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Brain Tumor Segmentation Using K-Means and Fuzzy C-Means Clustering and Its Area Calculation and Stage Using SVM Algorithm

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Abstract – This work denote the implementation of various techniques for detection of range and shape of tumor in brain MR images and identifies stage of tumor from the given area of tumor. Existing work in developed countries prove that the numbers of people who have brain tumors were died due to the fact of inaccurate detection. After researching a lot statistical analysis which is based on those people whose are affected in brain tumor some general Risk factors and Symptoms have been discovered. The development of technology in science day night tries to develop new methods of treatment. This image is visually defined by the physician for detection & diagnosis of brain tumor. However this method accurate determines the accurate of stage & size of tumor and identifies stage of tumor from the area of tumor. This work uses segmentation of brain tumor based on the k-means clustering and fuzzy c-means clustering. This technique helps for the segmentation of tumor with accuracy compare to manual segmentation. It also reduces the time for analysis and finds the stage of tumor from the given area of tumor.

Keywords – Abnormalities, Magnetic Resonance Imaging (MRI), Brain tumor, Pre-processing, K-means, fuzzy c-means, Thresholding, SVM classification.

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1. INTRODUCTION

A. Background

The MRI scan is more suitable than CT scan for diagnosis. It is not affect the human body. It is based on the magnetic field and radio waves. There are different types of algorithm were work for brain tumor detection. But they may have some drawback in detection and extraction.

In this wok, two algorithms are used for segmentation. K-means clustering algorithm and Fuzzy C mean algorithm. So it gives the accurate result for tumor segmentation. Tumor is due to the uncontrolled growth of the tissues in any part of the human body. The tumor may be either primary or secondary. If it is an origin, then it is called as primary. If the part of the tumor is spread to another place and grown as its own then it is called as secondary. The lifetime of that particular person who affected by the brain tumor will increase if it is detected at current stage of tumor. That will increase the life about 1 to 2 years. Treatment for brain tumor which is depends upon the type and stage of the tumor, the size and place of the tumor, and your general health and person's medical history. In most cases, the aim of treatment is to remove the tumor completely. A person who was affected by any kind of tumor has an increased risk of developing another brain tumor of any type in body. A person who has two or more close relatives (brother, mother, father, sister or child) who are responsible for developing brain tumor has a risk factor of developing brain tumor for his own. Rarely, members of a family will have a rooted disorder that makes the brain more sensitive and increases the risk of brain tumor. About 5% of brain tumors may be linked to inherited (genetic) factors or conditions.

B. Goal

After researching a lot analysis which is based on those people whose are affected in brain cancer some general Risk factors and Symptoms have been discovered.

C. Objective

The main aim of this paper is to detect the brain tumor of MRI image and calculating its area and identify stage of tumor which is easier, cost reducible and time savable.

2. REVIEW OF LITERATURE

K-means and Fuzzy C-means techniques are to detect the iron in brain using SWI technique. An accurate result of iron accumulation is required for diagnosis and therapy of iron overload in various neurodegenerative diseases. Susceptibility Weighted Imaging (SWI) denotes information about any tissue that has a different susceptibility than its surrounding structures (Wilson and Malar Dhas, 2014).

Different fuzzy techniques have been used as a suitable alternative and pattern recognition to the fundamental quandary of human idea and defect of standard mathematics to deal with its complex and unclearly defined work (Das, 2013). This work directs the problem of segmenting an image into different regions. We study two unsupervised learning techniques namely the K-means clustering and EM and compare it with a graph based normalized cut technique. The K-means clustering and EM are clustering techniques, which partition a data set into clusters according to some defines distance measure (Tatirajua and Mehta, 2008).

This work has mainly focused attention on Clustering techniques, specifically k-means and fuzzy c-means clustering techniques. These techniques are connected together with another technique called fuzzy-c-means clustering technique, which has a good result in terms of time utilization. The techniques have been implemented and tested with Magnetic Resonance Image (MRI) images of Human brain. Results have been analysed and recorded (Funmilola, et. al., 2012).

Proposed work of image registration and data fusion theory adapted for the segmentation of MR images. Propose a system of image registration and data fusion theory adapted for the segmentation of MR images. This system provides an efficient and fast way for diagnosis of the brain tumor. This system provides an efficient and fast way for diagnosis of the brain tumor called K-means algorithm (Bandyopadhyay and Paul, 2013).

Proposed deep study of brain tumor describes different type of diagnosis techniques. This work presents a systematic Type-II fuzzy expert system for diagnosing the human brain tumors (Astrocytoma tumors) using T1-weighted Magnetic Resonance Images with contrast. The work Type-II fuzzy image processing technique has four distinct steps: Pre-processing, Image Segmentation, Image Feature Extraction, and Approximate Reasoning (Fazel Zarandia, et. al).

Proposed approach of Spatial Fuzzy C means (PET-SFCM) clustering technique on Positron Emission Tomography (PET) scan image datasets. Proposed technique is incorporated the spatial neighbourhood information with traditional FCM and updating the objective function of each cluster. This technique is implemented and tested on huge data collection of patients with brain neuro degenerative disorder such as Alzheimer's disease. It has determines its effectiveness by testing it for real world patient data sets (Meena).

Proposed work has denoted a cooperative and an effective technique for the detection of brain tumors based on median filtering, K Means Segmentation, FCM Segmentation, and finally, threshold segmentation techniques. This approach improves the quality of the tumor images acquired by the aid of MRI and then to detect the size of the tumor (Rajesh, et. al.).

Proposed work is a study of the various techniques that are available for color images, text and gray scale images. Image segmentation result of brain is a set of segments that composed cover the image, or a set of contours obtained from the image. Each of the pixels in a region is same with respect to some features, such as color, intensity, or texture (Singh and Singh, 2010).

3. PROPOSED SYSTEM APPROACH

Four modules in this proposed work: image pre-processing, image segmentation, image feature extraction, approximate reasoning and classification. Image pre-processing is done by using median filtering. Image segmentation is done by using K-means and Fuzzy C-means algorithms. Image feature extraction is by thresholding and last, approximate reasoning step to calculate the tumor area and identify stage of tumor from resultant area of brain tumor

A. Pre-processing

Pre-processing step includes median filter for noise removal. The possibilities of noise in modern MRI scan are very inferior. The main aim of this work is to detect and segment the tumor cells. But for the complete system it needs the process of noise filtering of image.

B. Segmentation using K-means

In this process, segmentation of brain image using K-means clustering technique to segment the tumor from image.

C. Segmentation using Fuzzy C means

In this process, for more accuracy purpose, again segmentation of brain image using fuzzy c-means clustering technique to segment the tumor from image.

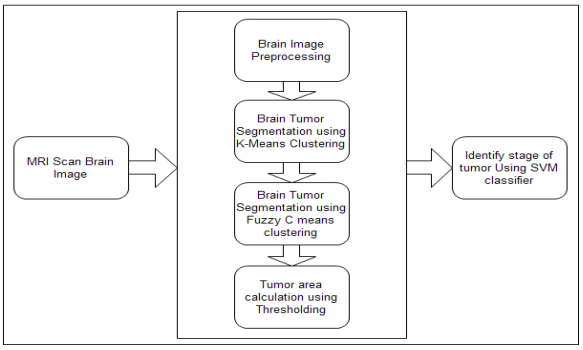
E. Approximate reasoning

In the approximate reasoning step the tumor area which is calculated using the binarization method. That is the image having only two values either black or white (0 or 1).

F. SVM Classification

In this step, classify the stage of tumor from the given area of tumor.

4. SYSTEM ARCHITECTURE



5. MATHEMATICAL MODEL

A. Mathematical equation in K- means clustering

1. $M = \frac{\sum_{i:c(i)=k} Xi}{Nk}$, k=1, 2,……, K.

2. D (i) = arg min$||X_i - M_k||^2$, i=1, 2,….., N.

B. Mathematical equation in Fuzzy-C means clustering

$$Y_m = \sum_{i=1}^{N}\sum_{j=1}^{C} M_{ij}^{m}||X_i - C_j||^2$$

Where,

m= any real number greater than 1,

M_{ij}= degree of membership of X; in the cluster j,

X_i= data measured in d-dimensional,

R_j= d-dimension center of the cluster,

The update of membership Mij and the cluster centers R are given by:

$$M_{ij} = \frac{1}{\sum_{K=1}^{C}\left(\frac{||Xi-Cj||}{||Xi-Cj||}\right)^{\frac{2}{m-1}}}$$

$$R_j = \frac{\sum_{i=1}^{N} Xi.Mijm}{\sum_{i=1}^{N} Mijm}$$

C. Mathematical Equations of Support Vector Machine

We have k sub-spaces so that there are k classification results of sub-space, called CL_SS1,

CL_SS2, ..., CL_SSk. Thus the problem is how to integrate all of those results. The simple integrating way is to calculate the mean value:

$$CL = \frac{1}{k}\sum_{i=1}^{k} CL\_SS_i$$

Or weighted mean value:

$$CL = \frac{1}{k}\sum_{i=1}^{k} w_i CL\_SS_i$$

Where w_i is the weight of classification result of subspace SSi, and satisfies:

$$\sum_{i=1}^{R} w_i = 1$$

The centroid of a hand is calculated as follows:

$$\overline{X} = \frac{\sum_{i=0}^{k} xi}{k}, \overline{Y} = \frac{\sum_{i=0}^{k} yi}{k}$$

Where $(\overline{X}, \overline{Y})$ represents the centroid of the hand, xi and yi are x and y coordinates of the i^{th} pixel in the hand region and k denotes the number of pixels that represent only the hand portion.

In the next step, the distance between the centroid and the finger-tip was calculated. For distance, the following Euclidean distance was used:

$$\text{Distance} = \sqrt{(x2-x1)^2 - (y2-y1)^2}$$

Where (x1, x2) and (y1, y2) represent the two co-ordinate values.

6. EXPERIMENTAL SET UP

(i) K-means clustering

K-Means is the one of the unsupervised learning technique for clusters. Clustering the image is grouping the pixels according to the same characteristics.

1. Give the no of cluster value as k.

2. Randomly choose the k cluster centers

3. Calculate mean or center of the cluster

4. Calculate the distance b/w each pixel to each cluster center

5. If the distance is near to the center then move to that cluster.

6. Otherwise move to next cluster.

7. Re-estimate the center.

8. Repeat the process until the center doesn't move.

(ii) Fuzzy C-Means Algorithm

The Fuzzy C-means is an unsupervised clustering technique which can be used to several problems involving feature analysis, clustering, medical diagnosis and image segmentation resp. The FCM algorithm minimizes the objective function for the partition of data set, $x = [x_1, x_2, ..., x_d]^T$ The fuzzy logic is a way to processing the data by giving the incomplete membership value to each pixel in the image. The membership value of the fuzzy set which is ranges from 0 to 1.

(iii) Support Vector Machine:

Step 1: Read the segmentation output Image. Step 2: Read random pixel of output Image and keep the pixel value (1 for white, 0 for black).

Step 3: Train the SVM and show the output which is classified with training data result.

Step 4: Test and Evaluate the performance of the classifier.

7. RESULTS

Let us consider the brain tumor image procured from image MRI scan, containing the tumor in figure 2. Median filtering is implemented on the acquired images to get rid of the unwanted noises. The outcomes are displayed in the figure 3.

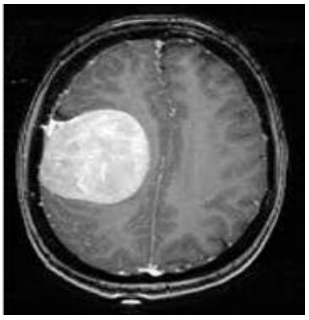


Fig. 2 Brain Tumor Image

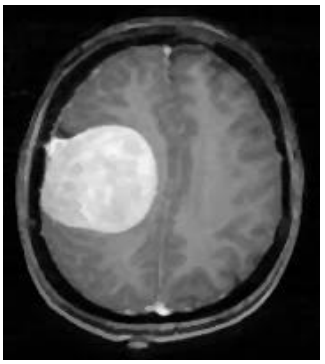


Fig. 3 Median Filtering Outcome

K means algorithm is implemented on such noise filtered images containing brain tumors. In figure 6, a white spot is seen in image, which is final output of application of threshold segmentation on the input image. This region is the area having higher intensity values compared to the defined threshold. Areas with higher intensity values mostly contains tumor. The outcomes of thresholding segmentation are shown below in figure 5.

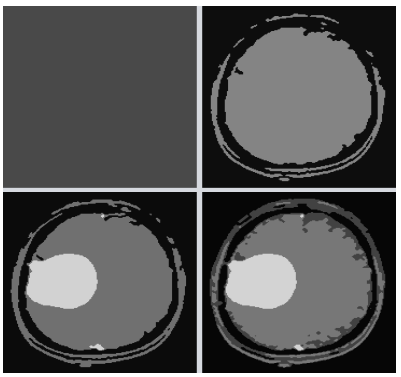


Fig. 4 K Means Clustering

\Once the K Means Clustering gets over, Fuzzy C-Means segmentation is finally implemented on the resulted image procured from K Means segmentation. The region affected by tumor is shown in this process. The outcome of the watershed segmentation is shown below in figure 4.

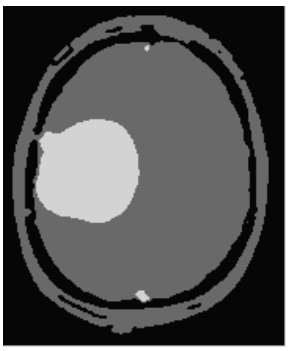


Fig. 5 FCM Segmentation

Eventually, the thresholding segmentation is implemented, once the FCM segmentation is completed. The outcomes are spectacular and proposed approach is efficient in nature to an extent. Figure 6 shows the resultant image obtains after the implementation of thresholding.

Fig. 6 Thresholding Segmentation

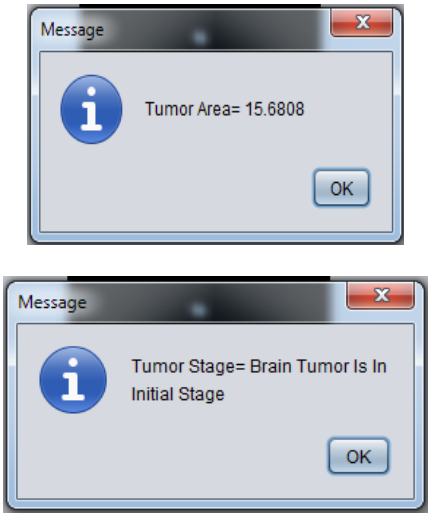


Fig. 7 Output Images of Tumor Area Estimation

The output is displayed above in figure 7. The proposed work is also very sensitive to the errors, because the small error will take the situation in ambiguous state which is not good for diagnosis of tumor. Again same FCM mean and k means techniques are used to compare individual performance with the proposed system and the result of all are compare and we find that the proposed system having less errors in the system.

8. CONCLUSION

K- Mean's algorithm is used for segmentation of brain tumor in this proposed work, also then segmentation using Fuzzy C means for accurate tumor shape extraction and thresholding of output in feature extraction to show the tumor part in brain image. After that, approximate reasoning for calculating brain tumor area and last using the SVM classification to identify stage of brain tumor from resultant area of tumor, i.e. identify stage of tumor which is easier, cost reducible and time savable.

The experimental results are compared with other existing algorithms. The proposed method gives more accurate result.

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