Absolute 3D Positioning of InSAR Point Clouds by Automatic Point Correspondence Detection in Multiple Viewing Angles Data Stacks

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Introduction

The German TerraSAR-X and TanDEM-X satellites are capable of 2-D absolute localization of point targets with accuracy in the centimeter regime. This level of accuracy is achievable thanks to the precise orbit determination of the satellites followed by a thorough correction scheme to quantify and remove mainly atmospheric and geodynamic nuisances. Recently it has also been shown that by StereoSAR, which combines observations from two or more satellite viewing geometries, 3-D absolute positioning with SAR data is possible [A]. However, the detection of corresponding scatterers in SAR images from multiple viewing geometries, which is the basis of the StereoSAR method, is a challenging task mainly due to the side-looking geometry of the satellite and the speckle effect. This research attempts to tackle the aforementioned problems by detection of point correspondences in data from same-heading and cross-heading tracks based on the fusion results of Persistent Scatterer Interferometry (PSI) and optical data, respectively. Furthermore, the application of the methods which lead to automatic generation of Ground Control Points (GCPs) from SAR images is shown.

Workflow of GCP generation using SAR data

The work-flow of automatic GCP generation is shown in Fig. 1. If positioning from same-heading tracks is required the input is generated based on the fusion of adjacent point clouds obtained from PSI. If positioning from cross-heading track is required, since these targets are usually vertically oriented cylindrical objects, the input is generated based on detection of lamp poles from high resolution optical data.
Examples in Oulu, Finland and Berlin, Germany
The first example in Fig. 2 shows the detected point scatterers from PS point clouds obtained from two descending (same-heading) tracks over the city of Oulu in Finland. The red and gray points represent the corresponding PSs and the yellow points are the best 50 localized Ground Control Points. The second example (see Fig. 3) demonstrates the positioning from ascending and descending (cross-heading) tracks over the city of Berlin in Germany. The point scatterers are detected based on the distinctive shadows of lamp poles on optical data.

Applications and Future work
With the methods explained in this contribution, it is possible to detect common scatterers from multiple viewing geometries. By extraction of precise timings of the scatterers from SAR images, applying the relevant corrections and combining the measurements by StereoSAR, it is possible to produce large amount of precise 3-D Ground Control Points. These absolute Ground Control Points can be further used as: reference networks in multi-pass InSAR techniques, support for phase unwrapping, observation to detect large magnitude motions and tie-points for optical data. The future work comprises of densification and homogenous distribution of the Ground Control Points to be further involved in geodetic network design. The designed network will be integrated with the InSAR phase-based methods to provide absolute coordinates and deformation maps.

References

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