# Segmentation of Brain Tissue using Fuzzy Local Information C-Means Technique

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**ABSTRACT**

Image segmentation is one of the important tasks of image processing. Medical image segmentation extracts and characterizes anatomical structures based on some input or expert knowledge. Magnetic Resonance (MR) image provides more detailed information for medical examination rather than other medical images such as X-ray, Ultrasonic and CT images. Captured MRI image is visually examined by radiologist for further detection and diagnosis of diseases. Segmentation and visualization on an MRI data manually is a time consuming process and hence to avoid complexity, computer aided diagnosis method of segmentation for tissues is proposed adopting fuzzy clustering techniques. Fuzzy C-Means (FCM) algorithm is a familiar fuzzy clustering technique used in image segmentation. In proposed method, Fuzzy Local Information C-Means algorithm (FLICM) is introduced which includes a parameter free novel fuzzy factor. This algorithm can be applied for medical image segmentation for classifying brain MRI into different regions such as Gray matter (GM), White matter (WM) and Cerebro-Spinal fluid (CSF). After classifying into different tissue regions, several diseases can be analyzed easily. Proposed method shows the effectiveness of algorithm in segmenting brain image into different tissue types.

**KEY WORDS:** Segmentation, Clustering, fuzzy c-means, brain image.

## 1. INTRODUCTION

One of the important tasks of image analysis is image segmentation. Image segmentation partitions image into clusters which is easy to analyze. Some of the applications of image segmentation include pattern recognition, object identification, feature extraction and medical imaging. For medical images, image segmentation plays a vital role. In this paper a technique is presented which is applied to detect the different tissues present in MRI brain images. After detecting the brain tissues, several diseases can be diagnosed easily.

Image segmentation is categorized into four types such as finding the threshold, grouping into clusters, detecting the edges and extracting the regions (Samina, 2010). The second type such as clustering is proposed for image segmentation. Hard clustering and fuzzy clustering or soft clustering is the two clustering strategies. Each object of the dataset corresponds to only one cluster in hard clustering approach. But in fuzzy clustering each object corresponds to more than one clusters based on membership value. No information can be gathered when medical image is restricted to only one cluster. So for medical images fuzzy clustering is a more advisable technique than hard clustering technique. In fuzzy clustering, objects are assigned with membership degrees between 0 and 1 representing their partial membership.

One classification of fuzzy clustering is named as fuzzy c-partitions and is also called out as fuzzy c-means (FCM) Clustering. FCM was first constructed by Dunn (1974), and is later modified by Bezdek (1981). Characteristics of FCM algorithm is validated based on selection of initial cluster center and membership value. In any type of images, image segmentation using FCM algorithm (Sucharitha, 2011) is powerful but there is still a drawback encountered. The drawback existing is desired number of clusters should be mentioned well in advance. To compensate the drawback of FCM algorithm, in order to achieve better performance local spatial information is incorporated into the original FCM algorithm by many researchers. This paper presents FLICM, a robust fuzzy local information c-means clustering algorithm, incorporates both spatial information and gray level information into the conventional objective function by introducing a new factor. The forthcoming chapters are organized accordingly as. Section 2 reviews the different clustering algorithms, the proposed method explained in section3, segmented output are drawn in Section 4 and focus on conclusion in Section 5.

**Existing Method:** Fuzzy clustering is a widely preferred technique. Fuzzy set theory was formulated by Zadeh in 1965 and the concept explained was uncertainty is related to membership function. The use of fuzzy set provides imprecise class membership function. For each cluster, membership values are assigned and the number of clusters tends to increase according to the membership value.

Fuzzy clustering (Martin, 2006) algorithms are widely employed and is categorized into clusters such as i) Classical and ii) Shape- based. The potential of classical fuzzy clustering algorithms is more in literature and coincidence of some of them are i) Fuzzy c means (FCM) ii) Suppressed fuzzy c-means (SFCM) iii) Possibilistic c-means (PCM) and (iv) Gustafson- Kessel (GK), while the shape-based fuzzy clustering algorithms include: i) Circular shape- based ii) Elliptical shape-based and (iii) Generic shape-based techniques .

The segmentation underwent using modified technique is lip segmentation. Lip segmentation was successful conducted and the comparative study of the proposed method with the traditional method is performed.

Yoon (1999), proposed an image segmentation method. The Fuzzy clustering method is implemented. Shan (2005), proposed an MRI segmentation. Tissues are segmented using neural network optimization using the neighborhood Attraction. Ahmed (2002), proposed a variant of FCM called FCM_S that concentrates on labeling of pixel depending on the immediate neighborhood labels. The processing is more, since the neighborhood labeling is computed in each iteration.

Chen and Zhang (2004), taken into account both mean and median of an image and proposed two class of FCM algorithm as FCM S1 and FCM S2. Processing time for both techniques are reduced but it is dependent on noise. Szilagyi (2003), improves the segmentation process by proposing an enhanced FCM (En FCM) algorithm. A linearly-weighted sum image is determined by incorporating both the local average of each pixel neighborhood gray level value and gray level value of original image. Cai (2007), formed a non-linearly weighted sum image by incorporating both spatial and gray level information and the technique is called out as Fast Generalized FCM algorithm (FGFCM).

A parameter '$a$' or '$\lambda$' is included which adjusts the tradeoff between the input image and its corresponding mean value or median value of image in the above techniques. Selecting the parameter is somewhat tedious since it has to come up with details of image as well as to overcome the noise. To tolerate the noise level 'a' is to be large value but on the other hand 'a' is to be small value in order to preserve the image sharpness and details. This paper deals with a novel FLICM which is independent of any assumptions and has the capability to segment the MRI brain image into three tissues.

**2. MATERIALS AND METHODS**

Based on fuzzy memberships (Noordam, 2000), Fuzzy $c$ means (FCM) algorithm (Ahmed, 2002) is the commonly used image segmentation method which groups each pixel into a cluster. Basics conventional FCM algorithm is used in many areas and it provides satisfactory results for noise-free images. But has a serious limitation as it does not include any information about spatial context and hence is more sensitive to noise and imaging artifacts.

Our proposed technique, novel fuzzy factor $G_{ki}$ is incorporated over the objective function of conventional FCM, to overcome the intrusion of any value and is shown below,

$$G_{ki} = \sum_{j \epsilon N_i, i \neq j} \frac{1}{d_{ij}+1} \left(1-u_{kj}\right)^m ||x_j - v_k||^2 \dots\dots (1)$$

Where $k$ is reference cluster, spatial Euclidean distance between pixels $i$ and $j$ is $d_{ij}$, degree of membership is determined as $u_{kj}$ which is the relation of $j^{\text{th}}$ pixel in $k^{\text{th}}$ cluster, fuzzy membership has a weighting exponent and s represented as $m$ and the center of cluster $k$ has the prototype as $v_k$.

FLICM technique is proposed by incorporating both spatial details and gray level details into conventional function and is expressed in way of $G_{ki}$ as,

$$\mathrm{J_m} = \sum_{\mathrm{i}=1}^{\mathrm{N}} \sum_{\mathrm{k}=1}^{\mathrm{c}} [\mathrm{u_{ki}^m} ||\mathrm{x_i} - \mathrm{v_k}||^2 + \mathrm{G_{ki}}] \dots\dots\dots (2)$$

**FLICM algorithm is described below as:**

Rule 1: Initialize the number of cluster as $c$, fuzzification parameter $m$ and the stop of process $\varepsilon$.

Rule 2: Assume fuzzy partition matrix using trial and error.

Rule 3: Assign the value of loop counter to be $b = 0$.

Rule 4: Cluster prototypes is determined based on the formula shown below

$$v_k = \frac{\sum_{\mathrm{i}=1}^{\mathrm{N}} u_{ki}^m \,\mathrm{xi}}{\sum_{\mathrm{i}=1}^{\mathrm{N}} u_{ki}^m} \dots\dots\dots\dots\dots\dots\dots\dots (3)$$

Rule 5: Find the fuzzy partition matrix with the help of the following equation as

$$u_{ki} = \frac{1}{\sum_{j=1}^{c} \left( \frac{\|\mathrm{x_i} - \mathrm{v_k}\|^2 + G_{Ki}}{\|\mathrm{x_i} - \mathrm{v_j}\|^2 + G j_i} \right)^{1/m-1}} \dots\dots. (4)$$

Rule 6: When $max\{U^{(b)} - U^{(b+1)}\} < \varepsilon$, then end the process, else, set $b = b + 1$ and move to Rule 4.

Fuzzy partition matrix $U$ is converted into a crisp partition once the complete iteration is over. To perform the above process defuzzification process is undergone and is mentioned below.

$$C_i = arg_k\{max\{u_{ki}\}\} \dots\dots\dots\dots\dots (5)$$

Fuzzy image achieved after doing the process is then converted into crisp segmented image. The above concept is implemented to segment brain MRI images into three tissue types and is free of any outliers and also

independent of parameters. The segmentation performance is much more enhanced than the existing techniques.
When outliers are present in the image the good qualities of the algorithm is explained by two basic cases. They are,
**Case (i)**: Pixels present in local window are corrupted by noise but pixel located at the Centre is not a noise pixel.

In such case, gray levels of noisy pixels to that of other pixels within the window are different and hence their membership values are balanced by factor$G_{ki}$. Therefore, the relation of noisy pixels is suppressed by factor $G_{ki}$. Noise is removed by including the combination of spatial and the gray level constraints into function. Algorithm is also more advantageous in case of outliers.
**Case (ii):** Pixels present in local window are homogenous, not corrupted by noise but pixel located at the Centre is a noise pixel.

In such case, central pixel membership value is balanced by factor $G_{ki}$ by considering both the spatial and the gray level of the without noise neighboring pixels in a fuzzy manner. Although membership value of central pixel does not corresponds to noise, the proposed method becomes more robust to outliers.

## 3. EXPERIMENTAL RESULTS

Experimentation is undergone for proposed method. The algorithm is implemented using MATLAB and tested on brain MRI images to explore the segmentation accuracy of the proposed approach. The comparison is made and the quality of segmentation of the proposed algorithm can be calculated by segmentation accuracy which is given as.

$$SA = \frac{number\ of\ correctly\ classified\ pixel}{(\text{Total number of pixels})}$$

The basic FCM algorithm and the proposed algorithm, FLICM are implemented on a brain MRI image and segmentation is performed. Initially, a brain MRI image is considered as original input image. Input image loaded is a gray scale image. Noise can be added if necessary. Input image and the FLICM segmented output is shown in fig.1.Cluster-1, Cluster-2 and Cluster-3 corresponds to Gray matter, White matter and Cerebro-Spinal Fluid.

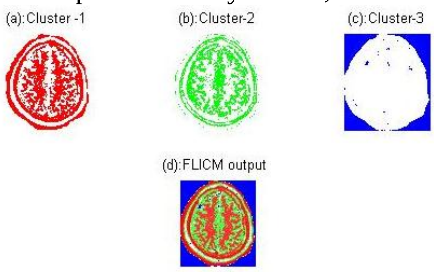


**Fig.1.Segmented output**

The segmentation accuracy achieved in the proposed method with respect to noise is 98.24%

## 4. CONCLUSION AND FUTURE WORK

Medical image segmentation is one of the important tasks in medical field. Several clustering algorithms have been introduced for image segmentation. FCM is the traditional algorithm which depends on parameter selection and also cannot be directly implemented on an original image. In the proposed FLICM method, the algorithm can be directly applied on the original image by introducing a novel fuzzy factor which is completely parameter free. In the proposed method, it is found out that the region is segmented accurately rather than traditional FCM algorithm. In addition to this, in future algorithm can be modified by introducing a tradeoff and a kernel factor in order to enhance its robustness and also to provide effective and efficient results on medical images.

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