Object oriented classification using Landsat images

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Abstract: In order to utilize remote sensed images effectively, a lot of image classification methods are suggested for many years. But, the accuracy of traditional methods based on pixel-based classification is not high in general. In this study, object oriented classification based on image segmentation is used to classify Landsat images. A necessary prerequisite for object oriented image classification is successful image segmentation. Object oriented image classification, which is based on fuzzy logic, allows the integration of a broad spectrum of different object features, such as spectral values , shape and texture. Landsat images are divided into urban, agriculture, forest, grassland, wetland, barren and water in sochon-gun, Chungcheongnam-do using object oriented classification algorithms in this paper. Preliminary results will help to perform an automatic image classification in the future.

Keywords: Object, Segmentation, Classification, Landsat

1. Introduction

The remote sensing technology is currently being offered a wide variety of digital imagery that covers most of the Earth's surface. This up-to-date image data is a promising tool for producing accurate land cover maps. To maximize the benefit of such data, automatic and efficient classification methods are needed. To achieve this objective, pixel-based classification has been extensively used for the past years. Currently the prospects of a new classification concept, object-based classification, are being investigated. Recent studies have proven the superiority of the new concept over traditional classifiers [1-5]. The new concept's basic principle is to make use of important information (shape, texture and contextual information) that is present only in meaningful image objects and their mutual relationships.

In order to obtain image objects, eCognition developed by DEFINIENS was used. It is optimized for cost-effective classification of very high spatial resolution land data and radar imagery [6]. Within the scope of this research project the main focus is set on two issues: On the one hand it is investigated to what extent the object-oriented software eCognition 2.0 serves as a suitable method for an extensively classification of Landsat data. On the other hand the goal is to derive information for classification of seven features (rural, agriculture, forest, grass, wetland, barren, water) for automatic classification.

2. Object oriented classification

The object oriented classification concept is that important semantic information necessary to interpret an image is not represented in single pixels, but in meaningful image objects and their mutual relations. Image analysis is based on contiguous, homogeneous image regions that are generated by initial image segmentation. Connecting all the regions, the image content is represented as a network of image objects. These image objects act as the building blocks for the subsequent image analysis. In comparison to pixels, image objects carry much more useful information. Thus, they can be characterized by far more properties such as form, texture, neighborhood or context, than pure spectral or spectral derivative information [7].

1) Segmentation

Basic to eCognition's procedures is multiresolution segmentation, a new, patented technique for image object extraction. Adjacent, similar pixels are aggregated into segments as long as the heterogeneity in the spectral and spatial domains is minimized. Neighboring segments are fused to a new segment if the resulting heterogeneity is minimized and below a specified level. The definition of heterogeneity is flexible and consists of a trade-off between homogeneity in the spectral domain (e.g. backscatter values in various channels) and form/shape in the spatial domain. Homogeneity in the spectral domain is defined by a weighted standard deviation over the spectral channels. Homogeneity of shape depends on the ratio of an object's border length to the object's total number of pixels (compactness), and the ratio between the length of an object's border to the length of the object's bounding box (smoothness). Compactness is minimum for a square; smoothness is minimum if the object borders are not frayed [6].

2) Classification

eCognition developed by DEFINIENS supports different supervised classification techniques and different methods to train and build up a knowledge base for the classification of image objects. The frame of eCognition's knowledge base for the analysis and classification of image objects is the so-called class hierarchy. It contains all classes of a classification scheme. The classes can be grouped in a hierarchical manner allowing the passing down of class descriptions to child classes on the one hand, and meaningful semantic grouping of classes on the other. This simple hierarchical grouping offers an astonishing range for the formulation of image semantics and for different analysis strategies [8].

3. Feature information extraction

In this study, preliminary study is carried out to extract class information for an automatic classification. Landsat images are classified as rural, agriculture, forest, grass, wetland, barren and water. It is based on a large-scale classification system of ministry of environment in Korea. Table 1 shows statistics of brightness in seven classes acquired by November 23, 2000 of Landsat-7 ETM+(path 116, row 35).

Table 1. Statistics of brightness in seven classes.

Class	Mean	StdDev	Min	Max
Rural	70.57	8.28	57.13	103.83
Agriculture	58.24	6.50	47.42	80.67
Forest	47.41	5.89	37.50	61.59
Grass	46.61	1.74	42.76	49.06
Wetland	62.26	6.09	54.76	90.76
Barren	75.27	3.01	72.50	83.30
Water	49.93	3.09	40.27	68.79

The standard deviation of rural area is high in table 1, as rural areas consist of land coverage with very diverse spectral information. It means rural class is a very heterogeneous class. It is difficult to classify image objects between forest and grass class because of similar mean value. This characteristic also shows in fig. 1 that plots 2D feature diagram.

If spectral information is constructed about seven classes, classification processing will be easy and convenient. So it is constructed as database at regular time intervals in nowadays.

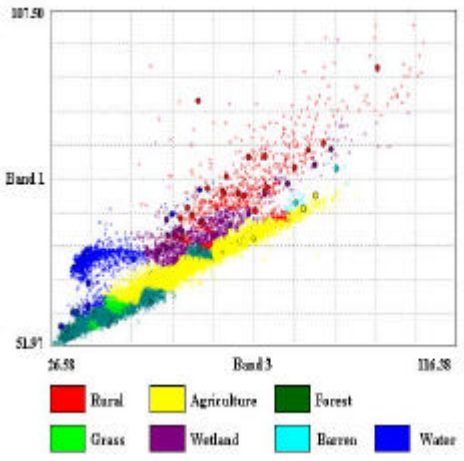


Fig. 1. Diverse spectral information in 2D plot diagram.

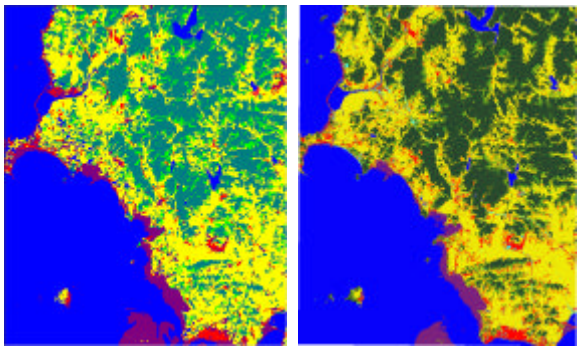
4. Implementation

The study carried out was based on Landsat-7 ETM+ images recorded on November 23, 2000 for object oriented classification. The area is a part of the sochon-gun region of Chungcheongnam-do in Korea.

(a) (b)

Fig. 2. (a) Sub-area of Landsat images (b) Sub-area of segmentation images.

Fig. 2 shows sub-image of study area in (a) and segmentation image in (b). Because of homogeneity, size of segmentation object is large relatively in water area, but it is small in land. Segmentation objects are classified using nearest neighborhood method of supervised classification into seven classes (Fig. 3 (a)). Fig. 3 (b) shows large-scale (1:50,000 scale) land cover map which ministry of environment produced. As large-scale land cover map is pixel based processing, it is difficult to assess accuracy of classification result in this study. So, middle-scale land cover map (1:25,000) will be used to assess accuracy in the future. It is digitized for classification.



(a) (b)

Fig. 3. Classification result (a) in this study (b) large-scale land cover map.

5. Results and conclusion

Within the scope of this study the main focus is set on two issues: On the one hand it is investigated to what extent the object-oriented software eCognition 2.0 serves as a suitable method for an extensively classification of Landsat data. On the other hand the goal is to derive information for classification of seven features. The object oriented classification concept is that important semantic information necessary to interpret an image is not represented in single pixels, but in meaningful image objects and their mutual relations. So, we think that object oriented classification has an advantage over a pixel based classification. And information of seven feature classes will be used for automatic classification that is not in need of training data to user. We will serve training data information from feature database. In addition to mean and standard deviation, band ratio and tasseled cap transformation feature will be used to construct a feature database.

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