Settlement Type Classification using PolSAR and Hyperspectral Data

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Introduction
The ongoing development of humankind leads to a growth of human settlements across the globe. In general, human settlement influences not only the economy, but also our environment and thus needs to be steered towards sustainable development. Remote sensing provides an efficient way to monitor human settlement on both local and global scales, making it an important instrument for stakeholders.

Among different remote sensing technologies, PolSAR (Polarimetric Synthetic Aperture Radar) sensors not only operate under any weather condition and independent of sunlight, but also provide geometrical and physical measurements of the observed scene. Complementarily, hyperspectral imagery provides spectral signatures of observed objects. Thus, this project focuses on the combined usage of PolSAR and hyperspectral data for settlement type classification from local to global scale.

One of main challenges in this topic originates from differences of the imaging geometries of PolSAR and hyperspectral sensors. Because of the side-looking configuration of SAR sensors, PolSAR images contain distortions such as layover, shadowing, and foreshortening. Thus, as shown in Fig. 1, the SAR representation of urban scenes is severely dissimilar to the one provided by hyperspectral data, which is collected from a nadir looking view.

![Fig. 1: Left: RGB bands of hyperspectral data; Middle: Intensity image of PolSAR data; Right: Pseudo colour image of PolSAR data; (R: VV; G: HH+VV-2*real(HV); B: HH) [1]](image)
Two proposed solutions
An object-based decision fusion framework, shown in Fig. 2, for classification was proposed in [1]. Superpixel segmentation was firstly applied on both PolSAR and hyperspectral data to extract objects. Pixel-wise classification results of each data source were then statistically summarized within each object. Therefore, the object based class-wise probabilities of both data sources were fused for final classification. This framework weakens the impact of geometrical differences on the final classification since the superpixel objects describe local neighbourhood. The method yields better classification results than pixel-wise and object-wise classifications of individual dataset.

Fig. 2: Framework of object-based decision fusion

In addition, a two-stream convolutional neural network was proposed in [2], for fusing PolSAR and hyperspectral image for classification purposes. It takes advantages of the well-known CNN power of automatically extracting informative features for classification. The structure of the network is shown in Fig. 3. It extracts features from individual data sets and fuses the extracted higher level features by concatenation. Afterwards, convolutional layers and fully connected layers are used for deep fusion of extracted PolSAR and hyperspectral features.

Fig. 3: Structure of two-stream CNN

References

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