MULTIRESOLUTION DESPECKLING OF VHR SAR IMAGES BASED ON MRF SEGMENTATION

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ABSTRACT

Aim of this work is to address the despeckling of very high resolution (VHR) synthetic aperture radar (SAR) images. The all-weather acquisition capability of SAR systems, either airborne or spaceborne, is hampered by the presence of the noise peculiar of coherent systems named *speckle*. Speckle severely undermines the possibility of performing automated analysis in general, and temporal change analysis in particular. A preliminary processing of real-valued, i.e., *detected,* SAR images for speckle reduction is beneficial in a number of applications but preprocessing should be carefully designed to avoid spoiling useful information, such as:

- local mean of radar cross section (RCS);
- point targets;
- linear features;
- texture.

Despeckling algorithms are often based on an image model. Under a perspective of statistical signal processing, despeckling aims at performing an estimation of the radar reflectivity, based on the available speckled image. Such an estimation may be approached either as a minimum mean square error (MMSE) estimation, whose simplified case is linear MMSE (LMMSE), or as maximum "a posteriori" (MAP) estimation. Under Gaussianity assumptions, LMMSE and MAP estimation yield identical solutions; otherwise, the MAP approach, relying on the probability density functions (PDF) of the signal and of the noise is more powerful, even though more crucial and computationally more intensive.

A promising approach to image denoising in general, and to despeckling in particular, consists of carrying out estimation in a transformed domain obtained via multiresolution analysis (MRA). In our method the stationary wavelet transform (SWT) has been used because exhibits the shift-invariance property and is particularly suitable for most of image processing tasks (e.g., denoising, fusion, etc.) with the exception of data compression.

In this work, MAP despeckling, implemented in the SWT domain, will be compared and assessed on high-resolution SAR images. More in detail the MAP solution in SWT domain [1] has been specialised to SAR imagery [2]. Every SWT subband is segmented into statistically homogeneous segments and one generalized Gaussian (GG) PDF (variance and shape factor) is estimated for each segment. This solution allows to effectively handle scene heterogeneity as imaged by the SAR system. The concept of heterogeneity is crucial for very high spatial resolution SAR: the circular Gaussian model of complex reflectivity may no longer hold when the resolution cell does not contain a large number of independent scatterers. Thus, the speckle model changes with the degree of texture. As a limit case, point targets are detected in the spatial image and removed (clipped) before wavelet processing, to be restored after despeckling.

Segmentation may be carried out following the method described in [3], exploiting a Tree Structured Markov Random Field (TSMRF), which is a low complexity MRF segmentation that allows the estimation of the number of segments and the segmentation itself to be carried out at same time.

Figure 1 shows some preliminary results on 1 m SAR data. The proposed method will be used for VHR SAR images acquired in X-Band by the MetaSensing [4] SAR system. The images acquired by this system have a 40 cm spatial resolution and 25

cm pixel spacing. The superior performances of the segmented approach over the earlier MAP approach stands out in terms of visual sharpness, background smoothing and texture preservation.

REFERENCES

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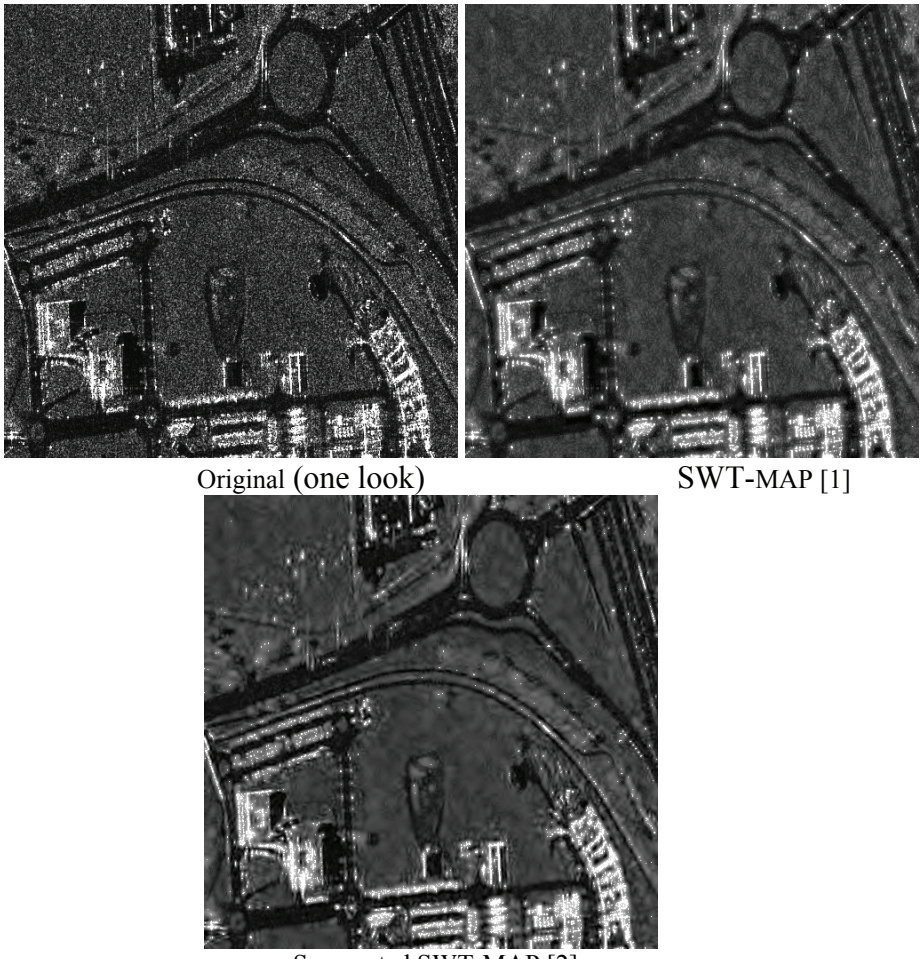

Figure 1 Original and processed VHR airborne SAR image of 1 m resolution.