A 2-D Continuos Wavelet Transform method for InSAR phase–maps denoising

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ABSTRACT

Analysis of Interferometric Synthetic Aperture Radar (InSAR) phase–maps with large wide band is still a challenging problem that requires the development of robust methods. This paper presents a 2–D Continuous Wavelet Transform method for denoising InSAR phase-maps. Owing to its high directionality, sensitivity and anisotropy, multiresolution analysis with 2–D Continuous Wavelet Transform (2–D CWT) is potentially a useful tool to construct appropriate filtering algorithms for detecting and identifying images with specific features, transient information content, or other properties. The 2-D Gabor wavelets naturally model the phase fringes, which means that can properly reconstruct the image. We describe the theoretical basis of the proposed technique and some experimental results with real InSAR phase–maps. As can be verified the proposal is robust and effective.

Keywords: Filtering, fringe pattern, multiresolution analysis

1. INTRODUCTION

SAR interferometry is a powerful technique for the generation of digital elevation models (DEMs) and the monitoring of small surface changes. SAR interferometry has been applied to the study of a number of natural processes including earthquakes, volcanoes, glacier flow, landslides, and ground subsidence.

Denoising InSAR phase-maps is an important steep for a proper and accurate height measurement in radar imaging techniques.[1–9] As it is known, remote sensing by means of InSAR imaging needs coherent electromagnetic waves, which are used to acquire both amplitude and phase information. The amplitude information corresponds to the reflectivity of the ground and the phase corresponds to the height variation. Interferometric SAR provides a means to obtain high resolution digital topographic maps with large swath without the effect the weather condition, in other words, the InSAR technique is advantageous in the sense that it is immune to clouds and darkness.

The InSAR technique consists on the acquisition of two complex images ($I_1 = A_1 e^{\phi_1}$ and $I_2 = A_2 e^{\phi_2}$) of a ground scene taken from different view angles. The well known *phase interferogram* ϕ is obtained by means of the difference $\phi = \phi_1 - \phi_2$, which contains the height information:

$$\phi = d\frac{4\pi}{\lambda}h, \tag{1}$$

where h is the height distribution of the ground in the scene and d is a parameter dependent on the system baseline.

Unfortunately, owing that the phase distribution ϕ represents a principal argument, *i.e.* $\phi \in [-\pi, \pi)$, Equation (1) can not be applied directly, so that an unwrapping procedure must be carried out to determine the continuous phase.[10] The wrapped phase field ϕ is related with the corresponding continuous phase ϕ_c by means of

$$\phi = W[\phi_c] = \phi_c + 2\pi K, \tag{2}$$

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