*Astronomical Data Analysis Software and Systems XII*
*ASP Conference Series, Vol. 295, 2003*
*H. E. Payne, R. I. Jedrzejewski, and R. N. Hook, eds.*

# Digital Access to Aero- and Astrophotographic Archives

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**Abstract.** The aim of this test-bed project, initiated and financed by the Belgian Federal Services for Scientific, Technical and Cultural Affairs (SSTC Project I2/AE/103), is to acquire within the coming 4 years, the necessary know-how, hardware and software in order (*i*) to preserve the historic and the scientific information contained in aero- and astrophotographic archives, both on glass plates and on film; (*ii*) to provide a user-friendly intranet and internet access to the catalogue and the (meta)data; (*iii*) to make the photographic information exploitable again for scientific applications, by means of a high resolution digitisation technique.

## 1. Prescanning

Quick-look images are created for future distribution on the web and to save the hand-written notes from previous measurements, that are present on the glass/film side of part of the astro-photographs, by prescanning at low resolution (250ppi and an 8bit grey scale), using commercial preprint flatbed scanners in transmission mode. At this resolution the notes are clearly readable. Further-



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more these digital images contain important information for making the digital catalogue as these images, although deformed, can be used for the redetermination of the coordinates of the plate center and of the measurable magnitude interval, allowing to determine the objects/stars visual on the plate.

The geometric deformation is due to the fact that these preprint scanners are equipped with 1-D CCD rows at a fixed optical resolution. For example, a scanner with a 1000ppi optical resolution used in 250ppi mode will only read out one pixel out of four to construct the digital image. At resolutions that are not a fraction of the optical one also (interpolated) rebinning is applied. Due to the fact that the original remains at rest and is projected by a moving mirror onto the detector, this type of scanners are suffering from scanner seeing. Hence these prescan images are not suited for scientific measurements.

## 2. Plate Errors

The deviations from a perfect mapping of the sky or ground area onto the perfect image plane, have a clear hierarchy:

- global (whole plate),
- large scale (extending over cm range),
- local (mm to sub-mm) and
- emulsion structure (granularity noise).

The origin of those errors can be:

- mapping defects of the optics,
- large scale systematics due to centering errors of the optical system,
- effects from the mechanical and darkroom processes, non homogeneous developing, rinsing and drying of the plates.

All this can and will produce systematic and random errors of any correlation length (i.e., the emulsion shifts are correlated over a mm or cm range).

To determine these effects reference stars or points are used. Some effects can also be calibrated by clever measuring setups at the telescope or camera (tilt of the image plane, position of the optical axes on the plate). Unfortunately these setup data are often not available. The size of these errors is in the 1–2$\mu$m range, the question is how regular they are to be calibrated to $< 0.5\mu$m.

Therefore it is important how precise the images of the reference stars or points can be measured (locally) on the emulsion. Depending on the granularity of the emulsion this is possible down to a few tenths of a micrometer. (See also the notes on SuperCosmos (Hambley et al. 1998) and on StarScan (Winter & Holdenried 2001)).

So we are facing a bandwidth of error contributions from the micrometer to the submicrometer range on the plate. These systematic errors can be calibrated successfully only in case the plate is measured precisely to at least a factor of ten better than their size. This is implied by the fact that if one tries to determine errors with a measuring accuracy of the same order, the unknowns in the calibration model will be meaningless statistically. Thus regardless what type of plates one is measuring, this is the essential condition.

## 3. High Resolution Scanner

Hence, in order to get the full information content from the plate, the measuring machine must have an absolute positioning accuracy of at least 0.5$\mu$m over the whole measuring area. This implies that a 0.1$\mu$m class positioning table is needed. The aim of this project is to construct a scanner using a XY airbearing table with an open frame structure and laser interferometer steering in a temperature (0.1K) and humidity (1% RH) stabilised clean room, giving submicrometer absolute positioning accuracy of the photographic plate with respect to the fixed telecentric objective and digital camera unit.

## 4. Testing

In order to determine their applicability depending on the introduced geometric and radiometric deformations this project will also study in detail: (*i*) the technique of first making an analogue copy of the plates on duplication roll film, this in order to have an analogue backup and to be able to automate the digitisation process by using an unattended all time scanning technique; (*ii*) the effects of the photochemical cleaning of plates containing fungi or aging deterioration.

## 5. Database Design

One of the essential aspects of this project is the elaboration—after a preliminary inventory—of a catalogue of the available images including all related data necessary for the exploitation of these images. The archives concerned are the astrophotographic plate archive of the Royal Observatory of Belgium and the aerophotographic archives of the National Geographic Institute of Belgium and of the Royal Museum of Central Africa (Congo, Rwanda, Burundi). All contain photographs on glass plates as well as on film sheets.

Digital catalogues are being generated in the form of ODBC relational databases. HTML files, ActiveX objects, C++ and JavaScript programming are used to create a user-friendly interface that allows easy searching and gives a straightforward overview about the available (meta)data.

The different types of data have been put together in tables. In order to prevent data duplications, several lookup tables were created. The database of the aerial archives for example, is constructed on two types of principle tables:

- Flight Tables (containing all the data concerning a particular aerial flight)
- Aerial Photograph Tables (containing the data concerning an individual aerial photograph)

The aerial photographic missions consist of one or more flights. The Mission Tables contain the flights making up one particular mission.

## References

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