iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VI **Month of publication:** June 2022

DOI: https://doi.org/10.22214/ijraset.2022.43545

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

Fuzzy Clustering Approach for Brain Tumor Detection

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***Abstract:** This paper focuses on using a simple algorithm to detect the range and shape of tumors in brain MR images and to determine the stage of the tumor from the given tumor region. Tumors are uncontrolled tissue growth that can occur in any section of the body. Tumors come in a number of varieties, each tumor type has its own set of characteristics and treatment options. Because of its nature in confined space of the cerebral cavity, brain tumors are inherently dangerous and life-threatening (space formed inside the skull).According to the studies carried out in developed countries, an increasing number of people with brain tumors have perished as a result of faulty detection. In most cases, a CT scan or MRI focusing on the cerebral cavity yields a comprehensive view of the brain. Some general risk factors and symptoms was established after extensive research and statistical analysis based on those people who are affected by brain tumors. The growth of technology in science day and night aims to provide new therapeutic approaches. The clinician examines this imaging method for the purpose of detecting and diagnosing a brain tumor. However, this method helps to accurately predict the size of the tumor, as well as the stage of the tumor from the tumor's location is detected during the process. The k-means and fuzzy c-means are the algorithms that are used in this study to segment brain tumors from the given brain tumor image. This method enables the accurate and repeatable segmentation of tumor tissue, comparable to manual segmentation. Furthermore, it cuts down on analysis time and detects tumor stage from a particular tumor region. Finally, create a system that uses Java to identify the tumor stage thatis easier to use, less expensive, and saves time.*

***Index Terms:** Magnetic Resonance Imaging (MRI),Fuzzy Ap- proach, Interval Type-II Fuzzy Logic System (IT2FLS); Tumor identification. Pre-processing, K-means*

I. INTRODUCTION

MRI or CT scans are usually used to image the brain's anatomy. The entire procedure is recorded in this paper using an MRI scan. For diagnosis, an MRI scan is more convenient than a CT scan. It does not have any adverse effect on the human body. It works by the use of magnetic fields and radio waves. Numerous algorithms have been created for the diagnosis of brain tumors. However, they may have somedisadvantages in terms of identification and extraction.

Two algorithms are used in this work to perform segmentation. Algorithms for clustering K-means and Fuzzy C-means. As a result, it produces a correct tumor segmentation result. Tumors are caused by excessive tissue growth in every portion of the body. A brain tumor is a mass of cells in your brain that are not normal. There are two general groups of brain tumors: Primary brain tumors start in brain tissue and tend to stay there. Secondary brain tumors are more common. Normally, a brain tumor has an effect on the CSF (Cerebral Spinal Fluid). It contributes to strokes. The surgeon treats the strokes rather than the tumor. Therefore, early identification of tumors is crucial for successful treatment.When a brain tumor is diagnosed at an early stage, the patient's life expectancy may be extended. This will add about one or two years to the lifespan. Typically, tumor cells are classified into two groups. They are classified as Massand Malignant. It is somewhat difficult to detect a malignant tumor in a bulk tumor. In this post, we will explore how to diagnose brain tumors using brain MRI images and how to assess the stage of the tumor depending on the given regionof tumor. Treatment for a brain tumor is determined by the tumor's form and level as well as according to its size and location and the general health and medical records. In the majority of cases, the main aim of this therapy is to totally remove or kill the tumor. The majority of brain tumors are curable if detected and treated early.

An individual who has been diagnosed with some kind of brain tumor is at an elevated risk of having another form of brain tumor. An individual who has two or more close relatives(father, mother,brother, sister or child) who have developed brain tumors has an increased chance of developing his or her own brain tumor. Occasionally, family members will inherit a mutation that makes the brain more vulnerable and raises the chance of developing a brain tumor. Around 5% of brain tumors are thought to be caused by inherited (genetic) causes or disorders. The aim of this work is to develop a method that can inform people about their estimated risk of developing a brain tumor, whether they areat risk or not, and by how much. Java is used to build the detection platform. Finally, we have systems that detect the tumor and its form, as well as the stage of the tumor, from a given region of the tumor.

II. LITERATURE SURVEY

For magnetic resonance imaging, the method of image registration and data fusion theory presented here has been modified for the segmentation of the magnetic resonance images. This research aims to propose an image registration and data fusion method that is optimal for segmentation of magnetic resonance images. This method enables the accurate and rapid detection of brain tumors. This device utilises the K-means algorithm to provide an effective and rapid tool for diagnosing brain tumors [1].

Meena and Raja demonstrated how to use the Spatial Fuzzy C Means (PET-SFCM) is used for PET scan image datasets to cluster data in 3D. To better assist the clustering process, a proposed algorithm helps to incorporate spatial neighbourhood information into the FCM, and this helps in the modification of the objective function of each cluster simultaneously. This algorithm has been applied and validated on a large data set of patients with neurodegenerative disorders of the brain, such as Alzheimer's disease. It hasbeen shown to be efficient in real-world patient data sets [2].

In this case, the presented framework features three image segmentation algorithms, namely K-Means clustering, Expectation Maximization, and Normalized Cuts. The main objective of this project is to find a solution to the issue of cutting up a picture into separate regions. When we compare the two unsupervised learning algorithms, K-means and EM, to a graph-based algorithm, the Normalized Cut, we equate them to each other. Clustering algorithms that divide a dataset into clusters based on a given distance measure, such as K-means and EM, are two common methods for clustering [3].

Funmilola et al. introduced the Combining the properties of Fuzzy C-means and K-means, the fuzzy K-C-means form can be used. While most of this work has focused on clustering algorithms like k-means and fuzzy c-means, this portion has done much of the work on both approaches. The k-c-means clustering algorithm was constructed by utilising these separate algorithms. This allowed the algorithm to providea more effective result in terms of computational time. the algorithms have been put to the test and proven correct by comparing them to human brain MRI images Results have been thoroughly investigated and reported [4].

Wilson and Dhas, respectively, The SWI technique was used to detect iron in the brain by first using K-means andthen using Fuzzy C-means. accurate assessment of iron stores is needed in a number of neurodegenerative diseases because of the relationship between iron accumulation and the aetiology of these diseases a susceptibility the weighted imaging SWI (SWI weighted for sensitivity) assists in getting an accurate depiction of a tissue's properties which are different from the structures under which it is located [5].

The overview of various brain tumor diagnostic techniques provided here contains a full examination of their varioustypes. The main purpose of this article is to provide a comprehensive Type-II fuzzy expert method for diagnosing human brain tumors (Astrocytoma tumors) with T1-weighted Magnetic Resonance Imaging (MRI) with contrast. four distinct modules make up the proposed Type-II fuzzy image processing method: pre-processing, segmentation, feature extraction, and approximate reasoning [6].

Human intuition plays a key role in pattern recognition, and mainstream mathematics cannot accurately accommodate this complicated and ambiguously defined system. This, coupled with the inadequacy of fuzzy mathematics to fully embrace these ideas, has led to the implementation of various fuzzy approaches [7].

This paper presents a technique that offers an efficient and synergistic algorithm for brain tumor diagnosis, utilising median filtering, K Means segmentation, FCM segmentation, and a final threshold segmentation. in this method, we aimto improve the accuracy of tumor images obtained via MRI and to use that increased accuracy to guide estimations onthe size of the tumors [8].

The author of the presented work is conducting an examinationof various algorithms that can be used to color images, text, and gray scale images. When image segmentation is done, the resultant collection of segments or contours will take up the whole image, or a collection of segments and contours willbe derived from the image. A pixel in a particular region can be identical in some way, such as color, strength, or texture [9].

This thesis showed how to isolate features from brain images and detect tumors using k-means and C-mean clustering techniques [10].

A. *Objectives*

1) Identify the brain tumor on given image.
2) Detect the tumor part in given image.
3) Calculate the area of brain tumor.
4) Identify the stage of tumor.
5) Predict the disease from the given area of tumor.

III. PROPOSED SYSTEM

The clustering techniques used in the proposed work area mixture of two others. Preprocessing, segmentation, feature extraction, and approximation reasoning are the four primary modules of the system under consideration. The median filter is used to filter the images in the pre-processing stage of the procedure. Following that, image segmentation is carried out using the K-means and Fuzzy C-means algorithms to separate objects. The image thresholding method is mainly used for feature extraction, and then approximation reasoning is used to detect the area of the tumor and position of the tumor in the given MRI image. It also determines the stage of the tumor from the resulting area of a brain tumor. To put it another way, ultimately design a system to detect the stage of a tumor thatis simpler, less expensive, and saves time.

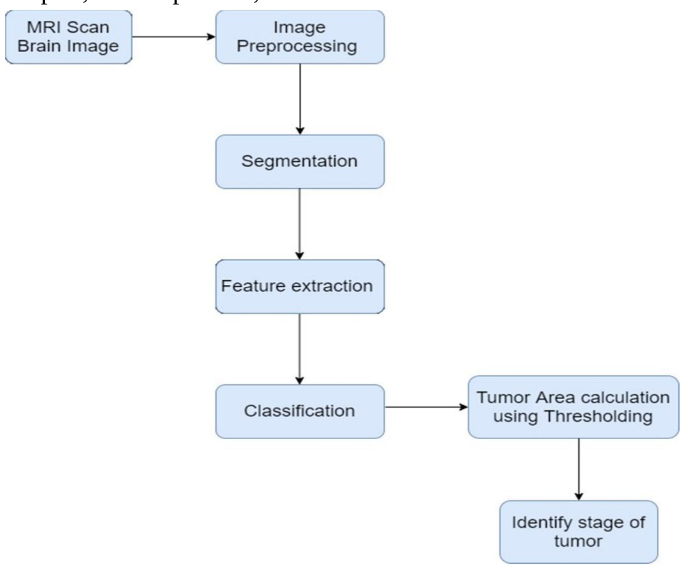

Fig. 1. Proposed System Architecture

A. *Explanation*

1) *Pre-processing:* In pre-processing step, removal of the noise from theinput image is carried out. It also performs filtering of noise and other artifacts in the image and sharpens the edges ofthe image.The conversion of the RGB to grey and reshapingis also performed in this step. It includes median filter for noise removal. Noise may arrive due to the thermal effectbut the possibility is very less in the modern MRI scan method.

2) *Segmentation using K-means*

Steps

1) We need to specify the no of cluster value as k.
2) Randomly choose the k cluster centers
3) Mean or center of the cluster will be calculated
4) The distance between each pixel to each cluster cente
5) If the distance is near to the center then move to thatcluster
6) Otherwise move to next cluster
7) Re-estimate the center.
8) Repeat the process until the center doesn’t move.

3) *Segmentation using Fuzzy C means:* In fuzzy-c mean clustering data is processed by givingthe partial membership value to each pixel in the image.The algorithm has the membership value set ranges from 0 to 1.It is basically a multi valued logic that allows intermediate values i.e.,The pixel which is member of one fuzzy cluster can also be member of other fuzzy cluster in the same image. There is no sudden transition between full membership and non-membership.
4) *Approximate Reasoning:* In the approximate reasoning step the tumor area is calculated using the binarization method. That is the image having only two values either black or white (0 or 1). Andthen classify the stage of tumor from the given area of tumor.

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B. Algorithms

1) *K-means Algorithm:* K-Means clustering is one of the unsupervised learning algorithm for clusters. Clustering is the technique where pixels are grouped according to the same characteristics. Inthe k-means algorithm, we have to define the number of clusters k. Then k-cluster center are chosen randomly. The distance between the each pixel to each cluster centers iscomputed. There is a comparison between a single pixel and all cluster centers using the distance formula. The pixel is assigned to the particular cluster which has shortest distance among all. At last the centroids for the clusters are computed by taking the average of all pixels of that cluster. After that each pixel is compared to all centroids. The process continuous until the center converges.
2) *Fuzzy C-Means Algorithm:* The Fuzzy C-means clustering is an unsupervised clustering algorithm which can be applied to several problemsinvolving feature analysis, clustering, medical diagnosis and image segmentation. In FCM algorithm each data point belongs to a cluster to a degree specified by a membership grade. The FCM algorithm minimizes the objective function for the partition of data set, x = $[x1, x2, xd]^T$

C. Mathematical Model

1) *Mathematical equation for K-means Clustering*

$$1.\ M_k = \frac{\sum_{i:c(i)=k} X_i}{N_k},\ k = 1, 2, \ldots, K.$$

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

2) *Mathematical equation for 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:

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

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

IV. RESULT AND DISCUSSION

Let us consider the brain tumor image procured from MRI,containing the tumor in Fig.2.

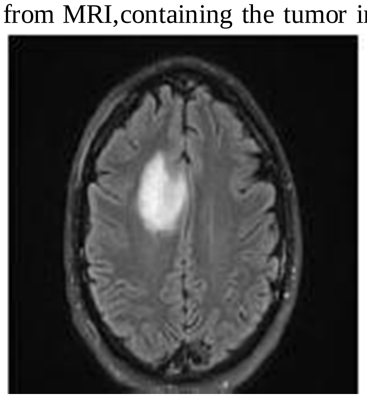

Fig. 2. Input Image

Median filtering is applied on the input image to get ridof the unwanted noises. The output image is displayed in the Fig.3.

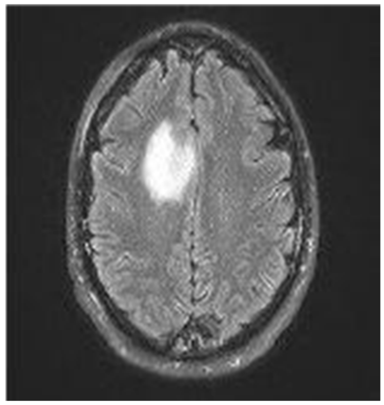

Fig. 3. Median filtering

K means algorithm is implemented on noise filtered image obtain as a output of median filtering. In FIG. 4. a whitespot is seen, which is outcome of K-means clustering on the input image. K-Means clustering is an unsupervised learning algorithm. There is no labelled data for this clustering, unlike in supervised learning.This algorithm performs the divisionof objects into clusters that has similar properties and aredissimilar to the objects belonging to another cluster.

Fig. 4. K-means Clustering

Fuzzy C-Means segmentation is eventually implemented onthe resulted image obtained from K-Means segmentation. The region affected by ulcer is highlighted in this process. The outcome of the Fuzzy-c mean segmentation is shown in Fig.5.

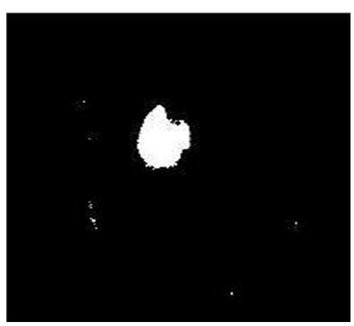

Fig. 5. Fuzzy-c mean Clustering

Thresholding segmentation is implemented on the image once the FCM segmentation is completed. The outcomes are spectacular and intended approach is efficacious in nature toan extent. Fig.6. shows the resultant image procured after the implementation of thresholding segmentation.

Fig. 6. Thresholding

Fig. 7. Output Image of Final Result

V. CONCLUSION

Segmentation of brain tumor is done in this presented work.To start, the image is pre-processed using the median filter technique. If noise is detected in the given input MR image,it is extracted before K-means phase then the output image is given as a input to K-means clustering algorithm. The noise- free image is fed into the k-means algorithm and then into fuzzy C-mean algorithm, which extracts the tumor from the MRI image. Eventually, estimated logic is used to calculate tumor area and location, and finally, the resulting area of the tumor is used to identify the stage of the tumor, which is simpler, less expensive, and faster.

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