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Object Based Classification Using Image Processing Techniques

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Abstract: *Remotely sensed image is the one of the most essential tool to access the features of Earth's surface .One can study many activities such as developments of suburban areas or the vegetation cover in the selected area from the satellite images. The use of satellite imagery technology has been applied in many application fields to monitor land-use and land-cover. Moreover satellite imaging is capable of estimating agricultural cover in a region. Separation of characteristics of an image leads to complexity because of the trouble to find appropriate technique for image segmentation. This paper proposes techniques to classify objects in the remotely sensed image by using various image processing methods . These are main steps supporting each other, Pre processing method: Image Enhancement using Histogram Equalization and Adaptive Histogram and Image Segmentation using thresholding and RGB channel. The algorithm is be able to detect the area of vegetation, water bodies, concrete and roads. The image segmentation methods can detect the Region of interests. The final output helps us to classify the objects in the satellite image.*

Keywords: *Image sensing, Preprocessing Methods, Enhancement, Histogram, Adaptive Histogram, Histogram Equalization, Gray-scale Image, Segmentation, RGB Channel, Color Segmentation, Kmeans,Object Classification, Area Coverage.*

I. Introduction

Many countries all around the world desire to be updated with the latest geographical information and activities of their area. This kind of data helps the respective authority in the Bureaucracy to plan the development of a particular place geographically. Also, by taking necessary steps, the responsible department overcomes the shortcomings. This can only be made possible if we have access to the remotely sensed images sent by the satellite. It is necessary that the one can study these images to extract the features of the particular area. We can obtain information such as pastures, forest, water-bodies, barren lands, concrete cover of that region.

For this we must this processing of image is necessary. This requires the techniques which will help us to study the characteristics of the satellite image. The first and the most primary step is to acquire the image sensed by various sensors such as infrared, etc. These images may be of different resolutions and contain various noises because of which it may give rise to difficulties in accessing the data we want. For this we require an image pre-processing method which is Image Enhancement

With the help of this enhancement technique we can improve the quality of an image by adjusting its contrast with the help of histogram techniques. The next step is segmenting the image; it is the process of partitioning the image in various sections. The enhanced image obtained earlier from the histogram technique is used in the image segmentation. This is done by setting the appropriate thresholding values. The classification of the features of the segmented image is done by the colour segmentation technique. The color segmentation includes setting the RGB channel appropriately to obtain output in such a way that is more accurate and conveys the desired data.

We can ensure the quality of the enhanced and segmented image by studying and comparing various parameters such as area, histogram, sizes, resolutions, etc.

II. Literature Survey

Several existing work was studied to gain better understanding of the happenings in the field of object based image classification. This section illustrates few recent research work related to testing of various image parameters and their properties to detect the region of interest.

Thomas Blaschke [8], discusses various techniques of image segmentation and shown a comparative analysis of pixel based and object based classification. The author concluded that object based techniques are better as compared to traditional pixel based classification technique. This analysis combined the idea of object based classification technique and shown that object based can also examine the regions by shapes and information from context. A good overview of various approaches for object based classification is elaborated in [7]. The author worked on differentiating between classes of land-use like forest, green lands and water bodies.

J.Schiewe[10] explained that for classification of high resolution images , approaches like point based, edge based and region based can be used.The method of classification which works on individual pixel are not convenient for the classification of multisource data .Therefore, technique which works best for classifying the high Resolution remotely sensed images is region based method that is composed of segmentation. The main purpose of this paper is to give an outline of state of the art and adoption of segmentation techniques which are used for different processes for remotely sensed data.

Anil K Goswami et al [15] proposed the technique for classification of the satellite image using Nearest Clustering algorithm. They concluded that this technique works well for classification of satellite images but one has to mind that rightness of the algorithm depends on the created datasets. Further work in future is possible by making fusion of more than one algorithm suggested in [15].

Thibaut Durand [9]proposed the image classification technique based on region detector which combined the spatial pooling and low level representation. In this the images are categorize for the purpose of detection of region and object for the perceptible content for individual images. By testing dataset of voc 2007 shown excellent result by combination of state of the art methods with their strategy for representation of compact images.

Satellite images are most powerful tool which is rich in geographical information [1, 14]. Many different techniques have been proposed for object recognition. A novel technique for recognizing and classification of the objects from satellite image using data mining is proposed in [13]. Advance techniques like Artificial neural network and Fuzzy logic for classification of digital images can be used for best results [12, 16, 17].To achieve the desirable output a good fused image is essential for image classification. [12] In this paper five different techniques are proposed for the performance evaluation of Image Fusion method. Satellite images are most powerful tool which is rich in geographical information [1, 14].

The paper describes[19] different techniques for the segmentation of satellite images, which are Fuzzy C-Means (FCM), K-Means (KM).Comparative analysis of KM and FCM are done in order to achieve the desired output. The author concluded that by observation that FCM is slow segmentation process but segmentation technique using FCM gives well segmented images with smaller details and precise location.

III. Methodology

The image processing is a wide concept. It consists of many methods and with its' aide the output image can be obtained. The methods, have step as shown in fig.1 ,which must be followed in order to get the object classified image.

When the input image is given, it has many anomalies and cannot be directly used to get the output desired. Hence, pre-processing methods and post -processing methods are done. These methods make the image ready for the upcoming processes. Simultaneously, it is important that we develop an algorithm which is more accurate and suitable according to our requirements. Hence, an extensive research and proper research must be done in order to get the output.

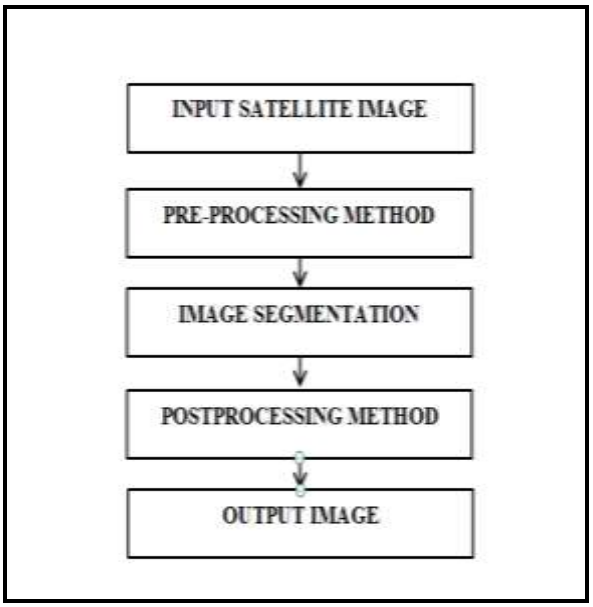

Fig 1. Block Diagram of the Image processing

The algorithms developed are verified on the satellite images ,Fig 1,provided by Maharashtra Remote Sensing Applications & Centre, Nagpur.

3.1 Image pre-processing

Image pre-processing is a primary phase of object classification to improve the quality of image by correcting the unwanted degradation, distortion and various noises in the system. This preprocessing includes enhancement using histogram equalization and adaptive histogram equalization of the input image (Fig 1).

Fig 2. Original Image (Image Courtesy: MRSAC, Nagpur)

3.1.1. Image Enhancement

Hongteng Xu [2] observed that sometimes anomalies such as the light exposure, undesirable climate change or because of the image sensing device, the contrast of the captured image may be unsatisfactory.

According to Rupneet Kaur [4] ,the basic principle of image enhancement is to obtain such an image so that this processed outcome is more suitable than the original image for the further image processing applications. To use the algorithm for the enhancement methods, we must convert color image into the grayscale image as shown in Fig 3. Kishore Sahoo [4] proposed that when the processed image is obtained , the viewer decides which particular method works best for him.

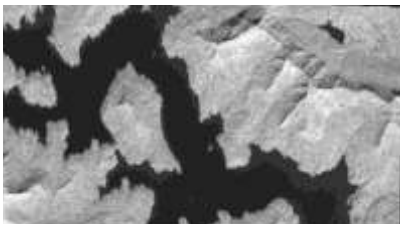

Fig 3. Gray-Scale Image

1) Histogram Equalization:

As authored by Kishor Sahoo [4] histogram of an image is the variation of the gray levels in the image. With the help of histograms ,we can decide whether the given image is low contrast (dark) or high contrast (bright) image. The gray levels are expressed in the discrete form. This technique also enhances the visual appearance of an image (refer Fig 4). The steps to be performed for the histogram equalization technique are:

i)The image is partitioned into segments.

ii) The histogram is used to plot the pixel values for the gray levels and is done in the range from 0 to 255.

iii) Histogram Equalization is used to measure the intensity values and make the uniform distribution of pixels to get the enhanced image. Thus histogram equalization technique is used to increase the dynamic range of pixels for the appearance of an image.

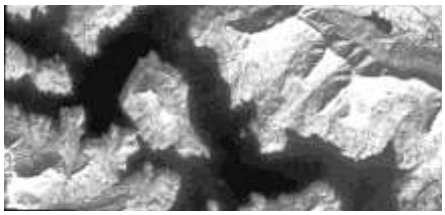

Fig 4. Enhancement Using Histogram Equalization

2) Adaptive Histogram Equalization:

Adaptive Histogram Equalization is used for improving contrast in images. Adaptive method differs from Histogram Equalization because by this method we can compute several histograms and hence the obtained histogram corresponds to a particular section of an image. Histogram equalization does not sufficiently improve the contrast of the section of an image. Adaptive Histogram Equalization betters this enhancement by transforming each pixel with a transformation function obtained from a neighboring region. It overcomes some of the disadvantages of global linear min max windowing method. Thus, the portion of noise is decreased in sections of the image. And Adaptive Histogram Equalization also reconstructs the contrast of grayscale image as shown in Fig 5.

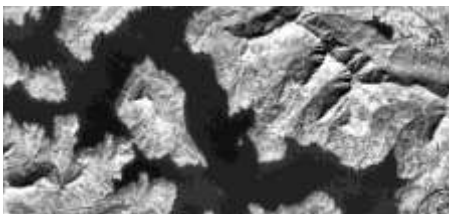

Fig 5. Enhancement Using Adaptive Histogram

3.2 Post processing Method- Image Segmentation

Image Segmentation is partition of an image in several sections. The main objective of the segmentation is to change the appearance of an image which is easier to analyze. Based on the similarity criterion of texture and digital number, neighboring pixels are grouped into a region which is called as segmentation. Images objects in remote sensing imaging are related and can be separated by segmentation. Thus the components present for a image classification are reduced widely. As proposed by J. Schiewe [10] . Image Segmentation can be done by various techniques. The main task is to select the proper segmentation technique to apply. We have applied to two techniques for image segmentation. The first one is Image Segmentation using thresholding and Image Segmentation using RGB channel.

3.2.1 Image Segmentation using Thresholding

A simple way to partition an image is thresholding. It can separate an image into background and closet part. This technique is a type of image segmentation technique which first converts gray scale images into binary image and then segments the image. It works effectively on high level of contrast images mostly. The algorithm for image segmentation using thresholding can be applied on grayscale image obtained from the adaptive histogram equalization ,Fig 5. The conversion of color image into gray scale is also proposed by C. Saravana [5].

$$g(u) = \begin{cases} 0, u < t \\ 1, u \geq t \end{cases} \quad (1)$$

where,
u- a grey value,
t- a threshold value.

The gray level image can be converted using binary image using appropriate threshold value t. The Threshold value is the value which has two regions on its either side that is below the threshold and above the threshold. The advantage of converting it first in a binary image is that it reduces the Shortcomings of the data and makes it easier to comprehend the process of recollection and classification.

A generalized method to select threshold value is by examining the histogram of the image. There are many other methods to find the threshold value like by Iterative method and OTSU. We developed an algorithm which segments the binary image using the threshold value. The pixel values will be compared with the threshold.

The algorithm won't allow the pixel values above the obtained threshold value and hence we will get the segmented image using thresholding. Then all the gray level values below the threshold value T will be partitioned as black (0), and those above the value will be white (1) as shown in Fig 6.

Fig 6. Segmentation using threshold value -0.3

3.2.2 Image Segmented using RGB channel

Digital Images are made up of pixels. The pixels are combinations of primary colors that are red, green and blue. The colors in the image are represented by series of code of this RGB channel. The images are formed by combining this RGB channel. There are different methods used to obtain region of interest of images such as threshold based method, region based method, histogram based segmentation. Xiaolin Wu,[2], proposes the color segmentation technique with the help of RGB channel. To display the images in electronic system RGB model is widely used. The segmentation of color image affects the human's daily life problems such as inspection of images that are generated in medical fields. The region of interest can be extracted with certain properties and pixels of that particular region should share certain characteristics.

Warinthorn Kiadtikornthaweeyot a, Adrian R.L. Tatnall [1] proposed the equation,

$$Igr = (Ir * 0.30) + (Ig * 0.59) + (Ib * 0.11) \quad (2)$$

Fig 7. Green Color Segmentation

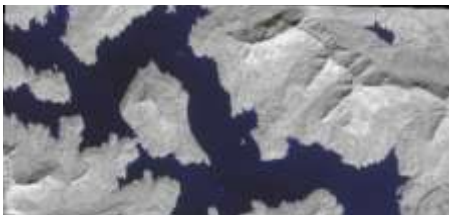

Fig 8. Blue Color Segmentation

I_{gr} is the gray scale image, and, I_r , I_g And I_b represent the image pixel value in red, green and blue channels respectively.

To extract a particular color from the image we develop an algorithm that suggests the use of RGB channel. If we want to extract blue color from the image we select the values of RGB combination in such a way that the pixels of blue color retain their shades of blue and the remaining pixels on the channel are converted into gray scale (Fig 8). Then we can give the color of our choice to the extracted region to highlight the particular region and the remaining portion which could be shown as background can be colored black or white. Following these steps the image can be segmented in the regions of our choice. We can apply the same algorithm to any color we want to segment from the image. Using this algorithm we can segment vegetation, water body, barren lands etc. Initially, by applying the algorithm we single out each color in the satellite image simultaneously. This results in coloring of the pixels in same shade of that particular channel. For example all shades of green are colored in a particular chosen shade of green as seen in Fig 7. After doing this, obtained images are added together to get the final image which is color segmented.

3.3 Object Classification

In the field of scientific research, the remotely sensed images which are obtained from satellite or photographs taken from flying object have become essential for resource managers.

There are different image classification techniques for the remote sensing. The important techniques are supervised, unsupervised and object based classification. The simplest way for understanding and partitioning of image is unsupervised classification. In this technique, firstly it forms the group of pixels into the clusters by using their characteristics.

3.3.1 Object Classification By Median Filter

It is quite essential to remove the noises in the input satellite images and hence we need a filter. This is done to ensure smooth processing of upcoming steps. There are many filter available for this. One of them is median filter. Median filter is a non linear filter. It is used for removing noise and extracts the colours from the RGB image, which eventually can help us to classify the features of the satellite images. The technique to remove the noise and feature extraction from the input image using median filter.

The extraction of RGB colours from the images is done by dividing the fixed size blocks of the pixels (Fig 9 & Fig 10). The purpose of medians filter is to discover the values to differentiate between the largest and intermediate values which are ordered in accordance with size.

The pixels values are arranged in ascending order and then the median is searched in the set of pixels by differentiating between the largest and the intermediate values. In this algorithm, the features extraction in the input image is done by colour indexing and size order.

Consider for the two dimensional input image f(x), corrupted by the noise g(x,y) in the area defined by S(x,y), then the mathematical equation for median filter in the time domain is given as:

$$\hat{f}(x) = \underset{(s,t)\in S_{xy}}{median}\{g(s,t)\} \qquad (3)$$

Where, $\hat{f}(x,y)$ gives the output noise free image.

This eventually paves the way for feature extraction or object classification by applying the developed algorithm to obtain the image as seen in Fig11.

The mean filter is another filter which can be applied here. But median filter works better than the mean filter. Mean filter takes the average of the neighbouring pixels. Whereas in median filter, the neighbouring pixels are first sorted and an already available intermediate value is chosen .This feature of median filter is greatly helpful when the sharp edges of the image is required to preserved. Mean filter creates a whole new pixel value and thus the edges in the image are affected.

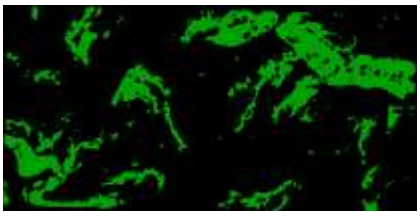

Fig 9. Green Color Extraction

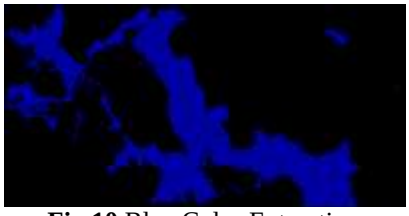

Fig 10.Blue Color Extraction

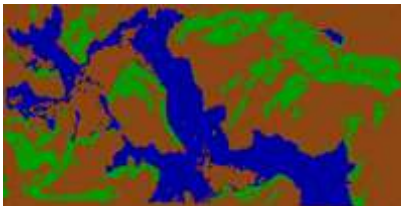

Fig 11.Object Classification by median filter

3.3.2. Object Classification by K-means (Alternative Method):

`In this technique, firstly it forms the group of pixels into the clusters by using their characteristics. For the clustering analysis algorithm of image clustering is used. Image clustering methods are k means and iso-data. Further process for clustering is to recognize the number of groups that has to be generated. Only two clusters can be identify after merging this classes. In short we can say that unsupervised classification requires two step that is to generate iso-clusters and after that classifying the iso clusters.

Supervised classification requires the training of dataset and it uses the spectral analysis. The frequently used techniques are maximum and minimum likelihood classification of distance. The process includes selecting the training area and generating and classifying the signature file.

In prior, research work it is observed that traditional pixel based classification is not convenient for high resolution images because of its properties. Pixel based classification works well for low resolution images. Object based classification technique is used for high spatial resolution imagery, it outperform traditional methods of classifying images. This is because object oriented classification techniques shows higher accuracy and make use of both spatial and spectral characteristics. The general steps for classifying image by object based classification is to perform multi-resolution segmentation and select the training areas to classify image. Define statistics and after that classify the whole image.

Image segmentation is crucial part of object based classification. Generally, after the segmentation of the high resolution images for the suitable image objects, the classification of images is done through various characteristics parameters and criteria.The object classification of an image can be done by Neural Network as well as Fuzzy logic. Another widely used method for the classification of object from the image is K means clustering. K Means is an unsupervised training process .The objective of the k means clustering is to section n observations into k clusters in which every observation belong to the clusters with closest mean serving as a prototype of the cluster. The clusters are converging and its goal is to make the separating decisions effective based on a initial set of clustering (given by the user)which is updated after each iteration. This technique is efficient and can be applied to multi-resolution data. Pooja Thav [20] said Clustering is the process of separating a type of objects into a similar sub-divisions can be used as a separate tool to fathom the object separation.

Median filtering is used to get rid of noise from the image, preserving the originality of the image. Throughout this method, the pixel value is reconstructed to the median of the 3x3 window, whereas the pixel value remains same at the sampling window boundary.

Fig 12. Object Classification by K-means

`We classify the given datasets by fixing a certain number of clusters (say R clusters). The important idea of the whole algorithm is to define the number of K centres, one for each cluster. These are called as centroids. The location of these centres should be far away from each other. This is because the location of these centres causes varying results.

Each point from the given dataset is taken and then these points are linked to the nearest centre. This is continued until no points are left. This leads to the formation of early group which in turns gives new k centroids (barycentre of the clusters).

Now, we repeat the initial process of linking these new centroids with the same dataset points. The k centres get new location each time a new cluster is formed as we go step by step. The loop continues until the centroids do not move anymore and we obtain output image as shown in Fig 12.

3.3.3 Comparative Analysis

All the techniques discussed here have good results on satellite images. The table below shows the comparative analysis of object based classification using k means and median filter. Median filter is a digital filtering technique in image processing which is usually applied for the de-noising of the digital images. By the study of various research work shown we applied the algorithm of median filter on RGB channels. And furthermore, the pixel counts on each channel of the image is obtained. Area percentage of different region of interest of satellite images can be obtained by pixel counts.

Another method applied on satellite images is unsupervised learning method that is k means clustering. In this k-means algorithm Euclidean distance based on minimum distance allot the observations to one of the clusters. Area cannot be calculated, because the position of the pixels in the channel keeps on changing as the loop of the pixel count is repeated. And hence distance calculated is different in each iteration. By observation and study of parameters we can conclude that image with median filter techniques works best on high resolution satellite images.

IV. Result

The objective of Object based classification techniques is to determine the best classified data for the further work. The result of this object based classification algorithm will help us to distinguish the object in the given input satellite images. The algorithm which we developed will also help in image categorization and object region detection in different levels of resolution of the input images.

The developed algorithm helps to detect the area which may be used for the development of further schemes. The analysis is done by experimentally comparing the approaches of the water bodies over two seasons. The analysis of classifying agricultural land helps us to provide a framework for classification of land which can be used at national, regional and local levels extends. Experimentally we can show by the developed algorithm deforestation percentage can be found out over a period of time(Table(1)).

Sr.No	Objects Classified	Area Covered By the Objects Classified (In percentage)
1.	Land	44.9371
2.	Water	35.0591
3.	Vegetation	20.0038

Table 1: Area Covered (in percentage)in the output image.

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