POLARIMETRIC AND INTERFEROMETRIC APPLICATIONS IN A BISTATIC HYBRID SAR MODE USING TERRASAR-X

Holger Nies, Florian Behner, Simon Reuter, Otmar Loffeld, Robert Wang

Center for Sensorsystems (ZESS), University of Siegen
Paul-Bonatz-Str. 9-11, D-57068 Siegen
Tel. + 49 271 740 2761, FAX + 49 271 740 2336
nies@zess.uni-siegen.de

1. INTRODUCTION

In summer 2009, the SAR research group at the Center for Sensorsystems (ZESS) started a project to generate high resolution bistatic SAR data, recorded by a stationary receiver [1]. The main issue of this project is to acquire bistatic data in a hybrid (spaceborne/airborne - stationary) configuration. In the first experiments, the TerraSAR-X satellite has been used as a high bandwidth illuminator. To extend the conventional bistatic SAR experiments, we also investigated whether our passive receiver system can be used in the field of bistatic interferometry and polarimetry. This paper describes the experiments and shows some first results.

2. BISTATIC INTERFEROMETRY

Two symmetrical channels with two 20 dBi-standard gain horns are used to record the direct signal as well as the radar echoes. One antenna points towards the satellite, the other antenna is directed to the scene center. The signals are mixed to an intermediate frequency, IQ demodulation is done later by digital signal processing. Since our receiving system is currently equipped with only one echo channel, we started with bistatic repeat pass interferometry, generating SAR interferograms. The baseline is exclusively given by the TerraSAR-X orbit. The receiver set up was identical during the data acquisitions. Between the two SAR images there is a temporal baseline of 11 days (7th and 18th September 2009). In both recordings the high resolution spotlight mode of TerraSAR-X was used, enabling a bandwidth of 300 MHz. The incidence angle of the transmitter was 54° the receiver's incidence angle was 5°, which explains the large shadows caused by the hills. For forming the interferometric SAR images more than 10.000 pulses with a prf of 3.224 KHz were recorded. The image shown in Figure 1 was taken from the roof of the university building with the echo antenna directed in eastern direction towards to village Dreis-Tiefenbach. The image shows the SAR processed result overlaid with the interferometric phase.

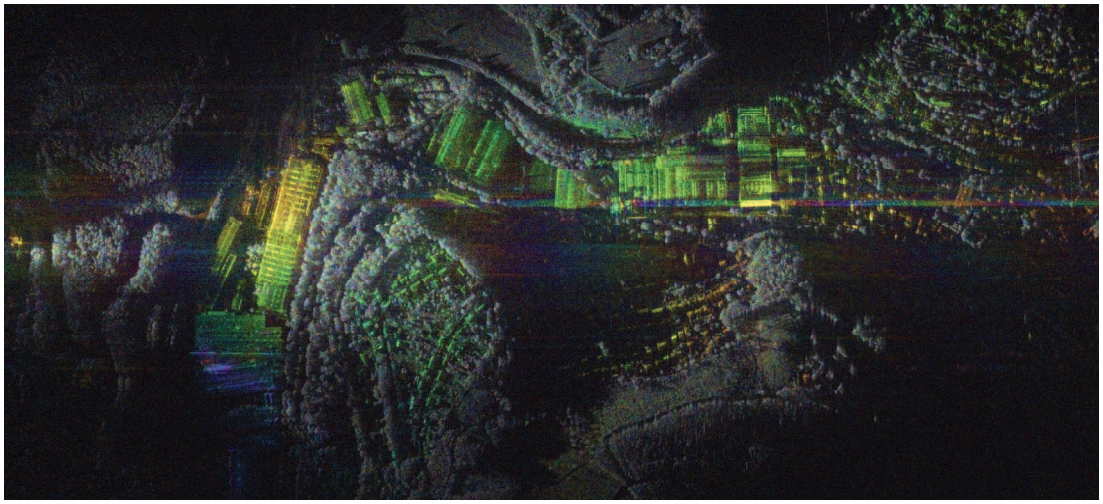

Figure 1: A combined image of the interferometric phase and radar intensity

3. BISTATIC POLARIMETRY

Next to the city of Siegen, we have done an experiment for obtaining fully polarimetric SAR images. Due to the restriction that only one channel could be used to record the reflected echoes from the scene, we again had to do a repeat pass experiment. As illumination the dual polarization mode of TerraSAR-X was used (150 MHz bandwidth), where the pulses were transmitted alternately in V and H polarization. Our direct signal antenna was lengthwise rotated 45°, so that the signal strength of the satellite's beam would be identical for both polarizations. The echo channel was firstly V orientated. 22 days later we have done the same experiment, collecting the echoes in H orientation. Because of this we obtained a VV and a HV image in the first experiment and HH and VH in the second one. Figure 2 shows examples of the multi temporal fully polarimetric images displayed in Sinclair decomposition (R: HH, G: (VH+HV)/2, B: VV). The images show nice results of the upper city of Siegen (left side) und the hill "Lindenberg" (right). The ground range resolution in this case was 1 m.

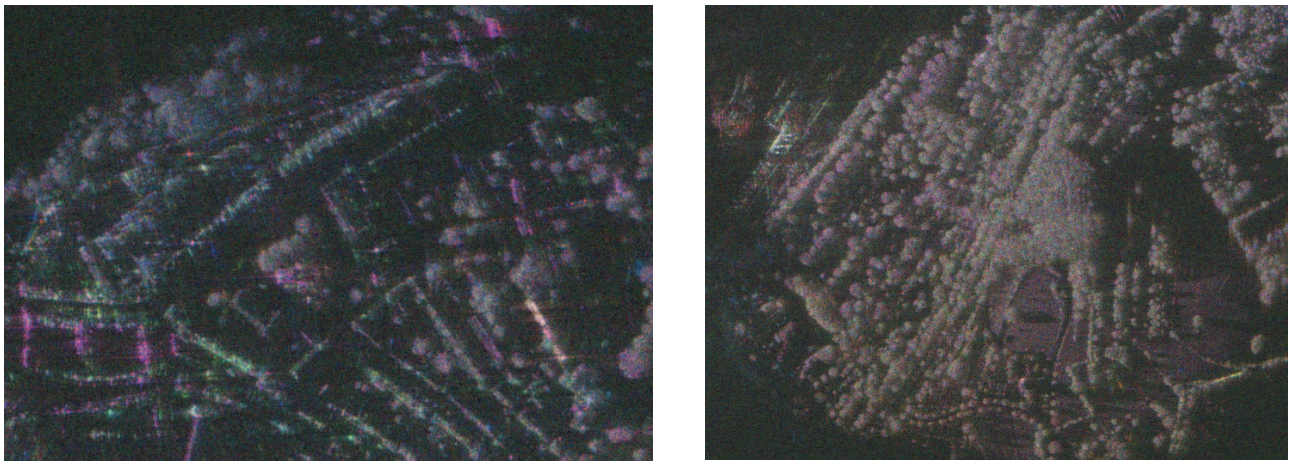

Figure 2: Polarimetric images of the region of Siegen

4. SUMMARY AND FUTURE PLANS

The hybrid experiments lead to very promising results for high resolution bistatic SAR. It could be shown that our bistatic system can also be used to generate interferometric/polarimetric data. The processing in both experiments was done with a bistatic backprojection algorithm. We have planed to extend our system with two additional channels in 2010, enabling fully polarimetric SAR and one pass SAR interferometry in one experiment. The new results are planed to be presented at IGARSS 2010. The final paper will include a comparison of the bistatic results with the monostatic ones and a further analysis of the obtained data. Furthermore there will be a detailed explanation of the experiments and bistatic interferometric processing.

5. REFERENCES

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[3] J. Sanz-Marcos, P.; Lopez-Dekker, J. J. Mallorqui, A. Aguasca, and P. Prats, "SABRINA: A SAR bistatic receiver for interferometric applications" IEEE Geosci. Remote Sens. Lett., vol. 4, no. 2, pp. 307–311, Apr. 2007.