OBJECT-ORIENTED CLASSIFICATION AND APPLICATIONS IN THE LUCC

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Abstract: With speediness of economy, the structure of land use has taken lots of change. How can we quickly and exactly obtain detailed land use/cover change information, and then we know land resource amount, quality, distributing and change direction. More and more high resolution satellite systems are under development. So we can make good use of RS data, existed GIS data and GPS data to extract change information and update map. In this paper a fully automated approach for detecting land use/cover change using remote sensing data with object-oriented classification based on GIS data, GPS data is presented (referring to Fig.1). At same time, I realize integrating raster with vector methods of updating the basic land use/land cover map based on 3S technology and this is becoming one of the most important developing direction in 3S application fields; land-use and cover change fields over the world. It has been successful applied in two tasks of The Ministry of Land and Resources P.R.C and taken some of benefit.
Key words: land-use and cover change (LUCC), change information automatic detected,object-oriented.

1. Introduction

With the advent of high-resolution satellite imagery, the increasing use of airborne digital data and radar data the need for context-based algorithms and object-oriented image processing is increasing. Recently available commercial products reflect this demand. In a case study, 'traditional' pixel based classification methods and context-based methods are compared. Experiences are encouraging and it is hypothesized that object-based image analysis will trigger new developments towards a full integration of GIS and remote sensing functions. If the resulting objects prove to be 'meaningful', subsequent application specific analysis can take the attributes of these objects into account.

2. Object-oriented change information automatic extracting

Data

Two different temporal SPOT images in Wuhan, China, one is panchromatic SPOT2.5 image in (August, 2002), anther is multispectral SPOT10 image (August, 2002). Land use data from March, 1995, and scale 1:10,000 topographical map data from May, 1998 are used.

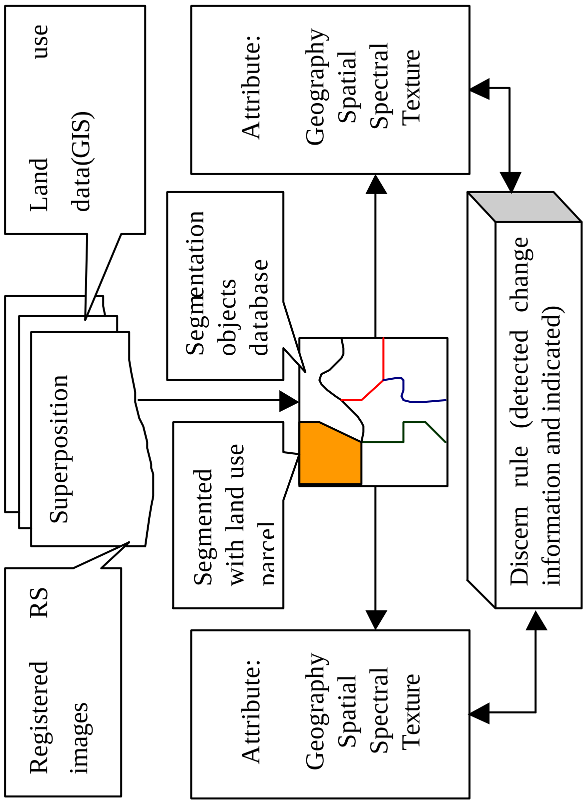

Fig.1 Object-oriented cross-correlation analysis extracting change information

Keynotes

If we want to automatic extracting change information, we must take into account these problems: (1) adopting reasonable method according as different data condition; (2) ensuring all kinds of data accordance in geometrical spatial, color mode and classifying system; (3) digging sufficiently up all kinds of data and data interrelation information, and then organizing and describing these information with reasonable method; (4) establishing uniform rule and method based on different data condition. There are three kinds of data condition: two different temporal remote sensing images, single remote sensing images and land use/cover GIS data, two different period land use/cover data.

1） Data preparation (RS image, land use/cover map, GIS, GPS data)

Two SPOT images was digitized, producing a high spatial resolution image with pixel size resampled to 5 by 5 meters and converted to the Universal Transverse Mercator (UTM) coordinate system, through a least squares second-degree polynomial rectification algorithm based on common control points, extracted from a topographic map at the scale of 1:10,000. Evaluation of the registration accuracy yielded root-mean square error values equivalent to 0.8 and 0.4 of a pixel size for the SPOT10 image and SPOT2.5 image, respectively.
The merging of multisensor data through intensity, hue, and saturation color transform (IHS) has been mainly used to produce hybrid products with high spatial resolution, which enhance terrain features.

2） Object-oriented segmentation of images and constructing hierarchical network of image objects

The segmentation technique permits partitioning off images into homogeneous regions, which may have particular common attributes, such as gray levels, mean values, shapes, and textures. The entire process can be described according to the following sequential steps: (a) segmentation of the image into pattern cells (one or more pixels); (b) each segment is compared with its neighbors to determine if they are similar or not. If similar, they are merged and the mean gray level of the new segment is updated; (c) the segment continues growing by comparing it with all the neighbors until there is no remaining joinable region, at which point the segment is labeled as a completed region; and (d) the process moves to the next uncompleted cell, repeating the entire sequence until all cells are labeled.To proceed with the segmentation, a similarity threshold value must be provided by the user. The choice of an adequate threshold value will greatly depend on the knowledge of the characteristics of the study area and of the objectives and particularities of the application. In order to receive meaningful context information, image regions of the right scale must be brought into relation. This scale is given by the combination of classification task and the resolution of the image data. Imagine for instance the classification task to identify parks in very high resolution imagery.
Only representing image information based on image objects of the appropriate scale enables one to handle image semantics. Additionally, in order to make image objects aware of their spatial context it is necessary to link them. Thus, a topological network is created. This network becomes hierarchical when image objects of different scale at the same location are linked. Now each object knows its neighbors, its sub- and super-objects. This additionally allows a description of hierarchical scale dependencies. (referring to Fig.2)

3） Fuzzy change information extracting systems

The combining of different features within a fuzzy system is always done after the feature is fuzzified. Therefore, all input values for fuzzy combinations are in the range between 0 and 1, independent of the dynamic of the originally crisp features. This simplifies working in a high-dimensional feature space with different dynamics and features of various types, e.g., backscatter from different sensors, geographic information, texture information and hierarchical relations. For successful extracting a deliberate choice of membership function is crucial. This allows the introduction of expert knowledge into the system. The better the knowledge about the real system is modeled by the membership functions, the better the final classification result.
After obtaining change information, all change information must be investigated by GPS to test them. Then we can update land use/cover map or database. First step, we can use obtained change information revision graphics in land use/cover map (GPS data importing, grooming, symboling and so on). Second step, we may modify attribute information of database from detected change information. In my system, we can update raster or vector format map or database at same time and output any one format of them (referring to Fig.3).

3. Conclusions

The results show that most of the changes which were found by the approach are real changes (referring to Table 1). That means that the amount of interactive checking of the data can be decreased significantly. The combination of the new approach of (Object-oriented Segmentation, hierarchical networks, Fuzzy Change Information Extracting) and the multispectral high resolution data of SPOT shows very promising results and is an important step towards the integration of remote sensing and GIS, GPS showing an operational way for interpretation of high-resolution data. The approach will be tested for huge heterogeneous areas in order to develop a stable change detecting and updating strategy. All steps of image analysis can be recorded as a complete procedure. Thus, the whole strategy for solving a particular problem can be applied to other data of the same type. An automated updating procedure requires data with the same geometric properties. The future task will be to adjust the data sources (multitemporal vector and image data) using high resolution imagery in order to enable an automated process.

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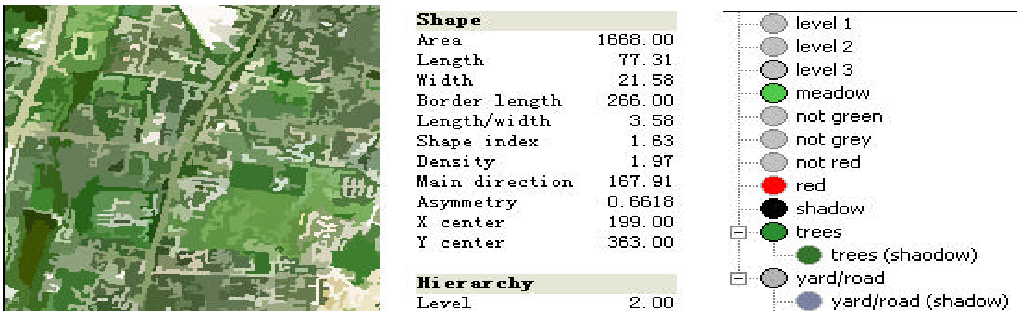

Fig.2 Segmentation results, segmentation object attribute and hierarchical network structure

Fig.3 Object-oriented change information automatic extracting (red region) and updating land use map (right)

Table 1 Precision evaluation of change information detected

Plot speckle level	10 Are	10-20 Are	20-50 Are	50 Are
Plot speckle count n_i	253	106	79	43
Speckle relatively mid-error dm_i	26.4%	16.9%	8.7%	2.3%
Area summation relatively error dm_i	1.8%	1.0%	0.5%	0.2%
Area summation A_i	1267	1384	1899	3369
Area summation mid-error dm	0.8%			
Area summation maximal error	2.2%			