Promotionsthema

2016-05-03

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Change detection in urban areas using very high resolution SAR data and scene knowledge

One of the most interesting applications of remote sensing data is the detection of changes due to human activity. Ideally, we want to detect the changes occurred in certain areas of interest (typically urban areas) as often as possible. Spaceborne SAR sensors revisit any point on Earth every few days and are able to operate day and night in all weather conditions, which makes them perfectly suited for this task. Current spaceborne SAR sensors with sub-meter resolution like TerraSAR-X are able to map small changes, and with future sensors with resolution in the decimeter level the possibilities will increase. Traditionally pixel-based techniques have been used for detecting changes between multiple SAR images. Even though these techniques work well, they have some important limitations:

- ❒ They are not well suited for unsupervised change detection. Automatic thresholding techniques exist but they result in many false alarms. The growing amount of SAR images available makes unsupervised change detection an important matter.
- ❒ They are not good at distinguishing different types of changes (e.g. a new building and a seasonal vegetation change). For most applications only certain types of changes are relevant.
- ❒ The used SAR images need to be acquired with the same sensor and imaging geometry. With more and more sensors available, change detection combining images from different sensors and/or different geometries becomes more interesting.

To try to overcome these limitations two important modifications will be done to the traditional change detection process. The first modification consists on including prior knowledge about the areas of interest where we want to detect changes. In an initial step, this prior knowledge should be organized and processed together with a reference SAR image to form the basis for the posterior change detection. Ideally, this prior knowledge should consist on a DSM or a 3D model of the scene, together with its classification in different semantic classes (e.g. buildings, roads, vegetation and water). If this information is not available, it can be obtained from a stereo pair from a modern multispecral sensor. The idea is to later use the 3D information to combine SAR images acquired with slightly different imaging geometries (taking into account effects like layover and shadow), and the semantic information as a help to reduce the false alarms and distinguish between different types of changes. Because this initial step only needs to be done once, it can be time consuming and does not need to be fully automatic. The second modification consists on doing an object-based analysis when doing the change detection, instead of detecting changes in individual pixels. This will take into account the relations between adjacent pixels to exploit the rich spatial information present in Very High Resolution (VHR) SAR images (e.g. texture and shapes). One promising way to do this analysis is using Morphological Profiles (MPs). Morphological Profiles have been proven suitable for handling the spatial information of images, and are capable of suppressing small brighter and darker regions while leaving the geometry of larger structures unaffected. This last property appears especially useful when we take into account the presence of multiplicative noise (speckle) in the SAR images.

The expected outcome is a new object-based change detection method that uses VHR SAR images and prior knowledge about the scene, and overcomes the previously stated limitations of current methods. That means it should be unsupervised, able to deal with images acquired with different geometries, and capable of identifying the changes relevant to the desired application. The focus will be on the detection and identification of changes in the SAR images, assuming that the prior knowledge is available.