An Analytical Study on Image Classification Methods Used in Remote Sensing Images

B.Sasi Prabha., Dr.T.Ramaprabha *M.Sc.,M.Phil.,P.hD.,*
II-M.sc(Computer Science), Professor,
Department of Computer science and Application,
Vivekanandha College of Arts and Sciences For Women(Autonomous),
Elayampalayam,Thiruchengode,Namakkal(DT).
South India.
ramaradha1971@gmail.com,sasibaskaran94@gmail.com

Abstract: **An image classification is a process of dividing an image into regions and boundaries and it is used to distinguish the foreground from the background. A thresholding is one of the simplest and widely well know technique used for remote sensing image classification. This field offers various challenges for the researchers. In this paper, we concentrate on the study of image classification by using two threshold methods as global Thresholding and local Thresholding. In global thresholding, a single threshold value is assigned to whole image. In the local Thresholding single threshold value is assigned to each pixel to determine whether it belongs to foreground or background pixel by using local information about the pixel. In general, to classify the local region or restrictions, the local Thresholding method is more efficient, easy to implement. We get result as quality of the image, when it is compare to global Thresholding.**

Keywords- **Thresholding, image classification, global Thresholding, local Thresholding.**

I. INTRODUCTION

Remote sensing image classification is one of the very essential to image processing and pattern recognition. Remote sensing image classification is a process of dividing an image into regions and boundaries and it is used to distinguish the foreground from the background. Image classification it represent its results in thematic maps. There are two types of classification supervised and unsupervised methods. Thresholding methods are used to discriminate foreground from the background. This can be done by adequate threshold value T, the gray level image is converted into binary image. The binary image will contain all the essential information about the position and shape of the object in foreground. The purpose of using binary image, it will reduce the complexity of the data and simplifies the process of classification. The common method to convert gray-level image to binary image is to select a single threshold value (T).The gray-level value below the T will classified as block (0), and the above the T will be represent as white (1).the digital image processing techniques of remote sensing application explains the image classification techniques are most generally applied to spectral data of a series of multidimensional images. Image classification is complex processes that may be affecting many factors. The different review method are suggest that, designing a suitable image processing procedure is a precondition for a successful classification of remotely sensed data into a thematic map. This paper focuses on the comparison on local classification and global classification methods and techniques used to improve the classification accuracy.

In global Thresholding, a histogram of the input image intensity will reveal two peaks, the peak is represent as bimodal. The value of T is selected as the valley point between two modes. In real application histogram image representation are more complex, with many peak, it will not represent clear valley, and it is not easy to select the threshold value(T).in local Thresholding ,the gray level of the pixels in a foreground object is quite different from the gray level of the pixel belongs to the background object. Example of local Thresholding application are document image graphic content, map processing where lines, character are to be found, quality inspection of material and so on[1]. The output of the local Thresholding operation is a binary images, the gray level of 0 represent as (black) will indicate a pixel to be print, legend, or target and gray level of 1(white) will indicate the background.

II. NEED OF REMOTE SENSING

Remote sensing is a process of gathering information about an object, area or phenomenon without being a direct contact with the object. The information needs a physical carrier to travel from the object to the sensor through the dominant medium. The electromagnetic radiation is normally used to carry a information in remote sensing. Remote sensing image normally in the form of digital image. In order to extract the useful information from the image, image processing technique is used to get the visual construal and to correct or restore the image, if the image has subject to the geometric distortions or dreadful conditions by other factors [2]. In many cases, image segmentation and classification algorithm are used to delineate different area in a image into thematic classes. The thematic map is used to combine with other database of the test area for further analysis and consumption. The Remote sensing satellite captures the image and transmitted to earth through telecommunication. The bandwidth of the telecommunication channel sets a limit to the data volume for a scene taken by the imaging system. It has a high spatial resolution image with many spectral bands covering a wide area. A small number of spectral bands or a smaller area of coverage may be accepted to allow high spatial resolution imaging.

III. GLOBAL THTRESHOLDING METHOD

Thresholding is the simplest method of image classification. From the grayscale image, Thresholding method is used to convert into binary image. In global Thresholding, it will check the histogram representation for given input image and the intensity value should reveal two peaks. Global Thresholding consist of setting an intensity value such that all object will have the intensity value below the Thresholding belongs to the one classes and remaining belongs to other. Global Thresholding, a single threshold value is used in the whole image. In Global thresholding, the input is a vector x, the output is an estimated threshold T, which groups x into two clusters using the basic global Thresholding. the procedures,

Step1: Randomly select the initial threshold T.

Step2: segment the image using threshold (T), it will yield two groups, G1 contains all points with the value <= T and G2 consist of points T.

Step3: compute the average distance between point G1 and T, and point G2 and T.

Step4: compute the new threshold value as T=(M1+M2)/2.

Step5: Repeat step 2 through 4 until the change of T is smaller enough.

In global Thresholding, the otsu's method is used to automatically performs cluster based image Thresholding and it will perform the reduction of a gray level image to binary image. The algorithm assumes that the image contain two classes of pixels followed by the bimodal of histogram representation. This method is used to separate the image from the foreground from background [3]. Then calculate the optimum threshold separating the two classes and it combines the intra class variance is minimal or equivalent. This method is useful to separate, the image from foreground and background .finally the single threshold value is used image and the quality of the result will be slightly low when it compare to local Thresholding.

IV. LOCAL THRESHOLDING METHOD

In Local Threshold, a threshold value is assigned to each pixel to determine whether it belongs to foreground or background pixel using the local information around the pixel. Local Threshold techniques are based on the local properties of the pixels and its neighborhoods. A local threshold methods are used to calculate at each pixel characterizes this class of algorithms. The value of the threshold depends upon some local statistics like range, variance, and surface fitting parameters or their logical combinations. In local Thresholding, the original remote sensing image is partitioned into smaller sub images and a threshold is determined for each of the sub images. This yields a threshold image with gray level discontinuities at the boundaries of two different sub images. The threshold of a region can be determined by either the point-dependent method or the region-dependent method [4]. A smoothening technique is then applied to eliminate the discontinuities. In this method, the original image is divided into some consecutive matrix of sub images and a threshold is computed for each sub image. However, a threshold is not computed for sub images with unimodal gray level histogram. Thresholds for such sub images are interpolated from neighboring sub images. For a bimodal sub image, the threshold is computed and to get the better result. First the gray level histogram for a sub image is approximated by a sum of two Gaussian distributions, and then the threshold is obtained by minimizing the classification error with respect to the threshold value. Finally, the entire threshold remote sensing image is processed by a low-pass filter to eliminate the gray level discontinuities at the boundaries of sub images.

Based on the gray level variation within or between object and background, the gray level co-occurrence matrix is divided into quadrants. Let Th be the threshold within the range $0 \leq Th \leq L-1$ that partitions the gray level co-occurrence matrix into four quadrants, namely O, B, O_1 and B_1. The quadrant O represents gray level transition within the object while quadrant B represents gray level transition within the background. The gray level transition between the object and the background or across the objects boundary is placed in quadrant O_1 and quadrant B_1. These four regions can be further grouped into two classes, referred to as local quadrant and joint quadrant. Local quadrant is referred to quadrant O and B as the gray level transition that arises within the object or the background of the image. Then quadrant O_1 and B_1 is referred as joint quadrant because the gray level transition occurs between the object and the background of the image. The local entropic threshold is calculated considering only quadrants O and B. The probabilities of object class and background class are defined as

$$P_O = \sum_{i=0}^{T_h} \sum_{j=o}^{T_h} P_{ij}$$

$$P_B = \sum_{i=T_h+1}^{L-1} \sum_{j=T_h+1}^{L-1} P_{ij}$$

The local transition entropy of the normalized probabilities of the object class and background class are functions of threshold vector (*Th* ,*Th*) are defined as

$$PO_{i,j} = P_{i,j} / P_O$$

$$PB_{i,j} = P_{i,j} / P_B$$

The second order local threshold of the object and its background class are functions of threshold vector (T_h, T_h) are defined as it can be seen that there exist small unconnected pixels in the threshold image. These isolated pixels are removed by performing length filtering based on connected pixel labeling. The result of removing these unconnected pixels can be seen in the final classified image [5][6]. To ensure that only the section of the remote sensing image containing data is considered during image processing and analysis, a mask image is generated for each image. It is applied to remove any artifacts present outside the region of interest. The proposed local threshold method for remote sensing image algorithm is shown in Fig. 1

The initial step of the algorithm tests whether the image has a bimodal histogram. If it does, then histogram-based Thresholding methods, which have been proven to have outstanding results for bimodal histogram of remote, sensing images. Local threshold methods are particularly effective at saving processing time. This algorithm focuses on remote sensing images of multispectral features. It is a local adaptive analysis method, which uses local feature vectors to find the best approach for Thresholding a local area. The original image is recursively broken down into sub regions using quad-tree decomposition until an appropriate weighted Thresholding method can be applied to each sub region. The outline of the local Thresholding algorithm is:

Step 1:Test whether the remote sensing image has a bimodal

Step 2: Decompose remote sensing image into four equal size local regions

Step 3: Extract feature vectors from each local region

Step 4: Apply local threshold method for classification

Step 5: Repeat steps 2, 3 and 4 until all regions are classified

Step 6: Define smoothing of the edges of each region

Step 7: Apply threshold method to each region.

Step 8: Finally the binary form of remote sensing image is obtained

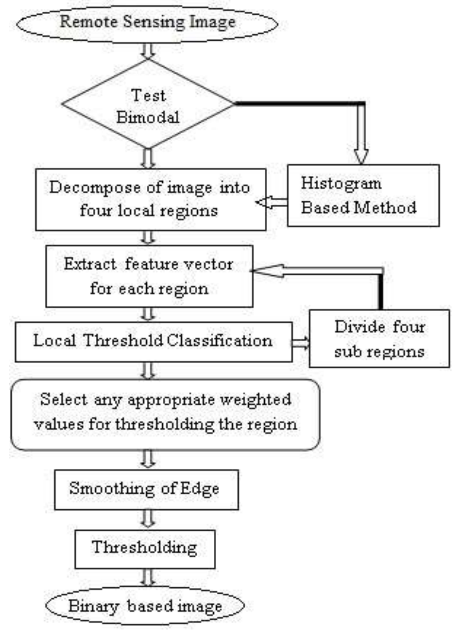


Fig.1Proposed Local Thresholding Algorithm

V. PERFORMANCE FACTORS

Thresholding techniques for remote sensing image systems have also received much awareness. Because of the wide range of quality distortions over a single image, a combination of threshold operators is often used, with each operator sensitive to a different type of deformation. For example, combines four linear threshold operators to form a single threshold. An example of these operators is **T = ku + c**, where u is the average contrast over previously scanned images, and k and c are optimizing parameters.

In the sequences, we use the following notation. The histogram and the probability mass function (PMF) of the image are indicated, h(g) and p(g) respectively. The gray scale of g = 0......G, where G is the maximum luminance value in the image, typically 255 if 8-bit quantization is assumed. If the gray value range is not explicitly indicated as [g_{min}, g_{max}] it will be assumed to extend from 0 to G. The cumulative probability function is defined as

$$P(g) = \sum_{i=0}^{g} p(i)$$

It is assumed that the PMF is estimated from the histogram of the image by normalizing to the number of samples at every gray level. In the context of document processing, the foreground (object) is the set of pixels with luminance values less than T, while the background pixels have luminance value above this threshold [6]. In satellite images the foreground area may consists of darker (more absorbent, denser etc.) regions or conversely of shinier regions, for example that hotter, more reflective, less dense regions. In contexts where the object appears brighter than the background the definitions of the foreground and background will be simply toggled.

The foreground and background area probabilities are calculated as:

$$P_f(T) = P_f = \sum_{g=0}^{T} p(g) \quad \text{and}$$

$$P_b(T) = P_b = \sum_{g=T+1}^{G} p(g)$$

The Shannon entropy parametrically dependent upon the threshold value T for the foreground and background is formulated as:

$$H_f(T) = -\sum_{g=0}^{T} p_f(g) \log p_f(g)$$

$$H_b(T) = -\sum_{g=T+1}^{G} p_b(g) \log p_b(g)$$

The sum of these two thresholds are expressed as

$$H(T) = H_f(T) + H_b(T)$$

When the entropy is calculated over the input image allotment p(g) then obviously it does not depend upon the threshold T and hence is expressed simply as H. For various other definitions of the entropy in the context of Thresholding, with some abuse of notation, we will use the same symbols of H_f (T) and H_b (T). A single threshold will not work well when we have uneven illumination due to shadows or due to the direction of illumination. The idea is to partition the image into *m x m* sub images and then choose a threshold $\boldsymbol{T}_{ij}$ for each sub image this approach might lead to sub images having simpler histogram (e.g. remote sensing image).

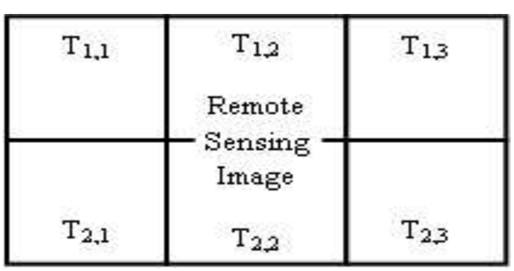


Fig. 2. Each Sub Images with Simple Histogram Thresholding

In case of uneven elucidation of histogram, another useful technique is to estimate the values of the image by a simple function called plane. Thresholding can be done relative to the plane (e.g., points above the plane will be part of the object and anything below will be part of the background).

VI.COMPARISION OF THRESHOLD METHODS

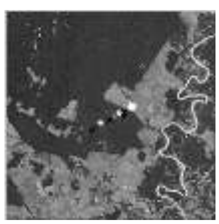
Thresholding is the simplest method of image classification. From the Thresholding method grayscale image, is used to convert into binary image. In global Thresholding, it will check the histogram representation for given input image and the intensity value should reveal two peaks. Global Thresholding consist of setting an intensity value such that all object will have the intensity value below the Thresholding belongs to the one classes and remaining belongs to other. Global Thresholding,a single threshold value is used in the whole image. In global Thresholding, the Otsu's method is used to automatically perform cluster based image Thresholding and it will perform the reduction of a gray level image to binary image. The algorithm assumes that the image contain two classes of pixels followed by the bimodal of histogram representation. This method is used to separate the image from the foreground from background. Then calculate the optimum threshold separating the two classes and it combines the intra class variance is minimal or equivalent. This method is useful to separate, the image from foreground and background. Otsu's method exhibits good performance, if the histogram representation is assumed to have bimodal distribution and assumed to possess the deep and sharp valley between two peaks [7]. But if the object area is small compared with the background area, the histogram does background not exhibits bimodality. And if the variance of the object and the background intensity value is larger when compare to the mean distance, or the image is rigorously corrupted by additive noise, the sharp valley of the gray level histogram is despoiled. The performance of global Thresholding techniques including Otsu's method is shown to be limited by the small object size, the small mean difference, the large variances of the object and the background intensities, the large amount of noise added, quality of the image will be low, the resulting process will be high, and so on.

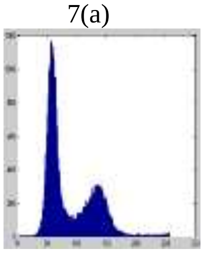
The threshold images obtained by various methods expose valuable information concerning the Thresholding techniques. In this paper a new local Thresholding structure called the decompose threshold approach is proposed and compared against some existing local Thresholding algorithms for normal gray scale images. From interpretation during the experiments reported in this paper, degraded remote sensing images normally contain the following uniqueness: varying contrast, varying stroke quality, many marks or blotches which do not contain any information. Satisfactory Thresholding results can be obtained if only a local method is applied to the whole image [7]. The decompose algorithm is established as effective at improving the result. It uses local feature vectors to analyze and find the best approach to threshold a local region. As an alternative of employing a single Thresholding algorithm, automatic selection of a suitable algorithm for specific types of sub regions of the remote sensing image is performed. The original image is recursively broken down into sub regions using quad-tree decomposition until a suitable Thresholding method can be applied to each sub region. This local Thresholding method can accurately classify the different regions so that the appropriate weighted value can be applied to the mean-gradient-based threshold method. These results may be interpreted as due to the more powerful energy minimization. The overall execution times of the proposed method were around 8.451064 seconds for the remote sensing data sets and acceptable times in the usual applications to land cover or remote based satellite mapping of classification methods.

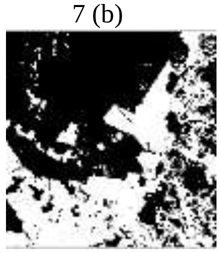
VII. EXPERIMENTS AND RESULT

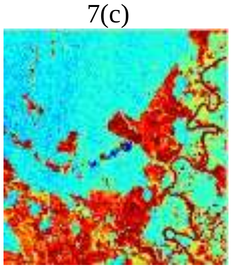
The various experiment carried out in the above remote sense imagery data set algorithm of LTM in MATLAB 7.6. The complete process of local thresholding and the standard are summarized in subsequent figure 1.

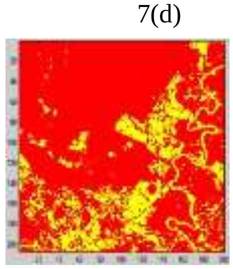

7(a)


7 (b)


7(c)


7(d)


7 (e)


7(f)

7(a). Original image, 7(b). RGB to gray-scale image, 7(c). Histogram of Image, 7(d). Erode of image. 7(e). Classification with jet factor 150,7(f). Classification with autumn factor.

VIII.CONCLUSION

In this paper comparative studies is applied to two techniques as local Thresholding and global Thresholding,a comparative study are explain about two techniques, in global Thresholding single threshold value is used in the whole image and Otsu's method has some limitation as the small object size, the small mean difference, the large variances of the object and the background intensities, the large amount of noise added, quality of the image will be low ,the resulting process will be high, and so on. In local Thresholding, a threshold value is assigned to each pixel to determine whether it belongs to foreground or background pixel using local information about the pixel. The original image is recursively broken down into sub regions using quad-tree decomposition until a suitable thresholding method can be applied to each sub region. This local Thresholding method can accurately classify the different regions so that the suitable weighted value can be applied to the mean-gradient-based threshold method. These results may be interpreted as due to the more powerful energy minimization. The remote sensing data sets and acceptable times in the usual applications to land cover or remote based satellite mapping of classification methods.

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