A UNIVERSAL COMPUTER PROGRAM FOR HIGH PRECISION POSITION DETERMINATION OF MINOR PLANETS ON CCD-FRAMES

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ABSTRACT. The necessity as well as the possibility of the development of a universal computer program for high precision position determination of minor planets on CCD-frames and the concepts of realization are discussed. In Dresden we started with the development of such a universal astrometric tool. The present status of this project is reviewed. Details such as special correction methods for projection errors are presented.

1. NECESSITY

In the past a lot of programs for processing astronomical pictures have been developed. Most of these applications were designed only for special observation equipment and do not give best results when using another. Others are very hard to handle or too interactive.

There is a need for a universal tool which both professionals and amateurs can use to get the best positions of minor planets out of their CCD-frames. The task of the program is not to detect new asteroids, but to assist follow-up observations of known ones. To stand out against the other applications it should be

- suitable for most equipment (observation and processing environment),
- as non-interactive as possible,
- easy to handle,
- giving best possible results,

or short universal.

2. CONCEPTS OF UNIVERSALITY

Portable code. An important characteristic of a universal computer program is the possibility to run it on different platforms and different operating systems. The best way to fulfil this requirement is to write portable code which can be run on most computers without any modifications. The current version of the program uses C++ and follows strictly the ANSI standards. Since there is no need for a graphical user interface in a non-interactive application, the ANSI instruction set should be sufficient.

Language. It is very desirable to give statements in the users native language. Currently the program reads all statements from a simple text file that can be altered to any language.

Interfaces. Universality implies flexibility for data input and output. Open interfaces programmable by the user with the help of an intuitive language would be useful. The current program version uses open interfaces for reading from a star catalog and producing output files.

Automatic algorithms. To become non-interactive a universal program must include smart algorithms that routinely do the work the user would normally have to do. As an example, the matching of stars found on the picture and in the star catalog is done by a program routine using an algorithm described in Valdez et al. (1995).

3. CURRENT STATUS

In Dresden we started with the development of an astrometric tool that fits the requirements to a universal program. The program was designed to run in batch mode. Thus, no graphic user interface is intended.

The frame is read and if needed preprocessed (dark field, flat field etc.). There is a possibility to create or load a defect pixel mask which marks pixels with unusual behavior to not use them in the measurement process. Then the objects on the picture are extracted and their properties (elongation, approximate center etc.) are determined. Accurate positions and magnitudes of all (suitable) objects are calculated next by least squares fit of the individual object images and a modelled point spread function (PSF). There are some analytical and one empirical PSF available at present. Afterwards the frame's corresponding star catalog window is loaded. The positions of the catalog stars are reduced to their apparent places. In the next step the stars on the picture are matched with the catalog stars automatically. Afterwards the exact orientation of the picture with respect to the celestial sphere is reconstructed. For this purpose, several projections are available depending on the used telescope-camera combination and the number of catalog stars on the picture. At the end the coordinates and magnitudes of all objects which were not found in the catalog are determined and the results are put out to a data file.

4. SOME PLANNED IMPROVEMENTS

New models for spread functions. There should be elongated models of spread functions for the case when the MP appears as a short line because of its movement during the exposure.

Approximate minor planets position from number. Because it is intended to use the program for tracking known minor planets it is possible to determine the coordinates of the frame from a given more or less accurate set of orbital elements and the observation time. Then it is not necessary to supply this position as an input parameter any longer.

Color refraction. Langhans et al. (2002) showed that color refraction has to be taken into account when trying to find accurate positions. An appropriate routine should be included in the program

JAVA-GUI for setup. Although the program works in batch mode there are still some configurations to be done. To assist the user in creating the appropriate files it is desirable to have a graphic user interface in a portable manner, maybe in JAVA.

5. REFERENCES

Valdez, F.G., Campusano, L.E., Velasquez, J.D., Stetson, P.B.: 1995, PASP 107, 1119

Langhans, R., Malyuto, V., Potthoff, H.: 2002, Calculated differential color refraction confronted with observed stellar positions, Poster for Journées 2002