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Image Segmentation using KFCM

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Abstract: Image segmentation can be characterized as in which we isolate the image into different parts as pixels. In segmentation, we basically speak to the picture into increasingly justifiable structure. Segmentation essentially is used to recognize the articles, boundaries and other pertinent information in the computerized pictures. There are various ways to perform segmentation like threshold, grouping and change strategy and so forth. Subsequent to playing out these approaches, the resultant segmented image is an aggregate pixel set of the whole picture. Pixels in the image compares to certain attributes of the picture like color, surface and so on.

Keywords: Fuzzy, Threshold, Segmentation, OTSU, KFCM

I. INTRODUCTION

Image segmentation is a method where a digital image is apportioned into numerous areas or pixel sets. The images are segmented based on a set of pixels in an area that are comparable based on the criteria of homogeneity for example color, intensity or texture, which helps to locate and recognize objects or boundaries in an image. The consequence of image segmentation is a set of regions covering the entire image collectively, or a set of contours taken from the image. With respect to the trademark property such as color, intensity, or texture, all the pixels in a region are comparative and adjacent regions are significantly different with regard to the same characteristics. Image segmentation is an image analysis branch and the main idea is to differentiate various objects in the content of the image. The picture is divided into two parts: background and foreground. The frontal area is defined as the objects that are interesting and the background as the rest. The process of image segmentation distinguishes and separates the two. The segmentation goal is to make the portrayal of an image simpler and/or easier to analyze. Typically, image segmentation is utilized to find objects and boundaries in images such as points, lines, edges and regions.

The consequence of image segmentation is a set of areas covering the entire image collectively, or a set of contours taken from the image. Image segmentation is the process by which each pixel in an image is relegated a label so that pixels with the similar label share certain visual attributes. Segmentation of images is a multiple objective problem and involves several processes such as representation of patterns, selection of features, and extraction of features and proximity of patterns. Consideration of all these goals is a difficult issue and a suitable optimization approach is therefore required for the segmentation process.

1) *Image Acquisition:* Different devices such as sensors, tomography devices and cameras read the given input image.
2) *Pre-Processing:* The pre-processing step is utilized to identify the focus area in the image.
3) *Image Segmentation:* The focused area of input image is segmented as sub-region into its constituent parts or objects based on the appropriate segmentation techniques.
4) *Post Processing:* This step processes the object's boundary from the background to create better segmented image.
5) *Feature Extraction:* This step is used to extract unique image features such as information about intensity, shape and color.
6) *Classification:* This step classifies the image segmented according to the extracted function [1]

II. SEGMENTATION USING KFCM

KFCM is FCM's kernel version, confining prototypes within the kernel space to be mapped from either the original information are a or the function area. That is, it describes the objective function as. [2]

$$Q = \sum_{i=1}^{c} \sum_{j=1}^{n} u_{ij}^{m} \left\| \varphi\left(x_j\right) - \varphi(O_i) \right\|^2 \qquad (1)$$

The objective function is then reformulated as,

$$Q = \sum_{i=1}^{c} \sum_{j=1}^{n} u_{ij}^{m} \left(1 - k\left(x_j, O_i\right)\right) \qquad (2)$$

Here,

$\left(1 - k\left(x_j, O_i\right)\right)$ can be considered as a robust distance estimate determined in kernel space.

Where, $\|$ is the Euclidean distance. u_{ij} is the membership data of x_j belonging to cluster i, which is characterized by the prototypes O_i. The constraint u_{ij} is $\sum_{i=1}^{c} u_{ij} = 1$ and m is the fuzzfication coefficient.
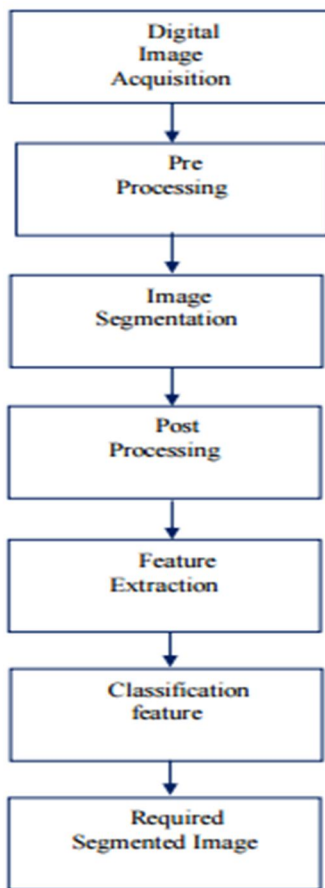
Fig1. Image Segmentation Process

III. OTSU ALGORITHM

The image is segmented into two classes in the OTSU method, the foreground (target) and background by searching for a suitable threshold value in the gray image level range. The interpretation is based on two classes ' inter-class variance. If the variance is greater, the greater the difference between the foreground and background provides better results in segmentation. If the variance is small, the lower the difference between foreground and background, results in poor segmentation. The OTSU method is simple, consuming less time than other algorithms of thresholding. The Otsu method is shown as follows; [3]. Let an image is denoted by L gray levels [0, 1,... L − 1]. The quantity of pixels at level i is given by n_i and the total number of pixels is given by $n_1 + n_2 + \cdots n_L$. The probability of i is denoted by:

$$P_i = n_i/N, \qquad P_i \geq 0, \quad \sum_0^{L-1} p_i = 1 \tag{3}$$

Assume the pixels of an image is partitioned into two classes C_1 (background) with gray levels [0, 1,... t] and C_2 (foreground) with gray levels [t+ 1,t+2 … L − 1] with threshold t. The probability distributions of gray level for the two classes denoted as w_1 and w_2 are given as [4]

$$w_1 = P_r(C_1) = \sum_{i=0}^{t} p_i \tag{4}$$

$$w_2 = P_r(C_2) = \sum_{i=t+1}^{L-1} p_i \tag{5}$$

The mean of C_1 and C_2 are:

$$u_1 = \frac{\sum_{i=0}^{t} ip_i}{w_1} \tag{6}$$

$$u_2 = \frac{\sum_{i=t+1}^{L-1} ip_i}{w_2} \tag{7}$$

The total mean is represented by u_T

$$u_T = w_1 u_1 + w_2 u_2 \qquad (8)$$

The class variances are

$$\sigma_1^2 = \frac{\sum_{i=0}^{t}(i-u_1)^2 p_i}{w_1} \qquad (9)$$

$$\sigma_2^2 = \frac{\sum_{i=t+1}^{L-1}(i-u_2)^2 p_i}{w_2} \qquad (10)$$

The within-class variance is

$$\sigma_w^2 = \sum_{k=1}^{N} w_k \sigma_k^2 \qquad (11)$$

The between-class variance is

$$\sigma_B^2 = w_1(u_1 - u_T)^2 + w_2(u_2 - u_T)^2 \qquad (12)$$

The variance of grey levels is

$$\sigma_T^2 = \sigma_w^2 + \sigma_B^2 \qquad (13)$$

OTSU has automatically selected the optimum Threshold value t by minimizing the intra-class variance holding an equivalent to maximizing the inter-class variance as the total variance for different partitions is constant.

IV. PROPOSED METHODOLOGY

The implementation of the work in MATLAB software, with the process described below. We consider an image, and then apply the grouping algorithm to the average K value of the original image. A median filter is applied to the split k-middle image to discard the noise. The image threshold is then obtained by applying OTSU threshold algorithm to the intermediate output of the filter. Then to strengthen the results we perform morphological closing on OTSU segmented image. Finally, for effective image segmentation the KFCM algorithm is applied to obtain accurate image result and calculate parameters such as PSNR, MSE, and SSIM.
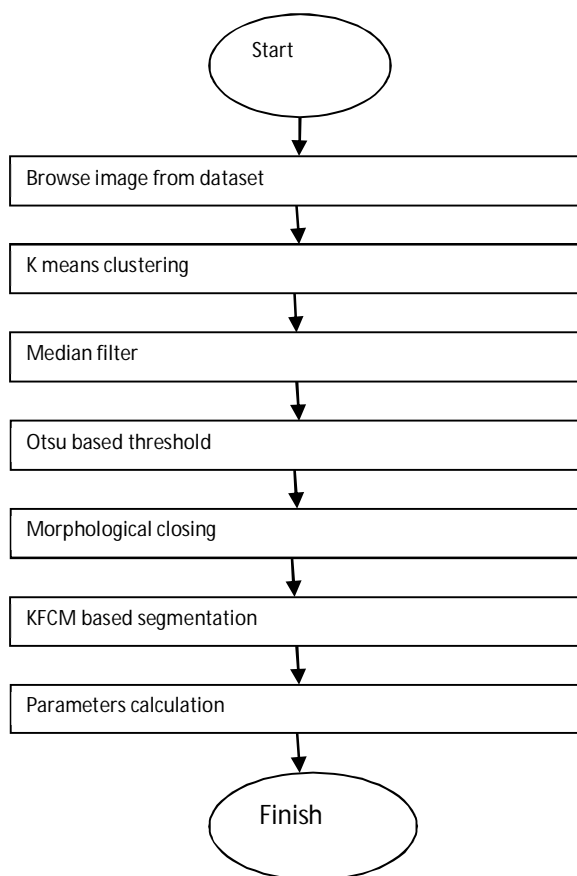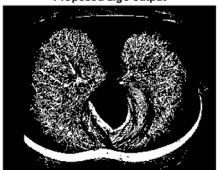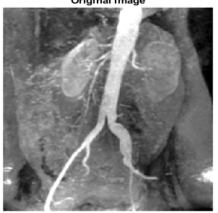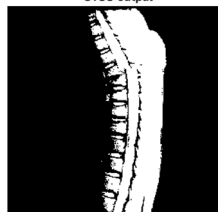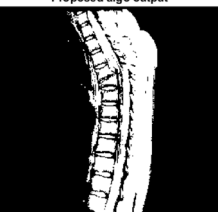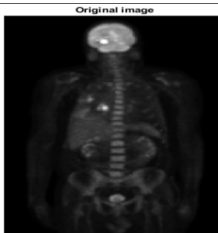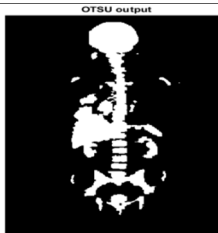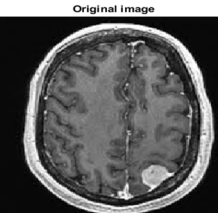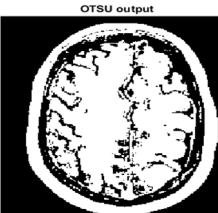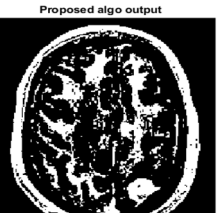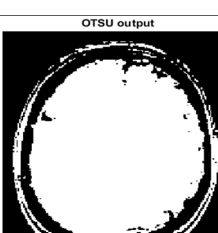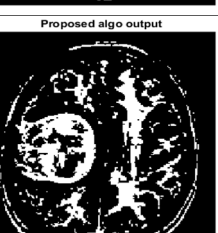

Fig.2 Flow chart of Propose Work

V.   RESULT

Threshold value of different images is calculated using the proposed algorithm and OTSU algorithm. Threshold values are improved by the proposed algorithm. Different images are segmented using both the algorithms.

S.No.	ORIGINAL IMAGE	PREVIOUS (OTSU) ALGORITHM	PROPOSED ALGORITHM	THRESHOLD VALUE (OTSU)	CALIBRATION VALUE	THRESHOLD VALUE (PROPOSED ALGORITHM)
1				0.3412	0.35	0.6912
2				0.5059	0	0.5059
3				0.4314	0	0.4314
4				0.1765	0.4	0.5765
5				0.3098	0.35	0.6598
6				0.298	0.4	0.698

VI. CONCLUSION

OTSU algorithm is providing threshold value for segmentation. OTSU is providing different values for each image as shown in above table. The result of OTSU is not appropriate for some images therefore as a proposed work, first we have applied CLAHE (Contrast-limited adaptive histogram equalization) algorithm for image contrast enhancement and then a calibration value is added with condition to get the improved results for each image.

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