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Brain Tumor Automated Detection and Segmentation

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ABSTRACT: More precisely, we propose to use Support Vector Machines (SVM) which is one of the most popular and well motivating classification methods. The experimental study will be carried on real and simulated datasets representing different tumor shapes, locations, sizes and image intensities. Tumor is an uncontrolled growth of tissue in any part of the body. The tumor is of different types and they have different characteristics and different treatment. This paper is to implement of Simple Algorithm for detection of range and shape of tumor in brain MR Images. Normally the anatomy of the Brain can be viewed by the MRI scan or CT scan. MRI scanned image is used for the entire process. The MRI scan is more comfortable than any other scans for diagnosis. It will not affect the human body, because it doesn't practice any radiation. It is centered on the magnetic field and radio waves. There are dissimilar types of algorithm were developed for brain tumor detection. But they may have some drawback in detection and extraction. After the segmentation, which is done through k-means clustering and fuzzy c-means algorithms the brain tumor is detected and its exact location is identified. Comparing to the other algorithms the performance of fuzzy c-means plays a major role. In Proposed system we develop K-Means Algorithm and Fuzzy C-means for Brain tumor segmentation. The patient's stage is determined by SVM classifier , whether it can be cured with medicine or not By using this we get more accurate result as compare to existing system.

KEYWORDS: Tumor, MRI Scan, CT scan, K-Means clustering, Fuzzy c-means, SVM.

I. INTRODUCTION

Tumor segmentation from MRI data is an important but time-consuming and difficult task often performed manually by medical experts. Radiologists and other medical experts spend a substantial amount of time segmenting medical images. However, accurately labeling brain tumor is a very time-consuming task, and considerable variation is observed between doctors [2].

Throughout the few years, different segmentation methods have been used for tumor detection but it is time consuming process and also gives inaccurate result. So, computer aided system can be designed for accurate brain tumor detection from MRI images. Brain tumor can be broadly classified as primary brain tumor(the tumor originates in the brain) and secondary brain tumor (spread to brain from somewhere else in the body through metastasis) Primary brain tumors do not spread to other body parts and can be malignant or benign and secondary brain tumors are always malignant. Malignant tumor is more dangerous and life threatening than benign tumor. The detection of malignant tumor is more difficult than benign tumor [3]. After the noise removing from the MRI images we have to focus on tumor only for that we need to extract the exact brain tissues for that we have performed the skull removing process in that we have used the horizontal, diagonal, anti-diagonal and vertical masks to perform the erosion and dilation which is results in to the skull masked image which further proceed to segmentation. Labeling of connected components ('objects') is one of the most important tools of image processing. It is the basis for the generation of object features as Well as of some kind of filtering, *i.e.*, removing of noisy objects or holes in objects. The criteria for removing an object or a hole can be chosen

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extremely flexible based on the object features. The task of labeling (object filling, region detection) is to assign labels (mostly unsigned integers) to the pixels in such a way that all pixels belonging to a connected component of the image are assigned the same label, and pixels belonging to different components get different labels [5] This paper proposed concept for brain tumor segmentation and finally the detection of brain tumor. Normally the structure of the Brain can be viewed by the CT scan or MRI scan. In this paper the MRI scanned image is taken for the whole process. The MRI scan is more comfortable and suitable than CT scan for diagnosis. It is not affect the humanbody. Because of this method doesn't use any radiation. This process 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 extraction and detection of brain tumor. In this paper, two algorithms are used for segmentation. K-means clustering algorithm and Fuzzy-C means algorithm. So it gives the accurate result for brain tumor segmentation. Tumor is due to the uncontrolled growth of the tissues in any part of our body. The tumor stage may be primary or secondary. If it is an origin, then it is known as primary stage. If the part of the tumor is spread to another place and grown as its own then it is known as secondary stage. Normally brain tumor affects CSF (Cerebral 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 further treatment. The lifetime of the person who affected by the brain tumor will increase if it is detected at current stage correctly. That will increase the lifetime about 1 to 2 years. Normally tumor cells are of two types. They are Mass and Malignant tumor. The detection of the malignant tumor is difficult to mass tumor. In this paper we focused on detection of brain tumor with the help of Brain MRI images. The developing platform for the detection is java. Because it is easy to develop and execute. At the end, we are providing systems that detect the brain tumor and its shape.

II. LITERATURE SURVEY

SN.	Author and Title	Proposed System	Implemented Concepts
1.	Samir Kumar Bandhyopadhyay, TuhinUtsab Paul , “Automatic Segmentation of Brain Tumor from Multiple Images of Brain MRI”	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.	Implanting the K-mean algorithm which consists of multiple phases. First phaseconsists of registration of multiple MR images of the brain taken along adjacent layers of brain. In the second phase, theseregistered images are fused to produce high quality image for the segmentation. Finally, segmentation is done by improved K -means algorithm with dual localization methodology.
2.	A. Meena, K. Raja, ” Spatial Fuzzy C-Means PET Image Segmentation of Neurodegenerative Disorder”	Meena and Rajaproposed an approach of Spatial Fuzzy C-means (PET-SFCM) clustering algorithm on Positron Emission Tomography (PET) scan image datasets.	The proposed FCM successful able to join the the spatial neighborhood information with classical FCM and updating the objective function of each cluster. It exploit the segmentation which used for quick bird view for any problem of K-means.
3	SumanTatiraju, Avi Mehta, ” Image Segmentation using k-means clustering, EM and Normalized Cuts”	In this project, we look at three algorithms namely K Means clustering, Expectation Maximization and the Normalized cuts and compare them for image Segmentation	The segmentation technique addresses the problem of segmenting an image into different regions. So the we can analyze both k-mean and C-mean algorithm in easy way.

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4.	AjalaFunmilola, " Fuzzy k-c-means Clustering Algorithm for Medical Image Segmentation"	Funmilola et al proposed the Fuzzy K-C-means method, which carries more of Fuzzy C-means properties than that of K-means.	The F-K-C means focused attention on Clustering methods. These k-mean and C-mean algorithms were combined together to come up with another method called fuzzy k-c-means clustering algorithm, which has a better result in terms of time utilization.
5.	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"	Wilson and Dhas used K-means and Fuzzy C-means respectively to detect the iron in brain using SWI technique.	Susceptibility-weighted imaging (SWI) is a neuro imaging technique, which uses tissue magnetic susceptibility differences to generate a unique contrast. The extraction of the iron region in the brain is made by K-means and Fuzzy C-means clustering method.
6.	M.H. FazelZarandia, "Systematic image processing for diagnosing brain tumors: A Type-II fuzzy expert system"	This paper proposed a dip study of brain tumor. It describes different type of diagnosis approaches.	A brief knowledge about tumor like glial tumor which cover 30 % of all brain tumor.
7.	Samarjit Das , "Systematic image processing for diagnosing brain tumors: A Type-II fuzzy expert system approach"	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	The proposed fuzzy c-means technique Euclidean distance has been used to obtain the membership values of the objects in different clusters; in our present work along with Euclidean distance we have used other distances like Canberra distance, Hamming distance to see the differences in outputs.
8.	Vignesh Rajesh, " brain tumor segmentation and its area calculation in brain mri images using k-mean clustering and fuzzy cmean algorithm"	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.	The implemented method enhance the quality of the tumor images acquired by the aid of MRI and then to detect the size of the tumors, approximate reasoning are applied.
9.	Krishna Kant Singh, " A Study Of Image Segmentation Algorithms For Different Types Of Images"	In this paper the author gives a study of the various algorithms that are available for color images, text and gray scale images.	Implementation of segmentation technique those are color-based-segmentation, pixel-based segmentation and edge-based segmentation.
10	payalmistry, shagunakhauri, sayalipatil, s.p.tondare, " segmentation of brain tumor and its area	In this paper proposed k-means and C-mean to extract the features from the images.	K-Means and Fuzzy C- Means In this process the tumor is extracted from the MR image and its exact position and the shape also

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	calculation in brain mr images using k-mean clustering and fuzzy c- mean algorithm”		determined. The stage of the tumor is displayed based on the amount of area calculated from the cluster
11	D.Judehemanth, D.Selvathi, J.Anitha “ Effective fuzzy Clustering algorithm for abnormal MR brain image segmentation”	In this paper, the application of modified FCM algorithm for MR brain tumor detection is explored	The effectiveness of thte FCM algorithm in terms of computational rate is improved by modifying the cluster center .
12	ipekoguz and milansonka “logismos-b: layered optimal graph image segmentation of multiple objects and surfaces for the brain”	This paper propose a novel algorithm, LOGISMOS-B, based on probabilistic tissue classification, generalized gradient vector flows and the LOGISMOS graph segmentation framework.	Automated reconstruction of the cortical surface is one of the most challenging problems in the analysis of human brain magnetic resonance imaging (MRI). The main goal of this manuscript is to present a novel method to obtain more accurate and robust cortical segmentations.
13	zhuowentu , xiangbai “auto-context and its application to high-level vision tasks and 3d brain image segmentation”	This paper, propose a learning algorithm, auto-context. Given a set of training images and their corresponding label maps, we first learn a classifier on local image patches.	Auto-context integrates low-level and context information by fusing a large number of low-level appearance features with context and implicit shape information. The resulting discriminative algorithm is general and easy to implement.
14	zhuowentu, katherine l. narr, piotrdollár, ivodinov, paul m. thompson, arthur w. toga “brain anatomical structure segmentation by hybrid discriminative/generative models”	In this paper, a hybrid discriminative/generative model for brain anatomical structure segmentation is proposed. The learning aspect of the approach is emphasized. In the discriminative appearance models, various cues such as intensity and curvatures are combined to locally capture the complex appearances of different anatomical structures.	A probabilistic boosting tree (PBT) framework is adopted to learn multiclass discriminative models that combine hundreds of features across different scales. The parameters to combine the discriminative appearance and generative shape models are also automatically learned. Thus, low-level and high-level information is learned and integrated in a hybrid model.
15	zexuanji, yongxia, quansen sun, qiangchen, deshenxia, dauidaganfeng “fuzzy local gaussian mixture model for brain mr image segmentation”	In this paper, we assume that the local image data within each voxel’s neighborhood satisfy the Gaussian mixture model (GMM), and thus propose the fuzzy local GMM (FLGMM) algorithm for automated brain MR image segmentation.	The algorithm estimates the segmentation result that maximizes the posterior probability by minimizing an objective energy function, in which a truncated Gaussian kernel function is used to impose the spatial constraint and fuzzy memberships are employed to balance the contribution of each GMM.

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Table 1: Literature survey

III. 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:

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

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

Let us consider S as a system for BRAIN TUMOR SEGMENTATION AND ITS AREA CALCULATION USING K-MEANS AND C-MEANS ALOGRITHM

S= { ... }

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 = {Query submitted by the user,...}

O = {Output of desired query, ...}

F = {Functions implemented to get the output,

K-means clustering,

Fuzzy C –means clustering }

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:

1. Huge database can lead to more time consumption to get the information.
2. Hardware failure.
3. Software failure.

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Success:

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

IV. PROPOSED SYSTEM ARCHITECTURE

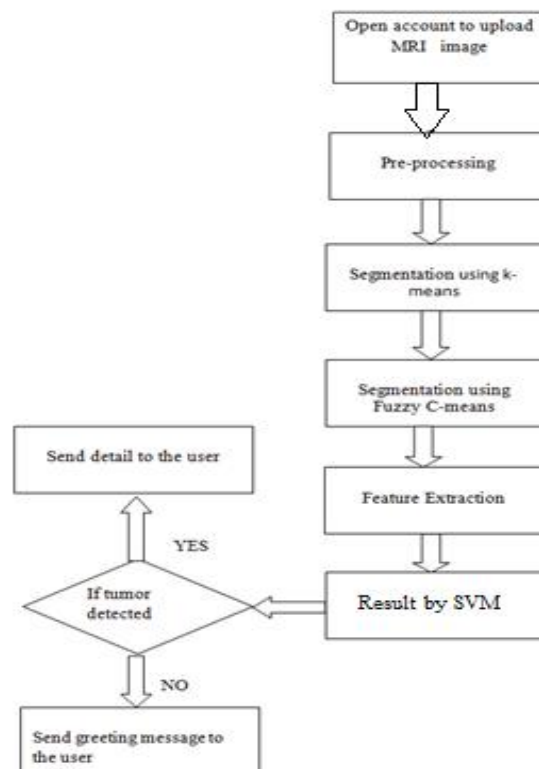


Figure 1 : System Architecture

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.

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 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.

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3. Segmentation using Fuzzy C means and SVM

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.

4. Feature Extraction

The feature extraction is extracting the cluster which shows the predicted tumor at the FCM output.

The extracted cluster is given to the thresholding process.

It applies binary mask over the entire image. It makes the dark pixel become darker and white become brighter.

In threshold coding, each transform coefficient is compared with a threshold.

If it is less than the threshold value then it is considered as zero.

If it is larger than the threshold, it will be considered as one.

The thresholding method is an adaptive method where only those coefficients whose magnitudes are above a threshold are retained within each block.

5. 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).

V. EXPERIMENTAL RESULT AND DISSCUSSION

Proposed Brain tumor detection system is improve with segmentation of preprocessed image then resulted image goes with object labeling and feature extraction. Extracted features used to train SVM and the database of feature is use for pattern matching and test the system.

1. Calculate the area of tumor=

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

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

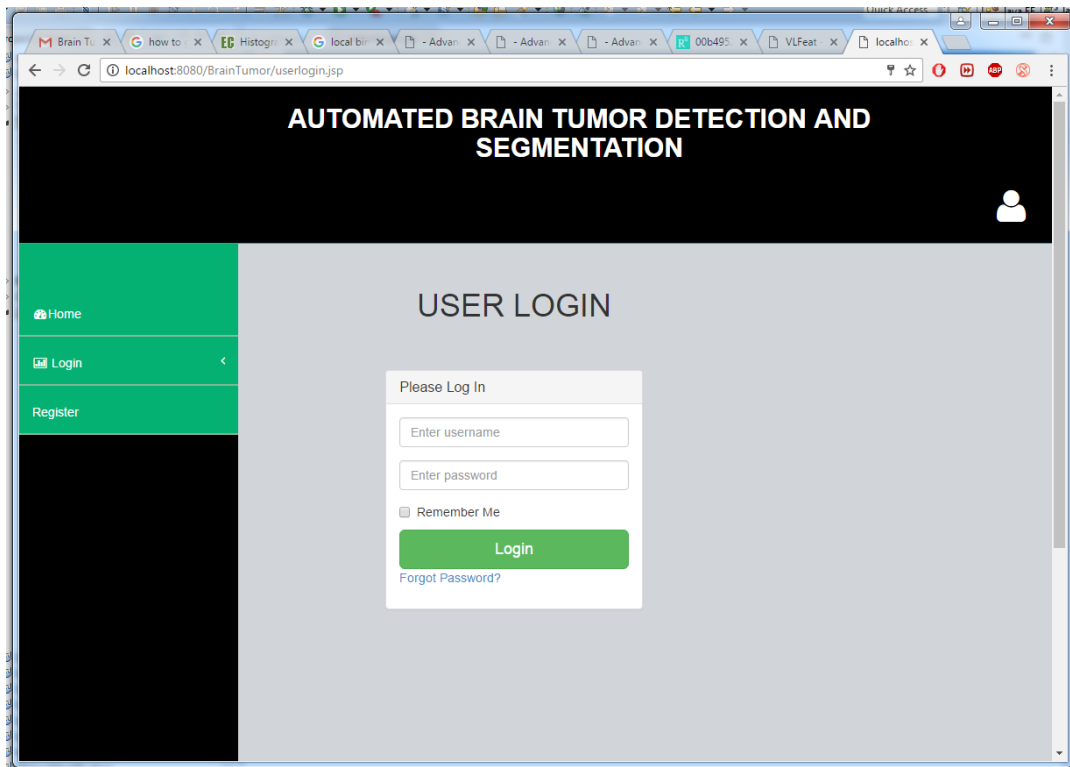
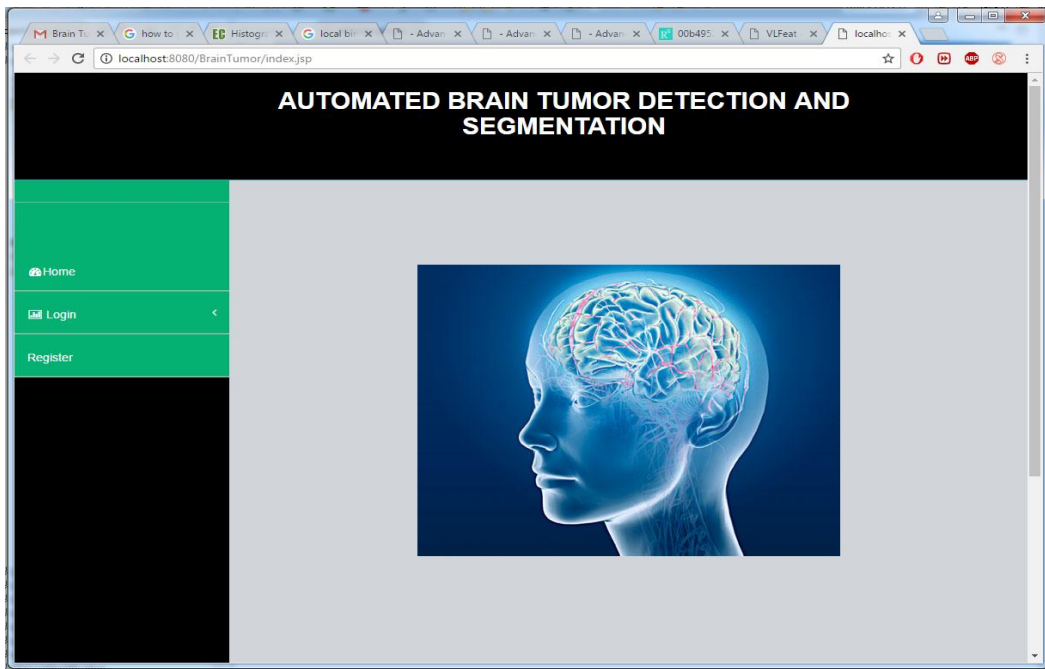
And 0.264 is the 1 pixel size.

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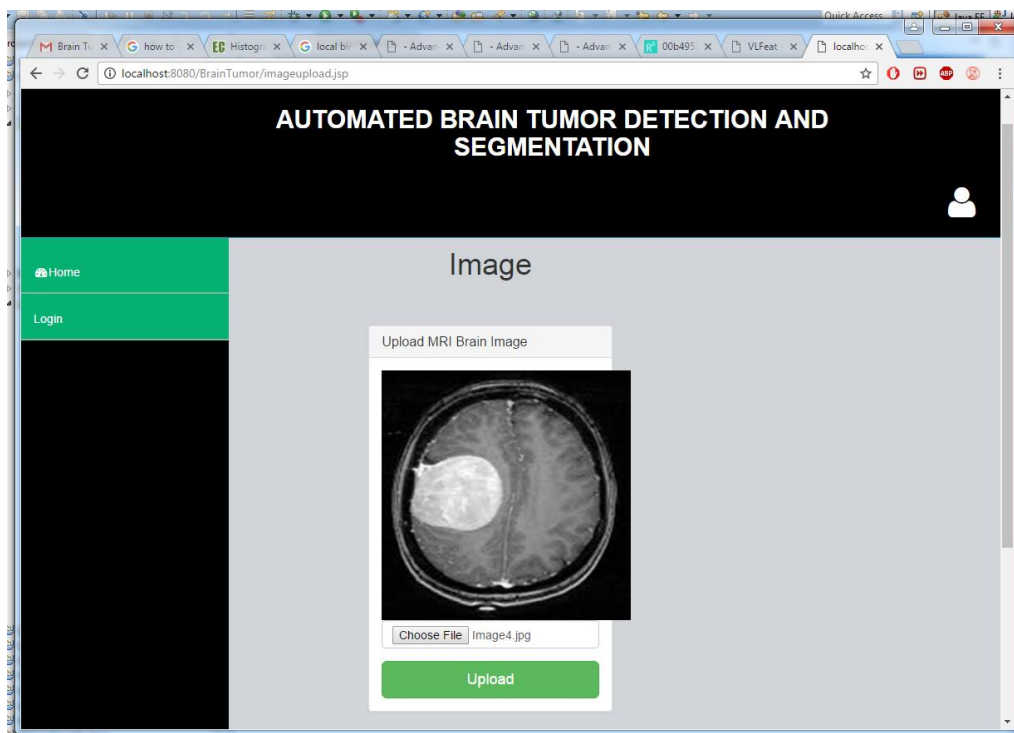
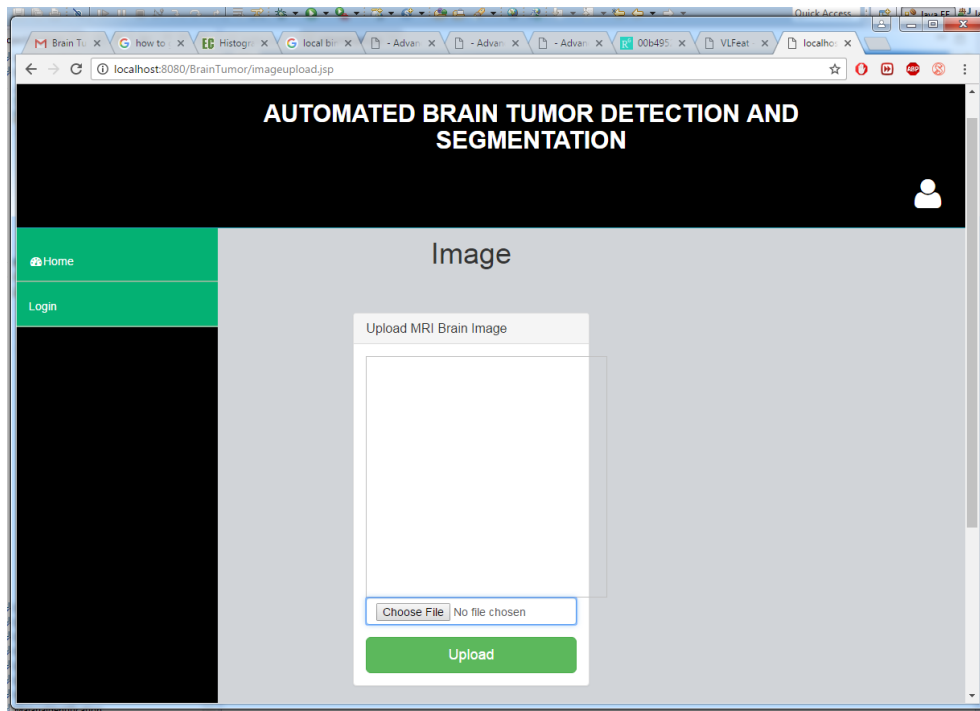


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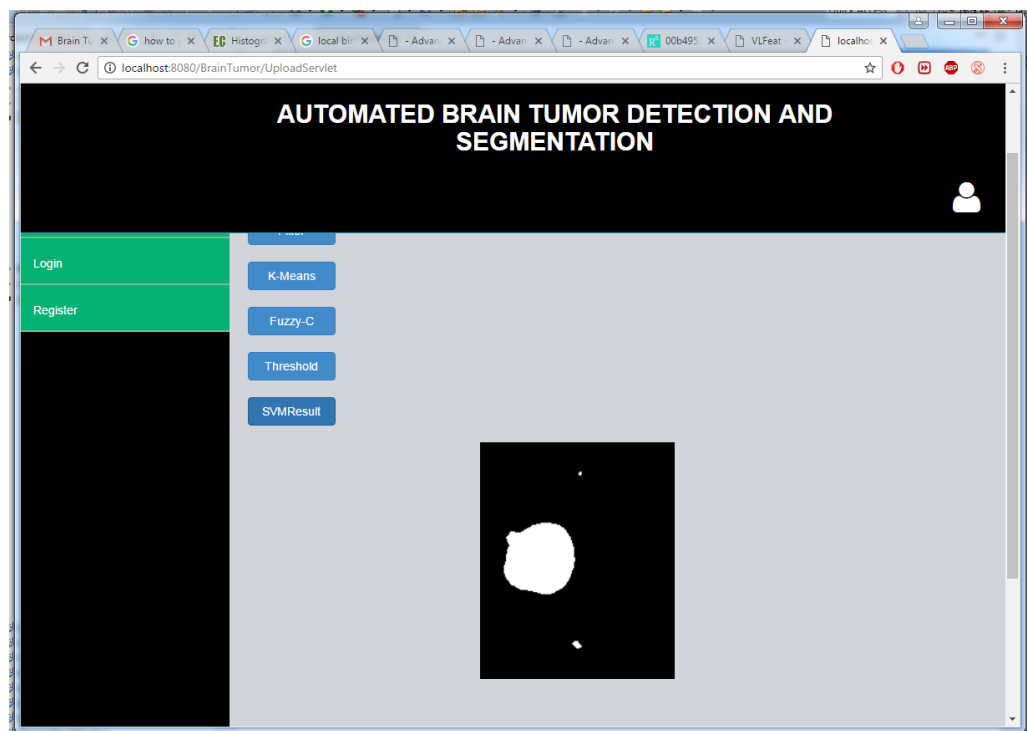
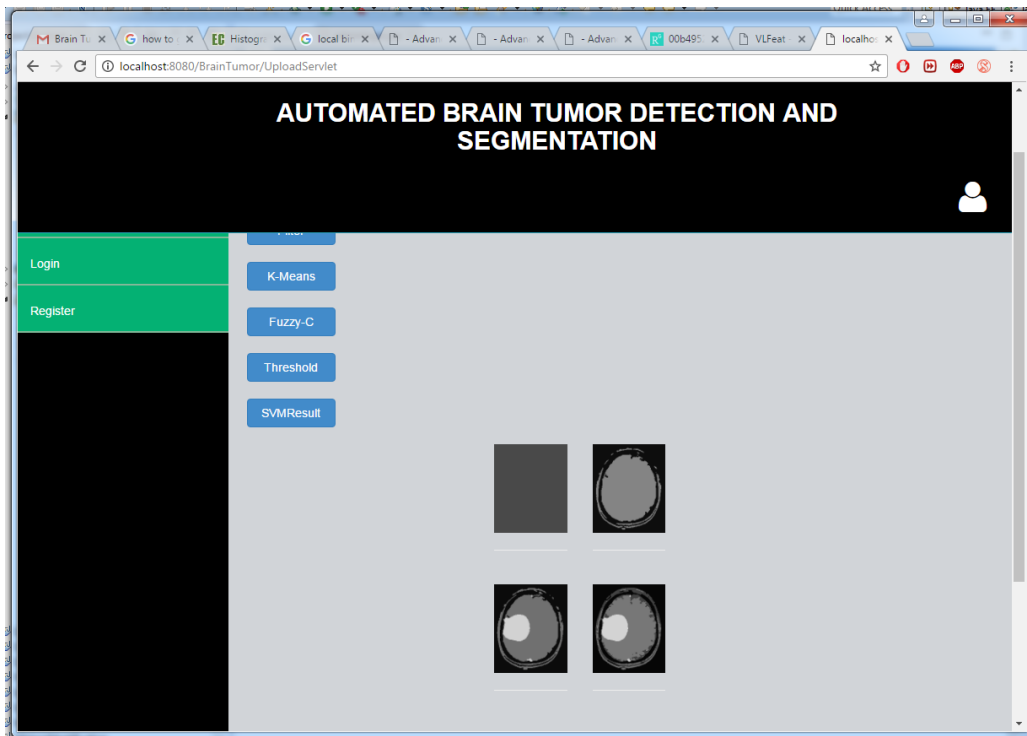


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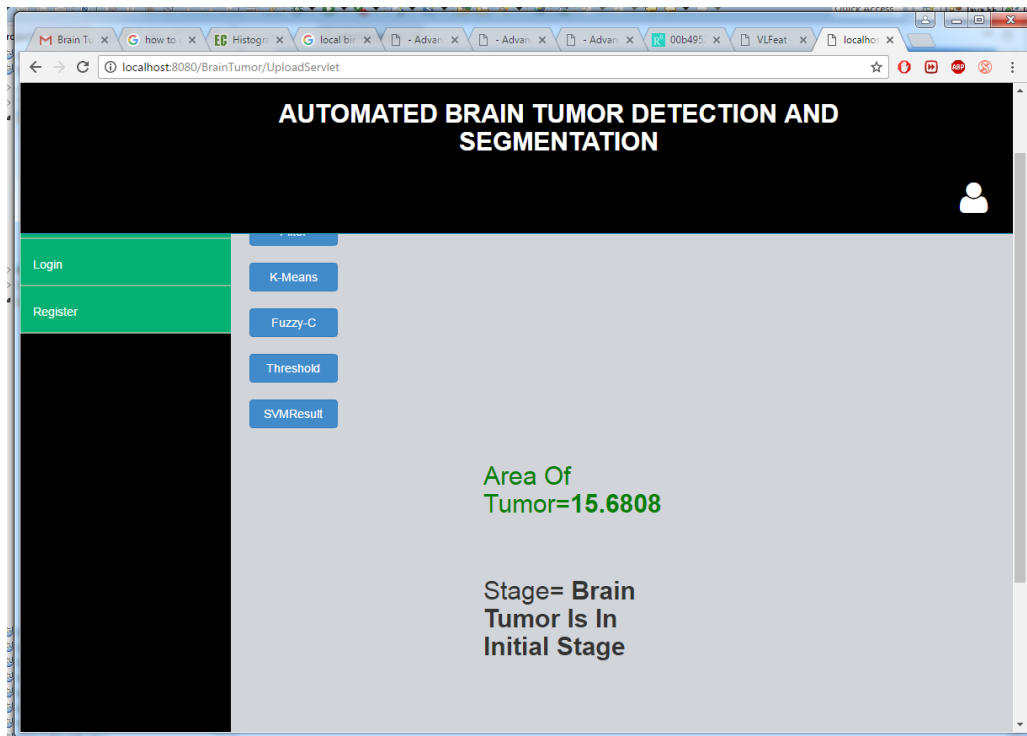


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In above figure the result of proposed system(SVM) is explained there, the first is original MRI image which is having some noise in it. The noise is removed with median filter the result of median filter is shown in (B) image. Then the morphological filtering is used on the preprocessed image and the masks are used to remove the fatty tissues and skull bone. Then the resulted image is go under the segmentation with thresholding, here we have used three colors to show regions according to the intensity slices. After that the resulted image of segmentation goes under object labeling with HOG algorithm and also does the extraction of texture, color and shape context feature. The resulted image of segmentation and object labeling goes under SVM learning, for SVM the linear classifier algorithm is used here and another features that are Mean, Standard deviation, Entropy, RMS, Variance, Smoothness, Kurtosis, Skewness, IDM, Contrast, Correlation, Energy, Homogeneity extracted and stored on the .mat file. This all features are stored in database and that are use for making patterns of the classes that are benign tumor or malignant tumor.

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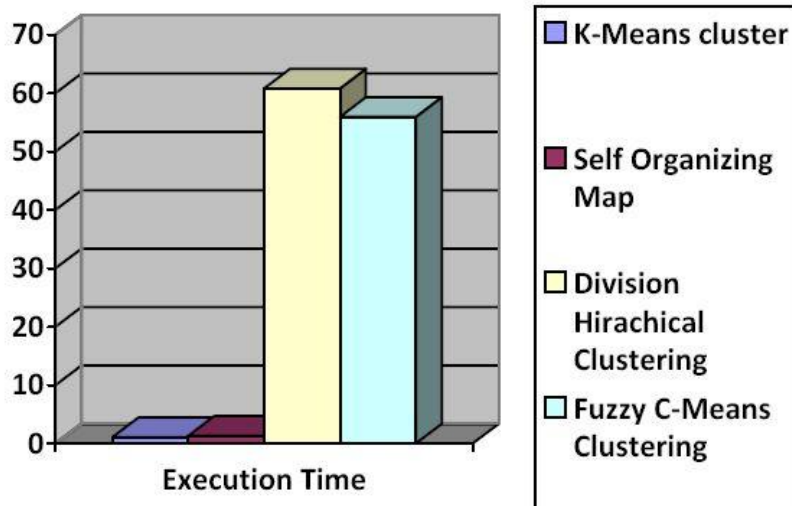


Figure 2: Result analysis of Execution time of various Segmentation methods

The above figure 2 shows the result analysis of Execution time of various Segmentation methods. In that the k-means clustering gives fine result than the other methods that's why here in improved system K-Means clustering is used for segmentation.

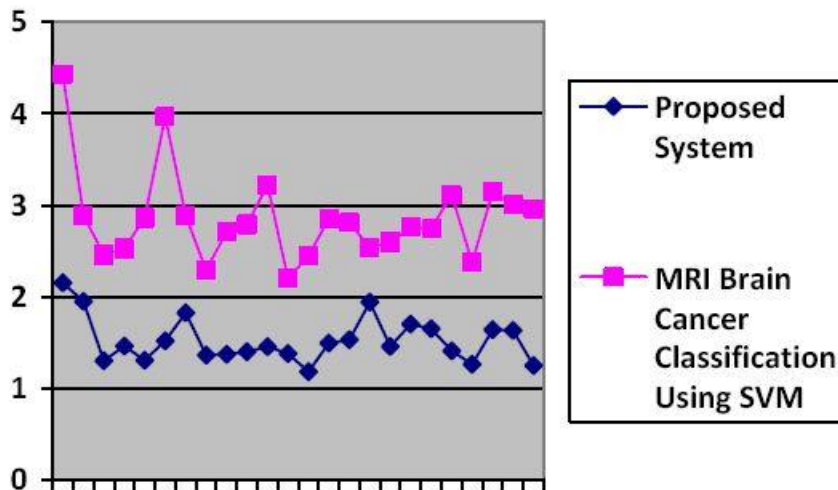


Figure 3: Result analysis of Execution time of Proposed system and Existing system

The proposed system gives a faire result for the input that is MRI images. The proposed method includes the k-means for segmentation HOG for segmentation and the SVM for pattern mapping and pattern matching process. Before this system there exist the other methods to identify the brain tumor one of them is FCM mean and only simple k-means is used for tumor detection. In above number of images verses accuracy graph the red line shows the graph of proposed

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algorithm, the green is FCM mean and the blue is k-means algorithm performance according to the accuracy towards the tumor detection.

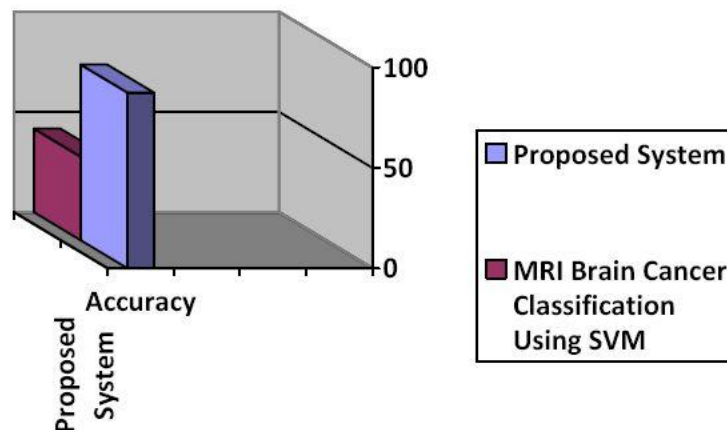


Figure 4: Result analysis of Accuracy of Proposed system and Existing system

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 so here we are taking a resulted graph of number of images verses overall error in system. Again same FCM mean and k means algorithms are use to compare individual performance with the proposed method and the result of all are compared and we found that the proposed system having less errors in the system.

VI.CONCLUSION

There are different types of tumors available. They may be mass in the 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 input to the k-means and tumors are extracted from the MRI image. The performance of brain tumor segmentation is evaluated based on K-means clustering. Dataset consists of Magnetic Resonance Imaging (MRI) size of 181X272. The MRI image dataset that we have utilized in image segmentation technique is taken from the publicly available sources. The brain image dataset is divided into two sets. Training dataset and testing dataset. Thus, the pre-processing is done by filtering. Segmentation is done by advanced K-means algorithm and fuzzy c means algorithm. Feature extractions is done by thresholding and finally, approximate reasoning method to recognize the tumor shape and position in MRI image using SVM. The stage of the tumor is based on the area of tumor.

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