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Brain Tumor Segmentation Using K-Means Clustering and Fuzzy C-Means Algorithms and Its Area Calculation and Disease Prediction Using Naive-Bayes Algorithm

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ABSTRACT: This paper shows the implementation of Simple Algorithm for detection of range and shape of tumor in brain MR images and predicts the disease risk details from the given area of tumor. Tumor is an uncontrolled growth of tissues in any part of the human body. Tumors are of various types and they have various characteristics and different treatment. A brain tumor is inherently serious and life-threatening because of its character in the limited space of the intracranial cavity (space formed inside the skull). In developed countries most research shows that the numbers of peoples who have brain tumors were died due to the fact of inaccurate detection. Generally, a CT scan or MRI that is conducted into intracranial cavity creates a complete image of brain. Researching a lot statistical search which is based on those people whose are affected in brain tumor some general Risk factors and Symptoms have been found. The development of technology in science day night tries to develop new techniques of treatment. This image is visually checked by the physician for detection & diagnosis of brain tumor. However this technique accurate shows the accurate of stage & size of tumor and also predicts the disease details from the area of tumor. This work uses segmentation of brain tumor based on the k-means and fuzzy c-means algorithms. This method allows the segmentation of tumor tissue with accuracy comparable to manual segmentation. In addition, it also decrease the time for analysis and predicts the disease details from the given area of tumor.

Finally implement a system using java to predict Brain tumor risk level which is easier, cost reducible and time savable.

KEYWORDS: Abnormalities, Magnetic Resonance Imaging (MRI), Brain tumor, Pre-processing, K-means, fuzzy c-means, Thresholding, Naive-Bayes classification.

I. INTRODUCTION

This paper shows the concept for brain tumor segmentation and finally the detection of brain tumor and risk of disease. The anatomy of the Brain can be explored by the MRI scan or CT scan. In this paper the MRI scanned image is taken for the whole process. The MRI scan is more convenient than CT scan for diagnosis. It is not affect the human body because it doesn't use any dissemination. It is located on the magnetic field and radio waves.

In this system, two algorithms are used for segmentation K-means clustering algorithm and Fuzzy C algorithm. This technique gives the perfect result for tumor segmentation. Tumor is due to the uncontrolled growth of the tissues in any part of the body. The tumor may be primary or secondary. If tumor is an origin, then it is known as primary. If the part

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of the tumor is spread to another place of body and grown as its own then it is known as secondary. So detection of tumor in body is important for the treatment. The lifetime of the person will increase who affected by the brain tumor if it is detected at current stage. That will increase the lifetime about 1 to 2 years of person. Normally tumor cells are of two types. Those are Mass and Malignant. The detection of the malignant tumor is difficult to mass tumor. In this work we focused on detection of brain tumor with the help of Brain MRI images and predict the disease details from the given area of tumor.

Treatment for brain tumor is depends on the type and stage of the disease, the size and place of the tumor, and your general medical history and health history. In most cases, the aim of treatment is to remove or destroy the tumor completely. Most brain tumor can be cured if found and treated early.

A person who was affected by any kind of tumor has an increased risk of developing another brain tumor of any type. A person who has two or more close relatives (mother, father, sister, brother, 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 an inherited disorder that makes the brain more sensitive and increases the risk of brain tumor. About 5% of brain tumors may be linked to hereditary (genetic) factors or conditions.

Another risk factor of Brain tumor as well as other diseases is taking any chemo therapy. A person who has taken any therapy is responsible for occurring different kinds of disease compare to other people who don't take any therapy.

Day by day the number of brain tumor person is increasing rapidly because of unconsciousness. The Objective of this work is to contract such a tool which can tell people about his/her approximate condition about brain tumor ,that is he or she in risk or not and how much?

The developing platform for the detection is java. At the end, we are providing systems that detect the tumor and its shape and disease details from the given area of tumor.

Motivation

A reliable method for segmenting tumor would clearly be a useful tool. Currently, however, there is no method widely accepted in clinical practice for quantitating tumor volumes from MR images.

The main objective of this work is to detect the brain tumor of MRI image and calculating its area and predict Brain tumor risk level which is easier, cost reducible and time saveable.

II. LITERATURE SURVEY

1. Author and Title: Samir Kumar Bandhyopadhyay, Tuhin Utsab Paul, "Automatic Segmentation of Brain Tumor from Multiple Images of Brain MRI".

Implemented Concept: This paper has proposed a system of image registration and data fusion theory suitable for the segmentation of MR images. This system provides an efficient and fast way for diagnosis of the brain tumor called K-means technique.

2. Author and Title: A. Meena, K. Raja," Spatial Fuzzy C-Means PET Image Segmentation of Neurodegenerative Disorder"

Implemented Concept: This paper proposed an approach of Spatial Fuzzy C means (PET-SFCM) clustering technique on Positron Emission Tomography (PET) scan image datasets.

3. Author and Title: Suman Tatiraju, Avi Mehta, "Image Segmentation using k-means clustering, EM and Normalized Cuts"

Implemented Concept: In this system, we look at three techniques namely K Means clustering, Expectation Maximization and the Normalized cuts and compare them for image segmentation.

4. Author and Title: Ajala Funmilola," Fuzzy k-c-means Clustering Algorithm for Medical Image Segmentation"

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Implemented Concept: This work proposed the Fuzzy K-C-means technique, which carries more of Fuzzy C-means properties than that of K-means.

5. Author and Title: Beshiba Wilson, Julia Punitha Malar Dhas, "An Experimental Analysis of Fuzzy C-Means and K-Means Segmentation Algorithm for Iron Detection in Brain SWI using Matlab"

Implemented Concept: Wilson and Dhas used K-means and Fuzzy C-means techniques respectively to detect the iron in brain using SWI technique.

6. Author and Title: M.H. Fazel Zarandia, "Systematic image processing for diagnosing brain tumors: A Type-II fuzzy expert system"

Implemented Concept: This paper proposed a dip work of brain tumor. It shows different type of diagnosis approaches.

7. Author and Title: Samarjit Das, "Systematic image processing for diagnosing brain tumors: A Type-II fuzzy expert system approach"

Implemented Concept: In pattern recognition due to the fundamental involvement of human perception and inadequacy of standard Mathematics to deal with its complex and incoherently defined system; different fuzzy techniques have been applied as an appropriate alternative.

8. Author and Title: Vignesh Rajesh, "brain tumor segmentation and its area calculation in brain MRI images using k-mean clustering and fuzzy c mean algorithm"

Implemented Concept: This paper suggested a synergistic and an effective technique for the detection of brain tumors based on Median filtering, K Means Segmentation, FCM Segmentation, and finally, threshold segmentation.

9. Author and Title: Krishna Kant Singh, "A Study of Image Segmentation Algorithms For Different Types of Images"

Implemented Concept: In this paper the author gives a study of the various techniques that are available for color images, text and gray scale images.

10. Author and Title: payal mistry, shagun akhauri, sayali patil, s.p.tondare, "Segmentation of brain tumor and its area calculation in brain MRI images using k-mean clustering and fuzzy c- mean algorithm"

Implemented Concept: In this paper proposed k-means and C-mean techniques to extract the features from the images.

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III. PROPOSED SYSTEM ARCHITECTURE

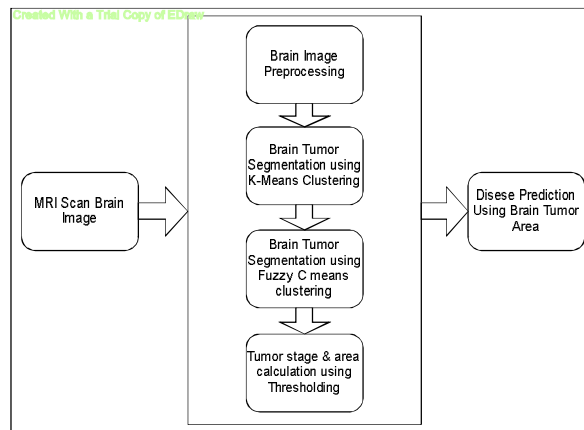


Figure: System Architecture

1. Pre-processing

According to the need of the next level in pre-processing step, performs filtering of noise and other artifacts in the image and sharpening the edges in the image. RGB image to grey image conversion and Reshaping of image also takes place here. It includes median filter for removing noise of image. The possibilities of arrival of noise in modern MRI scan image are very less. Noise may arrive due to the thermal effect. The main goal of this paper is to detect and segment the tumor cells. But for the complete system it needs the process of noise removal of image.

2. Segmentation using K-means

Steps:

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 cluster center then move to that cluster.
6. Otherwise move pixel to next cluster.
7. Re-estimate the cluster center.
8. Repeat the process until the center doesn't move.

3. Segmentation using Fuzzy C means

The fuzzy logic is a way to processing the data by giving the fractional membership value to each pixel in the image.

The membership value of the fuzzy set is ranges from 0 to 1.

Fuzzy clustering is basically a multi valued logic that allows intermediate values i.e., member of one fuzzy set can also be member of other fuzzy sets in the same image. There is no direct transition between full membership and non-membership.

The membership function defines the fuzziness of an image and also to define the information contained in the image.

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4. Approximate reasoning

In the approximate reasoning step the tumor area is calculated using the binarization/thresholding method. And also identify the stage of tumor. That is the output image having only two values either black or white (0 or 1).

So,

Calculate the area of tumor=

$$\text{Area} = \sqrt{P} * 0.264$$

Where, p= total no of white pixels of threshold image.

And 0.264 is the 1 pixel size.

5. Naive-Bayes Classification:

In is step classify to predict the disease details from the given area of tumor.

IV. MATHEMATICAL MODEL

Mathematical equation in K-means clustering

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

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

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_i in the cluster j ,

X_i = data measured in d-dimensional,

R_j = d-dimension center of the cluster,

The update of membership M_{ij} and the cluster centers R are given by:

$$M_{ij} = \frac{1}{\sum_{k=1}^C \left(\frac{\|X_i - C_j\|}{\|X_i - C_k\|} \right)^{\frac{2}{m-1}}}$$

$$R_j = \frac{\sum_{i=1}^N X_i M_{ij}^m}{\sum_{i=1}^N M_{ij}^m}$$

Let consider S is a system for Brain Tumor Segmentation Using K-Means clustering and Fuzzy C-Means techniques and Its Area Calculation and Disease Prediction Using Naive-Bayes technique.

S= {.....}

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INPUT:

- Identify the inputs

$F = \{f_1, f_2, f_3, \dots, f_n\}$ 'F' as set of functions to execute commands. }

$I = \{i_1, i_2, i_3, \dots, i_n\}$ 'I' sets of inputs to the function set }

$O = \{o_1, o_2, o_3, \dots, o_n\}$ 'O' Set of outputs from the function sets }

$S = \{I, F, O\}$

$I = \{\text{Query submitted by the user}\}$

$O = \{\text{Output of desired query}\}$

$F = \{\text{Functions implemented to get the output,}$

K-means clustering,

Fuzzy C –means clustering, Naive-Bayes Algorithm}

SPACE COMPLEXITY

The space complexity depends on Presentation and visualization of discovered patterns. More the storage of data more is the space complexity.

TIME COMPLEXITY

Check No. of patterns available in the datasets= n

If $(n > 1)$ then retrieving of information can be time consuming.

So the time complexity of this algorithm is $O(n^n)$.

Φ = Failures and Success conditions.

Failures:

- Huge database can lead to more time consumption to get the information.
- Hardware failure.
- Software failure.

Success:

Search the required information from available in Datasets.
User gets result very fast according to their needs.

V. ALGORITHM

K-means clustering

Steps:

1. Give the value to k for no of cluster.
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.

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6. Otherwise move to next cluster.
7. Re-estimate the center.
8. Repeat the process until the center doesn't move.

Fuzzy C-Means Algorithm

The fuzzy logic is a method to processing the data by giving the partial membership value to each pixel in the image. The membership value of the fuzzy set is ranges from 0 to 1.

Fuzzy clustering technique is basically a multi valued logic that let on middle values i.e., participants of one fuzzy set can also be member of other fuzzy sets in the same image. There is no direct transition between full membership and non-membership.

The membership function denotes the fuzziness of an image and also to define the information contained in the image.

Naive-Bayes Classification

Naive Bayes algorithm is the algorithm that learns the probability of an object with certain features belonging to a particular group/class. In short, it is a probabilistic classifier.

The Naive Bayes algorithm is called "naive" because it makes the assumption that the occurrence of a certain feature is independent of the occurrence of other features.

VI. RESULT

Let us consider the brain tumor image procured from MRI, containing the tumor in figure 1. Median filtering is implemented on the acquired images to get rid of the unwanted noises. The outcomes are displayed in the figure 2.

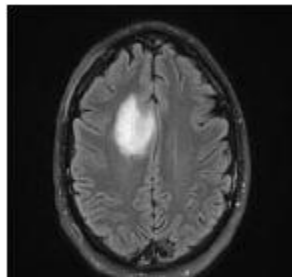


Fig. 1 Brain Tumor Image

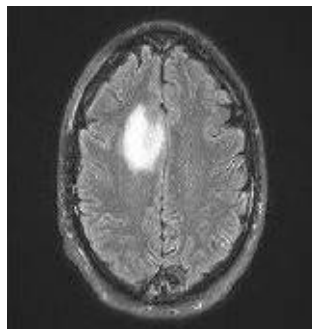


Fig. 2 Median Filtering Outcome

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K means algorithm is implemented on such noise filtered images containing brain tumors. In figure 5, 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 ulcer. The outcomes of thresholding segmentation are shown below in figure 5.



Fig. 3 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 ulcer is highlighted in this process. The outcome of the watershed segmentation is shown below in figure 3.

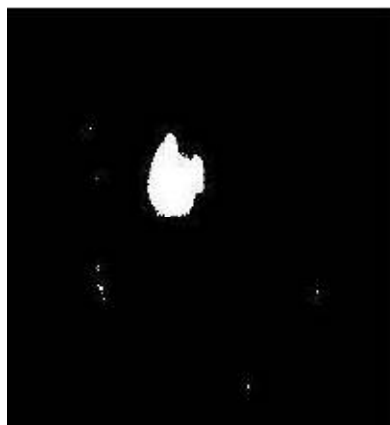


Fig. 4 FCM Segmentation

Eventually, the thresholding segmentation is implemented, once the FCM segmentation is completed. The outcomes are spectacular and proposed approach is efficacious in nature to an extent. Figure 5 shows the resultant image obtains after the implementation of thresholding segmentation.

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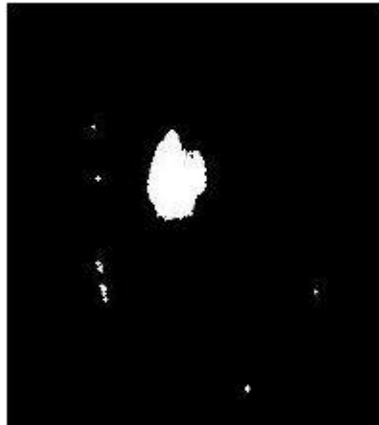


Fig. 5 Thresholding Segmentation



Fig. 6 Output Images Of Tumor Area Estimation

The output is displayed above in figure 6.

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 use 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.

Graph:

Fig. 7 shows the segmentation accuracy of K-Means approach and Fuzzy C means approach using MRI scan brain images. So our work gives the better accuracy as compared to existing work.

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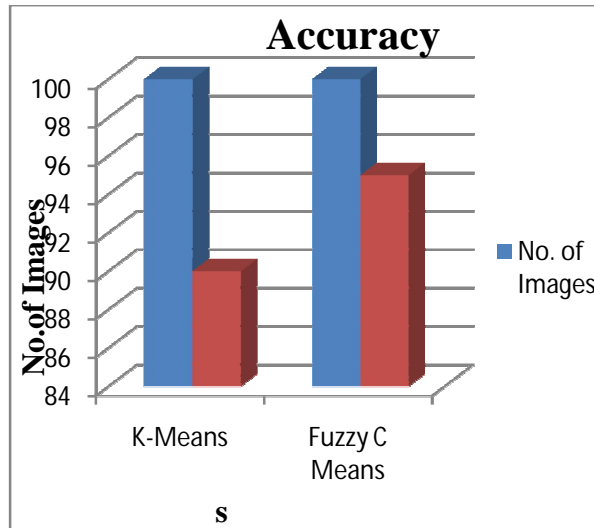


Fig7. Accuracy Graph

Table: Brain Image Clustering Accuracy

	No. of Images	Clustering Accuracy
K-Means	100	90%
Fuzzy C Means	100	95%

VII.PROPOSED OUTPUT

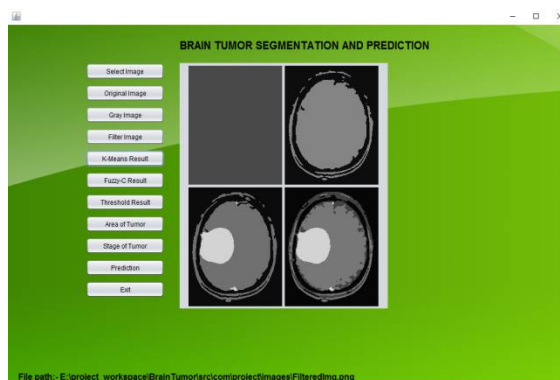


Fig8. K-Means Result

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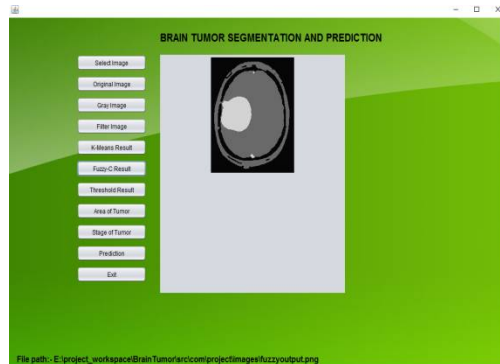


Fig9. Fuzzy Result

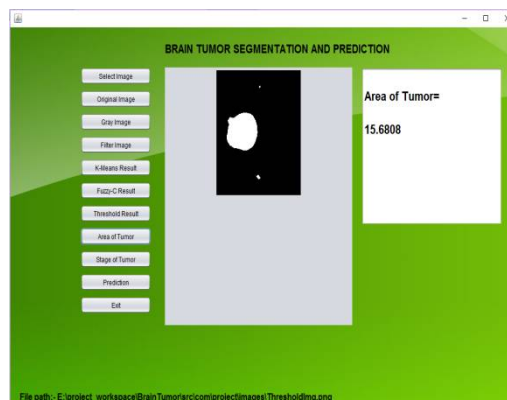


Fig10. Area of Tumor

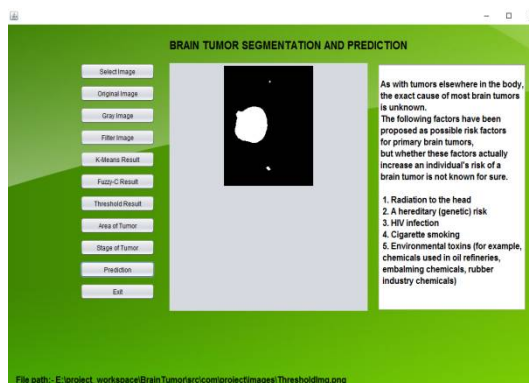


Fig11. Prediction

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VIII. CONCLUSION

There are various types of tumors are available. They may be as mass or malignant over the brain. Suppose if it is a mass then K- means technique is enough to extract it from the brain cells. If there is any noise are present in the MR scan image it is removed before the K-means process. The noise free image is given as an input to the k-means technique and tumor is extracted from the MRI scan image. Then using Fuzzy C means technique segmentation for accurate tumor shape extraction from an image. Finally approximate reasoning step for calculating tumor shape and position calculation and finally using the navy bias classification technique to classify the disease risk from resultant area of tumor. I.e. predict Brain tumor risk level which is easier, cost reducible and time savable.

The experimental results are compared with other techniques so the proposed method gives more accurate result.

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