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Suitability assessment of SENTINEL-1 InSAR data for bridge deformation monitoring in Alpine terrain

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Assessment of both condition and reliability of engineering structures is essential for appropriate infrastructure maintenance. In particular, changes in geometry (i.e. deformation) are an essential feature of structural condition. Among recent developments of scanning methods that have opened up new possibilities for contactless and rapid measurement of structural geometry, methods based on satellite synthetic aperture radar (SAR) interferometry are especially suitable for precise surface deformation monitoring. By exploiting information contained in the phase values of co-registered, multi-temporal SAR imagery, ground deformation and corresponding displacement rates can be obtained with sub-centimetric precision.

With the launches of Sentinel-1A and 1B in April 2014 and April 2016 respectively, C-band SAR data with a spatial resolution of 5×20 meters (Interferometric Wide Swath Mode) became freely available across large parts of the globe. The constellation of the two satellites entails a repetition time of 6 days, and resulting data are provided near-real time.

Within the scope of a feasibility study, the general applicability of Sentinel-1 InSAR imagery for monitoring infrastructure assets is evaluated. Specifically, focus has been put on the assessment of the structural health of bridges in terms of deformation rates obtained by means of persistent scatterer interferometry (PSI). This differential interferometric SAR technique relies on strong reflecting objects that are constant over time, and can be used to obtain deformation time series and the deformation velocity estimated over the analysed permanent scatterer points.

Bridge deformation monitoring tests are conducted at selected structures along the Austrian primary road network. Estimated permanent scatterer elevations are validated against in-situ measurements (ground truth). In addition, performance of Sentinel-1 based PSI is tested against ground-based measurements of the road geometry (i.e. changes in the longitudinal profile obtained via laserscanning) as well as UAV-based LiDAR measurements.

Preliminary results confirm the general applicability of Sentinel-1 SAR data for bridge monitoring in Alpine terrain. At the same time, certain challenges related to selection of persistent scatterers, topographic phase correction as well as atmospheric correction still need to be overcome.