Hybridization of Thresholding Techniques for Grey and Color Image Segmentation

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Abstract--- The work forms an image processing pipeline, consisting of noise reduction, feature extraction by image segmentation morphological operations to extract the region of interest. The work is based on the simultaneous use of segmentation and Thresholding. Thresholding technique gives a better performance in terms of accuracy and diagnosing the complete color image. Gray channel image segmentation were applied for each of the H, S and I channels separately to determine the suitable automatic threshold for each channel. After that, the new modified channels are integrated again to formulate a new color image.
Keywords: HSI Color model, segmentation, Otsu's Thresholding.

I. INTRODUCTION

The fundamental idea in color image segmentation is to consider color uniformity as a relevant criterion to partition an image into significant regions [1]. The first task of any image processing tasks is usually Segmentation.

A common problem in the segmentation of gray scale images occurs when an image has a varying gray level background. One of these problems is the progressively varying shadows, or when the image contains wide range of gray levels. This is an inveterate intensity problem in gray scale images [7]. On the other hand, thousands of color shadows and intensities could be distinguished by the human eye can. Nowadays, there is no robust mathematical theory of image segmentation. Consequently, no solitary typical method of image segmentation has originated. Therefore, there are a variety of solo methods that have been somewhat popular according to its success [12].

Generally, most of the segmentation techniques for gray scale images such as histogram thresholding, edge detection, feature clustering, fuzzy methods, and region based methods, and neural networks have been extended for color image segmentation by using HSI color space system or other color space like CYM, RGB, etc.

Color image segmentation is a method of mining one or more unified regions that are homogenous. This may be obtained from region's spectral elements [3]. Recently, there are a large number of color image segmentation techniques. They can be classified into four general categories: pixel-based, edge-based, region-based, and model-based techniques. Actually, the basic behavior of these techniques can be divided into three concepts. The first concept is the similarity concept like edge-based techniques. Alternatively, the second concept is based on the discontinuity of pixel values like pixel-based and region-based techniques. Finally, a complete different approach is the third concept which is based on a statistical approach like Model-based techniques. In the third concept, segmentation is implemented as an optimization problem [7].

The major process involved here is of segmentation. The first step is to preprocess the image to remove noise and enhance the edges. The preprocessed image is then segmented and the final output is obtained by post processing with the help of morphological operations.

II. PROPOSED METHODOLOGY

The techniques applied here follow the same three stages [6]:-

1. Preprocessing of the image
2. Segmentation on the preprocessed image
3. Post processing applied on segmented image.

This method eliminates the need of user intervention and make this technique fully automatic without any need to give an initial seed point for the progress of algorithm.

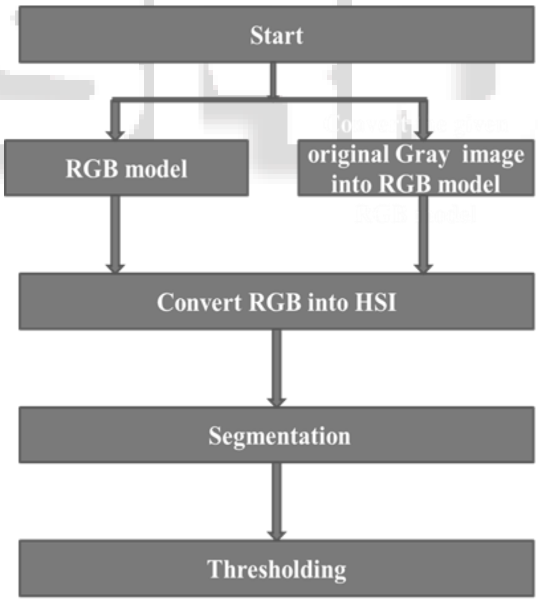


Fig. 1: Proposed method Flow Chart

A. *Converting colors from RGB to HSI [8]*

$$H = \begin{cases} \theta & \text{if } B \le G \\ 360 - \theta & \text{if } B > G \end{cases} \quad (1)$$

$$\theta = \cos^{-1}\left\{ \frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{1/2}} \right\} \quad (2)$$

$$S = 1 - \frac{3}{(R+G+B)}[\min(R, G, B)] \quad (3)$$

$$I = \frac{1}{3}(R+G+B) \quad (4)$$

B. Current Image Segmentation Techniques

In computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels) [10]. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze Image segmentation is typically used to locate 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 entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristics. When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like marching cubes.

1) Clustering Method [7]

The K-means algorithm is an iterative technique that is used to partition an image into K clusters. The basic algorithm is:

1. Pick K cluster centers, either randomly or based on some heuristic
2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster center.
3. Re-compute the cluster centers by averaging all of the pixels in the cluster
4. Repeat steps 2 and 3 until convergence is attained (i.e. no pixels change clusters)

In this case, distance is the squared or absolute difference between a pixel and a cluster center. The difference is typically based on pixel color, intensity, texture, and location, or a weighted combination of these factors. K can be selected manually, randomly, or by a heuristic. This algorithm is guaranteed to converge, but it may not return the optimal solution. The quality of the solution depends on the initial set of clusters and the value of K.

2) Compression based methods [7]

For any given segmentation of an image, this scheme yields the number of bits required to encode that image based on the given segmentation. Thus, among all possible segmentations of an image, the goal is to find the segmentation which produces the shortest coding length. This can be achieved by a simple agglomerative clustering method. The distortion in the lossy compression determines the coarseness of the segmentation and its optimal value may differ for each image. This parameter can be estimated heuristically from the contrast of textures in an image. For example, when the textures in an image are similar, such as in camouflage images, stronger sensitivity and thus lower Quantization is required.

3) Histogram-based methods [7]

Histogram-based approaches can also be quickly adapted to occur over multiple frames, while maintaining their single pass efficiency. The histogram can be done in multiple fashions when multiple frames are considered. The same approach that is taken with one frame can be applied to multiple, and after the results are merged, peaks and valleys that were previously difficult to identify are more likely to be distinguishable. The histogram can also be applied on a per pixel basis where the information results are used to determine the most frequent color for the pixel location. This approach segments based on active objects and a static environment, resulting in a different type of segmentation useful in Video tracking.

4) Edge detection [7]

Segmentation methods can also be applied to edges obtained from edge detectors. Lindeberg and Li developed an integrated method that segments edges into straight and curved edge segments for parts-based object recognition, based on a minimum description length (MDL) criterion that was optimized by a split-and-merge-like method with candidate breakpoints obtained from complementary junction cues to obtain more likely points at which to consider partitions into different segments.

5) Region Growing Method [7]

The first region-growing method was the seeded region growing method. This method takes a set of seeds as input along with the image. The seeds mark each of the objects to be segmented. The regions are iteratively grown by comparing all unallocated neighboring pixels to the regions. The difference between a pixel's intensity value and the region's mean, , is used as a measure of similarity. The pixel with the smallest difference measured this way is allocated to the respective region. This process continues until all pixels are allocated to a region.

6) Model Based Segmentation [7]

The central assumption of such an approach is that structures of interest/organs have a repetitive form of geometry. Therefore, one can seek for a probabilistic model towards explaining the variation of the shape of the organ and then when segmenting an image impose constraints using this model as prior. Such a task involves (i) registration of the training examples to a common pose, (ii) probabilistic representation of the variation of the registered samples, and (iii) statistical inference between the model and the image. State of the art methods in the literature for knowledge-based segmentation involve active shape and appearance models, active contours and deformable templates and level-set based methods.

C. Current Thresholding Techniques [6]

The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum, variance) and k-means clustering. Recently, methods have been developed for thresholding computed tomography (CT) images. The key idea is that, unlike Otsu's method, the thresholds are derived from the radiographs instead of the (reconstructed) image

1) Histogram Shape-Based Thresholding Methods [6]

This category of methods achieves thresholding based on the shape properties of the histogram. Basically two major peaks and an intervening valley is searched for using such tools as the convex hull of the histogram, or its curvature and zero crossings of the wavelet components. Other authors try to approximate the histogram via two-step functions or two-pole autoregressive smoothing.

2) Clustering Based Thresholding Methods [6]

In this class of algorithms the gray level data undergoes a clustering analysis with the number of clusters being set to two. Alternately the gray level distribution is modeled as a mixture of two Gaussian distributions representing, respectively, the background and foreground regions.

3) Clustering Otsu [6]

Otsu suggested minimizing the weighted sum of within-class variances of the foreground and background pixels to establish an optimum threshold. Since minimization of within-class variances is tantamount to the maximization of between-class scatter, the choice of the optimum threshold can be formulated as:

The Otsu method gives satisfactory results when the numbers of pixels in each class are close to each other. The Otsu method still remains one of the most referenced thresholding methods. In a similar study thresholding based on isodata clustering is given in Velasco.

4) Clustering Kittler [6]

In this method the foreground and background class conditional probability density functions are assumed to be Gaussian, but in contrast to the previous method the equal variance assumption is removed the foreground and background variances for each choice of T. Recently Cho, Haralick and Yi have suggested an improvement of this thresholding method by observing that in the original scheme the means and variances are estimated from truncated distributions resulting in a bias. This bias becomes noticeable, however, whenever the two histogram modes are not distinguishable. In our experiments we have observed that the peaks were distinguishable, hence we preferred the algorithm in Kittler.

5) Entropy-Based Thresholding Methods [6]

This class of algorithms exploits the entropy of the distribution of the gray levels in a scene. The maximization of the entropy of the thresholded image is interpreted as indicative of maximum information transfer. Other authors try to minimize the cross-entropy between the input gray-level image and the output binary image as indicative of preservation of information. Johannsen and Bille and Pal, King, Hashim were the first to study Shannon entropy based thresholding.

6) Thresholding Algorithms Based on Attribute Similarity [6]

The algorithms considered under this category select the threshold value based on some similarity measure between the original image and the binarized version of the image. These attributes can take the form of edges, shapes, or one can directly consider the original gray-level image to binary image resemblance. Alternately they consider certain image attributes such as compactness or connectivity of the objects resulting from the binarization process or the coincidence of the edge fields.

7) Otsu's Thresholding Technique

Otsu's method selects the threshold by minimizing the within-class variance of the two groups of pixels separated by the thresholding operator which in turn maximizes the between-class variance. The separability of two classes is given by

$$\sigma_B^2(k) = \frac{m_G P_1(k) - m(k)^2}{P_1(k)[1 - P_1(k)]} \quad (5)$$

Then the optimum threshold is that value of k that maximizes [11].

The method has been implemented in MATLAB 7.0.Firstly the image is preprocessed by applying a high pass filter of matrix of form:

-1	2	-1
0	0	0
1	-2	1

Table 1: Filter to enhance the image

After this the median filter is applied to the image. Then segmentation is done. In the methodology implemented, using the gray thresh function of MATALB, a threshold value is obtained and since the tumor region is a highly illuminated region, a value of 0.3 is added to the threshold value computed so that it can correctly diagnose the tumor area. The final threshold thus obtained is applied on the preprocessed image to convert it to a binary image with this threshold value. The image is thus segmented and this image is further ready for post processing to obtain the final tumor image which involves repeated use of dilation and erosion operation, for this a structuring element of shape 'disk' with radius 1 has been used.

III. RESULTS AND DISCUSSIONS

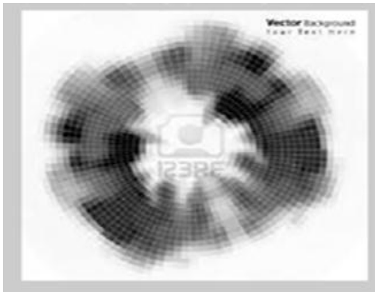


Fig. 2(a): Gray scale image

Fig. 2(b): Converted binary image based on thresholding

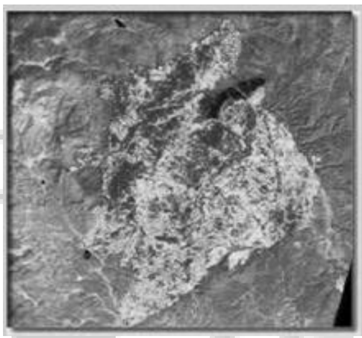
The techniques have been implemented in MATLAB 7.0.

Using the GUI; the image is browsed for which the brain tumor has to be extracted. The results for the two techniques that have been implemented follows in this section. It has been found that the otsu's thresholding technique has found to work better in terms of accuracy for extracting brain tumor while the otsu's technique clearly extracts the tumor area, giving a better result. The images are given:

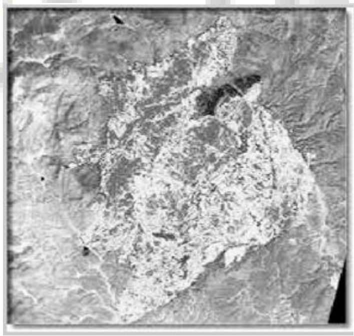
Fig. 2(c): Threshold output based on pixel counting

Fig. 2: (a), (b), (c)

The following images show the result of application of color based region

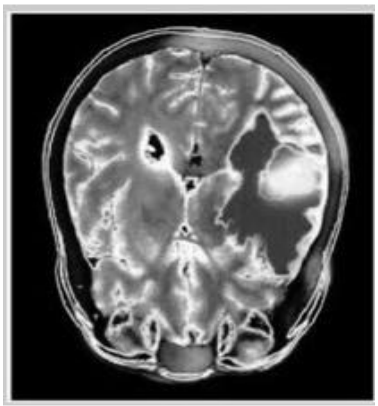


(a)

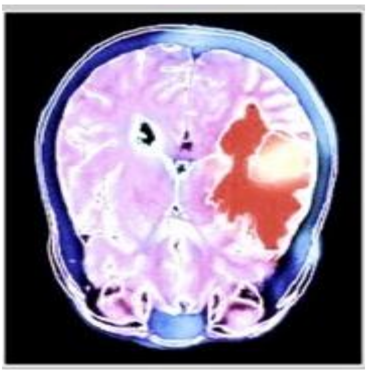


(b)

Fig. 3: (a) original color image, (b) thresholding image.



(a)



(b)

Fig 4: (a) color brain image,(b)thresholding color image

IV. CONCLUSION

In this paper A new Approach for color image segmentation has been presented that is based on the hybridization between the classical Otsu method for gray level and H, S, I color Image segmentation. This proposal technique is recommended in medical image processing another question may be arising as a future work and that is what about implementing. The proposed technique on aonther color space like RGB or CMY or other.

V. FUTURE WORK

Implementation of Otsu method to the H,S,I channels alone will produce some kind of noise and this noise is remove by using the filtering techniques use the filter carefully because it may cause blurring in the image. When increasing the window size k×k window size was implemented in filtering process, with this process this technique is applied on the different color image and check the In which window size this image will be clear in k×k window size. We use the different, different filter to clear the image and check every image get k×k image quality of window size also compare of all the method which one get better results.

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