Object Oriented Model Classification of Satellite Image

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Summary
This paper realizes an Object Oriented model for the classification of satellite image using data mining techniques. The object-oriented classification method overcomes drawback of conventional classification method by using feature object as basic processing units, which are generated from image segmentation. Through several key steps, such as image pre-processing, multi segmentation, data generation and image classification the land cover area is successfully mapped. The object oriented classification algorithm is developed using FCM and K-means clustering techniques. Dataset is generated from the segmented image and classification is done using K-means clustering. Final image is obtained by mapping the result of K-means. The classification accuracy with object oriented model is higher.

Key words: Object oriented classification, segmentation, dataset generation, IRS image.

1. INTRODUCTION
Information extraction is a very challenging task because remote sensing images are very complicated and can be influenced by many factors. How the information we can derive from a remote sensing image mostly depends on the image classification results. The most direct use of remote sensing images is to get the classes contained in the image and what kind of patterns presented across the spatial, by performing a series of classification techniques. Then further information extraction techniques can be applied based on the classification result. Image classification is an important task for many aspects of global change studies and environmental applications, but it is a complex process. In this paper classification is done using object based method. Object-based image analysis is often carried out in two steps, i.e. image segmentation. Firstly segment remote sensing images for obtaining homogeneous object, secondly monitor and extract a variety of features for target features (such as spectrum, shape, texture, shadow, spatial location, the relevant layout, etc.) and object classification. Conventional pixel-based classification methods are inadequate for the thematic information extraction; lot of characteristics such as shape, texture and context were not used. That is the main cause of the low accuracy of the traditional
classification. Object level classifications are high level classification are based on objects obtained from images. The basic processing units of the object-oriented classification are image objects or segments, rather than single pixels. This method comprises of two consecutive processes. The whole image is subdivided into separated regions according to the spectral and spatial heterogeneity in the image segmentation process. Then the objects are assigned to a specific class according to the class's detailed description in the image classification process compared with the pixel-based classification; the object-oriented method can satisfy the demands of land use classification, and can be used as a new technique in land resources survey.

In this paper fuzzy c-means clustering algorithm [8] is used for image segmentation and k-means clustering algorithm [10] is used for classification. After mapping back the result of k-means, the final classified image is obtained.

Motivation: Object-oriented classification method is based on objective, and an object is a region of interest with spatial, spectral (brightness and color), and/or texture characteristics that define the region. This object-based extraction method extracts surface features with a variety of characteristic types, like forest area, barren land, water bodies, agriculture land etc.

Contribution: The present study aims to classify the given area for different land cover types for environmental monitoring.

Organization: This paper is organized as follows – Section 2 deals with related works and Section 3 describes the study area. Section 4 presents the architecture model and methodology and Section 5 gives the problem definition. Section 6 explains the implementation of the proposed algorithm and performance analysis. Section 7 contains the conclusion.

2. RELATED WORKS

F. P. Kressler, K. Stein Ocher, M. Franzen [1] developed a workflow that allows the classification of high-resolution aerial images, the subsequent comparison with land use data and the assessment of identified changes. These changes are then evaluated on the basis of plausibility and the update of reference data can concentrate on those areas where building activities or other discrepancies have been highlighted. Mott, T. Andresen, S. Zimmermann, T. Schneider, and U Ammer [2] proposed a "selective" region growing algorithm which combines the evaluation of class specific spectral information and immediate vicinity relations of pixels. The algorithm reduces unclassified pixels remarkably, which increases the overall classification accuracy. Sunhui Sim, Keth Clarke [3] discusses an object oriented classification method for dasymetric mapping within remote sensing and census geography. This method overcomes many of the weakness of the choropleth mapping method. It allows the data to be independent from the arbitrary enumeration areas and limits therefore the extent of ecological fallacy and of the modifiable area unit problem. Luiz Felipe Guanaes Rego, Barbara Koch [4] designed an algorithm for automatic classification of land cover with high resolution data. This algorithm gives better accuracy. Bao Cao, Qiming Qin, Haijian Ma, Yunfeng Qiu [5] improves the accuracy of HRI classification, Feature Enhancement Techniques Combined with Object Oriented Classification Approach (FETCOOCA) algorithm are developed. Comparative analysis between FETCOOCA with classical classification approach indicates that FETCOOCA can significantly improve the classification accuracy of HRI compared with classical classification approaches. Heremans, A. Willekens, D. Borghys, B. Verbee P, J. Valckenhorph, M. Acheroyl, C. Pneell [6] discuss the two methods i.e. the object oriented method based on Ecognition and the active contour method, both are capable of finding, on an automatic basis, the delineations of the floods.
Gweon and Yun Zhang [7] used different spatial resolution images for change detection. Through the implementation, the methodology suggests how to compare high spatial resolution imagery with medium spatial resolution imagery and how to improve the classification result when the available spectral information is limited.

3. STUDY AREA AND DATA SOURCE DESCRIPTION

The study is the data with three bands (R, G, and NIR) is acquired from western side of Karnataka during 2000 from Karnataka remote sensing department. The study area is highly heterogeneous; information is mixed by different gradients. According to field survey, the study area is mainly covered with patches of grasslands and agricultural land (paddy field, aracanut, teak, and tree savanna), high, medium, low density forest, water bodies and mountains.

Rainfall season is during June to September with an average of 1000 mm/annum (sources: Directorate Economics and statistics Department). These are the main sources of water. It is between the longitude 75 04’ 51.23” to 77 57’ 50” E and latitude 14 10’ 22.04” to 16 06’ 34” N. This is an IRS p6 LISS III data acquired on 1997 with a spatial resolution 23.5m and three spectral bands (green, red and NIR) were used. Data obtained by GPS (Global positioning system) were used as ground truth information for the classification of the images.

4. METHODOLOGIES

The architecture for classification model is shown in Figure 1.

![Figure 1. Architecture for classification model](image)

4.1 Geo-Referencing

After obtaining satellite images in the digital format, images are Geo referenced and mosaiced using ERDAS IMAGINE image processing software. Geo-referencing attachés real world coordinates to the image so that it can be co-registered with any other imagery or spatial data, which overlie the same area. Geo-referencing also enables warping an image to correct the topographic displacement.
Real worlds Ground Control Points (GCP), obtained with a GPS, are used for Geo-referencing along with well-distributed points from Geo-coded hard copy of the image. This method also attaches real world coordinates to pixels within an image. The number of reference points required depends on the complexity of topography and instrumental displacement or distortion within the image. As the study area is a hilly region, the numbers of GCPs used are high.

Geo-coded hard copy of IRS-ID satellite image and GPS reading of the study area is used for geo-referencing. Geo-referencing is done on Lambert Conformal Conic (LCC) projection, Everest spheroid and an undefined datum. LCC projection is used for zones extending mostly in an east-west direction. LCC projection system is developed by Lambert in 1772 and commonly used in mapping of the United States by the U.S. Geological Survey. While some distortion is inherent in all map projections, a characteristic of the Lambert conformal conic projection is that shape distortion is minimized (GIS rule definition, 2001). This is used for minimized the data with given applications to extend the GPS.

4.2 Preprocessing

Once the data is acquired it is needs to preprocess. This includes geometric corrections, radiometric correction and image clipping. Geometric corrections and radiometric corrections are already been done. Image is in RGB format, it is converted into gray-scale image and unwanted part is clipped off from the image. Image is passed through the digital filters to remove the noise and inconsistency. Then the contrast of the image is improved.

4.3 Object Oriented Segmentation

There are many methods to segment images in obtaining objects from images, but Fuzzy C-means clustering algorithm is used for object oriented segmentation of the image. This uses fuzzy partitioning such that a given data point can belong to several groups with the degree of belongingness specified by membership grades between 0 and 1. The FCM function which searches for the belongingness that gives the least error, which reduces the spurious blobs and noisy spots. Objects are created during the segmentation process, when the image is subdivided into groups of pixels, which have a similar local contrast value.

It is acceptable that the segmentation of the image takes place in multiple phases. The required objects can be extracted along with their shape, texture and boundary of the objects. Fuzzy membership function can be developed to obtain more efficient, effective and reliable fuzzy clustering algorithms.

After obtaining the objects from segmentation, each object is labeled by assigning the numbers and coordinates are computed.

4.4 Dataset Generation

The dataset was generated from IRS p6 LISS III image. The multi-spectral values of pixels in 3x3 neighborhoods in a satellite image are used to create the database for classification. The aim is to predict the classification, given the multi-spectral values. In the sample database, the class of a pixel is coded as a number.

4.5 Object Oriented Classification

As pixels only do not hold enough information to detect the different phenomena, advanced and most knowledge based methods seem to be more promising, with object-oriented approach offers new possibilities to face these problems.
Object-oriented classification refers to the creation and interpretation of pixel regions representing meaningful image objects. Object-oriented remote sensing image classification method is based on the cognitive model of remote sensing information extraction method, which is closer to the human cognitive process. So the object-oriented remote sensing image classification method becomes superior to traditional classification method as follows: feature objects consist of homogeneous pixels generated from image segmentation. Objects are identified during segmentation process objects after being fragmented as statistical units can make full advantage of the rich land type description characteristics (spectral, texture, shape and size, context, etc.) and corresponding dataset is generated to create a database. Classification is done using K-means clustering technique.

K-means is one of the simplest unsupervised learning algorithms that solve the well known clustering problem. This algorithm looks for a fixed number of clusters which are defined in terms of proximity of data points to each other. This algorithm used to classify or to group objects based on attributes into K number of group. K is a positive integer number. The grouping is done by minimizing the sum of squares of distance between data and corresponding cluster centroid.

The K-means algorithm assigns each point to the cluster whose centroid is the nearest. The center is the average of all the points in the cluster, that is, its coordinates are the arithmetic mean for each dimension separately over all the points in the cluster. The main advantages of this algorithm are its simplicity and speed which allows it to run on large datasets. K-Means cannot handle non-globular data of different sizes and densities means clustering is used to cluster the dataset which generated from the image.

5. ALGORITHM

Problem Definition: For a given multispectral remote sensing image, the main objectives are:

a. Generating the database from the segmented image.
b. To develop a good algorithm for object oriented classification for the land cover types with relatively good accuracy.

Algorithm: The main objective is to obtain better segmentation of the satellite image for different ecological studies and planning using data mining techniques. The algorithm for classification is given in the table 1.

Input:

- $m$: Multispectral image
- $n$: number of clusters

Output:

a. A set of $n$ segments and $n$ number of classification
b. B. Obtain Map back classified image.

OOC()
begin
preprocess the image $m$ data;
fcmmeans(data, n); ooc(data, n);
end.

fcmmeans(data, n)
label2: randomly assign the membership coefficient $U$ for being in clusters repeat
compute the centroid $c_i$ for each cluster until algorithm converges
else go to label2 to compute new coefficient
\documentclass{article}
\usepackage[utf8]{inputenc}
\begin{document}

\textbf{6. IMPLEMENTATION AND PERFORMANCE ANALYSIS}

\textbf{6.1 Simulation Software}

Simulation is performed using Matlab7.5. MATLAB is a high-level scientific and engineering programming environment which provides many useful capabilities for plotting and visualizing data and has an extensive library of built-in functions for data manipulation. Data preprocessing, image segmentation, classification and computation is done using the tools supported by MATLAB.

\textbf{6.2 Performance Analysis}

IRS Landsat satellite image is one of the main sources of information. One frame of Landsat MSS imagery consists of three digital images of the same scene in different spectral bands. Two of these are in the visible region (corresponding approximately to green and red regions of the visible spectrum) and one is the (near) infra-red. With reference to the survey map, image is segmented for 11 segments using fuzzy c-means. Objects are created during the segmentation process and each object can be extracted along with their shape, texture and boundary of the objects. The total number of objects in each cluster is computed and each object is labeled. Classification algorithm is applied on segmented image to get the required classification. Generate dataset using the superimposed image where each row in the dataset corresponds to 3x3 masks in the image. Each pixel is a 8-bit binary word, with 0 corresponding to black and 255 to white. The spatial resolution of a pixel is about 80m x 80m. Each image contains 2340 x 3380 such pixels. For each row find the most common object which those 9 pixels belong to and add it as a column in the dataset along with the number of times the object appears in those 9 pixels. Also include the coordinate values of the first pixel among the 9 pixels which will be used for mapping back the dataset to image. Each line contains the pixel values in the three spectral bands of each of the 9 pixels in the 3x3 neighborhood, object number to which the pixel belongs to and segment number. The same procedure will be followed until entire image is scanned.

K-means clustering algorithm is applied on the dataset generated by the image. Map back the result got by k-means to get an image wherein the 11 clusters are assigned different 11 colors. The map back image is almost closer to the image referred by survey map.

The original image and segmented image is shown in the Figure 2 and Figure 3. The classified image obtained as a result of K-means is presented in the Figure 4. The total number of objects in each class and area of each class is computed and is tabulated in the Table 1.

\end{document}
Figure 2. Original image

Figure 3. Fuzzy C-means clustered output

Figure 4. Classified image
Table I. No. of objects and its area in square meter

<table>
<thead>
<tr>
<th>Classes</th>
<th>No. of objects</th>
<th>Area in sqm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Body and paddy fields</td>
<td>1091</td>
<td>30758</td>
</tr>
<tr>
<td>High Density forest</td>
<td>149</td>
<td>286052</td>
</tr>
<tr>
<td>Medium Density forest</td>
<td>1012</td>
<td>387322</td>
</tr>
<tr>
<td>Low density forest</td>
<td>836</td>
<td>1134484</td>
</tr>
<tr>
<td>Agriculture land</td>
<td>627</td>
<td>374712</td>
</tr>
<tr>
<td>Grass Land</td>
<td>427</td>
<td>242190</td>
</tr>
<tr>
<td>Degraded forest</td>
<td>1015</td>
<td>373620</td>
</tr>
<tr>
<td>Teak</td>
<td>210</td>
<td>111618</td>
</tr>
<tr>
<td>Tree savanna</td>
<td>721</td>
<td>449644</td>
</tr>
<tr>
<td>Aracanut</td>
<td>380</td>
<td>224510</td>
</tr>
<tr>
<td>Unclassified</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

7. CONCLUSION AND FUTURE WORKS

In this work pixel-sized objects were used to emphasize the Advantage of utilizing spatial dependence of neighboring pixel in remote sensing data. By using this data we can easily identify the class, no of objects and the given area to analyze the performance of System. So it is so useful for the people who are working on Satellite image processing works. In future we can apply this application to all the major area to find out classifications of data.

REFERENCES

[3] Sunhui Sim, Keth Clarke, Dasymetric Mapping with Object-Oriented Classification and GIS, IEEE 0-7803 9050-4/05.
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