Removal of direct path interference with CLEAN Algorithm in passive SAR imaging

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Abstract *This paper describes a method, based on the CLEAN Algorithm, to remove direct path interference in passive SAR imaging. Real data are used in order to evaluate this procedure.*

Introduction

In non-cooperative bistatic SAR imaging, one of the main issues is the direct path interference. Indeed, the conventional matched-filter used in SAR processing generates range and azimuth sidelobes that can hide weaker scatterers located in the immediate surrounding of the receiver. In this paper, we focus on the CLEAN algorithm [1] to deal with the direct path interference.

The CLEAN Algorithm basics

The central assumption is that the signal is made up of a sum of target echoes, including the direct path signal and noise. The CLEAN algorithm attempts to identify the location, the amplitude and the phase of the strongest targets in order to remove their contribution from the signal. A target assumed to be located at the location of the peak signal after matched filtering. The signal corresponding to that target is then subtracted. The procedure is repeated iteratively until all undesired targets have been removed. However in the case of several adjacent targets, the peak does not necessary correspond to a physical target. This is due to the finite resolution of the radar system and to sampling effects. This jeopardizes the application of the CLEAN algorithm as neither the amplitude nor the position of the targets can reliably be estimated. A solution, proposed in [2], consists in subtracting only a fraction of the amplitude of the detected pseudo-target. Their procedure is adapted here in the case of bistatic radar with strong direct path effects. The aim is to cancel this strong direct path signal and the surrounding echoes. To this end, the cancellation performed using the CLEAN algorithm is limited to pseudo-scatterers located around the receiver.

There are two central questions: what is the fraction of the signal that can be removed leading to an efficient suppression of the direct path signal, and whether the suppression of the whole signal indeed also reduces the sidelobes.

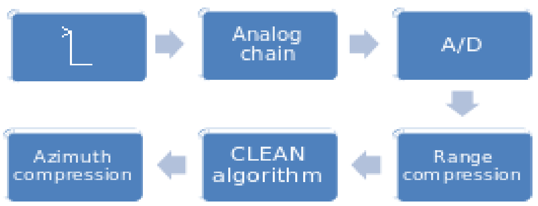

Figure 1: Block diagram of the processing.

Results

Figure 2 illustrates the received signal transmitted by Envisat after range-compression (solid line), and the maxima detected by CLEAN after five iterations (stars). The range interval is delimited by black vertical lines. For a coefficient of 0.75, i.e. a removal of three quarters of the detected signal at each iteration, the figure shows a considerable decline of the sidelobes amplitude at convergence (dashed line).

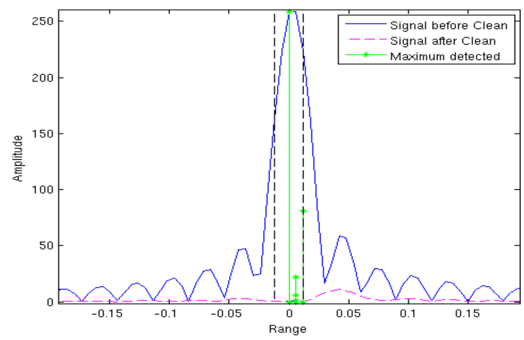

Figure 2: Clean algorithm after 5 iterations and a coefficient of 0.75

Despite the fact that we cannot accurately determine the position and the amplitude of the target, the cancellation of the pseudo-target leads to the reduction of sidelobes, as illustrated in fig.3.

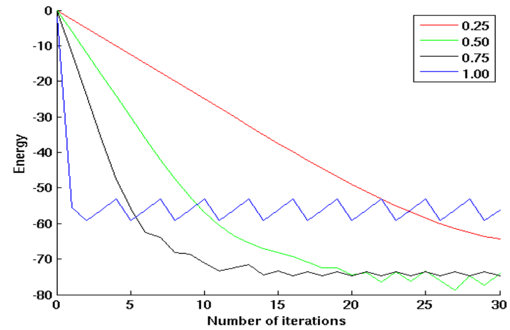

Figure 3: Evolution of sidelobes energy as a function of the iterations for varying coefficients.

Conclusions

The proposed CLEAN algorithm takes into account the fact that the position and the amplitude of the targets cannot accurately be detected. By using a fraction of the detected amplitude, the sidelobes can efficiently be removed.

References

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