Master Thesis: Classification of multi-temporal TerraSAR-X data with the help of an object-based approach

Author: Farah Haerinejad

Examiner: Prof. Dr.-Ing. Alfred Kleusberg

Tutor: Dipl. Geogr. René Pasternak

Duration: 6 months

Introduction

The main objective of this study is to classify the crop types in Leingarten, located in the southwestern part of Germany, using an object-based method. The classification was implemented in one of the latest versions of eCognition® software, offered by Trimble® in 2011.

In object-based classification methods, spatial context as well as the spectral values is used to classify features in digital images. Object-based approaches incorporate two steps: segmentation, which defines the image objects, and the classification itself. The images used in this study were delivered by TerraSAR-X Satellite. The images chosen for this study were taken within the period from April to October 2011 and had a VV polarization.

Figure 1 gives a brief overview of the major steps taken in this study for the object-based classification of crops in Leingarten using TerraSAR-X imagery.

Figure 1: The major steps taken in this study for the object-based classification of crops in Leingarten using TerraSAR-X imagery.
Radiometric calibration using ModelBuilder

Due to the presence of topographic effect, caused by the changes in the terrain elevation and slope, the SAR images needed to be first radiometrically calibrated before they were used for classifying the land cover. To facilitate the calibration process, using the ModelBuilder application in ArcGIS, first the model shown in figure 2 was created.

In this model, there are 3 types of input data (illustrated in blue) including the "calFactor", "IMGinput", and "GIMinput". The calibration factor, or so-called calFactor, is given in the TerraSAR-X data delivery package annotation file. "IMGinput" refers to the TerraSAR-X images of the chosen test site, in Leingarten, taken within the period from April to October, 2011. And finally, "GIMinput" refers to the Geocoded Incidence Angle Mask (GIM), from which the local incidence angle for each pixel of the geocoded SAR scene, and whether the pixel is affected by layover or shadow is derived. The output "IMGsigmadB" gives the calibrated images to be used in eCognition® software for the later step of classification.

![Figure 2: Model created in ArcGIS, for the calibration of the TerraSAR-X imagery.](image-url)
The result of the radiometric calibration for one of the 8 images (June 2011) using Geocoded Incidence Angel Mask (GIM) is shown in figure 3:

![Image of radiometric calibration result](image)

**Figure 3:** The result of the radiometric calibration for one of the 8 images (June 2011). The images respectively illustrate: a) the sample SAR image (from June 2011) before the radiometric calibration, b) the corresponding Geocoded Incidence Angel Mask (GIM) and c) the calibrated image.

**Segmentation**

The classification of the crops in this study is done using an object-based approach, where the spatial and contextual information of the pixels as well as the spectral properties are used to classify the features in digital images; therefore, unlike traditional pixel-based approaches, this method incorporates an initial step of segmentation where the neighboring pixels are grouped into meaningful areas to form homogenous image objects for the later step of classification, as shown in figure 4.

There are several algorithms to be used for segmentation in eCognition®. In this study chessboard and multi-resolution segmentations were used.
After the images were segmented into appropriate image objects, it was time to classify the images by assigning each of the image objects into a certain class. In object-based image analysis, the image objects form a hierarchical structure. Every level in this structure contains the information about certain areas in the image.

In this study, the classification was based on the mean backscatter values of the image objects within the period from April to October 2011.

The classification of crops from non-crops in eCognition®, was carried out in several steps. Every step was based on one of the previously defined arithmetic features. In other words, each arithmetic feature helps label some of the image objects in the digital image as crops, during the classification.

The choice of improper arithmetic features or threshold values can lead to a lengthy and inaccurate classification procedure.

Figure 5 shows the backscatter signatures for various crop types in the test site. These signatures were created based on the changes of mean backscatter values for each crop type.
Figure 5: The backscatter signatures for various crop types in the test site, located in southwestern part of Germany.

Results and discussion

The result of the classification of crop types in Leingarten using an object-based approach is shown in figure 3.1. The unclassified crops are shown in gray.

Figure 3.1: The result of the classification using an object-based approach. The unclassified crops are shown in gray.
Accuracy assessment test

The result of the error analysis is displayed as an error matrix (confusion matrix) in table 1. For this purpose the accuracy assessment tool in eCognition® was used.

![Error Matrix](image)

**Table 1:** The error matrix generated in eCognition® to evaluate the classification.

According to this error matrix, the object-based classification implemented in eCognition® had an overall accuracy of 96.2%.


Carleer, A.P. and E. Wolff, 2006. Region-based classification potential for land-cover classification with very high spatial resolution satellite data. Proceedings of 1st International Conference on Object-based Image Analysis (OBIA06), 4-5 July, Salzburg, Austria. ISPRS Archives Vol. XXXVI-4/C42.


