DEFORMATION MEASUREMENT USING SENTINEL-1A/B IMAGERY

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ABSTRACT:

Land deformation monitoring based on C-band Synthetic Aperture Radar Sentinel-1A/B imagery is the main focus of this paper. This type of data is exploited using a Persistent Scatterer Interferometry technique. The paper describes a deformation monitoring strategy, which is related to a specific monitoring scenario: a relatively small deformation area of interest surrounded by a stable area. In the case study considered in this work, the scenario corresponds to an area of potential subsidence induced by underground water pumping. In this specific case, the deformation area of interest has a radius of approximately 1 km. The proposed monitoring strategy takes advantage of the specific scenario at hand, and, in particular, of the availability of stable areas close to the area that potentially is affected by deformation. In this paper we briefly describe the proposed data analysis strategy. The key component of the strategy, i.e. the estimation of the atmospheric component, is illustrated in detail. Some examples of the two main products of the procedure, i.e. the deformation velocity map and the deformation time series, are discussed.

1. INTRODUCTION

This paper is focused on land deformation monitoring using C-band Sentinel-1A/B imagery and the Persistent Scatterer Interferometry (PSI) technique. The PSI technique represents an advanced class of the differential interferometric SAR techniques, which makes use of multiple SAR images acquired over the same site and appropriate tools to separate the deformation signal of interest from other components of the PSI observations, such as the residual topographic error component, the atmospheric component and the phase noise. For a comprehensive review of PSI, see Crosetto et al. (2016).

The PSI techniques have experienced a major development in the last decades, which has been mainly related to C-band data from ERS-1/2, Envisat and Radarsat sensors. The advent, in 2007, of very high resolution X-band data (TerraSAR-X and CosmoSkyMed) enabled a major step forward for the PSI techniques, e.g. see Strozzi et al (2009), Crosetto et al. (2010), Gernhardt and Bamler (2012) and Lan et al. (2012).

A new significant improvement comes from the availability of C-band data from the sensors on board the Sentinel-1A and 1B satellites. The potential of Sentinel-1-based PSI has been documented in the literature. Barra et al. (2016) and Barra et al (2017) use Sentinel-1 data for landslide detection and mapping. A case study related to a mega-landslide is described in Dai et al. (2016). Different studies concern volcano monitoring, e.g. see González et al. (2015) and De Luca et al. (2016). Examples related to subsidence monitoring are discussed in Crosetto et al. (2015) and Shirzaei et al. (2017). Finally, a case of infrastructure monitoring (long bridges) is described in Huang et al. (2017).

In this work we address the deformation monitoring over an urban area. In particular, we consider a specific monitoring scenario by assuming that the area to be monitored is surrounded by a stable area. The monitoring strategy exploits this stable area. In Section 2 we describe the proposed monitoring strategy. The results of the deformation monitoring are discussed in Section 3.

2. PROPOSED PROCEDURE

The proposed procedure involves the following steps.

- Generation of a redundant stack of multi-look interferograms.
- 2+1D phase unwrapping of the redundant multi-look interferograms (Devanthéry et al., 2014).
- Identification of a stable area in the surroundings of the area of interest.
- Atmospheric component estimation using the stable area. This component is assumed to be linear.
- Removal of the estimated atmospheric component from the original single-look interferograms.
- Estimation of linear deformation velocity and residual topographic error using the periodogram (Biescas et al., 2007).
- Removal of the residual topographic error from the original single-look interferograms.
- 2+1D phase unwrapping of the redundant single-look (residual topographic error-free) interferograms. Generation of the deformation time series.
- Estimation of the deformation velocity starting from the time series.
- Geocoding.

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