AUTOMATED INFORMATION EXTRACTION FROM HIGH RESOLUTION SAR IMAGES: TERRASAR-X IMAGE INTERPRETATION APPLICATIONS

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1. INTRODUCTION

High resolution remote sensing SAR images - such as the image data acquired by the German TerraSAR-X mission – contain a variety of details that have to be extracted by automated processing in order to fully exploit and understand the image content. In particular, the interpretation of man-made structures that are typical for built-up and/or agricultural areas poses a number of challenges including parameterized image focusing during routine processing, careful despeckling, descriptor and feature extraction, and final classification including specific scattering and 3D effects. Therefore, we propose a set of general sequential as well as dedicated application-dependent processing steps that allow user-oriented classification of high resolution SAR images. We will also report on actual classification results and experiences.

2. CHARACTERISTICS OF TERRASAR-X IMAGES

The German TerraSAR-X space mission offers the chance to analyze and interpret meter-scale SAR images of the entire Earth surface and allows us to compare the capabilities of various recording modes such as spotlight and strip-mode imaging, different polarizations, a large range of incidence angles, and the analysis of single look complex or detected image products in selectable geometrical formats.

3. INFORMATION EXTRACTION GOALS

The goal of our information extraction strategy is to provide algorithms for information extraction that are capable, on the one hand, to characterize the full information content of SAR images and, on the other hand, to provide dedicated support of specific application tasks. Typical examples are quality assessment, feature extraction and clustering, image classification, object and structure recognition, geometrical and topological description of scenes, or indexing and annotation of images. To this end, we compared the capabilities and limitations of three approaches:

- parametric stochastic models for complex-valued data,
- non-parametric statistical analysis,
- information and complexity theory.

4. SURVEY OF PROCESSING ALGORITHMS

After conducting a large series of test runs and verification steps, our final collection of toolbox-style algorithms resulted in:

- selectable (i.e. scene-dependent) side-lobe suppression during focusing,
- feature-preserving despeckling of image scenes,
- interferogram filtering by anisotropic phase diffusion
- pixel-based image classification,
- tile-based image clustering,
- object-based image segmentation.

5. PROCESSING RESULTS

Our most important findings can be summarized as follows:

- Good classification results of extended targets could be obtained by combining the despeckling with a sub-sampling step that limits speckle effects to single pixels.
- The interferogram filtering provides well preserved fringes and a very low number of residuals.
- The pixel-based image classification will result in realistic target classes if a semantic search engine is attached.
- The tile-based clustering represents a hierarchical parameter-free unsupervised approach, where we compute the inter-tile distances.
- Finally, the object-based segmentation (to be combined with pixel averaging) leads to a semi-automated interpretation of image sub-areas.

We will give a survey of typical results together with practical experiences, outline their dependence on imaging parameters, and include some theoretical justification of the performance of our algorithms. Finally, an outlook of future activities will conclude our presentation.

6. REFERENCES

[1] http://www.dlr.de/tsx/start_en.htm

[2] Chaabouni-Chouayakh, Houda; Datcu, Mihai (2008): Optimized PCA Based Feature Extraction from Multi-look/Multi-resolution TerraSAR-X Data. ESA EUSC 2008: Image Information Mining, Frascati, Italy

[3] Schwarz, Gottfried; Espinoza, Daniela; Datcu, Mihai (2008): Adapting Multilooking for Joint Radiometrical and Geometrical SAR Image Enhancement. ESA EUSC 2008: Image Information Mining, Frascati, Italy

[4] Soccorsi, Matteo; Datcu, Mihai (2008): TerraSAR-X Data Evidence Maximization-based Feature Extraction and Despeckling. In: VDE [Ed.]: EUSAR 2008, VDE Verlag, pp. 481 - 483, 7th European Conference on Synthetic Aperture Radar, Friedrichshafen, Germany

[5] Gleich, Dusan; Datcu, Mihai (2007): Wavelet-Based Despeckling of SAR Images Using Gauss-Markov Random Fields. IEEE [Ed.]: IEEE Transactions on Geoscience and Remote Sensing, 45 (12), ss. 4127 – 4143