

NEW CAPABILITIES OF THE SOFTWARE TO SUPPORT DIGITIZATION OF ASTRONOMICAL PHOTOGRAPHIC PLATES

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Abstract. We In this article, we announce improvements to two applications for digitizing astronomical photographic plates and developing a new one. In the software for creating the header of fits file using the data from WFPDB (wfpdb.org) we add feature for processing data for multiexposure plates. A new functionality of application for updating fits header allow us to complete fits header for fits files obtained from ImageMagic application. The development of virtual observatories has prompted us to realise a convertor of fits header to GAVO (www.g-vo.org) standard.

1. WIDE-FIELD PLATE DATABASE

There are about 2475000 astronomical photographic plates all over the world. Wide-Field Plate Database (www.wfpdb.org) is WEB-based database that contains meta-data for more than 600 thousand plates (see Kalaglarsky et al: 2014). It is one wide-field unique telescope, giving access to unique photographic astronomical observations, done systematically in the period 1880 – 2000!

The Catalogue of Wide-Field Plate Indexes contains meta-data for plates. For every plate many details are stored in the database: the coordinates of the plate centre, 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.

The meta-data of the plates are distributed in 6 plain-text files. For every file we give an example – one line in a file contains the data for a plate with identifier ESO040 007863.

- The most important information is in the maindata file:

ESO040 007863 053517-052328 19850114012100 ORION M42-43 NGC1976
S42 6120.0KODAK IIaO Pg161611111

- Availability file:

ESO040 007863 PLATE IS AVAILABLE AT THE WFPDB DEPOSITORY,
SOFIA, BULGARIA: milcho.tsvetkov@gmail.com

- Notes file:

ESO040 007863 ORIG_COORD:053400-052400 ST.ST= ST.END=0620
UT.ST=0121 UT.END=0329 MULTIP. EXPOS=6X20 FL! ANON L EXP1-
6_UT_STARTUT_END=01:21-01:41,01:42-02:02,02:03-02:23,02:27-
02:47,02:48-03:08,03:09-03:29;

- Observer file:

ESO040 007863 W.SEITTER

- Quality file:

ESO040 007863 3 ARCSEC SEEINGS

- Digitization file:

ESO040 007863 DIGITISED WITH PDS2020 AT AIM, AND IN THE WFPDB
WITH THE FB SCANNER EPSON PERFECTION V700 20MIC
PIXEL(1200DPI)

2. PLATE DIGITIZATION

Plate image is a digitized astronomical photographic plate image (16-bit grayscale FITS file), with high resolution aiming photometric and astrometric measurements.

The process of plate digitization consists of 3 steps:

- Scanning the plate (image) to produce .tif (row-tiff) file (see Tsvetkov et al: 2012).
 - Hardware: flatbed scanner and – Software: VueScan
- Completing metadata (header) to produce .hdr file
 - Transferring data from WFPDB: header application and
 - Adding actual data for scanning, time, etc.: header application
- Completing header file and merging it with image file to produce .fits file
 - Tif2fits application or
 - ImageMagic software + UpdateFitsHdr application

3. HEADER

The FITS header contains the complete metadata for the plate, the telescope, the place of the observation, the scanning process, etc. The main part of these data can be extracted from the corresponding WFPDB catalogues. This approach presumes that the collection of plates for digitization (plate archive) is already described in WFPDB. The second part of the data consists of constant values, and the third part can be calculated using the other parts.

.hdr denotes a plain text file producing by FITS header application.

- Most of the data for fits header are extracted from WFPDB.
- Additional data are entered automatically using config file for the processing archive
- All the data can be corrected manually.

Figure 1 presents the general view of FITS header application.

The screenshot shows the 'FITS header 2.3/3.04.2017' application window. At the top, there are navigation buttons: 'File data / POT015', 'Sort', 'Plate POT015', and '000317'. There are also 'Prev', 'Next', and 'Save' buttons. The main area contains a list of 13 parameters with their values and descriptions:

Parameter	Value	Description
1. SIMPLE	T	file does conform to FITS standard [T/F]
2. BITPIX	16	number of bits per data pixel
3. NAXIS	2	number of data axes
4. NAXIS1	18656	length of data axis 1
5. NAXIS2	18542	length of data axis 2
6. EXTEND	T	FITS dataset may contain extensions
7. BZERO	65536	
8. BSCALE	1	
9. INVERTED	T	T - big-endian, F - little-endian
10. DATE	2018-04-23 08:10:20	last change of file
11. FILENAME	POT015_000317.fits	source file name
12. PLATENUM	317	in original observing catalogue
13. PLATE-ID	POT015_000317	WFPDB plate identifier

At the bottom of the window, there is a summary of the header data:

```
POT015 000317 191548+151320 19100802222101 SA 87      F 0101 30.0      202001001
POT015 000317   Direct images
POT015 000317
POT015 000317 W.MUENCH
```

The format of the data in the FITS header is strictly defined (see FITS header format: 2014 and FITS Standard Document: 2016) but the extended content is very

flexible. There are some specific data for photographic plates, comparing with CCD images. Our choice of key words, fields and measurement units is defined from practice with various plate archives (see Kirov et al: 2012b). The development of virtual observatories (VO) during last years has prompted us to adapt our software for FITS headers for facilitation the publication of digitized archives in VO.

The important place for our digitized archives is German Astrophysical Virtual Observatory (GAVO) and our goal is to satisfy the requirements of GAVO.

GAVO header sections are:

- "Basic data"
- Original data of observation • Observatory and instrument • Photographic plate
- Derived observation data
- Scan details
- Data files

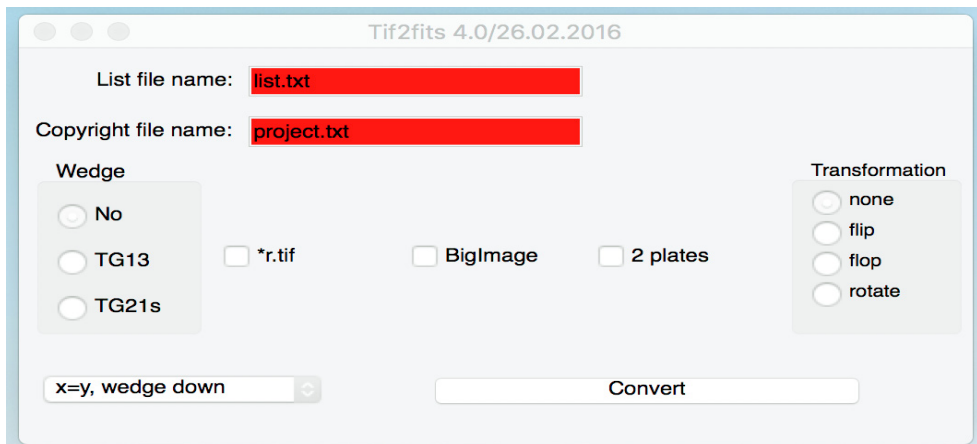
The data from WFPDB is transferred to .hdr file but the complete FITS header contains also information for image and we denote this file as .hdrf file (for easy on-line access to the plate meta- data.). If we denote by .hdrg GAVO header, we need the following convertors for various "standards":

- WFPDB → .hdr • .hdr → .hdrg
- .hdrf → .hdrg

Example of differences between two formats:

.hdrf: UT = '1911-02-02 01:31:39' / date and UT at mean epoch

.hdrg: DATE-AVG= '1911-02-02T01:31:39Z' / UT d/t mid-point of observation

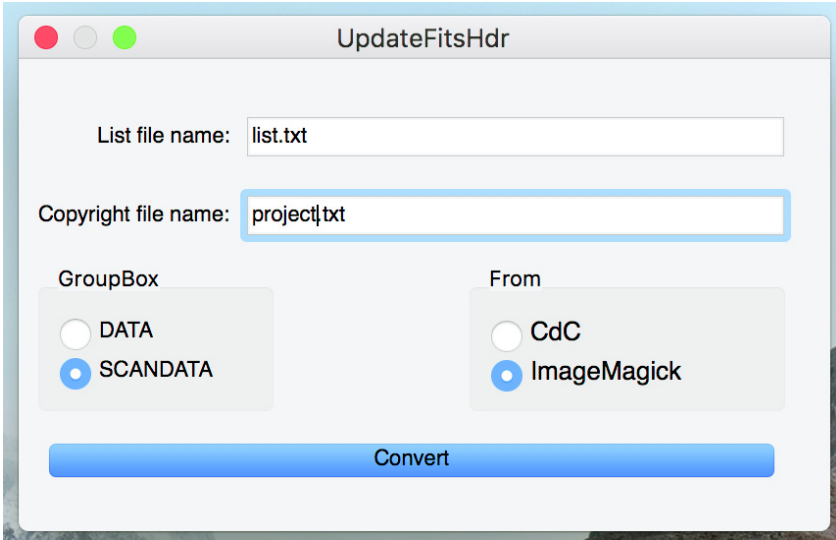


4. PROCESSING IMAGE

While VueScan produces .tif image format files, the conversion to .fits image format (including header) can be done in two ways – using Tif2fits application or

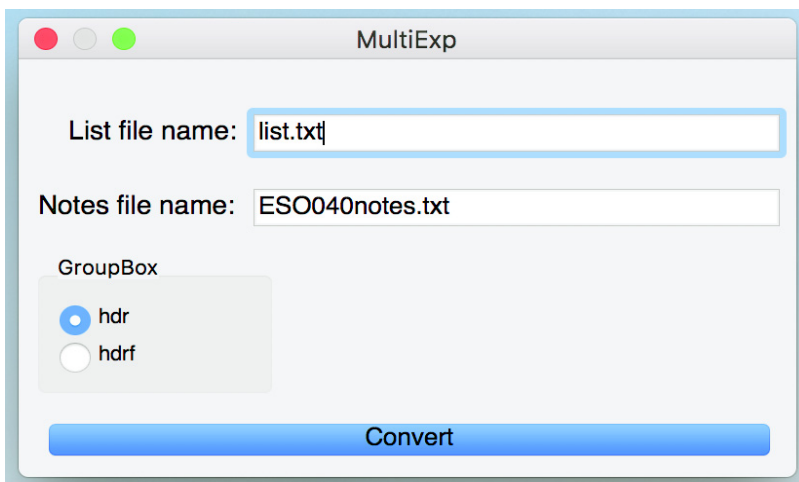
using a combination of ImageMagic software and our UpdateFitsHdr application. Tif2fits transforms .tif and .hdr files to .fits and .hdrf files (Figure 2).

ImageMagic converts .tif to .fits file with very small FITS header. UpdateFitsHdr application replaces this small header using .hdr file and produces normal .fits file and .hdrf header file (Figure 3).



5. MULTIPLE EXPOSURE

Multi exposure plates contain several exposures and its header has to contain data for every single exposure. This way the header turns to variable number of fields (lines), which does not match to FITS header application. MultiExp application solves the problem extending .hdr or .hdrf file (Figure 4).



The data for every exposure can be found in WFPDB – Notes file.

Example of a part of a line for one plate in WFPDB and the same data in FITS header for that plate.

WFPDB Notes file:

```
UT_STARTUT_END=01:21-01:41,01:42-02:02,02:03-02:23,02:27-02:47,02:48-03:08,03:09-03:29;
```

.hdrg file:

```
DT-OBS1 = '1985-01-10T01:21:00Z'
```

```
DT-AVG1 = '1985-01-10T01:31:00Z'
```

```
DT-END1 = '1985-01-10T01:41:00Z'
```

```
EXPTIM1 = 1200.0
```

```
DT-OBS2 = '1985-01-10T01:42:00Z'
```

...

6. CONCLUSIONS

The software is written in C++ using Qt – cross-platform application and UI development framework (www.qt.io). The applications are publicly available in GitHub as open source (github.com/nkirov).

References

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https://www.plate-archive.org/wiki/index.php/FITS_header_format
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