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FULLY AUTOMATED EXTRACTION OF ACCURATE GROUND CONTROL POINTS FROM SENTINEL-1/2 ACQUISITIONS

Abstract

This work outlines the key components of a completely automated system designed to create Ground Control Points (GCP) using Earth Observation (EO) data. The system relies on SAR and optical images obtained from the Copernicus Sentinel-1/2 constellation, which are widely accessible worldwide. The system was created by Planetek Italia and GAP companies as part of the ESA SEN3GCP project ("Sentinel for 3D Ground Control Point"). SEN3GCP is designed to offer Ground Control Points (GCPs) and accurate co-registration of Earth Observation (EO) products through an automated service that can be accessed via M2M Rest API and a dedicated portal on the Rheticus® platform. The article describes the algorithm developed for generating Ground Control Points (GCPs), which include a reference point with precise geographical coordinates (including height information) and an optical image chip focused on the target. Bright targets (e.g., SAR-Harris corners) are initially robustly detected on multiple radargrammetric datasets in Same-Side or Opposite-Side Looking configurations, which are despeckled by temporal filtering to preserve the native spatial resolution. A matching procedure identifies key-points that correspond to the same target on various SAR datasets, enabling 3D spatial triangulation and geographical location calculation. The GCP geolocation accuracy is improved by addressing air signal propagation

delays, geodynamic phenomena such as solid earth tides, and timining corrections related to the bistatic residual errors. The SAR image chip, created by combining geocoded Multi-Image Reflectivity maps, is compared with super-resolved optical data using advanced techniques such as Mutual-Information and Histogram of Orientated Phase Congruency. The algorithm's robustness was improved by using data collected over a calibration test site at the Physics Department of Bari, which provides a cluster of artificial reflectors, including both passive (trihedral corners) and active (transponders). The prototype service has been thoroughly and successfully evaluated using EO data obtained from the Sentinel constellation, while the performance evaluation with X-band high-resolution SAR data is currently under progress. The performance assessment was conducted on more than 20,000 Ground Control Points (GCPs) gathered from various test sites in Italy, encompassing both flat and hilly terrains. The evaluation utilised ground-truth data obtained via GNSS field surveys, high-resolution orthophotos, and LIDAR Digital Elevation Models. This work also presents the key results of the performance evaluation, focusing on the spatial density of GCPs and the accuracy of 3D geolocation, according to the target category such as vertical poles, light towers, buildings, metal structures.