Distinguishing features of CCD astrometry of faint GEO objects

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When performing the optical ground-based observations of faint objects of the geosynchronous orbit, including space debris, by small telescopes, one is forced either to track the target object or to observe without any sort of tracking at all. In both cases, this produces CCD images with reference field stars appearing as trails.

Compared with the measurement of regular, point-source stellar images, differential reduction of CCD images with trails may lead to the loss of positional, as well as photometric, accuracy. Among several other sources of this problem, the major difficulty is to correctly determine the centroid of each reference star and of the target GEO object. Centroids obtained using the conventional center-of-mass technique are distorted by atmospheric extinction fluctuations and jitter during exposure; moreover, these distortions appear to be not the same for stars and for the target object which has the different visible velocity and direction.

An easy and straightforward way to solve this problem would be the application of the PSF fitting technique to star trails. The trail-shaped PSF closely matches the observed star trail, and its geometric centroid is well-defined. PSF fitting technique is unaffected by position and intensity fluctuations along the trail, caused by the atmosphere and swing of the telescope tube due to wind. In most cases, these fluctuations are the same across the whole field of view, which allows one to use a single properly scaled PSF for all stars, further increasing the astrometric accuracy.

This method is implemented in the framework of Apex II - a universal software platform for astronomical image processing, being developed at the Pulkovo observatory. It has been successfully tested and is now used at a number of observatories participating in the network of the Pulkovo Cooperation of Optical Observers (PulCOO).