

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

Rituja Mandhare¹, Jaya Nawale¹, Prabhanjan Kulkarni¹, Affan Ansari¹, Smita Kakade²

B. E Student, Department of Computer Engineering, Sinhgad Academy of Engineering Kondhwa, Pune, India¹

Professor, Department of Computer Engineering, Sinhgad Academy of Engineering Kondhwa, Pune, India²

ABSTRACT: This paper deals with 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 body. Tumors are of different types and they have different Characteristics and different treatment. As it is known, 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). Most Research in developed countries show that the number of people who have brain tumors were died due to the fact of inaccurate detection. Generally, CT scan or MRI that is directed into intracranial cavity produces a complete image of brain. 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 examined by the physician for detection & diagnosis of brain tumor. However this method accurate determines 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 and reproducibility comparable to manual segmentation. In addition, it also reduces 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-Bayesclassification.

I. INTRODUCTION

This paper deals with the concept for braintumor segmentation and finally the detection of brain tumor and risk of disease. Normally the anatomy of the Brain can be viewed by the MRI scan or CT scan. In this paper the MRI scanned image is taken for the entire process. The MRI scan is more comfortable than CT scan for diagnosis. It is not affect the human body because it doesn't use any radiation. It is based on the magnetic field and radio waves. There are different types of algorithm were developed for brain tumor detection. But they may have some drawback in detection and extraction.

In this paper, two algorithms are used for segmentation K-means clustering algorithm and Fuzzy C 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 body. The tumor may be primary or secondary. If it is an origin, then it is known as primary. If the part of the tumor is spread to another place and grown as its own then it is known as secondary. Normally brain tumor affects CSF (Cerebral

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Spinal Fluid). It causes for strokes. The physician gives the treatment for the strokes rather than the treatment for tumor. So detection of tumor is important for that treatment. The lifetime of the person who is affected by the brain tumor will increase if it is detected at current stage. That will increase the lifetime about 1 to 2 years. Normally tumor cells are of two types. They are Mass and Malignant. The detection of the malignant tumor is somewhat difficult to mass tumor. In this paper 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 depends on the type and stage of the disease, the size and place of the tumor, and your general health and medical history. In most cases, the goal 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 chemotherapy. A person who has taken any therapy is responsible for occurring different kinds of disease compared 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 construct such a tool which can tell people about his/her approximate condition about brain tumor, that is he or she is 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.

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 adapted for the segmentation of MR images. This system provides an efficient and fast way for diagnosis of the brain tumor called K-means algorithm.

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

Implemented Concept: Meena and Raja proposed an approach of Spatial Fuzzy C means (PET-SFCM) clustering algorithm 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 project, we look at three algorithms 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"

Implemented Concept: Funmilola et al proposed the Fuzzy K-C-means method, 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"

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(A High Impact Factor, Monthly, Peer Reviewed Journal)

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

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

Implemented Concept: This paper proposed a dip study of brain tumor. It describes 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 the field of pattern recognition due to the fundamental involvement of human perception and inadequacy of standard Mathematics to deal with its complex and ambiguously 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 has suggested a synergistic and an effective algorithm 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 algorithms that are available for color images, text and gray scale images.

10. Author and Title: payalmistry, shagunakhauri, sayalipatil, 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 to extract the features from the images.

III. PROPOSED SYSTEM ARCHITECTURE

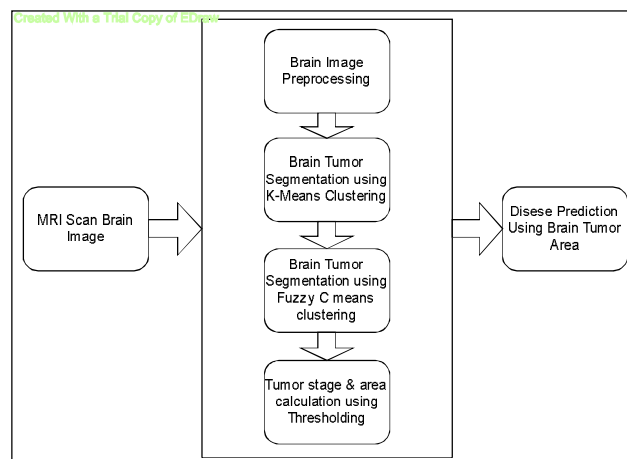


Figure: System Architecture

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1. Pre-processing

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

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 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.

Segmentation using Fuzzy C means

The fuzzy logic is a way 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 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 abrupt 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.

Approximate reasoning

In the approximate reasoning step the tumor area is calculated using the binarization method. And also identify the stage of tumor. That is the 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.

Naive-BayesClassification:

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

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

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 us consider S as a system for Brain Tumor Segmentation Using K-Means clustering and Fuzzy C-Means Algorithms and Its Area Calculation and Disease Prediction Using Naive-BayesAlgorithm.

$S = \{ \dots \}$

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' sets of inputs to the function set

$O = \{o_1, o_2, o_3, \dots\}$ '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-BayesAlgorithm}

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

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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. 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.

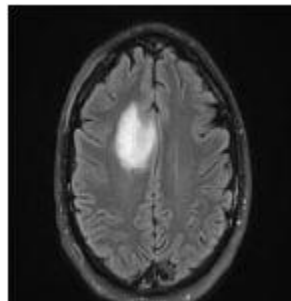


Fig. 1 Brain Tumor Image

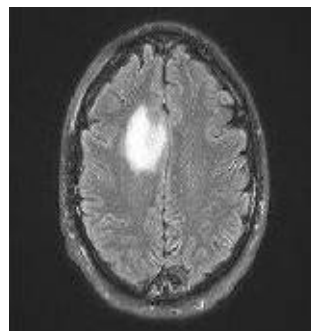


Fig. 2 Median Filtering Outcome

K means algorithm is implemented on such noise filtered images containing brain tumors. In figure 4, a white spot is seen, which is an outcome of the 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 3.

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Fig. 3 K Means Clustering

Once the K Means Clustering gets over, Fuzzy C-Means segmentation is eventually 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 4.



Fig. 4 FCM Segmentation

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

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(A High Impact Factor, Monthly, Peer Reviewed Journal)

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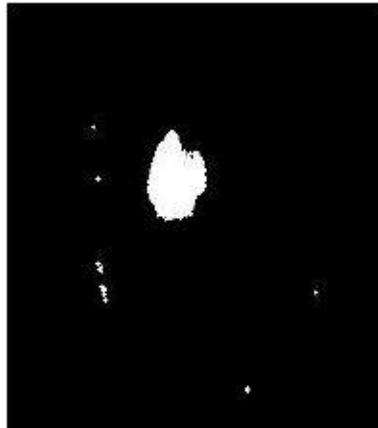


Fig. 5 Thresholding Segmentation

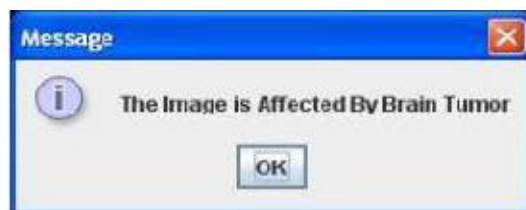


Fig. 6 Output Images Of Tumor Area Estimation

The detection output is displayed above in figure 6.

After tumor detection, next step to find the area of tumor and stage of tumor. $Area = \sqrt{P} * 0.264$

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

And 0.264 is the 1 pixel size.

The predicted tumor area and its stage calculation, the stage of tumor are based on the area of tumor. We considered that, if the area is greater than 6 mm^2 it will be the critical position.

A person who was affected by any kind of tumor has an increased risk of developing another brain tumor of any type. So next step is to predict the disease risk based on above area of brain tumor. This is very important for patient for the future treatment.

The proposed system 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 algorithms are used to compare individual performance with the proposed method and the result of all are compared and we find that the proposed system having less errors in the system.

VI. CONCLUSION

There are different types of tumors available. They may be as mass in brain or malignant over the brain. Suppose if it is a mass then K-means algorithm is enough to extract it from the brain cells. If there is any noise present in the MR image it is removed before the K-means process. The noise-free image is given as an input to the k-means and tumors

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(A High Impact Factor, Monthly, Peer Reviewed Journal)

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extracted from the MRI image. And then segmentation using Fuzzy C means for accurate tumor shape extraction of malignant tumor and thresholding of output in feature extraction. Finally approximate reasoning 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 algorithms. The proposed method gives more accurate result.

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