GROUND-BASED SAR INTERFEROMETRY: PRINCIPLES AND APPLICATIONS

Giovanni NICO

Instituto Dom Luiz - Universidade de Lisboa

Resumo: Synthetic Aperture Radar (SAR) is a coherent active microwave technique able to provide 2D refractivity images of a given area with high spatial resolution, independently of weather conditions and day-night cycle. The interferometric processing of two coherent complex valued SAR images acquired from slightly different view angles results in an image relating the phase difference between the pair of SAR images to the terrain relief. The most notable application of SAR interferometry is the so-called differential SAR interferometry. This last technique relies on the processing of a time series of coherent SAR images. It gives a powerful tool to produce maps of deformations occurring in infrastructures (dams, buildings, bridges) or terrain. All these SAR techniques have been mainly assessed by data acquisitions from satellite systems and in a less extent by airborne systems. If the use of satellite-borne systems has proven to be extremely successful for the measurement of deformations induced by slow-time processes over wide areas, it reveals being often unsuitable when high flexibility in terms of revisiting time is needed, as to foresee possible hazard conditions. For this reason, during the last few years the research activity of several remote sensing groups has dealt with the development of ground-based SAR (GBSAR) systems. Easy to deploy, cheaper if compared to space-borne systems, GBSAR sensors represent a cost-effective solution for the continuous monitoring of small scale deformation phenomena. These systems basically consist of a CW radar mounted on a sliding support and synthesizing in time an aperture longer than the physical dimension of their real antennas. The solution mostly adopted is the use of a vector Network Analyzers (VNA) for the generation of the bandpass signal transmitted at each position of the rail. On the one hand, VNAs provide a high versatility to generate tones from low up to high frequencies and the opportunity to simplify the hardware complexity. On the other hand, the time required for the sweeping process may come to be comparable to the decorrelation of troposphere medium or of the scenario itself. In fact, acquisition time turns out to be linearly proportional to parameters as signal bandwidth or cross-range minimum sampling, as well as the number of polarization channels to be gathered. Accordingly, only single polarization GBSAR systems, usually VV-polarized, have been operatively employed up-to-now for long-time monitoring activities, with performances going from 12 to 20 minutes for about two meter long synthesized apertures. In this work, an introduction to the basic principles of GBSAR interferometry is given. The structure of a typical ground-based system is detailed. Furthermore, the applications of GBSAR interferometry so far developed are detailed. Such applications mainly concern with the measurement of deformations. In particular, two kinds of examples of applications are presented. In the former case a detailed map of deformations occurring in a dam is derived. The interferometric map is compared to measurements obtained by traditional instruments in a few selected points of the dam. In the last case, an example of application of GBSAR interferometry to the measurement of terrain deformations induced by a landslide phenomenon is presented. The monitored landslide spans an area of a few squared kilometres and it is characterised by a fast deformation rate. In both examples, the GBSAR system was installed at a distance ranging from a few hundred meters up to about two kilometres. The main advantage of GBSAR measurements, characterized by a sub-millimetre accuracy, is that they furnish the spatial pattern of the deformation phenomenon and not only measurements in a few selected points as in the case of traditional geotechnical instruments. As a third example of application of GBSAR interferometry, a procedure is described to derive high resolution Digital Elevation Models of small areas.

Palavras-chave: Ground-Based SAR interferometry

Contactos
Giovanni NICO
gxnico@fc.ul.pt
Instituto Dom Luiz (IDL). Universidade de Lisboa
www.igidl.ul.pt
Portugal