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Interprétation Multi-Niveaux des Images RSO à Haute Résolution:
Application à l'Analyse des Zones Urbaines à l'aide de
Techniques de Fusion

Multi-Layer Interpretation of High Resolution SAR Images:
Application to Urban Area Mapping by Means of
Information Fusion

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Abstract

With the launch of the German TerraSAR-X system in June 2007, a new generation of high-resolution spaceborne SAR data is available. This opens new perspectives and challenges for the automatic interpretation of urban environments. A rich information content, previously hidden or not clearly distinguishable in low resolution images such as urban structures (small buildings, vehicles, etc), is now disclosed. However, only proper approaches are able to retrieve automatically this new detailed information. In fact, inside urban areas, the electromagnetic scattering is characterized by a variety of single or multiple scattering mechanisms with a wide range of scattering amplitudes. This makes the interpretation and information extraction over such areas from SAR images quite complex to perform.

This thesis provides solutions for the semi-automatic interpretation and mapping of urban areas using the high resolution provided by TerraSAR-X data. Our solutions take into account the raise of new man-made structures whose visibility has increased with the high resolution, and scattering response has improved with the high frequency X-band SAR sensor carried by the TerraSAR-X system. They are mainly based on two steps. Firstly, we adopt a multi-layer SAR image interpretation approach, which extracts and describes three kinds of information: backscattering, statistical and geometrical information. Secondly, information fusion techniques are applied to optimally exploit the different layers in order to improve the mapping of urban areas.

When assuming a SAR image to be a combination of backscattering, statistical and geometrical information, our multi-layer scheme turns out to be of great help since it offers to the user the opportunity to have a description of the scene contents from three perspectives. The first one characterizes the backscattering behaviors of the different structures existing in the scene by using the azimuth sub-band decomposition technique. The second layer extracts statistical information by means of projection based methods such as Principal Component Analysis (PCA) and Independent Component Analysis (ICA). The third perspective allows an interpretation of the scene from a geometrical point of view. Here, segments and bright/dark linear features are extracted to describe the different man-made structure geometries.

A further exploitation of our approach could be to introduce and enhance intelligence in the way the different layers are processed or treated. Hence, optimal information fusion scenarios have been suggested in this thesis so that accurate mapping of urban areas could be reached. Such fusions between the backscattering, statistical and/or geometrical layers, have achieved promising improvements and real progress toward automatic urban area mapping using TerraSAR-X data.

Keywords: High resolution TerraSAR-X data, multi-layer SAR image interpretation, backscattering information, statistical information, geometrical information, information fusion, urban area mapping.