SPECKLE REDUCTION BY WAVELET THRESHOLDING COMBINED WITH (SPATIAL) POLARIMETRIC WHITENING OF SAR FOR APPLICATIONS TO ATD/R

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1. PAPER ABSTRACT

One of the major problems of processing of synthetic aperture radar (SAR) is speckle or coherent noise [3, 1] which typically can be modeled as multiplicative noise. Recently some of the authors proposed a new algorithm for speckle reduction [4, 5] (see Fig. 1) of fully polarimetric complex SAR data, x, by a nonlinear thresholding of the wavelet coefficients [2]. The wavelet based algorithm promises to have great advantages over other known methods for speckle removal.

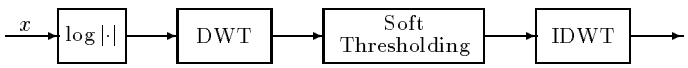

Figure 1. SAR speckle reduction via wavelet thresholding.

While the well known polarimetric whitening filter (PWF) [7] is based on exploiting polarimetric correlation without loss of resolution, the wavelet based speckle removal algorithm exploits spatial correlation with essentially no loss of resolution. Qualitatively there are two features of the wavelet based method that are important: *i*) no spurious oscillations are introduced in the reconstructed signal and *ii*) sharp features in the data are maintained.

Furthermore, when combining the wavelet based method with the PWF, initial investigations promises considerable improvements to relevant detection statistics (such as the Constant False Alarm Rate (CFAR)) as can be seen in Fig. 2.

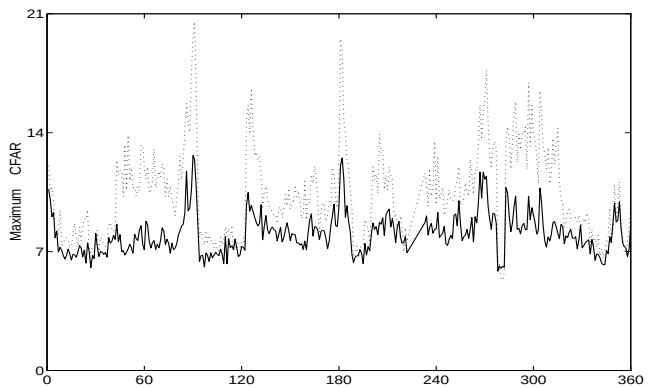

Figure 2. Maximum CFAR statistics as a function of target input orientation angle. The test data is obtained by collecting SAR data in spotlight mode. Dotted line: Despeckled PWF image; Solid line: PWF image.

Recently a modification to the PWF algorithm was published [6]. This new PWF algorithm exploits spatial correlation and combines this with the traditional PWF to yield the joint spatial-PWF (SPWF) algorithm.

We propose to evaluate several different configurations of the proposed despeckle algorithm (wavelet denoising combined with PWF/SPWF). In particular we will exploit the interaction of the PWF/SPWF with the wavelet denoising algorithm and derive an optimal algorithm for the combination of the two. We will perform both a theoretical and an experimental evaluation of the proposed algorithms. The experimental evaluation will consist of measuring detection statistics for the various algorithms on SAR data containing real targets. The theoretical evaluation will attempt to prove the results as suggested by experimental evidence.

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