METHOD FOR CALCULATING ORBITS OF NEAR–EARTH ASTEROIDS OBSERVED WITH TELESCOPE OMT-800

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ABSTRACT. One of the frame processing techniques, as well as an example of further use of the obtained results to calculate an asteroid's orbit are given in the present paper. The application of frame combination method to improve the telescope's limiting magnitude is described.

Key words: orbits, asteroids.

1. Introduction

Since a new telescope OMT-800 (0.8 m primary mirror, f/2.67 reflector with corrector + CCD) was installed at the observation station of the Astronomical Observatory of Odesa National University in Mayaki village, it became possible to obtain high-precision differential astrometric observations of geostationary objects, asteroids and comets with total magnitude brighter than 21.

The telescope's design features and capabilities are described in detail in the article by Andrievsky et al. (2013).

So far the positional observations of faint objects in the Solar System are of great importance as the ground-based support of space observations of these objects, as well as search and registration of space debris are required indeed.

2. Method for surveying and software for frame processing

It is not feasible to use long exposures for OMT-800 as due to its significant light-gathering power faint objects are overshone by the stellar background for exposures of longer than 30 sec. The optimum exposure of 10-20 sec (depending on the Moon's presence and atmospheric conditions) was experimentally chosen. Observations of faint objects are conducted by series of 5-15 consecutive exposures. A single observation results in a monochrome 16-bit 3056 x 3056 pixels image saved as FITS-file. A typical example of such image is shown in Fig. 1.

To increase the limiting magnitude for the observed objects, as well as to carry out astrometric reduction of images and obtain differential equatorial coordinates of the observed objects, we used OLDAS programme module, which is a component of CoLiTec software package (Savanevich et al., 2012), provided by courtesy of its developers. The indicated module enables to adjust frames of any size by brightness using median filter and the Fourier analysis, as well as to conduct auto-calibration and correction by eliminating dead and hot pixels. At this stage the vignetting of field of view, comatic aberration, any possible failures of daily tracking; ambient light which interferes with telescope viewing, as well as diffracted rays can be corrected. A typical result of a single frame processing using the mentioned software package is presented in Fig. 2. The frame shown in Fig. 1 is taken as the initial frame.

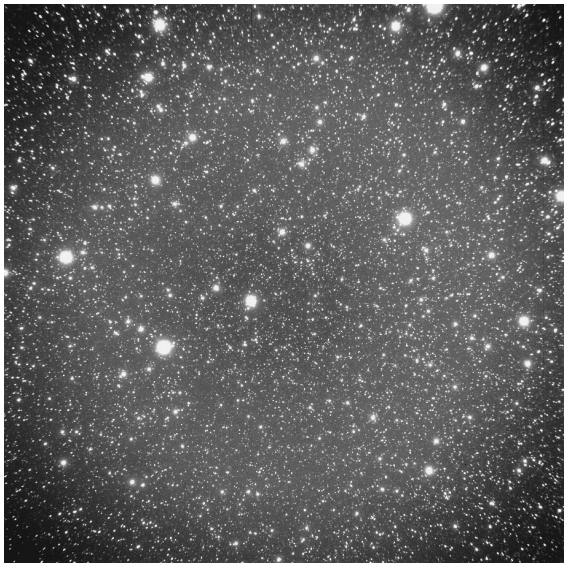

Figure 1: A frame before processing. The exposure time is 10 sec.

Application of the frame combination functional implemented in the CoLiTec software package enabled us to increase the telescope's limiting magnitude from 19 to 21, which is shown in Fig. 2 and Fig. 3.

A super-frame obtained by combining eight frames with 10 sec exposure is demonstrated in Fig. 3.

Experimental test of a number of observational techniques showed that at least three series of eight frames in each should be recorded to receive the best quality astrometric observations. Combination of eight frames allows of

Figure 2: A frame after processing. The exposure time is 10 sec.

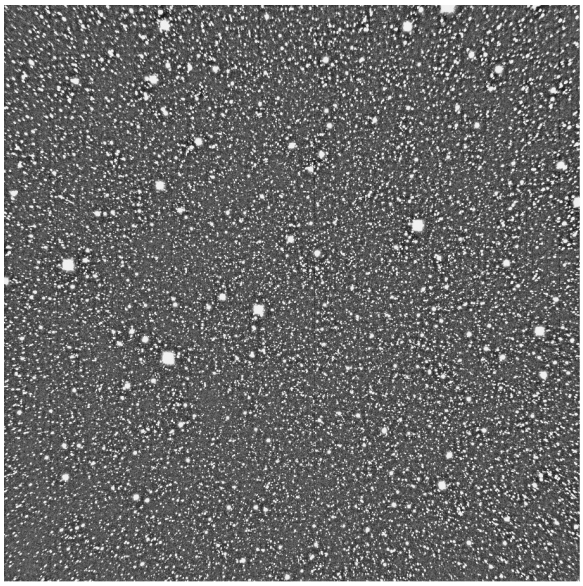

Figure 3: A super-frame made up of 8 individual frames with exposure time of 10 sec.

obtaining good signal-to-noise ratio while three super-frames are required to determine the target object's orbit.

Having got super-frames made up with OLDAS programme, we automatically search for known asteroids, as well as for new ones, in the frame. Such capability increases the value of this programme which can be applied for object search and sky survey.

3. Angular surveying reports and computation of asteroid orbits

The frame processing technique is still to be approved, but the first results have been already received. 90% of our reports on observations and results of primary processing for asteroids and comets (Williams et al., 2014) with magnitude up to 21 meet the Minor Planet Centre Orbit (MPCORB) database (www.minorplanet center.net) requirements.

The Keplerian elements of an asteroid are computed using the Gauss method by three observed positions (Montenbruck et al., 2002).

In questionable cases the fourth observation can be used to choose the correct orbit from several alternative solutions.

Orbital elements of an asteroid are refined using all observations by the method of differential correction of orbits (Bazyey et al., 2005).

4. Conclusion

The refined orbital elements are concordant with the corresponding asteroid's orbital elements from the Minor Planet Centre Orbit (MPCORB) database.

Our results of asteroid observations' processing will be further improved by advancing the algorithm of frame processing technique, upgrading OMT-800 and extension of computational method for orbit calculations. That in turn will enable to use the obtained orbital state vectors to solve the asteroid ephemerides problem (Bazyey et al., 2009).

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