An Effective Segmentation of Tissues from MR Brain Images

B Papachary*, M Amru, and S Rama Kishore Reddy
Department of Electronics and Communication Engineering, CMR Engineering College, Hyderabad, Telangana, India
Email: *biroju.chary@gmail.com

Abstract. Segmentation of MR brain image is quite useful in detection of tissues and further diagnosis. However, precise segmentation of tissues plays a significant role in diagnosing the patient more effectively. Previously, there are plenty of approaches was implemented and however they were failed to detect the exact tissue which led to the failure diagnosis. Therefore, an accurate detection of tissue is required for effective diagnosis. Here, this article presented an efficient segmentation of MR brain image tissues. Our approach includes a hybrid clustering mechanism with pre-processed by median filter. In addition, tissue area also estimated for better diagnosis of patient. In terms of computational complexity and segmentation accuracy the superiority of proposed hybrid approach over conventional segmentation algorithms of simulation results was disclosed.

Keywords: magnetic resonance imaging, brain tumour, thresholding, fuzzy c means, K-means and estimate arguing

1. Introduction
In general, Magnetic Resonance Imaging (MRI) [1] is used for studying the working mechanisms of the human psyche and animals. While the effects on improved patient care remains unclear, it affects care and diagnosis in many specialties. Over computed tomography (CT), these forms of imaging are preferable since it does not use any ionising radiation, as any method will provide the same details. Brain tissue is an uncontrolled growth in any part, which causes serious death to the human. Detecting these tissues in an early stage is a vital and quite difficult task to the medical diagnosis persons. Detection of tissues in MR images can be done by segmenting the images. Grouping of similar elements is known as segmentation. Clustering is a technique for this segmentation that groups the number of features into some very clusters depending on the similarities between the colour or pixel sizes and the grey colour of the background. Outcome of clustering consists of number of segmented objects in which it has extracted information of input image. For multiple images in application fields like image enhancement, detection of objects, compression, processing of medical images and retrieval system the segmentation has been used by which any image data can be retrieved [2]. Many segmentation approaches have been introduced over past years. An improved watershed segmentation algorithm is presented in [3], which renders quite enhanced performance over thresholding-based approaches. However, this has few limitations such as over segmentation and sensitive to false edges. Later on, clustering was proposed to obtain better segmented outcome. Fuzzy C’ (FCM) is an algorithm which clusters the homogeneous pixels into a group. It operates based on the functions of membership values [4, 5]. Though, it produces superior outcome over [3], it requires larger computational duration since the allocation of membership value consumes more time. Afterwards, K-means was introduced to mitigate the computation time [6]. This is being employed broadly, since it is quite easy and simple. Further, this is also quicker for Meta data clustering [7-9]. But, the selection of cluster points or centres is assumed randomly and required to
update these in every iteration. By utilizing hierarchical clustering and Gaussian Mixture Model with its variant Expectation Maximization segmentation of images was done. The classification of intravascular ultrasound images based classifier given in [10]. However, the algorithms presented in the literature have been suffering from inaccuracy in finding the exact tissue, higher computational complexity and lack of stability. To solve problems for identification of tissues in MR brain images [13], the measurement of the approximate region using number of white pixels in a differentiated MR image with an increased output such as [12] fuzzy C means (FCM), K-means and even manual differentiation has a proposed technique with then help of presenting the hybrid clustering algorithm.

2. Related Work
However, this K-means depends on the selected centroids initially. It needs new centroids to be updated by calculating the mean of obtained clustered points in the first iteration. The mean of these values provides the floating values which were not favourable for replacing as a new centroid. Therefore, K-means must need to optimize for the integer or scalar centroid to be replaced with the existed centroid. In, [11] Instead of calculating mean value to replace the initial centroid a proposal has been made by the author to optimize K-means clustering in which the maximum value is selected. Authors in presented a hybrid algorithm for tumour detection and extraction from brain images, but they were failed to detect the tumour with higher accuracy. The MEMS [14] sensor detects the change in head direction and the signal is sent to the microcontroller accordingly. The above algorithms, however, have the disadvantages of less precision and incorrect estimate of the field.

3. Proposed Algorithm
By applying fuzzy algorithm, we optimized the k-means clustering in the proposed clustering algorithm and the method diagram is shown in figure 1.

![Method diagram](image)

**Figure 1. Method diagram**

**Algorithm 1:**

| Step   | Description                                |
|--------|--------------------------------------------|
| Step 1 | Choose and read input image ‘I’            |
| Step 2 | Apply median filtering as a pre-processing to remove any unwanted information. |
| Step 3 | Now, the outcome of pre-processing is converted as data vector. |
| Step 4 | Choose number of cluster points.           |
| Step 5 | Compute the distance of every picture element to cluster point. |
| Step 6 | Select the cluster point that has a minimum value of distance. |
| Step 7 | Group the homogeneous picture elements to their respective cluster point. |
| Step 8 | Re-compute the new cluster points by calculating the average of grouped picture elements and reposition them with initial cluster points. |
| Step 9 | Repeat the procedure until there are symmetrical cluster points. |
Flow chart of algorithm 1 is explained in the figure 2 using step by step process.

**Algorithm 2:**
Step1: Read the outcome of algorithm 1.
Step2: Segment by employing fuzzy approach.
Step3: Obtain the segmented MR brain image which comprises of only tissue particles in it.
Step4: Now, compute the estimated area of segmented tissue by finding number of white pixels in it as per digital imaging units.
Step5: Finally, calculate the computation time.

3.1 Hybrid clustering algorithm:
Our proposed hybrid clustering is described in this section briefly. Figure 3 show that the block diagram of proposed methodology. Algorithm 1 and 2 explained the complete procedure for obtaining the segmented tissues of brain images by utilizing the proposed approach. Median filter is utilized as a pre-processing step to eliminate the noise from input MR brain image. When k-means clustering is applied to segment the vector into several clusters the obtained denoised MR brain image is converted into data vector. Now, segmented output is optimized by fuzzy algorithm [15] to enhance the segmentation accuracy and perfect tissue detection. By utilizing the typography and digital imaging units estimate arguing is applied to estimate the area of tissue image obtained. Here, we considered the images of size 256 x 256 and the pixels in the segmented image having only two values i.e., either black or white, where the pixel value 0 denotes the black and 1 denotes the white. Hence, we can represent the segmented output image as a summation of total number of white and black pixels.

\[
M = \sum_{x=1}^{L} \sum_{y=1}^{L} [f_{x,y}(0) + f_{x,y}(1)]
\]  

(1)
Where, \( L = 1, 2, 3 \ldots 256 \)
\[
\begin{align*}
 f_{x,y}(0) &= \text{black pixel having the value of zero}, \\
 f_{x,y}(1) &= \text{white pixels having the value of one}
\end{align*}
\]

\[ P = \sum_{i=1}^{L} \sum_{j=1}^{L} f_{x,y} \quad (2) \]

Were,

\[ P = \text{number of white pixels} \]

![Figure 3. Block diagram of proposed model](image)

Now, by utilizing eq. (1), area of segmented tissue is calculated, millimetres. i.e., 1 pixel = 0.264583 mm

\[ A_{\text{Tumor}} = (\sqrt{P}) \times 0.264 \text{mm}^2 \]

4. Experimental Results

In this simulated analysis of proposed hybrid clustering in comparison to conventional clustering algorithms for detection of single and multi-tissues from the MR brain images shown in figure 4. Various MR images have been utilized with different sizes and different stage of tissues for testing the effectiveness pf proposed clustering algorithm.
Then, with the suggested hybrid clustering algorithm for single and multi-tissue identification in MR brain pictures, we assessed the efficiency of traditional Fuzzy c means, K-means and various image algorithms schemes shown in the figure 5. By using the proposed hybrid algorithm and the current algorithms the experimental effects of MRI tumour detection statistics is displayed and the performance evaluation with CPU running time for multiple tissue detection is shown in figure 6.

![Figure 4](image1)

**Figure 4.** (a) MR brain image and obtained segmented images with (b) manual segmentation (c) Fuzzy C Means and (d) K-means (e) proposed hybrid clustering

![Figure 5](image2)

**Figure 5.** (a) Original image and obtained segmented images with (b) manual segmentation(c) fuzzy C means (d) K-means (e) proposed hybrid clustering

5. Conclusion
The application of tissue identification in MR brain images and tissue region measurement has been accomplished with increased sensitivity and decreased computational time. The use of hybrid clustering and region estimation on the basis of typography and digital imaging units has been efficient in terms of mm \(^2\). We correlated the outcomes of the simulation with the current algorithms as well. Furthermore, this can be extended to 3D multi modal medical image segmentation with more effective and accurate clustering algorithms.

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