TEXTURE ESTIMATION IN SAR IMAGES: THE IMPACT OF SCALE AND MODEL PARAMETERS

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When it comes to remote sensing image classification, the use of SAR image data is often regarded as being cumbersome and error-prone. Compared with optical images, SAR images have a very high dynamics, are plagued by speckle phenomena, and their radiometric calibration is less accurate than that of optical images. Many researchers have attempted to overcome these difficulties by applying, for instance, multi-look or de-speckling techniques prior to classification; the former methods depend on the initial number of looks and also on the ratio between resolution and pixel spacing. These aspects motivated us to investigate the impact of sub-sampling and multi-looking strategies.

We present recent results of texture estimation and classification of high resolution SAR images. Two alternative approaches have been taken to overcome the speckle problem by techniques that profit from pixel sub-sampling: our first approach is model-based despeckling, while the second approach uses Normalized Compression Distances (NCDs) to cluster sub-windows from down-scaled images. Both approaches deliver similar but surprising results; this may be due to the fact that high resolution Earth observation images with a characteristic pixel spacing of about 1 meter do contain substantial neighbourhood relationships from which we can profit. Since we used the same image data for both approaches, we could compare and verify the results of both test sequences.

Our results rely on image data acquired by the German TerraSAR-X mission that delivers various product levels with several processing options, e.g., spotlight mode multi-look ground range images [1]. Due to the intrinsic nature of SAR imaging, the actual image resolution depends on the radar incidence angle: a steep incidence yields an image with lower resolution, while a flat incidence results in higher resolution images. Therefore, we selected sub-scenes with comparable characteristics in order to obtain comparable test data.

For our application, we generated several non-standard multi-looked test products having a resolution equal to the pixel spacing and also created for each parent product a pyramid of multi-resolution sibling images. These multi-resolution images have a higher signal-to-noise ratio at lower resolution levels; however, many of their small-scale details get lost. In addition, a reduced resolution also results in noticeable changes in the equivalent number of looks.

Our first approach uses the Enhanced-Model-Based-Despeckling (EMBD) system that performs a high quality despeckling of SAR images [2]. To achieve this goal, important features contained in the SAR images are extracted, like textural information, edges of different kinds, and information about isolated targets and homogeneous areas. We sub-sampled our test images to obtain uncorrelated speckle and applied EMBD to generate texture files (we selected a model order of 3 and obtained 8 texture bands). Then the texture parameters were normalized to obtain comparable quantities and a classification of the 8 texture bands was performed. As we used a dynamic k-means algorithm for classification we could pre-select the number of resulting classes. Our results demonstrate that typical target classes such as forest areas, agricultural fields, urban scenes, etc. can be classified robustly if we apply appropriate reduction rates. We will demonstrate what target classes can be well classified if we select the optimal reduction rate.

Our second approach is a hierarchical clustering of sub-windows within all our reduced scale test images [3]. First, we compute the Normalized Compression Distance between each pair of 44 pre-selected sub-windows belonging to four surface cover classes yielding a 44*44 element distance matrix. Then, a binary tree is fit to the data in order to cluster subsets with similar characteristics. The binary tree then served as input data for classification and, again, we looked at the classification performance. The lessons learned from EMBD could be verified again: typical target classes can be classified robustly by applying an appropriate down-scaling factor.

REFERENCES

[1] TerraSAR-X Ground Segment Basic Product Specification Document TX-GS-DD-3302, available from http://sss.terrasar-x.dlr.de/pdfs/TX-GS-DD-3302.pdf, 2009

[2] M. Walessa and M. Datcu: “Model-based despeckling and information extraction from SAR images”, *IEEE Trans. Geosci. Remote Sens.*, vol. 38, no. 5, pp. 2258–2269, Sep. 2000

[3] D. Cerra and M. Datcu: “Image Classification Using Data Compression Based Techniques”, in: *Proc. IGARSS 2008*, DOI 10.1109/IGARSS.2008.4778837