High cross-range resolution SAR imaging in a bistatic configuration in wide-swath illumination modes

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Abstract *Wide-swath SAR imaging modes, such as ScanSAR or TOPSAR, are characterized by a degraded cross-range resolution compared to Stripmap mode. This degraded resolution can be enhanced if a bistatic configuration is considered in which the receiving antenna is dynamically pointed towards the area of interest. Based on real measurements, this paper evaluates the performance of two methods to recover the resolution of the Stripmap mode.*

Introduction

Compared to the Stripmap mode, wide-swath SAR imaging modes such as ScanSAR or TOPSAR modes offer global coverage by sweeping the antenna beam sequentially from near range to far range. While in the ScanSAR mode the antenna is steered only in the range direction, in TOPSAR mode, the antenna is steered in both azimuth and range. A classical way to focus wide-swath mode data is to process each burst independently, which results in the well-known poor cross-range resolution of wide-swath modes. If the area of interest is illuminated by several bursts of pulses, the cross-range resolution can be improved by coherently processing those bursts. In this case, azimuthal grating lobes appear in the SAR image [1] due to the gaps in the azimuthal phase history. Now, if a bistatic configuration is considered in which the receiving antenna is dynamically pointed towards the area of interest, the Stripmap cross-range resolution can be recovered by exploiting the sidelobe emissions of the beams illuminating the adjacent sub-swaths.

Although many bistatic configurations can be considered, the bistatic space-ground geometry of the experiments is shown in Fig. 1. In that configuration, a stationary receiver located on the roof of a building opportunistically exploits the illumination of a spaceborne SAR transmitter.

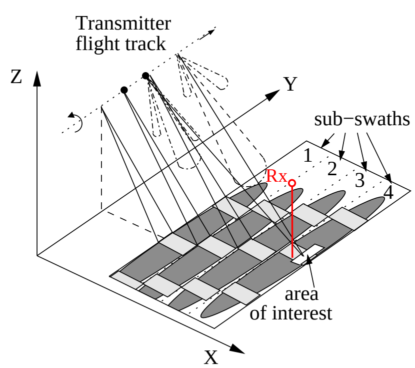

Figure 1: *Bistatic acquisition geometry in the ScanSAR imaging mode of RADARSAT-2 (four sub-swaths).*

The position of the area of interest in the global swath will obviously define the slow-time amplitude modulation of the measurement data.

Methods

In some unfavourable cases when the SNR of the signals coming from the elevation sidelobes is very poor, assumptions have to be made in order to add extra information to the scene reflectivity recovery process to guarantee uniqueness of the solution. In this paper, a novel cross-range resolution method based on the Maximum a posteriori (MAP) algorithm is compared to a Compressive Sensing based method implemented using the Orthogonalized Matching Pursuit (OMP) method [2].

Results and conclusion

Figure 2 illustrates a point-like target in the georeferenced SAR image obtained during a RADARSAT-2 overpass operating in ScanSAR mode.

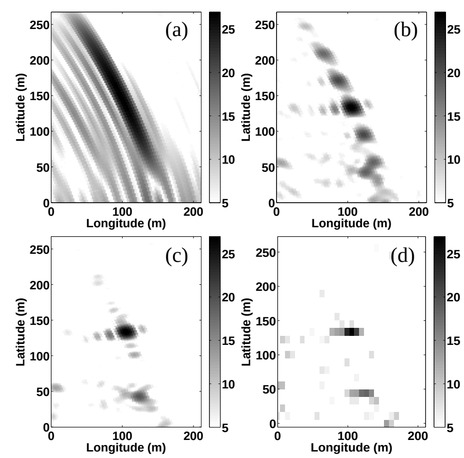

Figure 2: *Zoom on a point scatterer in the SAR image.*

If one single-burst is processed using the conventional Matched Filter (MF), a coarse cross-range resolution is obtained (Fig. 2 (a)). The MF processing of all the received bursts leads to a better cross-range resolution but grating lobes appear in azimuth (Fig. 2 (b)). The MAP approach reduces the grating lobes and reveals a second point target (Fig. 2 (c)). The OMP also distinguishes both point scatterers but leads to a range thickening.

Those methods considerably increase the opportunity to produce high cross-range resolution images over the area of interest as there are many more passes in the wide-swath mode than in the Stripmap mode.

References

[1] J. Holzner and R. Bamler, “Burst-mode and ScanSAR interferometry,” *IEEE Transactions on Geoscience and Remote Sensing*, vol. 40, no. 9, pp. 1917–1934, 2002.

[2] Y. C. Pati, R. Rezaiifar, and P. S. Krishnaprasad, “Orthogonal matching pursuit: recursive function approximation with applications to wavelet decomposition,” in *Asilomar Conference on Signals, Systems & Computers*, vol. 1, pp. 40–44, 1993.