

Segmentation & Classification Of MR Images of Brain Tissue Using IFCM & K-NN Algorithm

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Abstract— In the analysis of medical images for computer-aided diagnosis and therapy, segmentation is often required as a preliminary stage. Medical image segmentation is a complex and challenging task due to the intrinsic nature of the images. The brain has a particularly complicated structure and its precise segmentation is very important for detecting tumors, edema, and necrotic tissues, in order to prescribe appropriate therapy. Magnetic resonance imaging (MRI) is an important diagnostic imaging technique for the early detection of abnormal changes in tissues and organs. Image segmentation is an indispensable process in the visualization of human tissues, particularly during clinical analysis of magnetic resonance (MR) images. Unfortunately, MR images always contain a significant amount of noise caused by operator performance, equipment, and the environment, which can lead to serious inaccuracies with segmentation. A robust & improved segmentation technique based on an extension to the traditional fuzzy c-means (FCM) clustering algorithm will be used here. Simulated and real brain MR images are segmented to demonstrate the superiority of the proposed technique compared to K-means and FCM clustering methods. This segmentation method is a key component of an MR image-based classification system for brain tumours. A Brain tumor classification system will be designed and developed. The K-NN classifier will be used to classify subjects as normal or abnormal MRI human images. The known MRI images of affected brain cancer patients will be obtained and also images downloaded from Brain Web site will be used to train and test the system.

Keywords-Magnetic resonance imaging (MRI), K-Means Clustering, Fuzzy C-Means Clustering(FCM).

I. INTRODUCTION

Curing the cancer has been a major goal of medical researchers for decades, but development of new treatments takes time and money. Science may yet find the root causes of all cancers and develop safer methods for shutting them down. Approximately 40 percent of all primary tumors successfully treated with surgery and, in some cases radiation. The number of malignant brain tumors appears to be increasing but for no clear reason. Reliable and fast detection and classification of brain cancer is of major technical and economical importance for the doctors. Common practices based on specialized technicians are slow, have low responsibility and possess a degree of subjectivity which is hard to quantify. Brain cancer is a complex disease, classified into 120 different types. So called non malignant (Benign) brain tumors can be just as life-

threatening as malignant tumours, as they squeeze out normal brain tissue and disrupt function. Magnetic Resonance Imaging (MRI) has become a widely used method of high quality medical imaging, especially in brain imaging where MRI's soft tissue contrast and non-invasiveness is a clear advantage. MRI provides an unparalleled view inside the human body. The level of detail that can be seen is extraordinary compared with any other imaging modality. Therefore, the majority of research in medical image segmentation concerns MR images.

Many image processing techniques have been proposed for brain MRI segmentation, most notably thresholding, region-growing, and clustering. Since the distribution of tissue intensities in brain images is very complex, it leads to difficulties of threshold determination. Therefore, thresholding methods are generally restrictive and have to be combined with other methods. Region growing extends thresholding by combining it with connectivity conditions or region homogeneity criteria. Successful methods require precise anatomical information to locate single or multiple seed pixels for each region and together with their associated homogeneity [1]. Clustering is the most popular method for medical image segmentation. A loose definition of clustering could be the process of organizing objects into groups whose members are similar in some way. Cluster analysis is finding similarities between data according to the characteristics found in the data and grouping similar data objects into clusters. A cluster is therefore a collection of objects which are similar between them and are dissimilar to the objects belonging to other clusters. In this research work K-Means and Fuzzy C-Means clustering algorithms will be examined based on their clustering quality.

II. DETAIL EXPERIMENT

Literature Survey

SUI Yuan¹, WEI Ying^{2,3} [1]“MR Image Segmentation Algorithm Based On Non-Local Fuzzy C-Means Clustering”. In this paper the author deals with Fuzzy C-means clustering (FCM) is a kind of popular image segmentation algorithm currently. In this paper, Robust Fuzzy C-means clustering (RFCM) was improved by adding non-local weight value in it as penalty term, using redundant information of image to

eliminate the influence of noise. Therefore, an image segmentation algorithm based on non-local fuzzy C-means clustering has been proposed. Clinical MR brain images were segmented to verify the algorithm, the experimental results shows that: for segmentation of brain tissue in noisy MR images, the OLR overlap rate may reach above 90%. The algorithm has good performance for noisy MR brain image segmentation .[1]

B.Hachemi, S.Oudjemia, F.Alim, S. Seddiki, F.Talbi, M.Abdelaziz [2] “Cerebral Abnormalities Detection by Region-Growing Segmentation and KNN Classification” In this paper the author proposes a new technique In this paper, author propose a computer aided diagnosis system for brain MRI. This system is based on region growing segmentation and KNN classification. The co-occurrence matrix and the discrete wavelet decomposition methods are used to extract the parameters of suspect region. At the last part, author applied this system to other subject to estimate its accuracy.[2]

Noor Elaiza; Abdul Khalid; Shafaf Ibrahim; Puteri Nurain Megat Mohd Haniff [3] “MRI Brain Abnormalities Segmentation using KNearest Neighbors (k-NN)”. Segmentation of medical imagery remains as a challenging task due to complexity of medical images. In this paper author proposes a method of k-Nearest Neighbor (k-NN) in abnormalities segmentation of Magnetic Resonance Imaging (MRI) brain images. A preliminary data analysis is performed to analyze the characteristics for each brain component of “membrane”, “ventricles”, “light abnormality” and “dark abnormality” by extracting the minimum, maximum and mean grey level pixel values. The segmentation is done by executing five steps of k-NN which are determination of k value, calculation of Euclidian distances objective function, sortation of minimum distance, assignment of majority class, and determination of class based on majority ranking. The k-NN segmentation performances is tested to hundred and fifty controlled testing data which designed by cutting various shapes and size of various abnormalities and pasting it onto normal brain tissues. The tissues are divided into three categories of “low”, “medium” and “high” based on the grey level pixel value intensities. The overall experimental result returns good and promising segmentation outcomes for both light and dark abnormalities. [3]

Parveen, Amritpal singh [4] “Detection of Brain Tumor in MRI Images, using Combination of Fuzzy C-Means and SVM” . In this paper the author proposes data mining methods for classification of MRI images. A new hybrid technique based on the support vector machine (SVM) and fuzzy c-means for brain tumor classification is proposed. The purposed algorithm is a combination of support vector machine (SVM) and fuzzy cmeans, a hybrid technique for prediction of brain tumor. In this algorithm the image is

enhanced using enhancement techniques such as contrast improvement, and mid-range stretch. Double thresholding and morphological operations are used for skull stripping. Fuzzy c-means (FCM) clustering is used for the segmentation of the image to detect the suspicious region in brain MRI image. Grey level run length matrix (GLRLM) is used for extraction of feature from the brain image, 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. [4]

T. Velmurugan, T. Santhanam [5] ”Performance Evaluation of K-Means and Fuzzy C-Means Clustering Algorithms for Statistical Distributions of Input Data Points”. In this paper author proposes Data mining approach and its technology used to extract the unknown pattern from the large set of data for the business and real time applications. The unlabeled data from the large data set can be classified in an unsupervised manner using clustering and classification algorithms. Cluster analysis or clustering is the assignment of a set of observations into subsets (called *clusters*) so that observations in the same cluster are similar in some sense. The result of the clustering process and its domain application efficiency are determined through the algorithms. This research work deals with two of the most delegated clustering algorithms namely centroid based K-Means and representative object based Fuzzy C Means. These two algorithms are implemented and the performance is analyzed based on their clustering result quality. The behavior of both the algorithms depends on the number of data points as well as on the number of clusters. The input data points are generated by two ways, one by using normal distribution and another by applying uniform distribution . The performance of the algorithm is investigated during different execution of the program on the input data points. The execution time for each algorithm is also analyzed and the results are compared with one another.

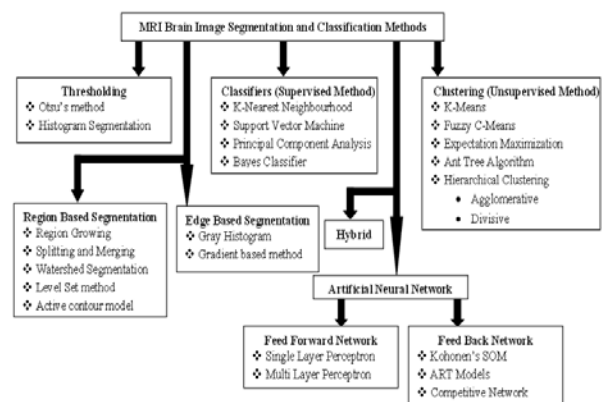


Fig1. Image Segmentation

III. RESULTS AND DISCUSSION

Research Methodology /Planning of Work

The proposed system consists of two stages namely segmentation and classification. In the segmentation stage the real MR image will be segmented using IFCM algorithm. In the classification stage non parametric statistic technique based K-NN (K- Nearest Neighbour) algorithm will be used. The GUI development in MATLAB for classification based on algorithm is proposed.

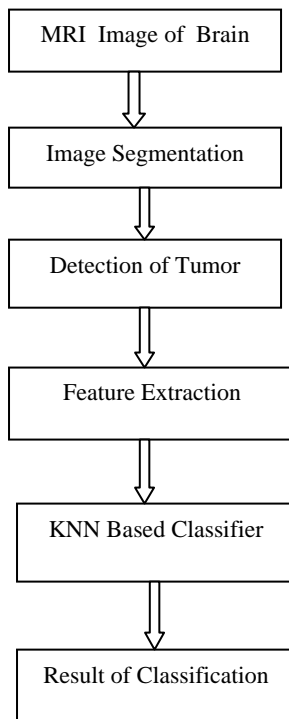


Fig2: Flow of project

Medical images generally contain unknown noise and considerable uncertainty, and therefore clinically acceptable segmentation performance is difficult to achieve. Therefore three clustering algorithms will be implemented by using MATLAB and their performance will be compared. The result of K-means depends upon the initial cluster set which are randomly assigned and value of K, due to which it does not yield the same result with each run. To overcome this problem FCM algorithm is used. The core of a fuzzy set is its membership function. Membership function is a function which defines the relationship between a value in the sets domain and its degree of membership in the fuzzy set. The relationship is functional because it returns a single degree of membership for any value in the domain. FCM is a popular segmentation method for medical images. However, literature

survey, shows that it is an intensity-based clustering algorithm which is not robust to noisy images. Although many extended algorithms based on FCM have been developed to overcome this shortcoming, none of them are flawless. Hence IFCM method is proposed here. Usually, one pixel is too small to represent part of an image. Assuming a pixel has a completely different intensity from its surrounding pixels, it is reasonable to conclude that this pixel must be affected by noise. Its real intensity should be identical to its neighbouring pixels. Therefore, it is assumed that an attraction exists between neighbouring pixels, which is coined as neighbourhood attraction. With IFCM algorithm, during clustering, each pixel attempts to attract its neighbouring pixels toward its own cluster. If a pixel has a very similar intensity to one of its neighbours, the attraction between them should be stronger than the attraction between the pixel and another neighbour with rather different intensities. A spatially closer neighboring pixel should also have a stronger attraction than a neighbour which is spatially distant. The components of the neighbourhood can also influence the attraction. Including neighbourhood attraction, segmentation using IFCM is not only decided by the pixel itself but also by its neighbouring pixels.

Preprocessing

Various preprocessing methods have been proposed to deal with the MRI brain images used for segmentation. Among all preprocessing methods, Skull stripping is used for the segmentation of brain tissues. The brain cortex can be visualized as a distinct dark ring surrounding the brain tissues in the MRI images. The distinct dark ring surrounding the brain tissues are removed by skull stripping method. In skull stripping, initially the given MRI brain image is converted into gray scale image and then a morphological operation is performed in the gray scale image. Then the brain cortex in the gray scale image is stripped by using region based binary mask extraction. The preprocessing process is performed in the classified normal images, not abnormal images. Because preprocessing process helps to improve the normal tissue is lightly placed in the cortex surrounding area. to determine the patient's stage whether it can be cured with medicine or not. The proposed system includes mainly four modules namely Pre-processing, segmentation using k-means and fuzzy c-means, Feature extraction, and approximate reasoning. If the tumor area is a mass then K-means algorithm is enough to extract tumor from the brain cells. If there is any noise present in the MR image then first it is removed before the K-means process. The noise free image is given as input to the k-means and tumors are extracted from the MRI image. The limitations of this technique is fuzzy membership determination is not a minor job and also calculation occupied in fuzzy approaches could be intensive MR image segmentation based on feed forward neural networks relies heavily on the training set used

for their supervised training. The training set is constructed by selecting feature vectors from a single MR image or an ensemble of MR images and reflects the judgment of the human experts who assign labels to the feature vectors according to the tissues they represent

Classifiers

1) KNN K-Nearest Neighbour (k-NN) classification technique is the simplest technique that provides good classification accuracy. The k-NN algorithm is based on a distance function and a voting function in k-Nearest Neighbours, the metric employed is the Euclidean distance. The k-NN has higher accuracy and stability for MRI data than other common statistical classifiers, but has a slow running time. The segmentation steps of k-NN are,
 Step1: Determine k value
 Step2: Calculate distance between the query instance and the training samples
 Step3: Sort the distance based on the kth minimum distance
 Step4: Assign the majority class
 Step5: Determine the class
 Step6: Segment the brain abnormalities

CONCLUSIONS

Several real images will be tested in the MATLAB project and results will be compared for consistency in diagnosis of brain tumors. To represent an image, large amount of data is required which occupies large amount of memory and time. In order to reduce the amount of data, memory and time, the features are extracted from an image. The extracted features contain the relevant information of an image. It can be used as an input to the classifier for image classification and segmentation. The type of features extracted from an image is classified

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