A Survey on Image Segmentation Using Threshoding Methods

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Abstract : *Image segmentation basically divided into two types as: based on similarity and based on discontinuity. Region based segmentation is a type similarity based segmentation. Another type of segmentation is called thresholding based segmentation. In thresholding based segmentation method some thresholding techniques are used. Thresholding techniques are classified into two major categories as: Global and Local. In global thresholding, pixel values are categorized into two classes, one class belongs to object and another class belongs to background. We use one threshold value in global thresholding for whole image that belongs to single level thresholding and if threshold value used in segmentation is more than one, technique is called multilevel thresholding. In this paper we have compared to global and local thresholding method.*

Keywords — *Image Segmentation, Thresholding, Local Thresholding, Global Thresholding.*

I. INTRODUCTION

Image segmentation is the process of dividing an image into different regions such that each region is homogeneous. Image segmentation is the key behind image understanding. Image segmentation is considered as an important basic operation for meaningful analysis and interpretation of images acquired. It is a critical and essential component of an image analysis and/or pattern recognition system, and is one of the most difficult tasks in image processing, which determines the quality of the final segmentation. It is the prime area of research in computer vision. Image segmentation is important part of computer vision and image processing. The applicability and diversity of image segmentation are increase day to day in various engineering and scientific filed for the purpose of data analysis and prediction of particular object in given image [1]. For the processing of image segmentation various technique are used some technique are based on histogram of image and some technique are based on image content such as color, texture and shape & size. In mid-decade used the concept of threshold based image segmentation technique. Threshold based image segmentation technique overcomes the limitation of pervious method of image segmentation.

The threshold based image segmentation method performs in terms of local, global and adaptive image segmentation techniques. The process of local and global image segmentation technique differs only in the selection of parameter for the threshold. The selection of threshold value includes the process of image binarization. The local and global image segmentation technique is based on the method of iteration [2]. The process of image iteration cannot be always good for image similarity index for segmented area.

II. SEGMENTATION

An image is a systematic arrangement of regions and shapes or objects and not just a group of pixels. Extracting bits of information from a source image is considered as image processing which is one of the prerequisite steps in pattern identification systems. Each part of the image is a group of set of pixels. Image segmentation is term which constitutes classification of all the pixels into different clusters in an image that exhibit similar patterns. This is a technique of dividing an image object into its component's objects in the image parts i.e. set of pixels/regions such that pixels in a region are equivalent while considering some homogeneity criteria to be compared such as color, texture or intensity so as to identify boundaries in a particular region of an image [3] .An image is further segmented to observe each of these objects residing in the region to extract some vital information of high level. The output of image segmentation technique is a group of segments that totally able to cover the entire image, or a set of contours lines retrieved from the image parts. Adjacent parts are significantly dissimilar to the characteristic which are equivalent. Segmentation is required in a wide range of algorithms. Different software libraries need different types of objects. The mostly used images are light intensity and range image, computerized tomography, magnetic resonance images. Image segmentation is dependent on the type of an image; hence there is no one generalized scheme that is most suitable for all kinds of images [4]. Normally, regions are divided into two types on the basis of their present color in the image, i.e. gray scale image and colorful one. Therefore image segmentation for non gray scale images is from the

bottom different from gray scale images, e.g., For content based image retrieval techniques.

RELATED WORK

1. Thresholding

Thresholding is the process of converting a gray scale image to a bi-level image using an optimum threshold value T. It is a process of partitioning an image into object pixels and background pixels. An individual pixel is made an object pixel if the pixel value is greater than a certain threshold value and a background pixel otherwise [6]. Thresholding is an important technique in image segmentation applications. Its main aim is to classify the pixels of an image into two classes that is, object and the background [7]. The basic idea is to select an optimal threshold value for separating objects from the background. The gray level histogram of an image is usually considered as efficient tools for development of image thresholding algorithms. Many threshold methods have been proposed to binaries the image [8]. Any pixel (x, y) is considered as a part of object if its intensity exceed or is in the range of the threshold value i.e. $f(x, y) \geq T$, otherwise the pixel belong to background.

2. Edge Detection For Image Segmentation

Edge detection schemes transform objects to edge images due to the changes of grey tones in the images [9, 10]. Edges determines lack of continuity, and end of image scale. As a result, edge of a sub-region of an image is retrieved without detecting any changes in actual qualities of the true image. Objects consist of various parts of a group of separate color levels. With an image of different grey levels, In spite of an obvious change in the image grey levels of the object region, the shape of the image object can be differentiated in Figure 1 [9,10].
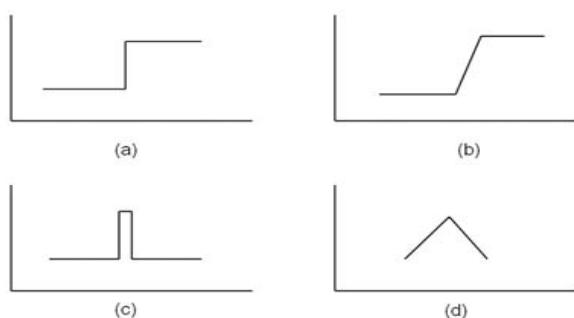

Figure 1: Four different edge types that may be present in the image [9,10]
(a) step-edge (b) ramp edge (c) ridge edge and (d) ramp edge

3. Fuzzy Approaches

There are one of the many possibilities for calculation of fuzzy logic based edge detections [10, 11]. One method is to define a membership function says the degree for edginess in each neighbourhood. This approach will definitely be regarded as a true fuzzy approach if fuzzy concepts are finally used to modify the membership values [10,12]. The membership function is determined heuristically. It is fast but the performance is not allowed as much.

4. Genetic Algorithm Approach

Basically, a genetic algorithm comprises of three important operations: selection, crossover, and mutation. The selection evaluates every individual and keeps only the fittest of them in the population. In addition to those best individuals, some less fit which could be selected for to a small probability [14]. The others are removed from the population we have. The crossover merges two individuals to have new ones which could be better. The mutation operator induces differences in a small number of chromosomes units [15]. Its actual motive is to maintain the population diversified much during the optimization technique.

5. Neural Network Approach

Neural networks are generated by several elements that are merged by links with variable weights. Artificial neural networks (ANN) are widely applied for pattern recognition. Their processing potential and nonlinear patterns are used for clustering. Self-organization of Kohonen Feature Map (SOFM) network is a powerful tool for clustering [16]. Ji and Park proposed an algorithm for watershed segmentation based on SOM .This method calculates the watershed segmentation of luminance aggregator of color image [17]. The method can be explained as: It consists of different two independent neural networks, each of the one for saturation and intensity planes. The neural network actually consists of three layers namely input layer, a hidden layer, and output layer.

III.THRESHOLDING FOR SEGMENTATION

Thresholding is the process of converting a grayscale image to a bi-level image using an optimum threshold value T. It is a process of partitioning an image into object pixels and background pixels. An individual pixel is made an object pixel if the pixel value is greater than a certain threshold value and a background pixel otherwise [6]. There are two types of thresholding algorithms:
- Global Thresholding Method
- Local or Adaptive Thresholding Method

Global Thresholding Methods uses a single global value of threshold to partition an image into distinct regions, whereas a Local Method uses the different local value of threshold for different area [19].

Thresholding is an important technique in image segmentation applications. Its main aim is to classify the pixels of an image into two classes, that is, the object and the background. The basic idea is to select an optimal threshold value [8] for separating objects from the background. The gray level histogram of an image is usually considered as efficient tools for the development of image thresholding algorithms [20]. Many threshold methods have been proposed to binaries the image. Otsu method is a global thresholding selection method, which is widely used due to its simple and effective process.
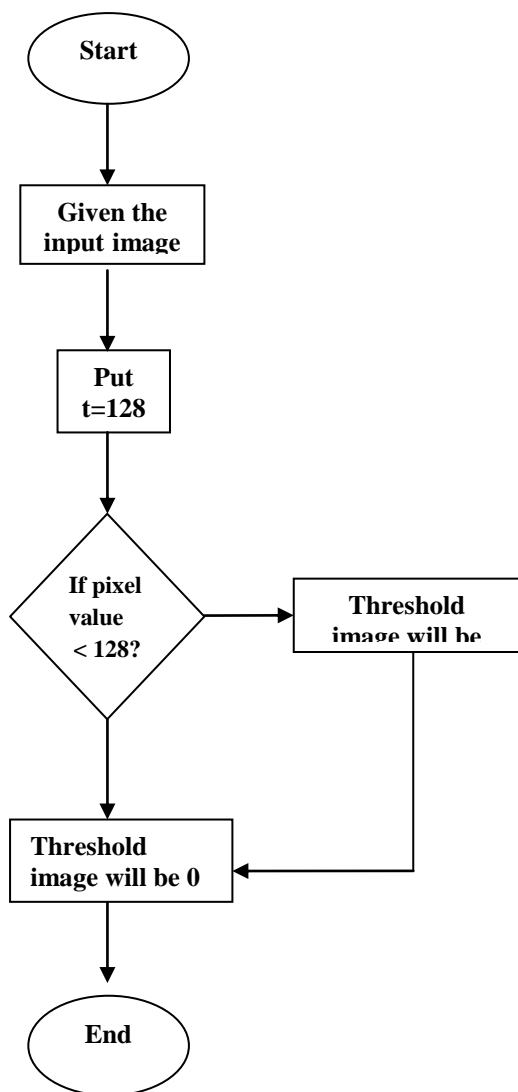

Figure 2: Flowchart of Thresholding Technique

Traditional thresholding techniques based on the histogram of the image suffered two major limitations:

➢ Unable to consider contextual information for selecting optimum threshold.

Inefficient for multilevel thresholding as computationally demanding and complicated to implement [21].

Thresholding techniques can be divided into bi-level and multilevel category, depending on the number of thresholds required to be detected. In bi-level thresholding, an image is segmented into two different regions depending on a threshold value selected from the histogram of the image. The pixels with gray values greater than the threshold value are assigned into the object region, and the rest are assigned into the background. Multilevel thresholding segments a gray level image into several distinct regions by detecting more than one threshold [22].

The reason behind using global thresholding is that background and object of interest areas in an image can be interpreted by taking its histogram with probabilities for each gray level. However, in case of remote sensing images or real life images, bi-level thresholding does not give appropriate performance. As a result, there is a strong requirement of multilevel thresholding, which splits histogram of the image into the number of classes of homogenous gray levels such that some criterion is optimized [23].

I. Local image segmentation

A single threshold will not work well when this has 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. Local thresholding is a type of multilevel thresholding. One of the simplest approaches to local thresholding is to subdivide an image into no overlapping rectangles. This approach is used to compensate for non uniformities in illumination and /or reflectance. The rectangle is chosen small enough so that the illumination of each is approximately uniform
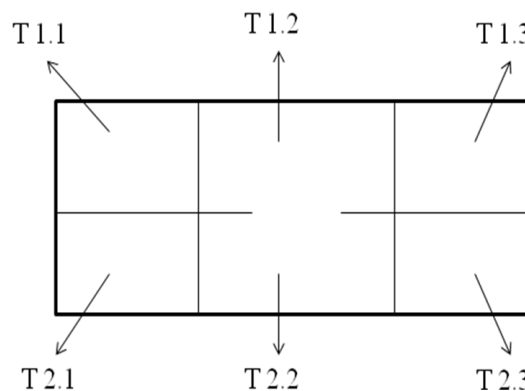

Figure 3: shows that image partion technique [24]

Local thresholding can be used effectively when the gradient effect is small with respect to the chosen sub image size. Local thresholding technique [25], the threshold value T depends on gray levels of f(x, y) and some local image properties of neighboring pixels such as mean or variance [26] . Threshold function T(x, y) is given by

$$g(x,y) = \begin{cases} 0, & \text{if } f(x,y) < T(x,y) \\ 1, & f(x,y) \geq T(x,y) \end{cases}$$

The algorithm followed for adaptive thresholding can be stated in general as:

- Divide the image into sub images.
- Choose a local threshold for sub images considered.
- Compare the pixels in that sub image and segment the region.
- Stop segmentation when all the sub images are processed.

II. Global image segmentation

The process of local thresholding using the multi-point segmentation process and increase the value of iteration [27] for the process of image segmentation, used single point segmentation is called global thresholding [25].

In global thresholding, a threshold value T is selected in such a way that it separates the object and the background.

Global Thresholding = Choose threshold T that separates object from background.

$$g(x,y) = \begin{cases} 0 & f(x,y) < T \\ 1, & f(x,y) \geq T \end{cases}$$

Equation has no indication on selecting the threshold value T. The threshold T separates the object from the dark background [28] Any point (x,y) for which f(x, y) ≥ T is called an object point [29].

A simple algorithm:

1. Initial estimate of T(the average intensity of the image is a good initial choice for T)
2. Initially put the value of ΔT that will be minimum like 0.1. parameter ΔT is used to control the number of iterations in situations where speed is an important issue.
3. Segmentation using T:
   a. G1, pixels brighter than T;
   b. G2, pixels darker than (or equal to) T.
4. Computation of the average intensities m1 and m2 of G1 and G2.
5. New threshold value:
   Tnew = (m1 + m2)/2

6. If |T − Tnew|> ΔT, Repeat steps 2 through 4 until the difference in T in

successive iteration is smaller than a predetermined parameter ΔT.

IV.RESULT

I. EXPRIMENTAL PROCESS

Some images, namely Barbara, Brain and Camera Man, have been taken for the performance evaluation procedure. These images are given as an input to the global thresholding algorithm and local thresholding algorithm. The results are compared on the basis of execution time taken by both algorithms using MATLAB

Figure 4: Describe the main implementation window for the experimental work

Figure 4 represents the implementation window for experimental work. After click on run button of Matlab window main window open. Main window has options for both local and global thresholding.

Figure 5: Describe the initial window for the experimental work

After choosing a method initial window is prompt to screen, Left panel shows the files, middle panel allows us to edit and save the file.
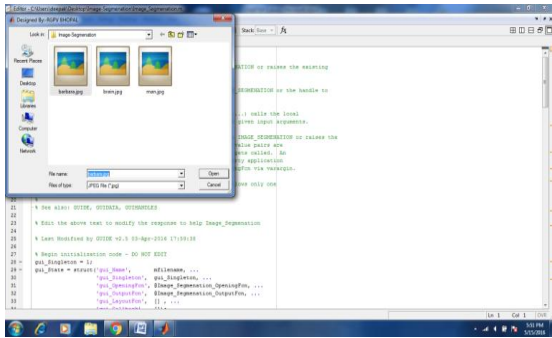
Figure 6: Describe the initial window for the upload image from the dataset

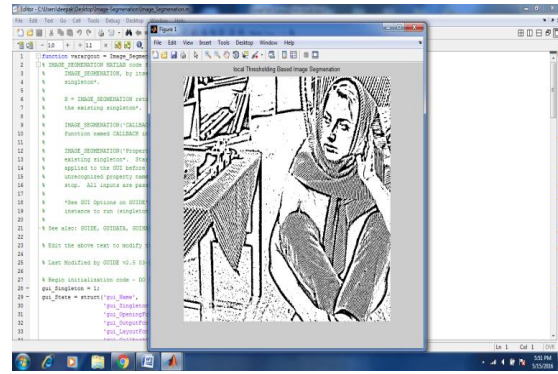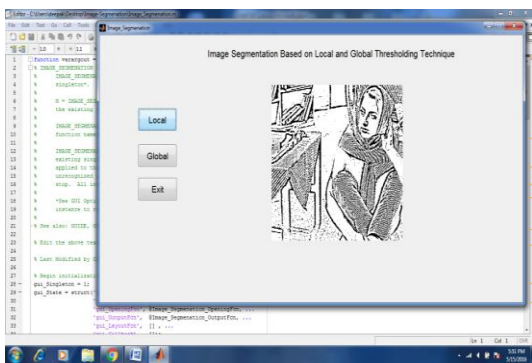File chooser panel is used to select the file from the available dataset as shown in the figure.

Figure 7: Describe the experimental window for local image segmentation method with Barbara image

Figure 7 shows the output of sample image after employing local image segmentation method.
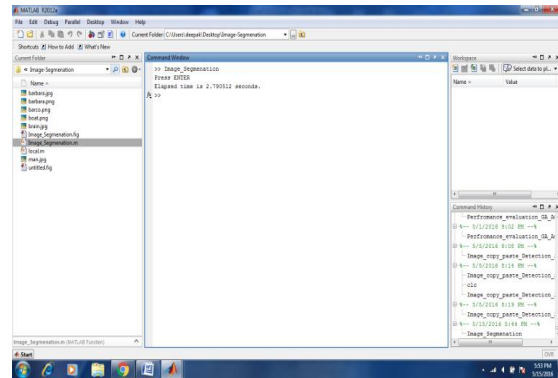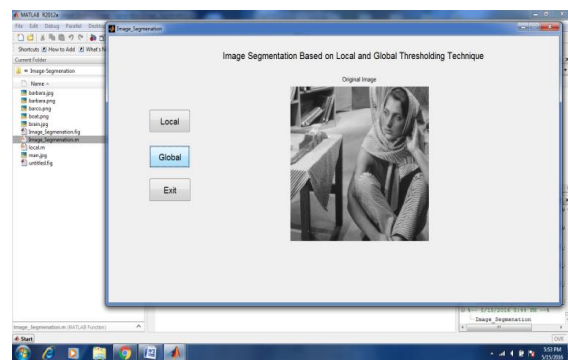

Figure 8: Describe the experimental window for local image segmentation method with original Barbara image

Original image can be seen by double clicking from the panel. Figure 8 shows the original Barbara image.

Figure 9: Describe the experimental window for local image threshold segmentation method for the Barbara image

Segmented image is shown in above panel using local thresholding.

Figure 10: Describe the result window for local image threshold segmentation method for the Barbara image with the execution time

After the execution, command window prints the execution time of the process.

Figure 11: Describe the experimental window for global image segmentation method with original Barbara image

Figure 11 shows the output of sample image after employing global image segmentation method.
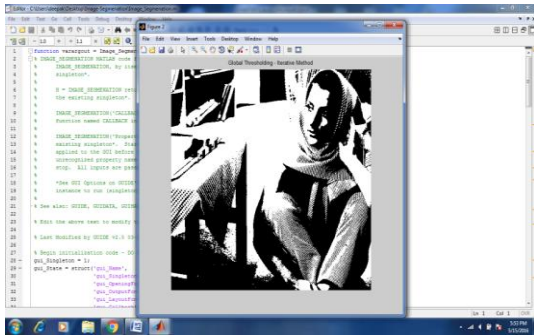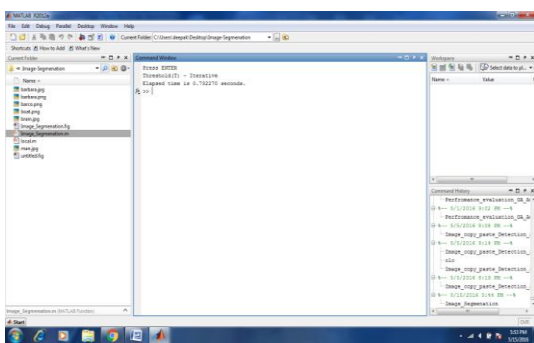
Figure 12: Describe the experimental window for global image threshold segmentation method for the Barbara image

Segmented image is shown in above panel using global thresholding.

Figure 13: Describe the result window for global image threshold segmentation method for the Barbara image with the execution time

After the execution, command window prints the execution time of the global thresholding process.

II. COMPARATIVE PERFORMANCE EVALUATION

The total time taken for the execution of process of a particular algorithm for the image segmentation.

Name Of Image	Name of Method	Execution Time
Barbara	Local	2.790
	Global	0.732
Brain	Local	0.840
	Global	0.641
Camera Man	Local	0.589
	Global	0.554

Table 1: Comparative performance evaluation for the local and global image segmentation techniques with the various images

The process on "Barbara" image segmentation has taken execution time of 2.790 seconds for local thresholding technique and global thresholding technique 0.732 seconds. Whereas, execution time for "Brain" image in local and global thresholding techniques is 0.840 and 0.641 respectively. Again, for "Camera Man" image total execution time for local and global thresholding technique was 0.589 and 0.554 respectively.

Thus, global thresholding technique took less time than local thresholding technique for "Barbara", "Brain" and "Camera Man" image.
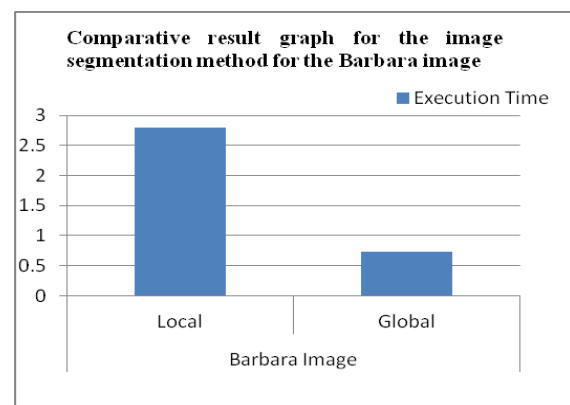

Figure 14: Comparative result graph for the Barbara image using image segmentation techniques such as local and global, it finds the value of execution time in seconds.
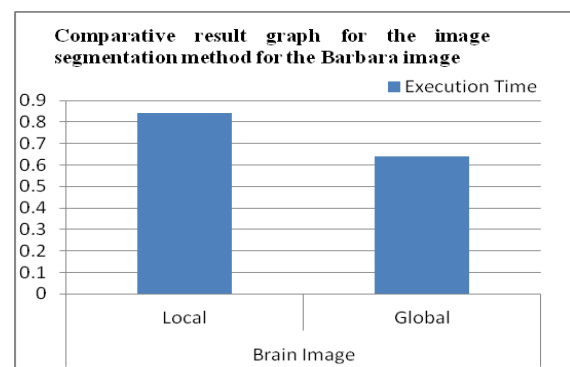

Figure 15: Comparative result graph for the Brain image using image segmentation techniques such as local and global, it finds the value of execution time in seconds.
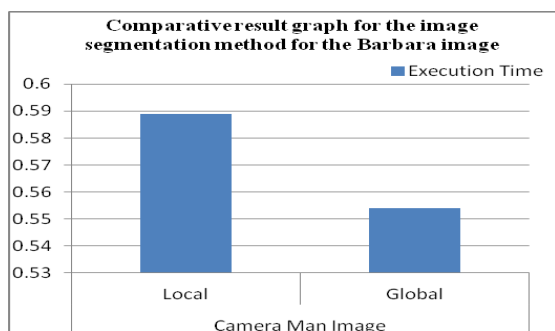
Figure 16: Comparative result graph for the Camera Man image using image segmentation techniques such as local and global, it finds the value of execution time in seconds

VI. CONCLUSION

Image segmentation plays a vital role in computer vision. The process of image segmentation provides the partition of image into different segment according to their feature attribute. Thresholding is the simplest method of image segmentation. The local thresholding technique used region based segmentation process and used multiple thresholds for the process of segmentation. In global thresholding concept used single threshold for the complete process of segmentation and in adaptive thresholding technique further estimate the value of threshold for the processing of segmentation.

For the validation of global and local image segmentation algorithm implement done in MATLAB software and used reputed standard image dataset such as cameraman, Barbara and boat image.

For the evaluation of performance of algorithm, elapsed time or execution time of both algorithms is used. Our experimental result shows that the global thresholding algorithm is very efficient instead of local image segmentation.

In future, Image segmentation methods can be applied to video formats in order to process video files. Also, there are many more methods fuzzy cluster means or tri class method, results can be analyzed for them.

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