Photographic plate digitization by digital camera

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Motivation

- Most of astronomical plate archives have no scanning device
- Tranportable device required
- Fast device required, up to 1000 plates/day
- For many types of astronomical photographic plates, the typical mean astrometric error of digital camera i.e. around 0.3 arcsec is satisfactory as the intrinsic plate errors are of the same order

Plate Digitization

- Very high astrometric positional accuracy 0.1 microns only with custom made scaners, very expensive
- Most applications do not need such high accuracy
- Pixelsize: emulsion 5 microns, Sonneberg 25 microns. Smaller pixelsize = very large size of image files = more difficult to store, to access, and to evaluate

Plate Digitization – Cost and Time Factor

- Dedicated custom made accurate scanner - very expensive, difficult to move, 1 plate > 100 Euro
- Commercial flatbed scanners – moderately expensive, 1 plate >> 10 Euro
- Digital camera - inexpensive, fast – 1 plate < 1 Euro
- Cost of purchasing instrumentation not included

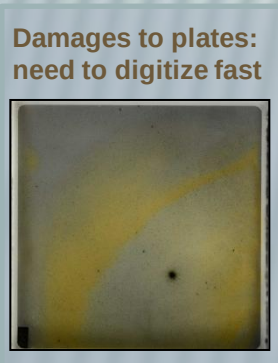
3 basic digitization techniques

- Custom made scanner. Very accurate but very expensive, expensive use, problems with maintenance and service later
- Commercial Plate/Negative flatbed scanner.
- Digital camera

Comparing Digital Camera vs Scanner

- Digital Camera
- Very fast (2 sec/plate)
- Very low-cost scanning
- No waves caused by irregular movement
- Easy transportable
- Satisfactory resolution for small and medium sized plates (5-20 microns)
- Need to apply automated algorithms for lens distorsion and edge cutting - solved

Damages to plates: need to digitize fast



Gold disease and damage by humidity
Collaboration with IChT Prague
in recovery damaged plates

Plate collections visited:
~50 plate astronomical archives visited and partly digitized by us in US, Europe, and China
About 3 million plates in these archives

~ 50 000 plate scans obtained

2 archives fully digitized by us (Tuorla Finland, 11 000 plates and UNAM Mexico 2000 plates)

Preferences: transportable, very fast scanning, high repeatability (no moving scanner parts)
Used equipment:
Camera: 39 Mpx Lenses: Canon EF 24-70 f/2.8 L USM & Canon 70-200mm F4 , tripod, light table

Transportable plate scanning device

CdC Plate digitization in Mexico

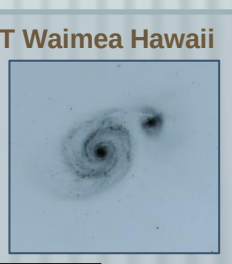
Carnegie Observatories Pasadena, ~ 500 000 plates

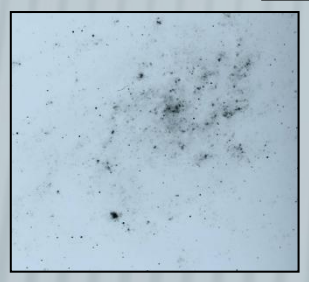
LDS (Low Dispersion Spectroscopy) plates from 1909 at Carnegie Obs, Pasadena, CA, USA

The North Mt Wilson – Michigan Halpha survey plates are deposited here

Scanning US collections of LDS plates

CFHT Waimea Hawaii





Valuable plates taken by 3.6 m CFHT telescope
Very deep lim magn

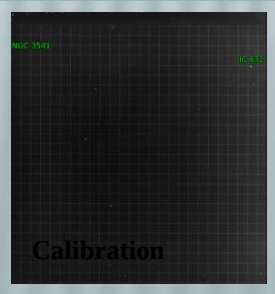
Tuorla and Hewitt plate digitization 2017, 2018

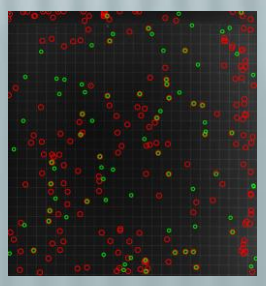
Figure 1. Dr René Hudec (at rear) and Lukáš Hudec photographing the plates in November.

Astrometry Tests of digitized CdC plates

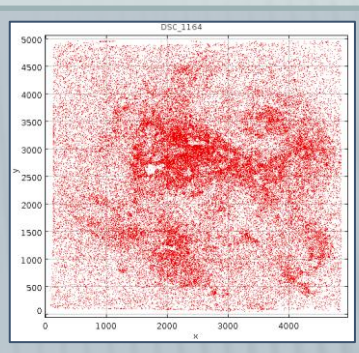
the typical internal astrometric accuracy of astrometric CdC plates is 0.2 to 0.3 arcsec

We have typically 0.3 arcsec so it is obvious that the technique we use is accurate not adding any significant error





Center (RA, Dec):	(168.362, -11.518)
Center (RA, hms):	11h 13m 26.982s
Center (Dec, dms):	-11° 31' 04.637"
Size:	2.18 x 2.35 deg
Radius:	1.601 deg
Pixel scale:	1.96 arcsec/pixel
Orientation:	Up is -89.1 degrees E of N



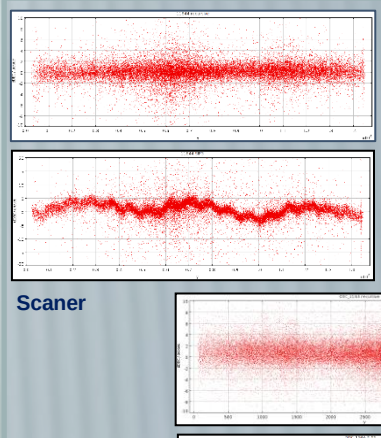
The Bamberg Plate digitized by digital camera

The procedure (Taavi Tuvikene)

The images were run through solver script, which calls SExtractor for extracting all stars, then astrometry.net for an initial solution, and finally does solving in sub-fields recursively.

Two sets RA and Dec were obtained: one from astrometry.net (with SIP order 3) and second from the SCAMP software in sub-fields. The resulting coordinates were matched with the UCAC4 catalogue in TOPCAT and plotted the residuals (in arcsec).

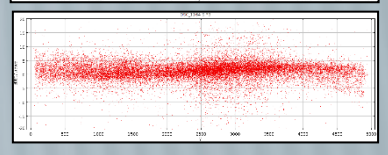
The SIP3 solution shows wobbles from the scanner arm movement (in Dec). These wobbles are missing from the digital camera image.



Comparing Camera vs. Scaner (the residual plots)

Scaner

Bamberg Southern Sky Survey Plate NZ 11844



Camera

- The "recursive" solution eliminates the distortions. The standard deviation of the residuals with the scanner method are 1.8 and 1.6 arcsec (plates 11844 and 11855, respectively). Stddev with the digital camera are 2.4 and 2.2 arcsec. Pixel scale is 1.77 arcsec with scanner and 5.36 arcsec with camera.
- The photometric accuracy was also investigated
- Comparison with scaner not trivial as similar studies are, to our knowledge, not available
- Not trivial to compare with scaner as no such study available.

Offering full service

- We offer full service to users / Institutes with astronomical plates)
- The service includes plate digitization, metadata extraction and recording, lens distorsion treatment, and storage of clean deconvoluted images in data archive with easy access and searching tools

Conclusions

- The use of digital camera with high-end lens, tripod and light table together with lens distorsion solving offers alternative inexpensive (0.25 USD) and fast (2 sec) plate scanning method
- Typically, small plate archives with about 10 000 plates can be digitized within about one week
- The equipment can be easily trasferred