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A STUDY OF IMAGE SEGMENTATION USING THRESHOLDING TECHNIQUE ON A NOISY IMAGE

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ABSTRACT

Image segmentation is usually accustomed distinguish the foreground from the background of an image. The main target of this paper is an effort to review Image Segmentation using Thresholding Technique on a picture corrupted by Gaussian Noise as well as Salt and Pepper Noise which is

enforced using MATLAB software and the results obtained are studied and thereby mentioned, highlighting the techniques performance. The algorithm is demonstrated through the segmentation of color images. The classification accuracy of the proposed method is evaluated and a comparative study versus existing techniques is presented. The experiments were conducted on an extensive set of color images. Satisfactory segmentation results have been obtained showing the effectiveness and superiority of the proposed method.

Keywords: Computer Vision, Thresholding, Segmentation, Noisy Image

I. INTRODUCTION

In computer vision, segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels). The image segmentation is typically used to find the objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the full image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to any characteristic or computed property, such as color, intensity, or texture. Due to the importance of image segmentation, a number of algorithms have been proposed, but based on the image that is inputted into the algorithm should be chosen to get the best results [1].

In many vision applications, it is useful to distinct out the regions of the image corresponding to objects in which we are absorbed from the regions of the image that correspond to the background. Thresholding often provides an easy and convenient way to perform this segmentation on the basis of the different intensities or colors in the foreground and background regions of an image [2]. Image segmentation is a fundamental yet still challenging problem in computer vision and image processing. In particular, it is a vital process for numerous applications such as object recognition, target tracking, content-based image retrieval and medical image processing, etc. Generally speaking, the goal of image segmentation is to partition an image into a certain number of pieces which have coherent features (color, texture, etc.) and in the meantime to group the meaningful pieces together for the convenience of perceiving. In many practical applications, as a large number of images are needed to be handled, human interactions involved in the segmentation process should be as less as possible [3].

II. IMAGE SEGMENTATION

Segmentation subdivides an image into its basic regions or objects. The level of detail to which the subdivision is carried depends on the problem being solved. That is interesting in an application have been detected[4]. The goal of image segmentation is to cluster pixels into salient image regions, i.e., the regions corresponding to individual surfaces, objects, or natural parts of objects [5].

The image is formed in the eye and in the camera by the amount of illumination reflected by an object[6]. In computer vision; image processing is any form of signal processing for which the input is an image, such as

photographs or frames of videos. The output of image processing can be either an image or a set of characteristics or parameters related to the image. The image processing techniques like image restoration, image enhancement,image segmentation etc. [7].

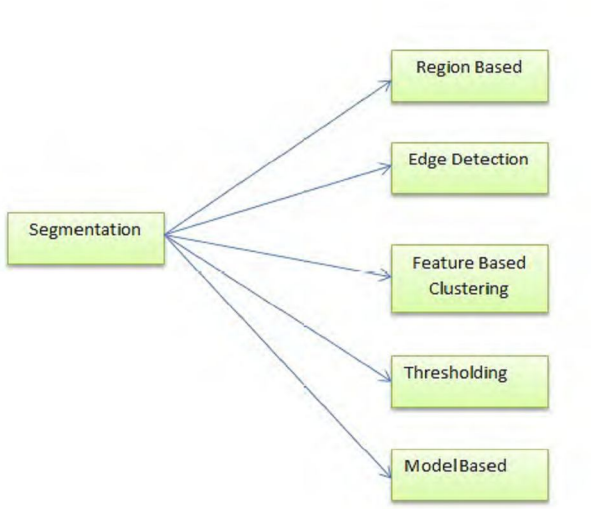

Figure 1. Various types of segmentation

Image segmentation is important yet still challenging problem in computer vision and image processing. In specific, it is an essential process for many applications such as object recognition, target tracking, content-based image retrieval and medical image processing, etc. Generally speaking, the goal of image segmentation is to partition an image into a certain number of pieces which have coherent features (color, texture, etc.) and in the meanwhile to group the meaningful pieces together for the expediency of perceiving [8].

III. IMAGE THRESHOLDING

Threshold is one of the widely methods used for image segmentation. It is useful in discriminating foreground from the background. By selecting an adequate threshold value T, the gray level image can be converted to binary image. The binary image should comprise all of the essential information about the position and shape of the objects of interest (foreground). The benefit of obtaining first a binary image is that it decreases the complexity of the data and simplifies the process of recognition and classification. The most common way to change a gray-level image to a binary image is to select a single threshold value (T). Then all the gray level values below this T will be classified as black (0), and those above T will be white (1). The segmentation problem becomes one of selecting the correct value for the threshold T. A common method used to select T is by analyzing the histograms of the type of images that want to be segmented. The ideal case is when the histogram presents only two dominant modes and a clear valley (bimodal). In this case the value of T is selected as the valley point between the two modes. In real applications histograms are more complex, with many peaks and not clear valleys, and it is not always easy to select the value of T [9].

A. Iterative Method for Finding T

1. Estimate value of T (start with mean)
2. Divide histogram into two regions, R1 and R2 using T
3. Calculate the mean intensity values μ1 and μ2 in regions R1 and R2
4. Select a new threshold T = (μ1 + μ2)/2
5. Repeat 2-4 until the mean values μ1 and μ2 do not change in successive iterations

$$G(x,y) = f(x) = \begin{cases} 1, \text{ if } f(x,y)>T \\ 0, \text{if } f(x,y)\leq T \end{cases} \quad \text{---------- (1)}$$

Any point (x,y) in the image at which f(x,y)> T is called an object point; otherwise, the point is called a background point. In other words, the segmented image g(x,y), is given by [4].

IV. LITERATURE REVIEW

Liang and et al [10] proposed an approach for detection of edges in noisy images. Here pixels are classified as fuzzy sets based on their gray values. The performance of the algorithm is rather similar to that of the Canny algorithm, but proposed one is meaningfully faster. Here the ground truth evaluation and the evaluation parameter for comparison is not considered.

An image segmentation method is proposed by Dong and et al. in [12] for the segmentation of color image based on neural networks. In order to measure the color difference properly, image colors are signified in a modified color space L*u*v. It uses color reduction and color clustering technique with Neural Network. The ground truth evaluation and performance parameter is not considered. Evans and Liu proposed a Morphological gradient approach to color edge detection based on vector differences. The technique is computationally effectual and can also be readily applied to other vector-valued images [13]. The performance is compared with (vector order statics) VOS method and MVD (minimum vector dispersion) method. The method is robust to noise and computationally efficient. Performance evaluation parameter used here is SNR for noisy images.

Dollar and et al. proposed a supervised learning algorithm for edge and object boundary detection called Boosted Edge Learning (BEL). A decision of an edge point is made independently at each location in the image. It uses Probabilistic Boosting Tree classification algorithm for learning [14]. The algorithm is compared with Konishi and et al, It is highly scalable, adaptive and assessment is done on BSD images.

Nikou and et al. proposed a novel approach for image segmentation based on a hierarchical and spatially variant mixture model. According to this model, the pixel labels are random variables and smoothness prior is imposed on them [15]. Comparison is done with the finite mixture model (FMM) and spatially invariant finite mixture model (SVFMM) on BSD images. Parameter used for evaluation is Probabilistic Rand Index (PRI).

In 2007, Unnikrishnan and et al. proposed (NPR) Normalized Probabilistic Rand Index and Probabilistic Rand Index (PRI) parameter for objective evaluation and quantitative comparison of image segmentation algorithms[16]. It has following physiognomies. It does not degenerate with respect to special segmentation cases. It does not make any assumptions about the data. It is normalized to give scores which are comparable between algorithm and images.

Max Mignotte in [17] proposed an approach for segmentation by using Fusion of histogram and means clustering in different color spaces. The proposed method is fast to implement. The performance is compared with N-cuts, mean shift and compression based texture merging (CTM) methods. It gives a better segmentation and PRI when evaluated on BSD images.

Salem Saleh Al-amri [18] has applied Mean technique, Pile technique, HDT, and EMT technique on three satellite images in order to select the best segmented image from all above techniques. Experiments and comparative analysis of techniques have shown that HDT (Histogram Dependent Technique) and EMT (Edge Maximization Technique) are the best thresholding techniques which outperform all other thresholding techniques.

Kaiping WeI [19] have found that current image segmentation techniques are time consuming and require lot of computational cost in order to perform image segmentation. It is a big problem for real time applications. They proposed a new threshold based segmentation method using Particle Swarm Optimization (PSO) and 2-d Otsu algorithm (TOPSO).

Civahir Cigla [23] presented a new graph theoretic color image segmentation method, and tries to improve the normalized cut image segmentation method. They used image with weighted un-directed graph, whereas nodes represent the regions, and weights between nodes represent the intensity match of neighboring regions. Their modified normalized cut method has solved the problem of over segmentation in which extra regions are created for image. Experiments are conducted on images of cow, mosaics, and multi-resolution NC image and results compared with NCIS algorithm on the basis of MSE criteria. The results shown that proposed method improves the NCIS algorithm.

Yuan and et.al [18] proposed a method for segmentation by determining automatic thresholds using picture contents. A gradient of the histogram and quad tree decomposition technique is used for decisive automatic threshold. It considers the ground truth evaluation and algorithm is compared with E-GVF (extended –gradient vector flow) and crisis region growing. Performance evaluation parameter used is SNR on BSD images.

Edge detection is a basic step in the image segmentation process [24]. It divides an image into an object and its background. Edge detection divides the image by observing the change in intensity or pixels of an image. Gray histogram and Gradient are two main methods for edge detection for image segmentation [25]. Several operators are used by the edge detection method, i.e., Classical edge detectors, zero crossing, Laplacian of Guassian(LoG)[26], and color edge detectors etc. [27]. In this section several new approaches regarding Edge detection based image segmentation is discussed from the last ten years.

Yu Xiaohan [28] proposed a new image segmentation technique based on region growing and edge detection methods. Their hybrid method helps the segmentation process to avoid from errors when both techniques used in a separate manner. Region growing is used to find the edge pixels in the image, while 2nd order derivative is used for edge detection. Experiments are conducted on 3D MRI image data. Gaussian technique is used for smoothing after edge detection. Results have shown that their technique is better in order to preserve more edge information.

Wesolkowsk [29]-[30] have used the Markov Random Fields for edge and region based hybrid color image segmentation. Firstly, line process is implemented using edge detection algorithm. The vector angle measure is used as a distance measure between pixels in order to detect edges. The main problem with their technique is that it is a pixel neighbor model and has the same drawbacks of region growing method. A parameter estimation technique is used to evaluate the MRF model.

Ugarriza and et al. Proposed automatic image segmentation by dynamic region's growth in [19], which uses color gradient detection and clustering technique. The algorithm produces better segmentation and higher NPR, comparison is done on BSD images.

Bhoyar and Kakde[20] proposed an image segmentation algorithm based on JND (Just Noticeable Difference) histogram. The method is compared with (conventional color

histogram) CCH. It gives better results than CCH technique. The algorithm is faster and gives better PRI and PSNR values. Here ground truth is not considered. Comparison is done on BSD images.

V. EXPERIMENTAL RESULTS

This section presents the results obtained from Global Thresholding(GT) using Iterative algorithm which was carried out for the study. This type of image segmentation was implemented using MATLAB software on a colored image with pixel size of 265x340 which was taken in our college front view merged with my passport size photograph. The figures show the experimental results.

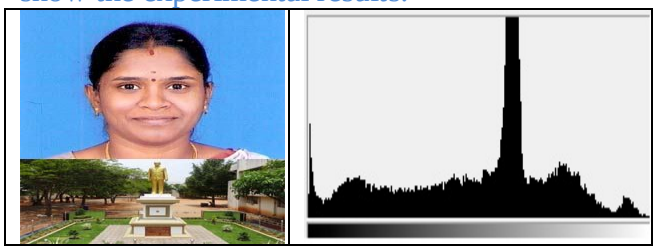

Figure 2. (a) Showing Original Colored Image (b) Histogram of the Original Image

The above figure 2(a) shows a colored image and figure 2(b),shows the histogram representation of the colored image. From the above figures, it was observed that, the histogram has reasonably clear valley between the modes related to objects and the background.

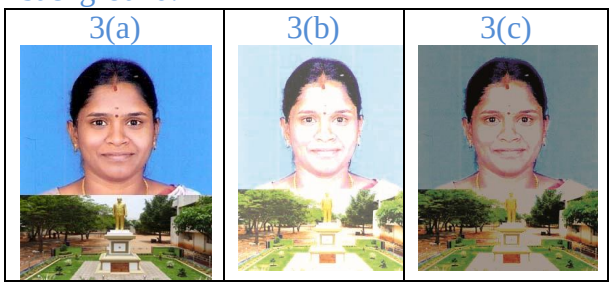

Figure 3. (a). Image without noise (b) Image after applying Gaussian Noise (c) Image after applying Salt and Pepper Noise

In figure 3 (b), it can be observed that, Gaussian noise was added to the original image and in figure 3(c) Salt and Pepper was added to the original image,

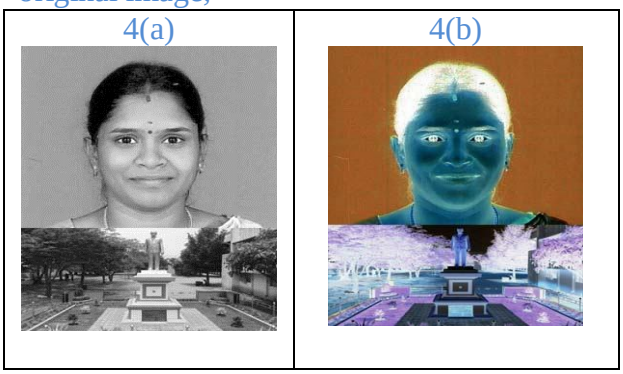

Figure 4. (a). Shows grayscale Image with Gaussian noise (b) Thresholded Image with Gaussian Noise

For the figure 4(a) above, the image with Gaussian Noise was first converted to grayscale, then global thresholding using an iterative algorithm was performed on the image. The object was successfully separated from its background (Background and Foreground). In figure 4(b), it can be observed that the white (1) represents the foreground and black (0) represents the background.

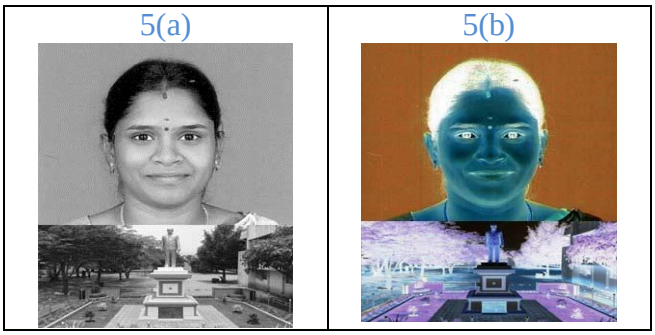

Figure 5. (a). Grayscale Image with Salt and Pepper Noise (b) Thresholded Image with Salt and Pepper Noise

For the figure 5(a) above, the image with Salt and Pepper Noise was first converted to grayscale and global thresholding using an iterative algorithm was performed on the image.

The object was successfully separated from its background. In figure 5(b), it can be observed that the white (1) represents the foreground and black (0) represents the background.

Image segmentation is often used to differentiate the foreground from the background. The focus of this paper is an attempt to study and achieve Image Segmentation using Thresholding Techniques on images with Gaussian Noise as well as Salt and Pepper Noise using MATLAB software. The study made use of the Iterative algorithm for the purpose of Image Thresholding on an image with pixel size 265x340 and the results obtained in the experiment were studied thereby highlight the performance of this image segmentation technique. From the results obtained, figure 2 (a) shows a colored image and figure 2 (b), the histogram representation of the colored image. It was observed that, the histogram has reasonably clear valley between the modes related to objects and background. In the Figure 4(a), the image with Gaussian Noise was first converted to grayscale and global thresholding using an iterative algorithm was performed on the image. The object was successfully separated from its background. In figure 4(b), it was observed that the white (1) represents the foreground and black (0) represents the background. In the Figure 5(a), the image with Salt and Pepper Noise was first converted to grayscale and global thresholding using an iterative algorithm was performed on the image. The object was successfully separated from its background. In figure 5(b), it can be observed that the white (1) represents the foreground and black (0) represents the background. This technique of image segmentation by using Image Thresholding performed on an image corrupted with two different kinds of noise successfully separated the object from the background. Thus the background of the image is represented as black and the object represented as white (1) as seen in the figures above.

VI. COMPARATIVE ANALYSIS

The implementation of the various methods starts with the identification of all the adjustable parameters for each method. We have implemented and tested real images with and without noise. It starts in all cases by a simple and closed curve (circle or rectangle). Before the segmentation is activated, one needs to initialize the contour that will be shown in the first frame of the subsequent results. In general, six experiments will be conducted, and three methods are employed in this paper for performance comparison,

1. Original level set by Caselles-Kimmel-Sapiro
2. Level set by Chan & Vese,
3. level set by Yezzi,
4. level set by Lankton
5. Level set by Bernard et al.
6. Proposed level set by Shivakumar et. al. and
7. Banu Chitra et al., The whole implementation (MATLAB coding) is run on a PC with a 3GHz Intel system. Table 1 summarizes the performance comparison of these seven methods in different circumstances, where in general the our scheme is superior to the others in terms of location accuracy and computational time. The details follows.These values were normalized to facilitate their comparisons.

• Visual criterion: This criterion allows you to plot the results of the selected algorithms on the image to compare them with the reference you have selected.
• Computation time.
• Similarity criterion : Four similarity criteria can be computed between the result of the algorithms and the reference :

i. Dice criterion
ii. peak signal-to-noise ratio(PSNR)
iii. Hausdor_ distance
iv. Mean Sum of Square Distance

Table 1.1. Criteria values for each of the methods for segmentation of image.

	Geodesi Cactive Countour	Chan and Yese Method	Yezzi Method	Lanktn Method	Bernad Method	Shivaku mar et al	Proposed Method
Visual Criterion	1	1	1	0	1	1	1
Dice	0.69	0.69	0.28	0.6	0.7	0.70	0.76
PSNR	10.63	8.86	8.31	7.19	9.01	7.10	7.1
Computation Time	1.28	0.85	2.60	1.1	1.26	0.75	0.70
Hausdor Distance	21.35	31.98	21.54	16.97	20.10	28.01	29.84
MSSD	54.65	153.35	119.09	59.85	49.64	135.01	137.40

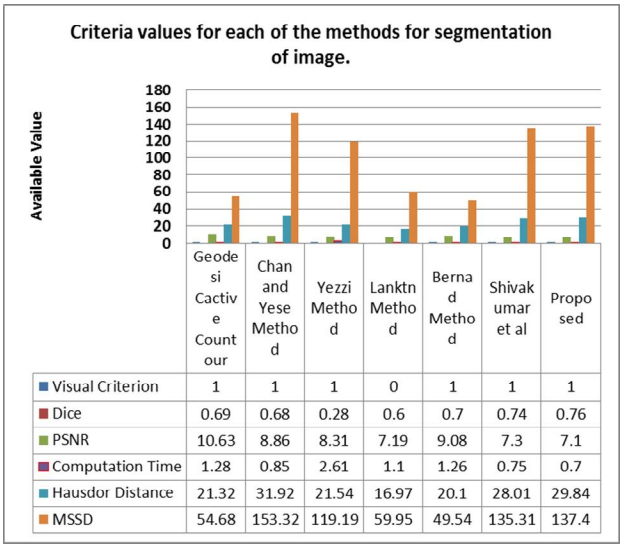

Figure 6. Performance of different Criteria values for each of the methods for segmentation of image.

According to our tests, our segmentation method seems to be the best. It depends on the nature of the image, and other parameters.

VII. CONCLUSION

The document image under test is attempted with the help of global Thresholding approach while estimating most likely background information using an iterative algorithm. In each iteration the average intensity of the document image is adopted as the midpoint between the pixels. In the next step the remaining pixels are equalized. The number of iterations depends on the sensitivity of successive thresholds. This algorithm is found to be effective on historical document images as well as camera captured stone carvings. However, it is observed that further improvement is necessary on palm leaf manuscripts.

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