INTERPRETATION OF BUILDINGS IN HIGH RESOLUTION SAR IMAGES BASED ON ELECTROMAGNETIC METHOD

*Fengli Zhang**, *Yun Shao, Zi Wan, Xiao Zhang*

State Key Laboratory of Remote Sensing Science, Institute of Remote Sensing Applications, Chinese Academy of sciences, #3 Datun Road, Chaoyang District, Beijing 100101, China, flizhang@irsa.ac.cn

1. INTRODUCTION

Synthetic aperture radar (SAR) is an important supplement to optical remote sensing in emergency situations or where the cloudy and rainy weather hinders optical remote sensing, and high resolution SAR satellites will promote the applications in urban area greatly. For low or middle resolution SAR images (with resolution about tens of meters), analysis of buildings is often restricted to radiometric properties and detailed structure of buildings can not be identified. In high resolution SAR images, geometric structures become prominent and can be more effectively used for target identification [1]. Nevertheless, interpretation of SAR images in urban areas is particularly difficult due to the geometric distortions (layovers, shadows), multi-reflections, together with speckle noises. It is usually difficult to establish a determined relationship between scattering centers in high resolution SAR images and the basic units of building targets. In order to thoroughly understand the backscattering behaviour of building targets in high resolution SAR images, analysis and experiments were carried out in this paper based on electromagnetic scattering model and high resolution TerraSAR-X image.

2. SCATTERING BEHAVIOUR MODELLING BASED ON ELECTROMAGNETIC METHOD

Simulation has become an important tool for SAR image understanding. For urban target, simulation can be carried out taking the building target as a whole, or first imaging for each component and then to obtain a whole simulated SAR image [2]. The first one is a little complicated but can provide more precise results [3], thus has been employed for building imaging simulation in this paper. SAR imaging simulation for three-dimensional building target adopted in this paper mainly include the following procedures, 3-D model establishment for the building target, triangular facets partition, RCS (radar cross section) prediction for each facet, and SAR imaging through coherent superposition of echo from each triangular facet. In this paper, physical optics model was adopted to calculate the surface currents on the triangular facets, and then to predict RCS from each facet.

Based on this electromagnetic method building targets owing arbitrary geometric configurations and made of different materials with certain dielectric constant, can be modeled and their backscattering characteristics in various imaging conditions, can be obtained. According to the simulated SAR images, the layover, corner reflector, surface refection of smooth roof, shadow, as well as the outstanding superstructures, all can be well interpreted.

3. BUILDING TARGET INTERPRETATION FOR HIGH RESOLUTION TERRASAR-X IMAGES

TerraSAR-X is a new German radar satellite launched in June of 2007, carrying X-band SAR sensor that can be operated in different modes and polarization. In this paper, spotlight mode (up to 1-meter resolution) TerraSAR-X images in Beijing and Guangzhou city were used.

First typical characteristics of buildings were analyzed using the 1-meter resolution TerraSAR-X image, and the relationships of them with incidence angle, aspect angle of SAR imaging, were compared and analyzed. Then the scattering centers of buildings, such as layovers, corner reflectors, and outstanding superstructures, were identified using thresholding algorithm and Hough transform. Fig. 1 shows an example of building targets on 1-meter TerraSAR-X image. Here, the image was imaged on April 4, 2008, HH polarization, in descending orbit and right looking, and incidence angle of 33.53°

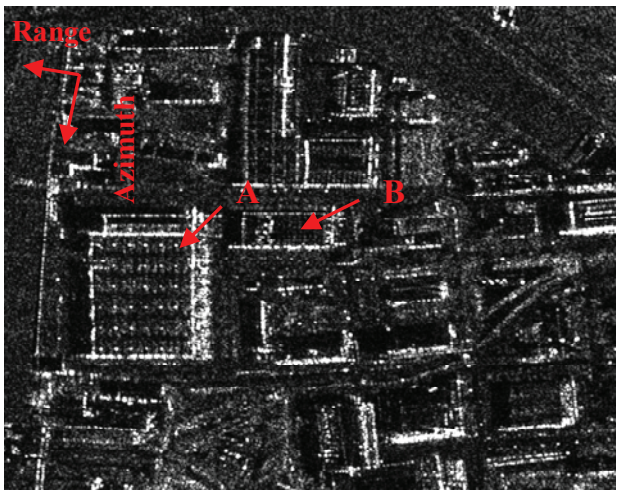

Fig. 1 An example of building targets on 1-meter TerraSAR image

Then the building target was modeled using computer aided design (CAD) software, according to field measured parameters, including length, width, height, as well as the geometric features of the building. Material was also investigated in field experiment and the dielectric constant was then determined. Then the 3-D model and the dielectric constant were imported to the electromagnetic model and simulated SAR image was obtained according to the same imaging parameters as the TerraSAR-X image. Then the simulated image was combined with

TerraSAR-X image for comprehensive analysis, and scattering characteristics of building target could be more thoroughly explained based on the electromagnetic method.

4. CONCLUSIONS

High resolution SAR is anticipated to provide more valuable information for urban areas, yet the interpretation of high resolution SAR image has still remained as a tough work. In this paper, electromagnetic method was employed for analysis of building target backscattering behaviour, and then used for aiding the interpretation and understanding of high resolution SAR images. According to field measurements, building target can be accurately modeled in 3-D space and their backscattering signatures can be obtained using electromagnetic method. With the aid of these results, building target characteristics in high resolution SAR image can be interpreted correctly.

5. REFERENCES

[1] E. Michaelsen, U. Soergel, and U. Thoennessen, "Perceptual Grouping for Automatic Detection of Man-made Structures in High-Resolution SAR Data," *Pattern Recognition Letters*, pp. 218-225, 2006.

[2] R. Guida, A. Iodice, D. Riccio, and U. Stilla, "Model-Based Interpretation of High-Resolution SAR Images of Buildings," *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, pp. 107-119, 2008.

[3] G. Franceschetti, A. Iodice, and D. Riccio, "A Canonical Problem in Electromagnetic Backscattering from Buildings," *IEEE Transactions on Geoscience and Remote Sensing*, pp. 1787-1801, 2002.