ASTROMETRIC INSTRUMENTS OF GGI FOR GEODETIC TASKS

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SYMPOSIUM LEIPZIG

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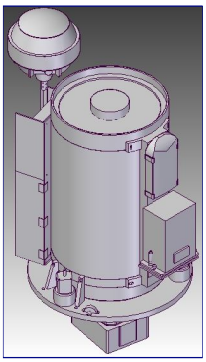
Introduction

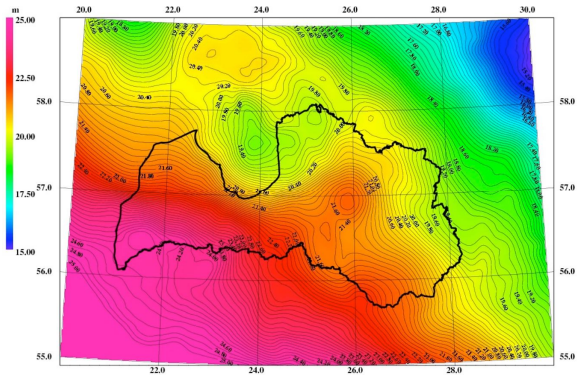
During the last five-year period the Institute of Geodesy and Geoinformatics (GGI) has been developing original and advanced astrometric instruments: a digital zenith camera and a new Alt-Alt mount construction multi-purpose optical tracking system (twin-optics SLR).

Multi-purpose optical tracking system

GGI and Institute of Physics of the University of Latvia during 2014-2015 are engaged in a joint project, the result of which will be a functional prototype of a new multi-purpose optical tracking system for both positioning and laser ranging observations of near-Earth objects. The design of the mount is optimized to minimize deformations, besides that, a software-implemented mount error model will be used to achieve the expected positioning accuracy. Additionally, active beam direction control will be used in the transmitting coudé path. One of the twin optical systems will be fitted with a CCD and used for astrometric purposes (including mount pointing direction determination, object coordinate determination and object guiding). The other, fitted with a reflected light pulse detector, will be used for SLR pulse processing.

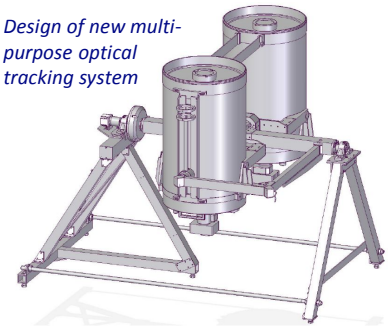


Design of zenith camera

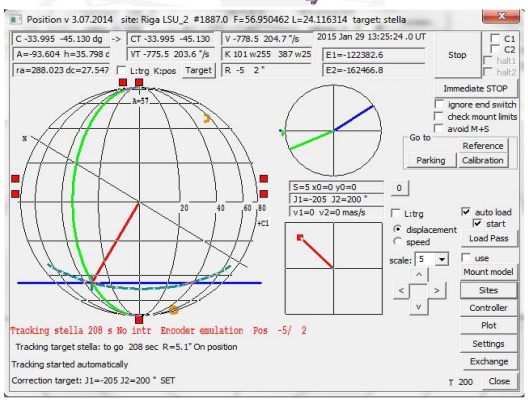


LV'98 – Latvian geoid model from gravimetric and ERS-1 data

Design of new multi-purpose optical tracking system

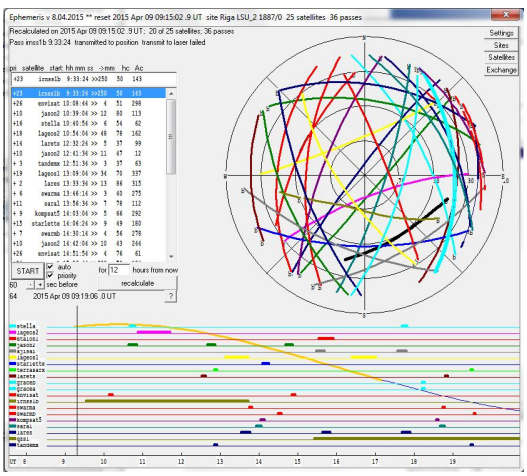


- Twin 40 cm optical systems on Alt-Alt mount, separate transmitted beam collimator.
- Tracking of any orbital object, positioning accuracy within a few arcseconds.
- Positional observation accuracy within a fraction of arcsecond for objects with optical magnitude up to 15m.
- SLR capability (depending on laser transmitter properties) up to geostationary orbit.
- Possibility of simultaneous positional and SLR observations, usage of both optical systems in various combinations.



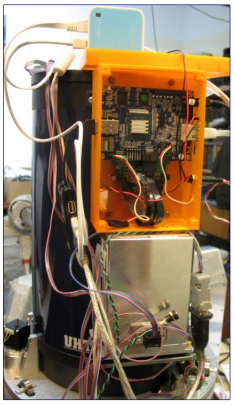
Positioning module *is responsible for processing of encoder information, control of positioning motors and beam correction actuators, collecting and processing of mount error model measurements and implementation of the model. Prediction information is received from ephemeris or astrometry modules. Positioning module also visualizes mount position; it contains manual mount control interface and instrument dome controls.*

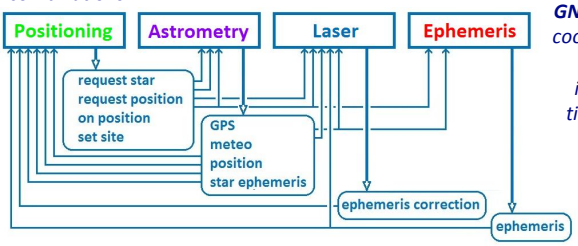
Tasks of ***Ephemeris module*** *are satellite prediction data management, situation visualization and providing of current pass prediction to positioning module. Sites, satellites and predictions databases are maintained here.*



Digital zenith camera

Detailed knowledge of local geoid surface has become increasingly important in order to fully use the potential of accurate geocentric positions, provided by GNSS. Recent advances in a number of scientific and technological fields - accurate astrometric reference star catalogs, development of digital imaging technology, high-accuracy tiltmeter technology, and geocentric coordinate availability using GNSS - have made it possible to use astrometric methods for accurate, fast and automated determination of vertical deflections with an accuracy below a tenth of an arc second. Such measurements can give an important contribution in determination of local geoid properties. That is very appropriate for quality control and performance of fine adjustments for the quasi-geoid model at short wavelengths. Presently GGI has engaged in a project for the development of a digital zenith camera, too. The goal is to design a portable and reliable instrument of this type, using off-the-shelf components as much as possible.

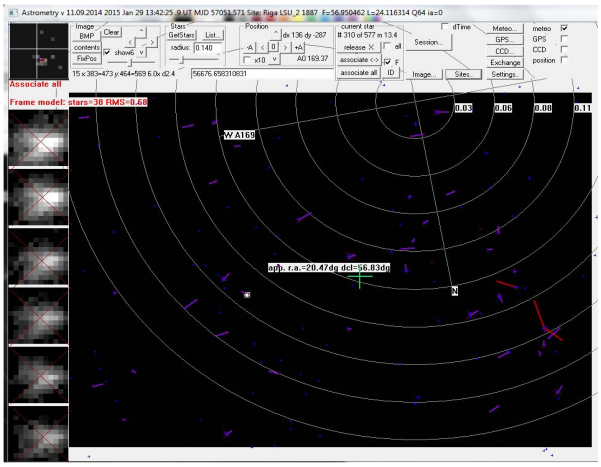




GNSS *provides geocentric coordinates (15-20 cm) of instrument site in precise (10 mks) UTC time so that direction of reference ellipsoid's normal in astrometric coordinate system can be calculated.*

Reference star observations *provide position of instrument main axis relative to reference ellipsoid's normal.*
Tiltmeter readings *provide inclination corrections for the instrument main axis relative to plumb line.*

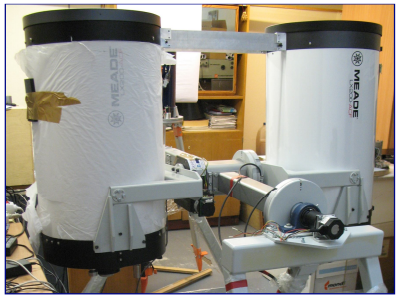
Control software *consists of 4 semi-autonomous main modules supporting positioning, ephemeris, astrometry and SLR functionality. Modules can reside on separate computers, joined in a local network; inter-process communication is asynchronous, using Windows mailslot mechanism.*



Astrometry module *supports image acquisition and analysis, reference star selection and identification, astrometric processing of frame data (a subset of NOMAD star catalog up to star magnitude 16[m] and NOVAS astrometry package are used), object recognition and test for presence in star or minor objects catalogues. Additionally, focusing support and interfaces to GPS receiver and to meteostation are located here. Although manual control is possible, astrometric processing is designed to be fully automatic.*

Present stage

Both projects currently are in the stage of integrating components, functionality tests are expected within 2015.



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