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# Brain Tumor MRI Image Segmentation using FCM and SVM Techniques

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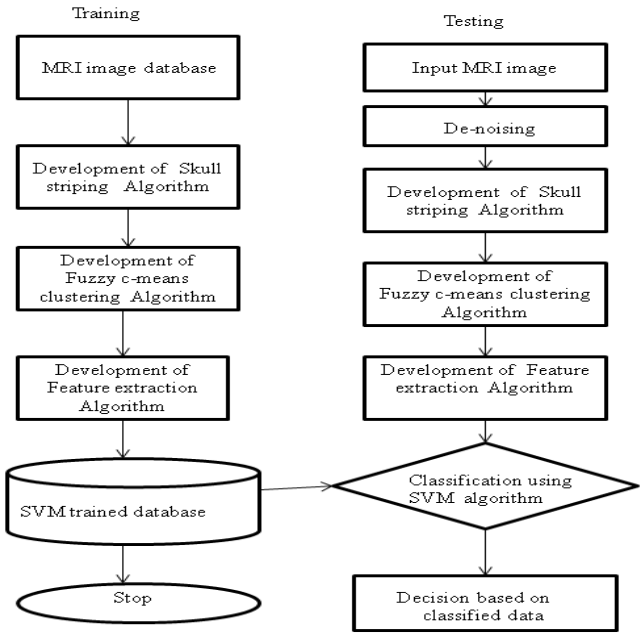
**Abstract:**
Medical imaging is a technique that is extensively used to create images of human body for medical and research purposes. Automatic brain tumor detection from MRI images has become one of the major areas of medical research. The important task in the diagnosis of brain tumor is to determine the exact location, orientation and area of the abnormal tissues. A new hybrid technique based on the support vector machine (SVM) and fuzzy c-means for brain tumor classification is proposed. The proposed algorithm is a combination of support vector machine (SVM) and fuzzy –c- means, a hybrid technique for prediction of brain tumor. In this algorithm the image is De-noised first and then morphological operations are used for skull striping. Fuzzy c-means (FCM) clustering is used for the segmentation of the image to detect the suspicious region in brain MRI image & features are extracted from the brain image. The feature extraction is the process to represent raw image in its reduced form to facilitate decision making such as pattern classification. Feature extraction is a method of capturing visual content of an image. This approach combines the Intensity, Texture, shape based features and classifies the abnormal area in image as tumor or non tumor normal area. The experiment is performed on tumor contained brain MR images from the Internet Brain Segmentation Repository and Diagnostic centers. After which SVM technique is applied to classify the brain MRI images, which provide accurate and more effective result for classification of brain MRI images

**Keywords:** Data Mining, MRI, De-noising, Fuzzy C-means clustering, Support Vector Machine (SVM)

## I. INTRODUCTION

In medical image segmentation, brain tumor detection is one of the most challenging tasks, since brain images are complicated and tumors can be analyzed only by expert physicians. Brain tumor is a group of abnormal cells that grows inside of the brain or around the brain. The tumor may be primary or secondary. There are over 100 different types of brain tumors, which make effective treatment complicated. A brain tumor can directly destroy all healthy brain cells. It can also indirectly damage healthy cells by crowding other parts of the brain and causing inflammation, brain swelling and pressure within the skull. Due to the large amount of brain tumor images that are currently being generated in the clinics, it is not possible for clinicians to manually annotate and segment these images in a reasonable time. Hence, the automatic segmentation has become inevitable. Brain tumor segmentation is to segment abnormal tissues such as active cells, necrotic core, and edema from normal brain tissues including GM, WM, and CSF. In recent years, medical imaging and soft computing have made significant advancements in the field of brain tumor segmentation. Medical image segmentation has vital role in clinical treatments. Segmentation of brain images in MR can be useful in diagnosis of pathology, presurgical planning and computer integrated surgery. Main application of this technique is to obtain size & location of tumor, which will help in planning of treatment. Clustering is used in segmentation of images that can be used to unionize set of pixels into groups based on similarities among the individual data items in such a way that data points of the same group are more identical to one another than samples belonging to different groups. The Classification and detection of brain tumor is done by using the Support Vector Machine technique. Classification is done to identify the tumor class present in the image.

### Flow Chart



## II.OVERVIEW OF EXISTING METHODS

There are several methods which have been used for detection of brain tumor. In this paper, we have used three state-of-art techniques for comparison purposes. The first one is Threshold-based second one is Clustering and the third one is the Region-based method. But the proposed work for getting high accuracy in tumor detection image is using Fuzzy –C- Means & SVM

### *1) Threshold – based methods*

Threshold-based method is a simple and effective segmentation method by comparing their intensities with one or more intensity thresholds. At present, threshold-based methods are classified into global and local thresholding. If an image contains objects with homogeneous intensity or the contrast between the objects and the background is high, global thresholding is the best choice to segment the objects and the backgrounds. When the contrast of an image is low, threshold selection will become difficult. Local thresholding can be determined by estimating a threshold value for the different regions from the intensity histogram. The threshold values of local thresholding are generally estimated by using the local statistical properties such as the mean intensity value in T1w MRI, by the prior knowledge and by calculating partial volumes of each region to determine the threshold for the segmentation of each component. In addition, the Gaussian distribution was applied to determine the thresholds in normal brain MRI image. Due to the special structure of brain tumor, global and local thresholding are mainly used to determine the approximate location of brain tumor in the brain. In most cases, thresholding is used as the first step in the segmentation process of brain tumor. Thresholding based segmentation is easy and effective technique but require prior knowledge about image

### *2) Clustering*

Cluster analysis or clustering based segmentation technique groups a set of objects in such a way that objects in the same cluster have higher degree of similarity to each other than to those in other clusters. Clusters may be defined as contiguous regions of a multidimensional space containing relatively high density of points, separated from other such regions containing relatively low density of points. In image analysis, Clustering is the process of grouping pixels according to some characteristics such as intensity. In hard clustering, data elements belong to one cluster only and the value of membership of belongingness to a cluster is exactly one. In soft clustering, data elements belong to more than one cluster, and the value of membership of belongingness to a cluster range from 0 to 1.

### *A) K-means Clustering*

K-means clustering is a type of hard clustering algorithms. This technique belongs to the category of unsupervised cluster analysis algorithms. Given 'n' number of observations, this algorithm groups these observations into clusters. The observations that belong to same cluster are alike in nature and those belonging to different clusters are different in nature. The number of clusters 'k' is assumed to be fixed. Each cluster has a leader called 'centroid'. Cluster centroids are initialized with random values. The sum of squares of distance between observation and cluster centroid is minimized iteratively. Centroid is then recalculated until convergence.

### *B) Fuzzy C-means Clustering*

Fuzzy C-means clustering is a soft clustering technique which allows partial belongingness of pixels into different clusters. This partial membership is calculated using membership functions. The sum of all membership degrees for any given data point is equal to 1. This method has better applicability to segmentation applications than hard clustering algorithm. The algorithm finds 'c' clusters by minimizing the objective function given by equation (1).

$$J_{FCM} = \sum_{k=1}^{n} \sum_{i=1}^{c} (u_a)^q \, d^2(x_k, v_i) \ldots\ldots\ldots$$

where, $x_k = \{x1, x2, \ldots, x3\}$ are the data points, n is the number of data items, c represents the number of clusters, the degree of membership of xk in the ith cluster is represented as uik, q is the weighting exponent on each fuzzy membership, vi represents the centre of cluster i, $d^2(xk, vi)$ is the distance between data point $x_k$ and cluster centre vi.

### *3) Region Growing*

Region growing is a region-based image segmentation technique [14] in which the pixels in whole image are grouped into sub regions or larger regions on the basis of some predefined criterion. Region based segmentation is relatively simple and has higher noise immunity as compared to edge detection method. It can also be termed as a pixel-based image segmentation technique which incorporates the selection of initial seed points from the image. This method of segmentation is performed by observing neighboring pixels of initial seed points and determining to which region the neighboring pixels belong. The process is repeated on till the image is divided into regions. In the implementation of this algorithm, there are three important aspects. The first and the most important one is to select the group of initial seed pixels by which we can accurately represent the required region; second one is to choose the criteria by which adjacent pixels can include in the growth process and third one is to select conditions to terminate the growth process. The primary disadvantage of region growing method is the partial volume effect which limits the accuracy of MR brain image segmentation. Partial volume effect blurs the intensity distinction between different tissue classes at the border of the two tissues types, because the voxel may represent more than one kind of tissue types. Some segmentation methods incorporate the region growing process as a refinement step.

## IV.A HYBRID TECHNIQUE BASED ON FUZZY-C-MEANS AND SVM

The proposed methodology consists of a set of stages starting from collecting brain MRI images. This hybrid technique involves the following main steps such as De-noising, skull striping, segmentation, feature extraction and training the SVM classifier using MRI images. All the above said steps are involved in testing phase, using the new MRI images with same

features to SVM and brain MRI images are classified. This study used dataset of patients MRI brain images and classified them as tumor or non tumor. The image is processed through:
• Attainment of images • De-noising MRI images • Skull striping • Fuzzy c-means • Feature Extraction • SVM Classifier

**1) Attainment of images**: Brain MRI images were collected from different medical centers & internate. These brain MRI images were converted into two dimensional matrices using MATLAB.

**2) De-noising MRI images:** The qualities of images are improved using De-noising technique. It is essential to improve the image information for human viewers, so that accurate outcomes are achieved. The methods given below that are used for enhancement of brain MRI images. The first step is enhancement of MRI. Here only the brightness of the images was increased to enhance perceptibility. This was complete to improve the quality of the brain MRI images.

• Contrast improvement- MRI images are RGB images, which are converted into gray scale images. These gray scale images are called intensity images. Here intensity values are mapped into low and high intensity values using imadjust (MATLAB function).

• Mid-range Stretch- this is also an enhancement technique. In this method, the middle range MRI image intensity values are stretched. So it improves the quality of brain MRI images. In this technique, gray scale image pixels are mapped between 0 and 1 value by dividing 255 intensity values

Subsequently applying the above function f (xij) the gray-scale images are converted to indexed images. The output images obtained after applying all the operations are done to improve the quality of images.

**3} Skull stripping**: Skull stripping is a significant step. The steps involved in skull stripping are given below.

• Double thresholding- it is a segmentation technique. This technique, convert the image into binary form, that is gray scale image to binary image.

• Erosion- in this stage unwanted pixels are removed from MRI image after thresholding. Thus the skull portions are removed. Here disk of radius 3 was taken as a structuring element for removing all unwanted pixels which are contributing to the brain MRI images.

• Region filling- this method is used to fill the holes in the images. After the erosion, eroded images are filled using region filling algorithm. Here the associated background pixels are converted into foreground pixels so that the holes present in the eroded images are removed in brain MRI image.

**4) Tumor segmentation:** In this work, fuzzy c-means algorithm was used in MRI image segmentation. Fuzzy C-Means (FCM) algorithm is used to find out the suspicious region from brain MRI image. The advantages of FCM algorithm include: (1) Giving the best result for overlapped data set and comparatively better hank means algorithm.(2) Unlike k-means where data point must exclusively belong to one cluster center, assigning the membership of data points to more than one cluster center. As a result, a data point may belong to more than one cluster center. (3) The application of FCM to MR data has shown encouraging results. Therefore, FCM for segmenting brain tumors is becoming a fruitful research area. Membership function is the curve that defines how each point in the input space is mapped to membership value (or degree of membership) between 0 and 1 as shown in figure

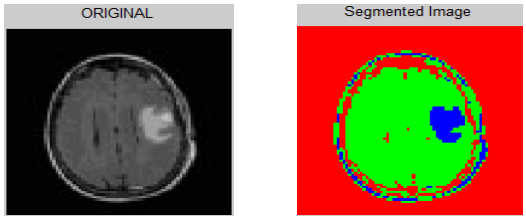



**Figure.1: Original image, Fuzzy-c-mean-segmented image**

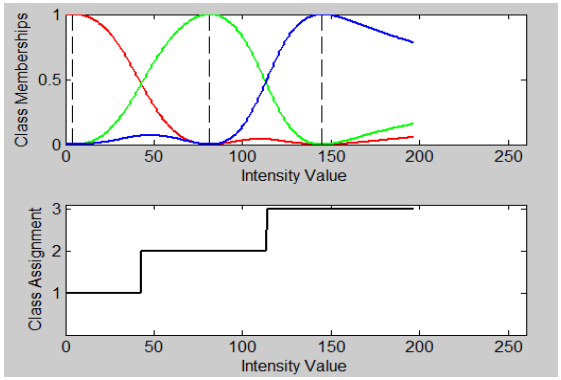



**Figure.2.Fuzzy membership functions**

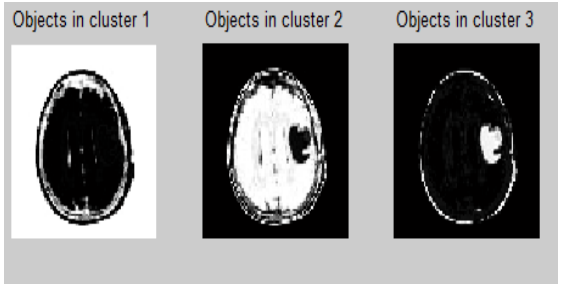



**Figure.3. Membership maps**

**5) Feature extraction**: Feature extraction is a technique to find the relevant features from images, which are used to understand the images easier. This input data set images are converted into compressed form is called feature extraction. It can reduce the work for further processing such as image classification. Features, the characteristics of the objects of interest, if selected carefully are representative of the maximum relevant information that the image has to offer for a complete characterization of a lesion. Feature extraction methodologies analyze objects and images to extract the most prominent features that are representative of the various classes of objects. Features are used as inputs to classifiers that assign them to the class that they represent. The purpose of feature extraction is to reduce the original data by measuring certain properties, or features, that distinguish one input pattern from another pattern. The extracted feature should provide the characteristics of the

input type to the classifier by considering the description of the relevant properties of the image into feature vectors. In this proposed method we extract the following features. Shape Features - circularity, irregularity, Area, Perimeter, Shape Index Intensity features – Mean, Variance, Standard Variance, Median Intensity, Skewness, and Kurtosis Texture features–Contrast, Correlation, Entropy, Energy, Homogeneity, cluster shade, sum of square variance. Accordingly, 3 kinds of features are extracted, which describe the structure information of intensity, shape, and texture.

**6) Support Vector Machine (SVM):** SVM is a supervised learning method. It is a good tool for data analysis and classification. SVM classifier has a fast learning speed even in large data. SVM is used for two or more class classification problems. Support Vector Machine is based on the conception of decision planes. A decision plane is one that separates between a set of items having different class memberships. The Classification and detection of brain tumor was done by using the Support Vector Machine technique. Classification is done to identify the tumor class present in the image. The use of SVM involves two basic steps of training and testing.

## V. RESULTS AND DISCUSSIONS

The proposed algorithm implemented using MATLAB to verify its performance. To assess the performance of the proposed method, it tested on brain MRI dataset. In this proposed work fuzzy c-means is used for segmentation of brain MRI images. The result for segmentation provides accurate for large data sets. FCM works well for high as well as low density noise as well as it requires no prior information on the images to segment. The computation speed is fast so less execution time. Less memory requirement. Compared to other methods, it gives superior results without any boundary leakage even at high density noise. After this step features like Intensity, shape and Textur are extracted

## VI. CONCLUSION

In this proposed system MRI images of brain proved to be a significant way to detect the brain tumor. The combination of methodology like support vector machine and fuzzy c-means clustering for classification gives accurate result for identifying the brain tumor.

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## VIII. BIBLIOGRAPHY


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