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Digital zenith camera VESTA and its applications

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The portable digital zenith camera (DZC) VESTA (VERTical by STArS) determines the deflection of vertical (DoV) components as the difference between the direction to the ellipsoidal zenith (calculated from reference star observations, fixing precise time moment and site coordinates) and the direction of the plumb line, which is determined with a sensitive tiltmeter. DZC VESTA was developed at the University of Latvia and has been used extensively for the determination of the Latvian quasi-geoid model since 2016. The typical accuracy of VESTA is ~0.1 arc second.

Unlike levelling, relative gravimetry or GNSS measurements, the method used by the zenith camera determines DoV directly, allowing validation of data from other geodetic techniques, for example, DZCs are used for geoid slope validations.

Currently, the focus is on further improving the accuracy of the digital zenith camera. Investigation of the limiting factors to achieve the highest accuracy for applied and scientific applications includes:

- testing the digital zenith camera in different environments to investigate and mitigate the phenomenon of anomalous refraction at zenith; anomalous refraction is the main limiting factor of ground-based astrometric observation's precision, as it causes irregular angular displacements of the observed stars. The proposed tests include more thorough long-term observations to search for the anomalous refraction properties at multiple test sites (such as near the seacoast, on a hill slope, in a forest, in an open field, covering a wide range of environmental conditions) under different weather conditions. Simultaneous observations with several adjacent DZCs would be an efficient method to distinguish instrument-related variations from changes in the measured quantity itself and to find the spatial properties of the anomalous refraction effects.
- performing accuracy analysis in a permanent test site to estimate the spatial and temporal properties of the measured DoV values. Astrogeodetic determination of DoVs is an absolute observational technique, and any undetected systematic errors remain in the data. Various instrumental settings will be tested during the observations.

However, digital zenith cameras are not limited to geodetic applications; there are other ideas for possible fields of application:

- research focusing on applications in a geological survey;

- monitoring of changes in mass distribution in the Earth's crust in case of active tectonic movements.

These areas of geoscience would benefit from an additional measurement technique that complements the traditional method of relative gravimetry.

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