMETOOL

For time conversion we use the approximation given in Aoki et al. (1982) – (12), (13):

$$T_U = \frac{J - 2451545}{36524}$$

$$G = 24110.54841 + 8640184.812866 T_U + 0.093104 T_U^2 - 6.2 \times 10^{-6} T_U^3$$

$$U = L - \frac{G}{3600} - \frac{O}{15}$$

where J denotes Julian day, G – Greenwich Mean Sidereal Time, L – Local Sidereal Time, O – Observatory Latitude, U – Universal Time.

Input files for timetool are:

- config file: timetool.cfg;
- summer time file (optional): <instrument name>.dst;
- data file: <dir><instrunent name>maindata_st.txt;
- catalog file: <dir>Cat<version>.txt.

The configuration file timetool.cfg for the example is:

```
2
ROB033
Cat7.0
0
../../astroinformatics/data/
```

Time Zones and Daylight Saving Dates for a given location can be found in www.timeanddate.com/time/change/. Table 3 presents a part of summer time file BAL080.dst (Baldone Schmidt, Riga).

Table 3. Part of summer time file BAL080.dst (Baldone Schmidt, Riga)

1987-03-29	03:00:00	1987-09-27	02:59:59	3	4	UTC+4h	MSD
1988-03-27	03:00:00	1988-09-25	02:59:59	3	4	UTC+4h	MSD
1989-03-26	03:00:00	1989-09-24	02:59:59	3	3	UTC+3h	EEST
1989-09-24	03:00:00	1989-12-31	23:59:59	3	2	UTC+2h	EET
1990-03-25	03:00:00	1990-09-30	02:59:59	2	3	UTC+3h	EEST

The data for plates are contained in the file <instrunent name>maindata_st.txt where the time is LST or LT and the coordinates are in arbitrary time epoch.

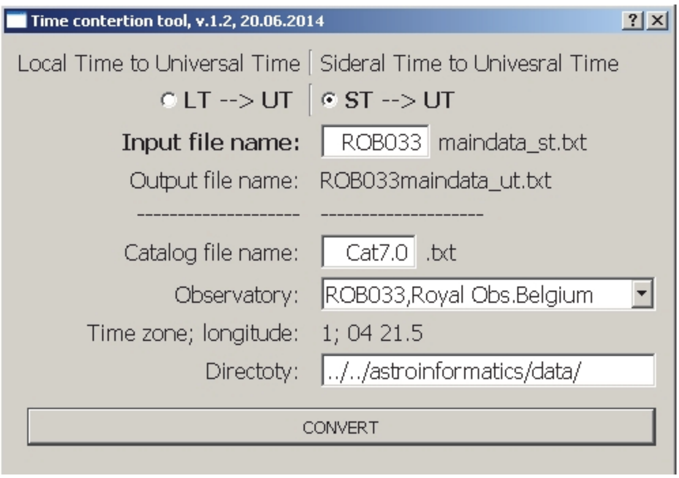

Figure 3: The user interface of timetool.

Output files for **timetool** are:
- config file: timetool.cfg;
- data file: <dir><instrument name>maindata_ut.txt.

5. Epochtool

The formulas for epoch transformations can be found in idlastro.gsfc.nasa.gov/ftp/pro/astro/premat.pro.

Input files for epochtool are:
- config file: epochtool.cfg
- data file: <dir><instrunent name>maindata_ut.txt

The configuration file epochtool.cfg for the example is:

```
0 0 0 1 0 0
ROB033
../../astroinformatics/data/
```

The data for plates are contained in the file <instrunent name>maindata_ut.txt where the time is UT and the coordinates are in arbitrary time epoch.

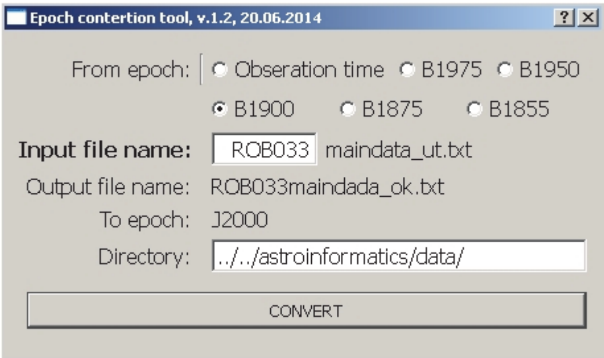

Figure 4: The user interface of epochtool.

Output files for epochtool are:
- config file: epochtool.cfg
- data file: <dir><instrunent name>maindata_ok.txt

The data for plates are contained in the file <instrunent name>maindata_ut.txt where the time is UT and the coordinates are in J2000. Now the metadata file is ready and it can be added as a new archve to WFPDB.

6. CONCLUSIONS

Two software tools for time and coordinates conversions suitable for needs of WFPDB are presented. For our example – for the plate No 8 from the archive with identifier ROB033 we have:

- original data in ST, B1900.0
  `ROB033 000008 232800+330000 19081019235400`
- converted data in UT, J2000.0
  `ROB033 000008 233256+333308 19081019214619`

The software is written in C++ using Qt – cross-platform application and UI development framework (`qt.digia.com`). The software tools are publicly available in GitHub and open source. The links are: `github.com/nkirov/timetool` and `github.com/nkirov/epochtool`.

References

Aoki, S., Kinoshita, H., Guinot, B., Kaplan, G. H., McCarthy, D. D., Seidelmann, P. K.: 1982, The New Definition of Universal Time, *Astron. Astrophysics*, **105**, 359-361.

Kalaglarsky, D., Tsvetkova, K., Tsvetkov, M.: 2014, WFPDB: Import of Catalogue of Wide-Field Plate Archives v7.0 and Recent Development, Proceedings of the IX Serbian-Bulgarian Astronomical Conference (IX SBAC), Sofia, Bulgaria, July 2-4, 2014, Editors: M. S. Dimitrijević and M. K. Tsvetkov, *Publ. Astron. Soc. "Rudjer Bošković"*, in this issue.

Kirov, N., Tsvetkov, M., Tsvetkova, K.: 2012a, Software Tools for Digitization of Astronomical Photographic Plates, *Serdica Journal of Computing*, **6**(1), 67-76.

Kirov, N., Tsvetkov, M., Tsvetkova, K.: 2012b, Technology for digitization of astronomical photographic plates, Proceedings of the 8th Annual International Conference on Computer Science and Education in Computer Science, Boston, USA, 5-8 July 2012, Publ. New Bulgarian Uiniversity, 109-114.

Tsvetkov, M., Tsvetkova, K., Kirov, N.: 2012, Technology for scanning of astronomical photographic plates, *Serdica Journal of Computing*, **6**(1), 77-88.