OBJECT BASED SEGMENTATION TECHNIQUES FOR CLASSIFICATION OF SATELLITE IMAGE

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Abstract

Automatic feature extraction of features such as building, roads, vegetation etc., which also includes collapsed, height-changed and removed buildings, require the use of high resolution images. This research is helpful to develop a technique that can detect changes in urban buildings after natural disasters such as earthquakes, typhoons or tsunamis. This is also helpful in providing an accurate information about the changes for urban planning and updating Geo-spatial information system (GIS).It is necessary that the remote sensing imagery has to be converted into some meaning information, which in turn requires some segmentation methods followed by classification. Earlier pixel based approaches was followed which requires more computation on these high resolution images .This paper proposes few object based method (K-means , KFCM , Moving KFCM)for classification that segments the image followed by classification.

Keywords**:** High resolution image, GIS, K-means, KFCM, Moving KFCM.

1. Introduction

Remote-sensing research focusing on image classification has long attracted the attention of the remote-sensing community because classification results are the basis for many environmental and socioeconomic applications. Scientists and practitioners have made great efforts in developing advanced classification approaches and techniques for improving classification accuracy (Gong and Howarth 1992, Kontoes et al. 1993, Foody 1996, San Miguel-Ayanz and Biging 1997, Aplin et al. 1999a, Stuckens et al. 2000, Franklin et al. 2002, Pal and Mather 2003, Gallego 2004).

However, classifying remotely sensed data into a thematic map remains a challenge because many factors, such as the complexity of the landscape in a study area, selected remotely sensed data, and image-processing and classification approaches, may affect the success of a classification.Continuous emergence of new classification algorithms and techniques in recent years necessitates such a review, which will be highly valuable for guiding or selecting a suitable classification procedure for a specific study.Building extraction from high resolution satellite images is an important application in updating the GIS database and digital maps.This procedure cannot be implemented in single step and cannot be automated fully.This paper proposes an object based image analysis method which involves both segmentation and classification,where segmentation before classification is followed.Urban areas are to be analyzed which could list about the need for environmental protection ,climatic change, urban planning etc. The water bodies ,vegetation areas settlement areas can be clearly detected.The GIS database has to be improved and updated faster to fulfill the user's demand.But this updation process is too expensive due to complexity and time-consuming.Mayer [1] provides an overview study of building detection developed between 1984 and 1998. Levitt and Aghdasi [2] derived the existence of buildings using the edge detection methods. Shackelford [3] used the combination of pixel-based and object-based approach to detect buildings.. Unsalan and Boyer [4] provided a novel method to detect buildings in residential regions. Jiang et al. in [5] proposed a semi-automatic method to extract buildings through segmentation and edge detection. Shorter and Kasparis [6] implemented a classification method for the identifying building and non-building objects from a single nadir aerial image. Grigillo et al. [7] tried to extract building in suburban areas using Digital Surface Model (DSM) and Digital Elevation Model (DEM).

2. Remote-sensing classification process

The object-based image analysis(OBIA) for classification is shown in Figure 1 which is a three stage flow diagram (Benz 2001).Remote-sensing classification is a complex process and requires many factors to be considered. The main steps of image classification includes (i) determination of a suitable classification system, (ii)selection of training samples,(iii) image preprocessing, (iv)feature extraction, (v)selection of suitable classification approaches, (vi)post-classification processing, and (vii)accuracy assessment.

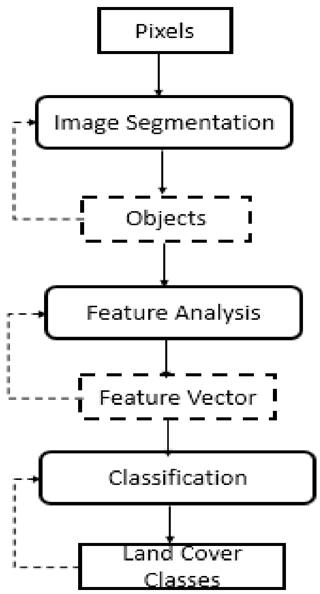


Figure 1.OBIA image classification process

Relationship between objects under consideration and spatial resolution is shown in figure 2[8]

(1) **low resolution**: pixels significantly larger than objects, sub-pixel techniques needed.

(2) **medium resolution**: pixel and objects sizes are of the same order, pixel by-pixel techniques are appropriate.

(3) **high resolution**: pixels are significantly smaller than object, regionalization of pixels into groups of pixels and finally objects is needed.

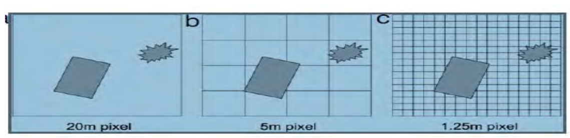


Figure 2: pixel and object based comparison

The user's need, scale of the study area, economic condition, and analyst's skills are important factors influencing theselection of remotely sensed data, the design of the classification procedure, and the quality of the classification results. This section focuses on the description of the major steps that may be involved in image classification.The prerequistes for classification is a classification system and training samples.Selection of suitable classification system needs to consider factors such as spatial resolution of the remote sensing data,classification software,different sources of data.

Supervised classification

The Land cover classes are clearly defined. Reference data are available sufficiently and are used as training samples. The signatures generated from the training samples are then used to train the classifier to classify the spectral data into a thematic map.

Unsupervised Classification

Clustering-based algorithms are used to partition the spectral image into a number of classes based on the statistical information in the image. No prior definitions of the classes are used. The analyst is responsible for labelling and merging the spectral classes into meaningful classes.

3. Experimental Setup

Setup in this project includes MySQL Server Management 2008 as the backend and Visual Studio 2010 as the front-end. MySQL is used to create a database which stores the input image with the attributes like image name and image id which are specific to a particular image. Visual Studio is used to create a windows application where the processes like image pre-processing, usage of clustering algorithms and lastly performing the classification technique on the image obtained after segmentation.

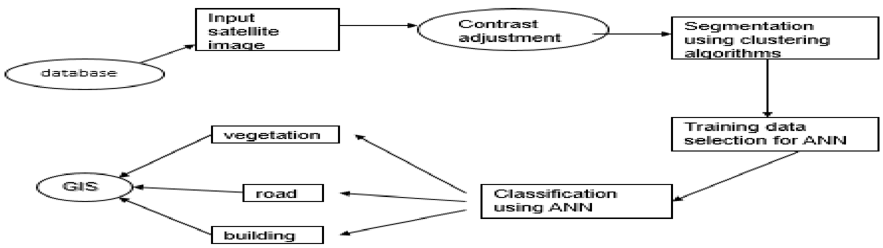


Figure 2: System architecture

This paper deals with an input satellite image which is stored in the database and is taken from the database at the time of project execution (figure 2). Data pre-processing is done with the help of contrast adjustments using the RGB colour model. After the data pre-processing is done the image becomes fit for segmentation. Segmentation is done with the help of three clustering algorithms namely K-Means , KFCM and MKFCM. Lastly for classification mean and variance of the image pixel is calculated and histogram is drawn which gives the final segments as Roads, Building, Vegetation.

3.1 Database creation

```
Create Database MyProject

create Table ImageDetails
(
ImageID int identity(1,1) primary key,
ImageName nvarchar(75) Not Null,
InputImage Image,
OutputImage Image
)
```

Results Messages

	ImageID	ImageName	InputImage	OutputImage
1	1	C:\Users\Public\Pictures\Sample Pictures\Desert.j...	0x474946383961FA00FA00F70000000000000330006600...	0x474946383961FA00FA0087000000000000330006600...
2	2	C:\Users\Public\Pictures\Sample Pictures\Lightho...	0x474946383961FA00FA00F70000000000000330006600...	0x474946383961FA00FA0087000000000000330006600...
3	3	F:\a-birds-eye-view-shows-very-few-remaining-buildi...	0x474946383961FA00FA00F70000000000000330006600...	0x474946383961FA00FA0087000000000000330006600...

Figure 3: MySQL database

3.2: Upload the input image (c# code)

```
string dir = Directory.GetParent(Environment.CurrentDirectory).FullName;
dir = Directory.GetParent(dir).FullName;
this.openFileDialog1.InitialDirectory = dir;

this.openFileDialog1.Filter = "IMAGES |*.jpg;*.bmp";
this.openFileDialog1.FileName = "";
```

Figure 4: Input satellite image

3.3 Contrast adjustments

Image analysis is based on the extraction of meaningful information and can involve many steps, such as pre-processing (e.g. noise removing), segmentation and characterization of the identified objects.Mean filter-to reduce noise which make image fit for segmentation.

Figure 5: Output of data pre-processing

3.4 Implementing the clustering algorithms

The initial satellite image segmentation process is done by converting the image into six color space. Subsequently, the histogram is determined for every color spaces. To determine the histogram, neighborhood pixel of every pixel is found.

The six color spaces based pixels are grouped together into different clusters as like road, vegetation and building .From the clusters, the center value based on six color spaces is computed.

3.4.1 K-means algorithm

This algorithm deals with defining the k centers for k clusters. These center should be placed in a unique way as different location results in different output. So, its better to place them as far as possible from each other. In the next step the new centers are computed with the new clusters. When no point is free , the first step is completed.

These two steps are repeated until all the points have been clustered.

```
_kMeans = new KMeans((Bitmap)picContrastImage.Image, Convert.ToInt32(5),
ImageProcessor.Colour.Types.RGB);
```

Here k= 5;

Fig 6: output of k-means algorithm

3.4.2 KFCM Algorithm

The algorithm is obtained by modifying the main function in the primitive fuzzy c-means algorithm using a kernel. Experimental results show that the proposed algorithm is more prone to noise than the conventional fuzzy image segmentation algorithms. KFCM confines the prototypes in the kernel space that are actually mapped from the original data space. The different types of image pixels with different information are combined in the kernel space are combined using different kernel functions Here 1 - k (x j , o i) can be considered as a direct measure for measuring the distance between the kernel space .

Fig 7: output of KFCM algorithm

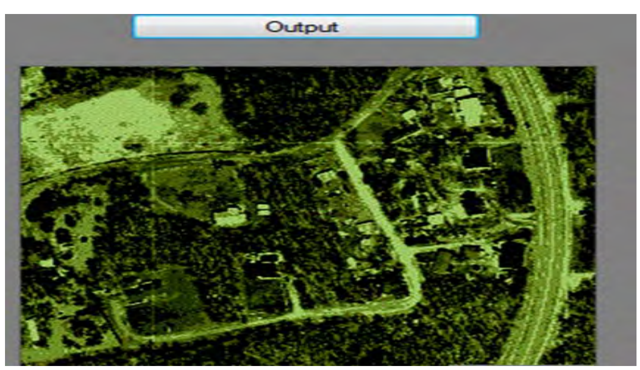
3.4.3 MKFCM Algorithm

Moving KFCM is used to improve the object segmentation in satellite images.During the clustering process, the distance between the centre and each cluster is constantly checked and if the center fails to satisfy a specified criterion the center will be moved to the region that has the most active center. The algorithm is designed to have the following properties:

- There is no dead center as the centers will have the same fitness in term of the fitness criteria.
- More centers will be allocated at the heavily populated data area but some of the centers will also be assigned to the rest of the data so that all data are within an acceptable distance from the centers.
- The algorithm is capable of avoiding poor local minima as the algorithm can reduce the sensitivity to the initial centers.

Fig 8: output of MKFCM algorithm

Different images produced different result so an average was calculated and Moving KFCM was declared the best for object based segmentation.Output images of the clustering algorithm are compared among themselves keeping in mind the pixel length in the image. Image with the smallest pixel length is considered the best. The final classification is done using artificial neural network. Supervised classification using back propagation network is followed. The training data are selected from segmented output and fed to the classification network.



4. Conclusion

The performance and accuracy of three different clustering algorithms –K-means, KFCM, Moving KFCM- have been compared based on the parameter pixel length. Accuracy assessment is an integral part in an image classification procedure. In case of noise, the input image undergoes pre-processing before the segmentation process. The output of the segmentation is the best image out of the three images obtained by the three algorithms. This best image is then classified by the classifier into roads, vegetation and buildings. It is being observed that the image with the smallest pixel length is said to be more accurate than the image with comparatively larger pixel length. In most of the case, it is inferred that the image with the smallest pixel length uses the Moving KFCM algorithm. Thus it can be said that Moving KFCM is more accurate and better performance than K-means and KFCM algorithms.

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