PSINSAR: USING SATELLITE RADAR DATA TO MEASURE SURFACE DEFORMATION REMOTELY

A. Ferretti[1], S. Cespa[1], F. Novali[1], D. Perissin[2], F. Rocca[2], C. Prati[2]
[1]Tele-Rilevamento Europa - T.R.E. s.r.l.
[2]Dipartimento di Elettronica e Informazione - Politecnico di Milano

Abstract: Synthetic Aperture Radar Interferometry (InSAR) from Earth-orbiting spacecraft has revolutionized the field of crustal deformation research since its first geophysical application, about a decade ago. During the last 10 years, InSAR has been used to study a wide range of surface displacements related to active faults, volcanoes, landslides, aquifers, oil fields and glaciers, to name just a few, at a spatial resolution of less than 100 m and cm-level precision. The temporal resolution is limited by the monthly repeat time of satellite flyovers. Due to the viewing geometry of the radar satellite, InSAR is particularly sensitive to vertical deformation, but can not detect displacements parallel to the orbit track. Severe limitations to the InSAR method remain, especially decorrelation of surface scatterers due to vegetation or other surface change processes, incoherence caused by large satellite orbit separations between the two image acquisitions used to make an interferogram, and noise from signal delays in the Earth's atmosphere.

A new approach, the Permanent Scatterer (PS) method, developed by Politecnico di Milano (POLIMI) and TRE (a POLIMI spin-off) has been introduced to improve our ability to determine mm-scale displacements of individual features on the ground using all data collected over the target area by a SAR satellite (such as the European Space Agency's Earth Remote Sensing, ERS-1&2 spacecraft). As long as a significant number and density of independent radar-bright and radar-phase stable points (i.e., permanent scatterers) exist within a radar scene and enough radar acquisitions have been collected, displacement time series and range-change rates can be calculated. Using the PS method, we can resolve surface motions at a level of ~0.5 mm/yr and can resolve very small-scale features, including motions of individual targets/structures (e.g. a bridge or a dam), not previously recognized in traditional SAR interferometry.

PS usually correspond to buildings, metallic objects, outcrops, exposed rocks, etc. exhibiting a "radar signature" constant with time. Once these "radar benchmarks" have been identified from a time series of radar data, very accurate displacement histories can be obtained for the period 1992 to the present. The effect is akin to suddenly having a very dense GPS network retrospectively available for the last ten years in any moderately urbanized area (at least whenever ERS data have been collected).

In this work, after presenting the mathematical background of this technology, we show how many applications related to surface deformation monitoring and with a huge potential impact on many engineering fields can benefit from radar space measurements. As it will be discussed, historical data can be important also for insurance companies for claim assessment after tunneling works.

The last part of the presentation will be devoted to the future of this technology, the new three SAR sensors that will be launched in the next months and the need of a *regular* acquisition of SAR data. In the near future, different SAR sensors will be jointly exploited to extract information not only for the scientific community but also for other users such as engineering companies, Civil Protection authorities and Public Administrations in charge of land management.

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