SPECKLE REDUCTION OF TERRASAR-X IMAGERY USING TV SEGMENTATION

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ABSTRACT

Synthetic Aperture Radar (SAR) data are particularly interesting for land cover classifications and operational monitoring systems, because SAR sensors operate independently from weather conditions and solar illumination. Regarding recent missions as TerraSAR-X, with increased revisit times and better spatial resolutions, SAR applications become even more promising. However, the presence of speckle is a drawback in the analysis of SAR imagery. It degrades image quality, reduces information content and hampers image analysis. Standard SAR processing routines hence include image filtering to suppress the speckle. An ideal filter reduces the speckle while preserving the image information and this way simplifies image interpretation as well as increases classification accuracies. However, the filter performance is always a tradeoff between speckle reduction and preservation of image information. Simple speckle reduction methods, e.g. a mean filter, lead to a random averaging of the pixel values. Therefore a multitude of adaptive filters have been developed. Many of these filter algorithms assume a multiplicative speckle noise model and are based on local image statistics, calculated within a moving window. One drawback of these methods can be blurring of the image, particularly obvious between sharp edges of image objects. In contrast to this are speckle reduction methods based on multiscale representations as wavelet, curvelets and contourlets transformations.

Here we are going to use two methods, the time invariant adaptive combined method (ACM) and pixel by pixel (PBP) method for denoising SAR images. In both these methods, the undecimated discrete wavelet transform is used to code homogeneous areas of the SAR image while the nonsubsampled contourlet transform is used to code areas with edges. By combining the attributes of both transformations, it is possible to reduce the speckle noise more efficiently compared to using the methods individually.

The difference between homogeneous areas and regions with edges is obtained by using total variation (TV) segmentation. A binary approach of this TV-based segmentation method is applied. The histogram of the TV-image contains two clusters of intensities. Whereas one refers to homogenous regions, the other represents edges in the SAR image. An automatic threshold is derived to separate the histogram in these two classes.

To evaluate the speckle reduction of the proposed method, two real TerraSAR-X images from summer 2008 were used: a high-resolution spotlight from Reykjavik and a stripmap-mode acquisition from a rural area north of the capital. The results underline that the proposed method reduces speckle and enhances the visible quality of the SAR images.