COMBINING GIS AND INSAR DATA FOR 3D BUILDING RECONSTRUCTION

Antje Thiele[1,2], Stefan Hinz[1], Erich Cadario[2]

[1] Karlsruhe Institute of Technology (KIT), Institute of Photogrammetry and Remote Sensing (IPF), Germany
[2] Fraunhofer FOM, Research Institute for Optronics and Pattern Recognition, Germany

1. INTRODUCTION

The new generation of space-borne high resolution SAR sensors such as TerraSAR-X, SAR-Lupe or Cosmo-SkyMed provides SAR images of 1-3m spatial resolution or even better in special spotlight modes. Naturally, the development of methods to automatically derive detailed cartographic information of both rural and urban areas from this kind of data is a major issue driven by these missions. Since SAR is largely independent from weather conditions, it is furthermore an attractive imaging technology for rapidly acquiring area-wide information of regions hit by disasters such as floodings, landslides, or earthquakes. Thus, the development of automatic methods for damage analysis or – generally – change detection is another important issue. For such kind of tasks existing Geo-data available from Geographic Information Systems (GIS) have to be adjusted with current SAR data.

Man-made building detection from SAR and InSAR data presented in the literature up to now was mainly based on magnitude data alone or a combination of magnitude and interferometric height data [1,2,3,4,5]. In most cases, these approaches exploit the magnitude of building signatures by analyzing the layover and shadow areas. The exploitation of the interferometric heights was restricted to mean height calculation within an estimated building footprint. But in high resolution InSAR data even the shape of the interferometric phase profile at building locations contains valuable information [6].

In this paper, an approach for building modeling and height estimation based on multi-temporal information fusion by exploiting GIS and InSAR data is presented. The GIS information can be provided by the above mentioned reconstruction algorithms or by cadastral data taken from Geo-databases. In our experiments, building footprints are used as initial, yet possibly coarse information.

2. APPROACH

Our simulation approach in [6] is adapted to provide the synthetic InSAR phase signature of a building based on a given 2D foot-print and an assumed building height. Besides the 2D footprint information also the sensor and scene parameters of the InSAR data are taken into account in the simulation step. The simulation model considers furthermore the fact that – especially at building locations – a mixture of several backscatters can contribute to the measured interferometric phase within a single range cell. The interferometric phase simulation is carried out according to the slant range grid of the real measured interferogram. Subsequently, the phase of each single slant range cell is calculated by coherently summing up all contributions (e.g., from ground, building wall and roof). This step is passed for all ground range profiles, which describe the considered building. Finally, all simulated phase profiles are connected to a final InSAR phase signature of the building. The subsequent assessment of the similarity between simulated and real InSAR phases is based on the correlation coefficient. An iterative adjustment and modeling refinement of the simulation input enables the reconstruction of the actual building shape. In the case that reconstruction fails, a significant change in the signature is assumed.

3. FIRST RESULTS

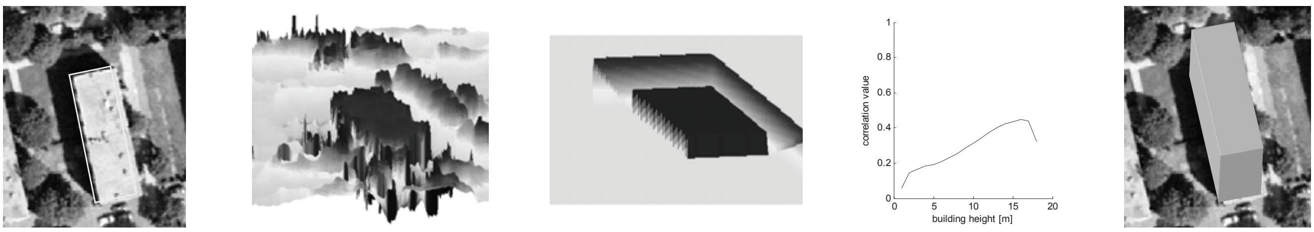
The first result of the described approach is given in Fig. 1. The GIS information (a) was extracted from cadastral data. The 3D visualized interferometric phases (b) are provided by the airborne SAR sensor AeS-1 from Intermap Technologies. The simulated interferometric phases for one defined height value are shown in (c). The result of the assessment between measured and simulated phases depending on the increasing building height are plotted in (d). An optical image overlaid with the final 3D result is given in (e).

In the final paper we will show the reconstruction results of more complex buildings and configuaration of buildings. Because, in addition to the analysis of such isolated buildings, in dense urban areas interaction effects between neighbored buildings have to be considered. Furthermore, we will refer to crisis information system, due to the fact that a detected change between measured and simulated phase, can be interpreted as a possible damage. Focusing on the test data, we will show first results on high-resolution space-borne data, whereby our work is primarily dedicated to the design and prototyping of automatic mapping tools for TanDEM-X data.

4. REFERENCES

[1] R. Bolter, “Buildings from SAR: Detection and Reconstruction of Buildings from Multiple View High Resolution Interferometric SAR Data,” University Graz: Ph. D. Thesis, 2001.

[2] U. Soergel, U. Thoennessen, and U. Stilla, “Iterative Building Reconstruction in Multi-Aspect InSAR Data,” In: Maas HG, Vosselman



a b c d e

Figure 1 Optical image overlaid with 2D GIS information (a), real InSAR phases at building location (b), simulated InSAR phases at building location (c), correlation plot of real and simulated phases (d), optical image overlaid with 3D reconstruction result (e)

G, Streilein A (eds) 3-D Reconstruction from Air-borne Laserscanner and InSAR Data, IntArchPhRS, vol 34, part 3/W13, pp 186-192, 2003.

[3] M. Jahangir, D. Blacknell, C.P. Moate, and R.D. Hill, "Extracting information from shadows in SAR imagery," IEEE Proceedings of the International Conference on Machine Vision, pp 107-112, 2007.

[4] F. Xu, and Y.Q. Jin, "Automatic Reconstruction of Building Objects From Multiaspect Meter-Resolution SAR Images," IEEE Transactions on Geoscience and Remote Sensing, vol 45, no7, pp 2336-2353, 2007.

[5] A. Thiele, E. Cadario, K. Schulz, U. Thoennessen, and U. Soergel, "Building recognition from multi-aspect high resolution InSAR data in urban area," IEEE Transactions on Geoscience and Remote Sensing, vol 45, no 11, pp 3583-3593, 2007.

[6] A. Thiele, E. Cadario, K. Schulz, U. Thoennessen, and U. Soergel, "InSAR Phase Profiles at Building Locations," Proceeding of ISPRS Photogrammetric Image Analysis, vol. XXXVI, part 3/W49A, pp 203-208, 2007.