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Optical Tracking System for Observations of Natural and Artificial Space Objects

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Introduction

The Institute of Geodesy and Geoinformatics (GGI) of the University of Latvia (UL) is focused now on configuring of the optical tracking system and launching of a test program for positional astrometric observations. The instrument is eventually intended for both positional and laser ranging observations of near-Earth objects.

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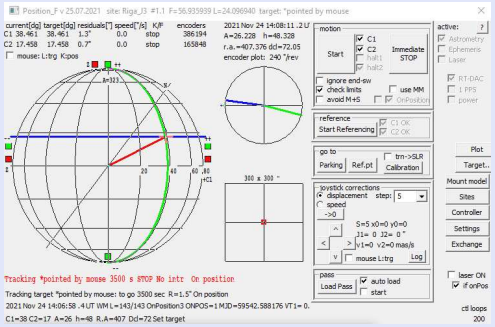
Optics' scheme

The tracking system has Alt-Alt mount and optics' scheme with three optical channels: transmitter equipped with laser collimator and two 16″ F/10 receiving optical tube assemblies (OTAs). One of the twin optical systems is fitted with a CCD camera and used for astrometric and positioning purposes. The other may be fitted with a reflected light pulse detector and used for SLR pulse processing or configured for other purposes.

The system into dome, which is located on the House of Science, UL

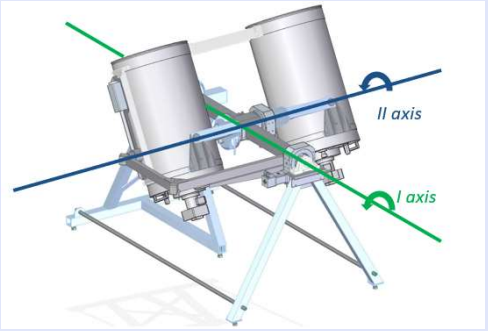
Positioning



Interface of the positioning module

Rotation of the first axis is shown in green, and rotation of the second axis in blue in the mount vertical coordinate system. The connection to the topocentric coordinate system is defined by the North-South direction line.

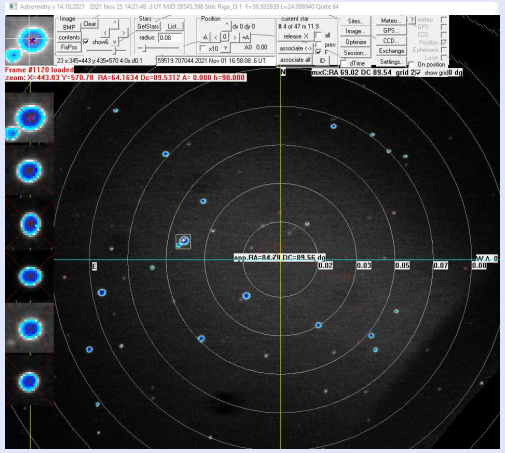
The positioning module is responsible for processing of encoder information, control of positioning motors, collecting and processing of mount error model measurements and implementation of the model. It also visualizes mount position and contains manual mount control interface.



The tracking system has Alt-Alt mount

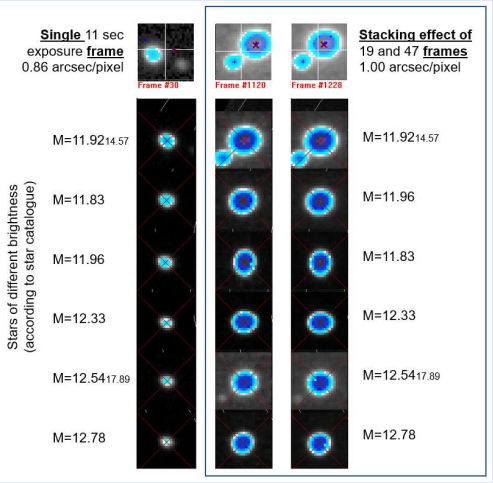
A subset of GAIA star catalogue (release 3E, ~1.5 G stars up to magnitude 22) is used. =>

Star imaging

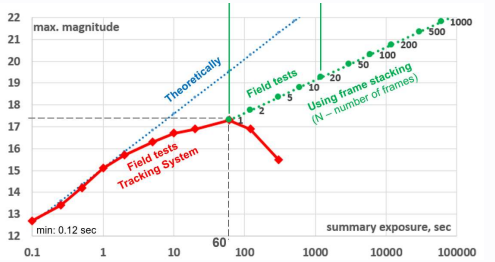


Interface of the astrometry module

The astrometry module supports image acquisition and analysis, star image recognition, reference star selection and identification, astrometric processing of frame data using NOVAS astrometry package, object coordinate determination, frame stacking, star ephemeris calculation.



Preliminary results



Preliminary tests indicated that due to the field rotation, which elongates star images in the periphery of the frame, the effective exposure duration is limited to about one minute. At such exposure, stars of magnitude up to 17-18 can be recognized by the software.

Frame stacking is proposed to increase this limit by several magnitudes. Using it, it should be possible to reach maximum magnitude of about 22.

Conclusions

- After adjustment of mount mechanics, orientation parameters and optimization of mount error model the positioning accuracy of up to 5-10 arc seconds is expected.
- The limiting factor for positional observations is speed of object relative to stars, rendering images into elongated tracks, and thus decreasing both image brightness and timing resolution.
- Practical limit for simple star-tracking mode might be object displacement of about arc minute during exposure.
- Complex star-tracking / object-tracking modes can be developed for faster objects with at least approximately known trajectories.