

LITERATURE SURVEY

There are many approaches to segment a noisy brain MR Image volume. The main approaches to segment a noisy brain MR image volume can be summarized in these three broad categories:

1. Fuzzy Logic Based Statistical Methods.
2. Convolution Neural Networks (CNNs)
3. Fuzzy clustering methods based on Entropy

Fuzzy Logic Based Statistical Methods

Ahmed et al. presented a modified FCM algorithm for segmentation of brain MR image and as well as estimation of IIH. It modified the objective function of the FCM algorithm to compensate the IIH while allowing labeling of a pixel using the labels of the pixels in its immediate neighborhood. It used an empirically selected value to handle the trade-off between the original image and its median-filtered image.

The above method computed the neighbourhood iteration-by-iteration. It was a time-consuming affair. Cai et al. proposed a fast and robust FUZZY C-MEANS (FGFCM) algorithm. It used local information for image segmentation. It introduced a novel factor that calculated the similarity factor of the i^{th} pixel and its neighboring j^{th} pixels.

Adaptive Spatial Information-Theoretic Fuzzy Clustering (ASIFC) proposed by Wang, solved two of the drawbacks of FCM algorithm. The proposed methodology incorporated a new similarity measure, which solved the problem of lack of spatial information. It defined the mutual information (MI) maximization process to identify the reliable and outlier data points among all the data points. It made the algorithm more robust to noise.

The proposed sFCM algorithm by Chuang also addressed the spatial information problem of the FCM algorithm. It incorporated local spatial information into the membership function. This spatial information is defined as the summation of the membership function in the immediate neighbourhood of each pixel under consideration. This helped to greatly reduce the spurious blobs of data points and less sensitivity to noise.

In another method proposed by Qiu et al. used two fuzzifiers in the form type-2 interval fuzzy set and a spatial constraint. It used two fuzzifiers instead of one to properly represent the uncertainty that arises due to the presence of noise and IHH.

Pal et al. proposed a possibilistic FCM, where membership possibilities and cluster centres are generated simultaneously.

Mahata et al. proposed an algorithm that uses a Gaussian function, characterizing the IHH and local contextual information. Each pixel uses two membership functions. The global and local membership functions are inbuilt into the objective function and they contribute to identifying centres of the proper cluster prototypes. It greatly undermines the effect of noise and IHH.

In novel two-stage fuzzy multi-objective framework (2sFMoF) for segmenting 3D brain MR image volume, the segmentation process is divided into two steps. In the first stage, the global membership function is incorporated with the local membership function to generate the initial cluster centres. The cluster centres generated are considered to be the initial cluster centres of the new 3D modified FCM algorithm, where the local voxel information is further incorporated to generate the final membership function and cluster prototype.

A modified FCM algorithm using scale controlled spatial information is proposed by Sing et al. to segment noisy brain MR images.

A probability function is defined utilizing the scale-controlled spatial information from the immediate square neighbourhood of a pixel under consideration. This parameter is used with the local membership function in the objective function. The local and global membership functions are combined to yield the final clusters.

Adhikari et al. proposed a conditional spatial FCM (csFCM) algorithm for brain MR image segmentation. Apart from using the global membership function, it introduced a local membership function implemented by conditional variables. These conditional variables are generated from the neighbouring spatial information and they contribute in constructing the cluster prototypes. It then integrates the local and global membership functions using a weighted parameter to increase the immunity to noise and IHH.

Convolution Neural Networks (CNNs)

Pereira proposed a method for brain tumour segmentation in MR images using deep convolutional neural networks. It exploited small convolutional kernels. The method stacked more convolutional layers having the same receptive fields as bigger kernels.

Moeskops proposed an automatic brain MR image segmentation method based on multi-scale CNN. It combines multiple patches and kernel sizes to learn multi-scale features, which estimates both the intensity and spatial characteristics.

The main disadvantage of CNN is that it requires high-quality noise-free data for the training part. If the data is corrupted then it can ruin the predictive behaviour of the Convolution Neural Network.

To select noise-free data, the initial intervention of human expertise is required. Apart from the high initial data required, it also requires huge computation prowess to train the model.

Fuzzy Clustering Methods Based on Entropy

Yao et al. proposed a fuzzy clustering method based on entropy to find all-natural clusters from the input data. The algorithm selects the initial cluster centres based on minimum entropy associated with the data points.

In the case of heavy noisy data, Zarinbal proposed an algorithm that used the relative entropy method. In this algorithm, instead of using the absolute entropy of a particular data point, relative entropy was incorporated into the objective function. The main goal of the objective function is to maximize the dissimilarity among all clusters and to minimize the dissimilarity inside the cluster.

Askari proposed a generalized entropy based possibilistic fuzzy c-means algorithm for noisy data. It integrates fuzzy, possibilistic and entropy terms in the objective function.

Kannan proposed a quadratic entropy based FCM algorithm by combining regularization function, quadratic terms, mean distance functions, and kernel distance functions. The algorithm is evaluated on time series data.

Gharieb proposed a modified FCM algorithm by combining both local data and membership function into the objective function. It uses two membership relative entropy (MRE) functions to incorporate local membership function. Whereas, the local data information is incorporated using a weighted distance computed from the local neighbourhood.

Mahata and Sing et al. proposed novel fuzzy clustering algorithm by minimizing global and spatially constrained likelihood-based local entropies for noisy 3D brain MR image segmentation. In this methodology two membership functions are used. A global entropy using fuzzifier weighted global membership function, and a spatially constrained likelihood-based local entropy using fuzzifier weighted local membership function. The final membership function is obtained by weighted combination of these two-membership functions using a regularizing parameter which is selected empirically. The global and local membership functions are treated as two unrelated or independent parameters and they contribute proportionally to form the final cluster centres. As two membership functions are used in tandem, it provided a better immunity to noise and IHH, and provided a greater range of flexibility to variety of noise.