Modelling star trailed images of DZCS to improve the astro-geodetic geoid of Istanbul

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Geodetic Astronomy provides high precision deflection of the vertical (DoV) data using Digital Zenith Camera Systems (DZCS) with an accuracy of $0.1 - 0.2$ arc seconds, which contribute to the accurate geoid modelling studies. The concept of processing DZCS observations depends on the data coming from various sensors such as CCD camera, GPS, and tiltmeters. The star images are captured using CCD camera near zenith direction, and the image solutions (astronomical coordinates) are combined with GNSS data to calculate DoV components. The DoV observations can be used to derive the slope of the geoid, and to produce geoid undulations using astronomical levelling technique.

The astro-geodetic studies in Turkey using DZCS has started in 2012 with the ACSYS V.1. Later on, beginning from 2015, the modernized version of the system has started its first observations in Istanbul using more precise sensors. Observed DoV components have been used to determine geoid height differences which are compared with the ones acquired using GNSS/Levelling data in Istanbul.

The accuracy of the DZCS is not only dependent on the precision of the sensors but also to the image processing methods used for astrometric reduction. Geodetic astronomy that uses CCD images follows the same procedure of astrometric reduction process; however, opposing the conventional astronomical observations, the DZCS does not track the celestial objects. Leaning on this background this study investigates a new method for increasing the number of stars in the images by extending the exposure time up to 60 seconds, which yields trailed images of the reference stars. The test data was collected as star images in various exposure time in order to model the best solution to acquire accurate astronomical coordinates. With this method of image processing it is possible to improve the accuracy of the astronomical coordinates using fitting functions of the star trails.