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# Iterative Triclass Thresholding Technique using Otsu's Method

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**Abstract:** ***A new Iterative Triclass Thresholding method in image segmentation which uses the Otsu's method to segment the image. This method iteratively searches for the sub-regions of the images, instead of treating the full image as a whole region for segmentation. First the Otsu's method is applied on the input image to find the Otsu's threshold and compute the mean values of two classes as separated by the threshold and based on this the image is divided into three sub-region instead of two as the standard Otsu's method does. The three classes are determined as foreground, background and "to-be-determined" [TBD] region. The foreground and background are not included for further processing. The Otsu's method is again applied on the TBD region to find the new threshold value and the two class mean, based on this the TBD region is again divided into three sub-regions. The iteration stops when the Otsu's threshold calculated between two successive iterations is less than that of the pre-set threshold. Finally all the previous foreground and background is combined to form the final output. The obtained output will achieve better result than the standard Otsu's method.***

**Keywords:** Binarization, Otsu's method, segmentation, threshold, triclass segmentation

## 1. Introduction

Images are considered as one of the most important medium of conveying information, in the field of computer vision, by understanding images the information extracted from them can be used for other tasks. Image segmentation is the process of partitioning a digital image into multiple segments. Image denoising is done before the segmentation to avoid the selection of falsely object for segmentation to segment the image into multiple parts without loss of information. The goal of segmentation is to change the representation of an image into more meaningful and easier to analyse. Image segmentation is basically used to locate the objects and boundaries (lines, curves, etc.) in images. Segmentation technique can be classified into different types namely, Region Based, Edge Based, Threshold Based etc.

As a segmentation technique, Otsu's method is widely used in pattern recognition, document binarization and pattern recognition. Otsu's method searches for a threshold that minimizes the intra-class variances of the segmented image[2] and can achieve good results when the histogram of the original image has two distinct peaks, one belongs to the background, and the other belongs to the foreground. Otsu's threshold is found by searching across the whole range of pixel values of the image. Based on this threshold, the image is divided into foreground and background. Otsu's method produces sub-optimal results for the multi-model histograms and if one of the class has larger variance than the other.

The proposed method is a new method in image segmentation which uses the Otsu's method for segmentation but differs from the standard application. First the image is divided into two parts that is foreground and background by applying the Otsu's method. By this will obtained the threshold which is called as Otsu's threshold and the mean value of the two classes separated by the Otsu's threshold. Then, in the next iteration the image is divided into three regions instead of two as the standard Otsu's method. The three classes is divided based on the Otsu's threshold and mean value are defined as the foreground with the pixel values which are greater than the larger mean, the background with the pixel values which are lesser than the smaller mean and the third class as "to-be-determined" [TBD] region with the pixel value fall between the two class means. The foreground and background are kept as permanent foreground and background which are not include for further processing. In the next iteration the TBD region is considered for processing. Again this region is divided into three sub-regions - foreground, background and to-be-determined by re-applying the Otsu's method. The iteration stops after meeting present criterion. Then the last TBD is separated into two regions foreground and background, instead of three. The final foreground and background is obtained by combining the entire previous foreground and all previous background with the help of logical union operation. Except for thestopping criteria the proposed method is parameter free and has minimal computational load.

## 2. Problem Statement

Some researchers suggested several approaches like recursive approach based on Otsu's technique to focus on the brightest homogeneous object in an image and quad-tree approach was developed to segment images by combining a centroid clustering and boundary estimation methods. The existed thresholding techniques having the problems like inaccurate in finding the threshold or only works under the assumption that the histogram consists of Gaussian distribution. The standard Otsu's threshold is found by searching across the whole range of the pixel values of the image until the intra-class variances reach their minimum. Disadvantage of this is it may create suboptimal results when the histogram of the image has more than two peaks or if one of the classes has a large variance, which tends to miss weak objects or fine details in images. The proposed method in image segmentation is based on Otsu's method but iteratively searches for sub regions of the image for segmentation. The iterative method starts with Otsu's threshold and computes the mean values of the two classes as separated by the threshold. Based on the Otsu's threshold and the two mean values, the method separates the image into three classes instead of two as the standard Otsu's method does. The first two classes are determined as the foreground and background and they will not be processed further. The third class is denoted as a to-be-determined (TBD) region that is processed at next iteration.

## 3. Related Work

Clustering algorithm such as Fuzzy C Mean (FCM). These are implemented to extract the suspicious region in MRI image. Fuzzy Clustering Mean algorithm is most accepted since it can preserve much more information than other approaches. [4]

Level set method which adds structure to a raw image. In the case of medical images, this can involve identifying which portions of an image is the tumor, or separating white matter from grey matter in a brain scan. The basic idea is to represent the curves or surfaces as the zero level set of a higher dimensional hyper surface. [5]

A method to select a threshold automatically from a gray level histogram has been derived from the viewpoint of discriminant analysis. [2]

Image processing in MRI of brain is highly essential due to accurate detection of the type of brain abnormality which can reduce the chance of fatal result. [1]

The use of digital images of scanned handwritten historical documents has increased in recent years, especially with the online availability of large document collections. The recursive Otsu algorithm, combined with selective bilateral filtering and background subtraction or compensation provides an effective method for intensity parsing of historical documents. Incrementally thresholded portions of the handwriting are then effectively combined into a single binary result that compares very favourably with existing thresholding algorithms. [3]

## 4. Methods

A. Image Pre-processing

- Histogram Equalization is used for contrast enhancement. All R, G, B channels are histogram equalized and combined again to form an equalized image.
- Smoothing filters are low pass filters and are used for noise reduction. It blurs the objects. Smoothing operation is applied to RGB channels. Here averaging filter is used.
- Sharpening filters are high pass filters and produce sharp images with dark background. RGB is converted to YIQ colour space and then high pass filtering is applied to intensity component only.
- Noise Reduction can be achieved by averaging spatial filters or low pass filters in frequency domain. Here the salt and pepper noise is added to the image and then the median filtering is used in R, G, B channels and the resultant image is combined.

B. Otsu's Method

Otsu's method searches the histogram of an image to find a threshold that binarizes the image into two classes, the background with a mean of $\mu_0$ and the foreground with a mean of $\mu_1$, as shown in the top of Figure 1. Here the assumption is that the foreground is brighter than the background, i.e., $\mu 1 > \mu 0$.

The calculation of threshold T is as follow

$T = \arg\min \sigma^2_w (T)$ Eq (1)

Where

$\sigma^2_w(T) = q_0(T)\,\sigma^2_0(T) + q_1(T)\,\sigma^2_1(T)$ Eq(2)

where the subscript 0 and 1 denote the two classes, background and foreground, respectively, and $q_i$and $\sigma_i$ , i = [0, 1] are the estimated class probabilities and class variances, respectively.

These quantities are calculated as

T K
$q0 = \sum P(i)$ Eq(3) $q1 = \sum P(i)$Eq(4) i=1 i=T+1

and the individual class variances are given as

T
$\sigma^2_0(T) = \sum[i - \mu_0(T)]^2 P(i)/q_0(T)$ Eq(5)
i=1

K
$\sigma^2_1(T) = \sum[i - \mu_1(T)]^2 P(i)/ q_1(T)$ Eq(6)
i=T+1

Where the pixel values of the image are from 0 to K. So from the above equation T is function of the pixel values of both the foreground and the background. If the signal intensity changes, it may affect T in such a way that the segmentation result may become less optimal.

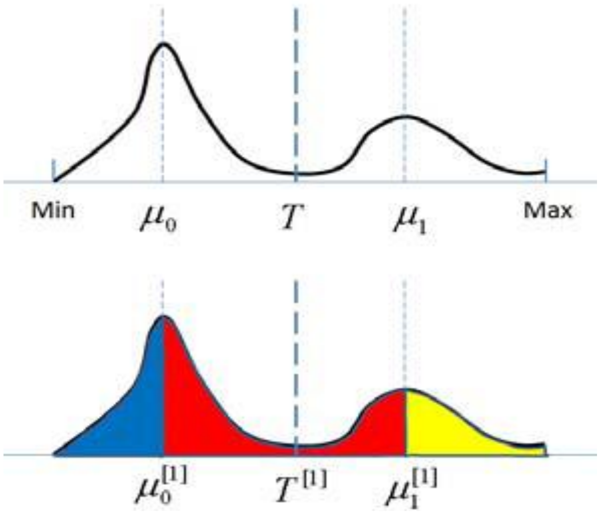


**Figure 1:** Calculating the threshold by Otsu's Method

Figure 1, Top, Otsu's method binarizes an image to two classes based on threshold T by minimizing the within-class variances. Bottom, in iterative method we classify the histogram into three classes, namely the foreground region with pixel values greater than $\mu_1$ (shown in yellow), the background region with pixel values less than $\mu_0$ in blue, and the third region, called TBD, in red.

## 5. Data Sets

Hundreds of MRI is collected from JSS hospital.

## 6. Experimental Results and Discussions

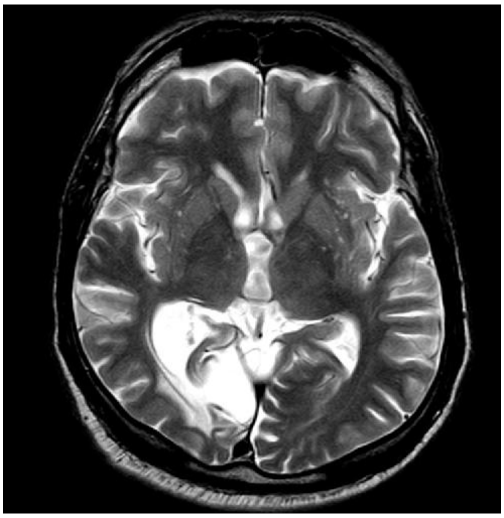

**Figure 2 (a):** Input Image

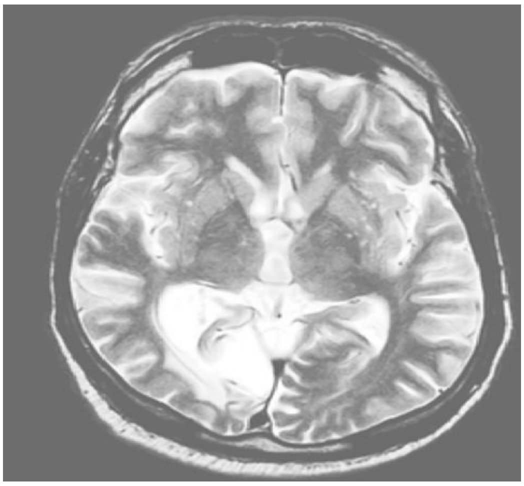

**Figure 2 (b):** Pre-processed image

**Figure 2 (c):** Result of Otsu's method

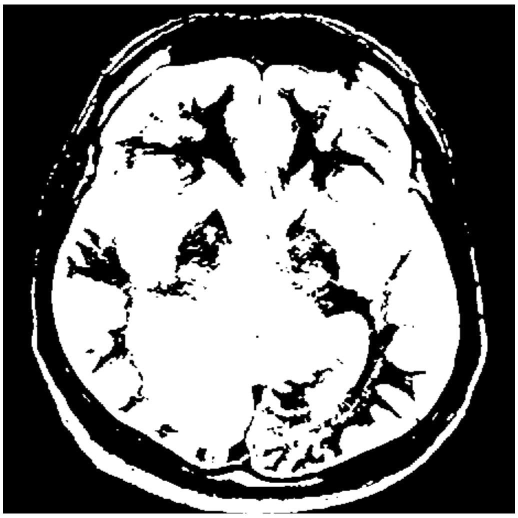

**Figure 2 (d):** Result of proposed method

Figure 2 represents the example to demonstrate the performance of new iterative tri class method. Figure 2(a) represents the input image, Figure 2(b) represents the pre-processed input image, Figure 2(c) represents the Otsu's result for the input image and Figure 2(d) shows the outcome of the proposed work.As the iteration proceeds more foreground objects are correctly segmented.

The threshold monotonically decreased from a larger value of 0.64314 on iteration one, which is also the Otsu's threshold, to a smaller value of 0.55824 0n iteration four, indicating that the iterative method progressively searches for weak objects to segment.

## 7. Acknowledgement

A few data sets are collected from JSS hospital. Dr. Sathya Narayana Rao, Pshyscyatrist. We are Thankful for your invaluable support.

## 8. Conclusion

As Otsu's method is widely used as a pre-processing step to segment images for further processing, it is important to achieve a high accuracy. However, since Otsu's threshold is biased towards the class with a large variance, it tends to miss weak objects or fine details in images. Proposed method takes the advantage of Otsu's threshold by classifying the image into 3 classes instead of 2 permanent classes in the iterative manner. The performance of the new algorithm is evaluated on real and microscopic images. The new method is less biased towards the class with large variance than Otsu's method does. Experimental results demonstrate that the proposed algorithm can achieve superior performance in segmenting weak objects and fine details. The new method is also almost parameter-free except for the preset threshold to terminate the iterative process. The added computational cost is minimal as the process usually stops in a few iterations and each iteration only processes a monotonically shrinking TBD region.

## References

[1] G. Evelin Sujji, Y.V.S. Lakshmi, G. Wiselin Jiji, "MRI Brain Image Segmentation based on Thresholding", International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-3 Number-1 Issue-8 March-2013 97.

[2] N. Otsu, "A threshold selection method from gray-level histograms", IEEE Trans. Syst., Man. Cybern., vol. 9, no. 1, pp. 62–66, Jan. 1979.

[3] Oliver Nina, Bryan Morse, and William Barrett "A Recursive Otsu Thresholding Method for Scanned Document Binarization", 978-1-4244-9497-2/10/$26.00 ©2010 IEEE 307.

[4] Sayali D. Gahukar et al, "Segmentation of MRI Brain Image Using Fuzzy C Means for Brain Tumor Diagnosis", Int. Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 4, Issue 4 (Version 5), April 2014, pp.107-111.

[5] Tenn Francis Chen, "Medical Image Segmentation using Level Sets", Technical Report #CS-2008-12