Development of SAR Interferometry at IIT Bombay

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Abstract -- The emphasis of this paper is on the implementation of SAR Interferometry at CSRE, Indian Institute of Technology, Bombay. ISAR software by ESA was used for generating the fringes and the phase unwrapping software was developed in-house. A test site around the western ghats was chosen for testing the software.

INTRODUCTION

SAR Interferometry is a promising technique for various applications like producing 3-D relief maps, detecting and monitoring small changes of surface shape caused by crustal movement and landslides, mitigation of volcanic hazard and generally monitoring changes in surface geophysical parameters.

Realising the importance of SAR Interferometry, CSRE at IIT Bombay has taken up the project entitled - "SAR Interferometry for topography and earth surface movement" sponsored by ISRO-IITB Space Technology Cell. Under this project ISAR software, developed by ESA has been implemented on a DEC ALPHA system. The phase unwrapping software was also developed around the same system. The subsequent sections describe the processing the SLC data using the ISAR software, phase unwrapping etc.

TEST SITE AND DATA SETS

The study area is a part of Ratnagiri district on the west coast of Maharashtra lying between 16° 50' to 17° 23' North Latitude and 73° 15' to 73° 46' East Longitude. Physiographically, the study area can be divided into three parts as coastal plains, Sahyadri hills and undulating uplands. The height of the terrain varies from 20 m to 400 m above the mean sea level.

Two SAR scenes of ERS-1 acquired on 13th and 19th February 1992 have been obtained from NRSA. The normal baseline for the two scenes is 267m. Several subimages of 512*512 were taken for generating interferometry and one set of images are given as illustration.

IMPLEMENTATION OF THE ISAR SOFTWARE

We have obtained the ISAR (Interferometric SAR) software developed by the Politecnico di Milano, Italy, the details of which are given in [1]. We have used the software for processing the SLC SAR data for the Ratnagiri area and have been successful in generating the interferometric fringes for it. Figures 1-4 illustrate the various steps in the processing of the SLC data.

PHASE UNWRAPPING

The ISAR software leaves us at the stage where we have a "wrapped" phase value corresponding to every pixel in the grid. By wrapped we mean the value (as from any interferometrical experiment) is between -π and π. The basic aim of phase unwrapping is to generate the total or 2π value of the phase from this wrapped phase.

A variety of techniques have been proposed in the past few years in an attempt to solve this problem. We analyzed most of the techniques such as, integration of differences [2], the incorporation of branch cutting into integration [3], cellular automata [4] and the robust technique [5].

We have implemented the robust technique for which the time taken for
unwrapping is small (of the order of 10 sec. for a 512*512 grid).

Having implemented the Robust technique (till now we have used DCT’s to solve the Poisson equ) we have tested it on a variety of synthetically generated images. What we are doing currently is to merge the ideas of the integration technique (the part concerning residue location) and then form a weighted wrapped phase value grid on which we can use the Robust technique.

RESULTS AND DISCUSSION

Figure 1 shows the radar image of a part of the study area in which the ridges on west running North-South and also on the South-East corner are clearly visible. In between there is a valley portion with a drainage line. Figure 2 gives the interference fringes developed for the area corresponding to Figure 1. The fringes corresponding to the ridge lines are clearly visible on both the corners. In the middle of the ridges the shape of the fringes indicates the effects of shadow. Figure 3 and 4 show the slope images in the azimuth and range directions. Due to the viewing geometry of the SAR, only the Eastward slopes are visible. There is an uncertainty in quantifying the slopes which are in the shadow region.

Figures 5 and 6 show the wrapped and unwrapped images for a synthetically generated surface. The unwrapped image agrees well with the simulated surface. We are now working on the fringes generated for the Ratnagiri area.

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REFERENCES


FIGURES

Fig.5 Wrapped Phases.
Fig.6 Unwrapped Phases.
Fig. 1 Amplitude Image.

Fig. 2 Interferometric Fringes.

Fig. 3 Azimuth Slopes.

Fig. 4 Range Slopes.