Experimental Analysis of Brain Tumor Segmentation using FCM and SVM Classification Methodologies

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Abstract: **Magnetic resonance imaging (MRI) is the most important techniqu1e, in discovering the brain tumor. Brain tumor is an abnormal growth of cells in brain which affect the functioning of the brain. If we find the tumor in early stages, we can stop further growth of the tumor and proper treatment is undergone for the tumor. . Brain is the main organ of the human central nervous system. A new combination technique based on the FCM (fuzzy c-mean) and Support vector machine (SVM) for brain tumor classification is suggested. So, Here we made an attempt for finding the tumor in brain MRI images. For preprocessing, used method like Gray scale contract, noise removal, thresholding etc. For clustering, we used the FCM clustering and the classification used the SVM classifier.**

Keywords: ***Brain tumor, gray scale image, fuzzy c-means clustering, support vector machine, Performance measures***

I. INTRODUCTION

Brain is the important part of the human body, which is invisible from direct view by the possessive skull and has a very complex structure .One of the accepted reasons for de-function of brain is brain tumor. A tumor means excess cells growing in an undisciplined manner. Brain tumor cells build in a way that they finally take up all the fiber meant for the healthy cells and tissues which outcome in brain failure. Presently, doctors locate the position and the area of brain tumor by seeing at the MR image of the brain of the patient .MRI imaging is a medical

Visualize technique that provides insignificant details about anatomy of human smooth tissues. helps to recognize brain tumor and used by radiologists. Brain tumors have primarily two types, Firstly the Benign tumors are unable of growing beyond the brain itself. Benign tumors in the brain typically do not essential to be consider and their progress is self-limited. Sometimes they can cause confusion because of their position and surgery or emission can be helpful. Secondly is Maligant tumors are often called brain cancer.These tumor can measure outside of the brain. Maligant tumors of the brain will regularly change into the problem if left organic and a violent approach is almost always allowed [1,2,9].

Image processing is a mechanism to perform some operations on an image, in order to obtain an enchanced image or to excerpt some useful information from it. It is the category of signal processing in which input is an image and output may be image or component accociated with that image. Image pre-processing may have impressive positive effects on the nature of feature extraction and the results of image test. Image pre-processing is related to the mathematical normalization of a data set, which is natural step in many feature description methods.When we illusterate or observe brain image, require accurate consideration of the constract, because all the data about the brain mapped into anxiety variation. So we need pre-processing to remove additional marks and labels present in the image. Pre-processing manner makes the image suitable for more processing, to enhance the image quality and certainly pre-processing extract the noise present in the image [3,4,5].

Clustering to Magnetic Resonance (MR) brain tumors maintains capability. Clustering is relevant for biomedical image segmentation as the sum of clusters is usually known for images of distinct regions of the human anatomy. Clustering is used in image segmentation to collect set of pixels into groups established on the similarities. Crisp and fuzzy clustering procedures are two main approaches for clustering. Fuzzy clustering technique will allow the pixel to reside to more than one cluster, which will give improved result in brain tumor segmentation as the border between clusters in brain tumor image cannot be distinctly defined. In this paper segmentation procedure was done by FCM clustering. The hard k means and FCM algorithm have obtain found useful when object and backdrop regions are well equitable.The brain MRI images were confidential using SVM techniques which are generally used for data analyzing and pattern remembering. It construct a hyper plane in between data sets to illustrate which class it belongs to. The main equitable of this work is to develop a hybrid procedure, which can organize the brain MRI image successfully and effortlessly via Fuzzy C-means and SVM. This effort is an decisive classification method is to identify the tumor in MRI images [1, 6, 7, 8].

II. LITERATURE SURVEY

Different segmentation methods accepting using computer-aided system for brain tumor detection were proposed. Image segmentation is annually applied using these methods: thresholding and clustering. Gajanayake et al (2009) presented a comparision of accepted image segmentation methods for brain tumor MRI. Support vector machine were applied in many reachers which are given in. H.B. Nandpura ,Dr. S.S. Salankar worked on MRI cancer classification using SVM. In this paper feature extraction from brain MRI Images were carried out by gray scale, symmetrical and texture features. They achieved good result. A. Padma and R. Sukanesh, their study on SVM Based Classification of Soft Tissues in Brain CT Images using Wavelet Based Dominant Gray Level Run Length Texture Features. This combination of FCM and the level set provides a higher degree of accuracy in the segmentation process. This algorithm is not suited for all types of medical images especially for images with low resolutions. Fuzzy sets are usually referred as expansions of classical sets. Unlike classical sets, a fuzzy set permits partial membership. An arbitrary element p can belong to different fuzzy sets with different degrees of membership. The result of this study show that the optimized c-means solved the over segmentation problem and gives better results than the other.FCM and SVM was implemented as a classifier. SVM performance on dataset with smaller amount of input features, but finally SVM classifier provided better result for tumor[7, 15, 16, 17, 18, 19, 20].

III. METHODOLOGY

The suggested methodology consists of a set of stages origin from collecting brain MRI images. The primary steps are shown in fig 1.The proposed system involves the following main steps like as enhancement, thresholding, clustering and SVM classifier using MRI images. All the above said steps are elaborated in using the MRI images. This Expermentation is carried on the dataset which consists of 100 patients MRI brain images.

Flow chart of methodology

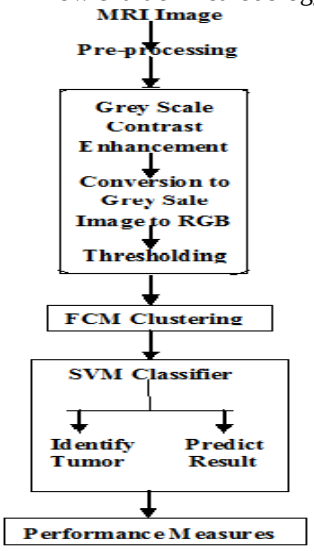
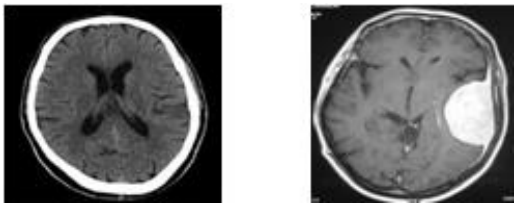


Figure 1: The primary steps of Methodology

A. *Attainment of images:-*

Brain MRI image were possessed from different medical centers. These brain MRI images were transformed into two dimensional matrices using MATLAB (R2012a) [8].

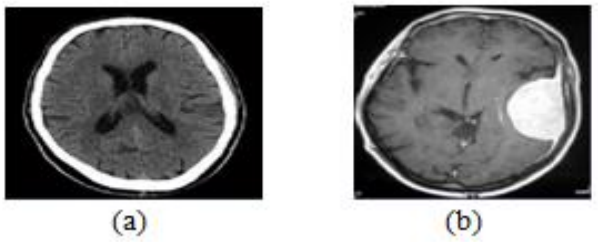


(a) (b)

Figure 2: (a) Non tumor MRI Image and (b) Tumor MRI Image.

B. *Enhancement of MRI Image*

- *Gray Scale Contrast enhancement:* The aim of contrast enhancement is to improve the interpretability or concept of information in images for preparing the image relevant for further processing like image understanding and interpretation. Contrast enhancement process is used to make the image brighter, to improve the visual particulars in the image. Contrast Enhancement is mainly classify into two groups; they are direct methods and indirect methods. In the case of the direct method of contrast enhancement, a contrast measure is first defined, which is then modified by a mapping function to develop the pixel value of the enhanced image [5]. Pre-Processing techniques mainly aimed for the enhancement of the image without altering the information content in an image. In this paper, we implement a pre-processing method for the enhancement of brain tumor MRI image without altering image content and make suitable for further processing. The output images attain after applying all the operation are done to develop the quality of the image [5, 8].



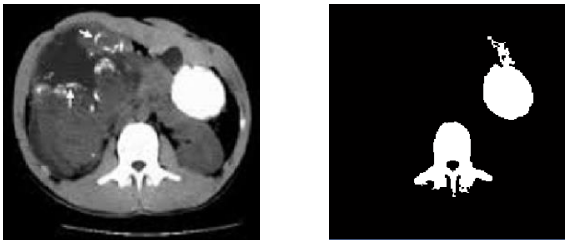
(a) (b)

Figure 3: (a) Enhanced Non tumor Image (b) Enhanced Tumor

- *RGB to grey scale conversion:-* Image achieve after scanning, usually in RGB color format. The image contain three separate planes namely Red, Green and Blue components. In the case of RGB image, pixel intensity represented by the sequence of these 3 plane intensity values. In the case of greyscale image pixel values expressed by the intensity values ranges from 0 to 256. Grey scale image feeding from black to white with different shades of grey. Changeover of a color image to greyscale is executed with the help of different weighting

to the color channels red, green and blue to effectively represent the effect of black-and-white film with different-colored photographic filters on the cameras. Similarity between the RGB image and greyscale image is that contest between the luminance of the greyscale image and RGB image [5].

- *Thresholding:*-Thresholding is generally known simple and mostly used for gray scale images to disciple it into a binary images, process of creating a black and white image out of a gray scale image consisting of setting exactly those pixels to white whose value is above a given threshold, setting the other pixels to black Two types of thresholding mainly occur first is global thresholding and another is local thresholding.The output images obtained after applying all the operation are done to improve the quality of the image[11, 12].



(a) (b)

Figure 4: (a) Brain MRI Image (b) Thresholding Image

IV. FCM ALGORITHM

The Fuzzy c means (FCM) clustering algorithm was suggested by Bezdek . The method is mainly used for pattern recognition, which pervilege one pixel to belong to more than one cluster, and its aim to divide a given set of data into a positive number of clusters based on two parameters. In this work, FCM algorithm was used in MRI image segmentation. This algorithm is used to find out the suspicious region from brain MRI image. The FCM clustering method provides a good segmentation results [1, 7, 8].

The FCM algorithm allow pixels to each category by using fuzzy memberships. Let $X_z = (x_1, x_2, .., x_N)$ denotes an image with N pixels to be separation into c clusters, where Xi represents features data. The algorithm is an iterative optimization that minimizes the cost function defined as follows:

$$J=\sum_{j=1} N \sum_{i=1} C \, u_{ij}^{m} \|xj - vi\|2$$

where uij is the membership of pixel Xj in the ith cluster, vi is the ith cluster center, is a norm metric, and m is a constant. The parameter m controls the fuzziness of the resulting partition. The cost function is minimized when pixels close to the centroid of their clusters are assigned high membership values, and low membership values are assigned to pixels with data far from the centroid. The membership function represents the probability that a pixel belongs to a specific cluster. In the FCM algorithm, the probability is dependent solely on the distance between the pixel and each individual cluster in the feature domain. The membership functions and cluster centers are updated by the following: [1].

Starting with an initial guess for each cluster center, the FCM converges to a solution for representing the local minimum or a saddle point of the cost function. Convergence can be detected by comparing the changes in the membership function. It results the segmented image as shown in the fig 6. After that the clustering three images of clustering method are displayed as shown in the figure. The data is shown in cluster format in background like, cluster 1 image displayes the overall regions in MRI image, and cluster 2 image displayes the affected area while in cluster 3 image for outer layer of the segmented image as shown in fig7. In that clustering images we have to select one MRI image for fine result of the fuzzy c means clustering algorithm.

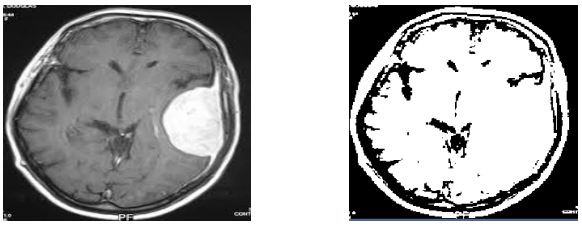


Figure5: Input MRI Image and Image after Segmentation

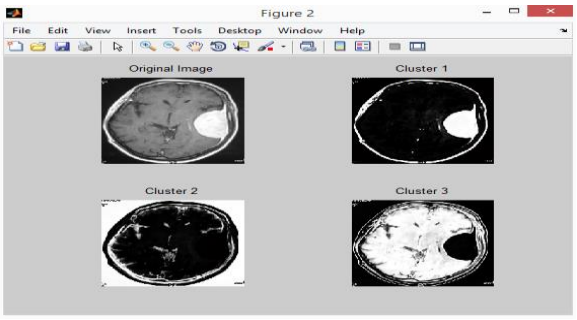


Figure 7: The image after FCM Clustering

V. SVM ALGORITHM

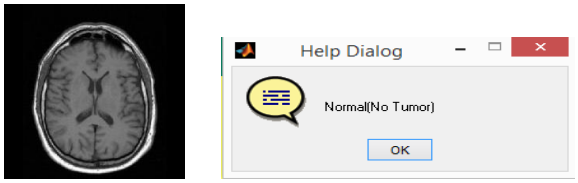
SVM algorithm was first developed in 1963 by Vapnik and Lerner. SVM is a binary classifier based on supervised learning which gives better result than other classifiers.SVM method is a managed learning method. SVM classifies between two classes by constructing a hyper plane in high-dimensional feature space which can be used for classification. SVM is a classification algorithm, which is based on different kernel methods. Support vector machine is based on the concept of decision planes. A decision plane is one that divide between a set of items having different class participation. The classification and disclosure of brain tumor was done by using the SVM technique. Classification is done to find the

tumor class present in the image. The use of SVM comprise two basic steps of teaching and testing [8, 9]. In the SVM the classes are affected to be identified as ± 1, and the decision boundary is evaluation as y=0. So using the equation:

$$\sum_{i=1}^{N} w_i \; x_i \, x_i w + b\mathrm{Y}$$

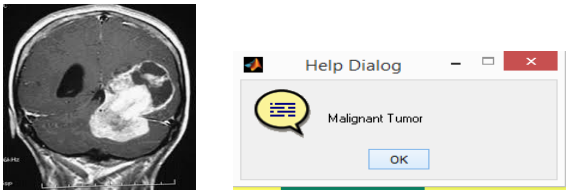
The distance from the hyper plane (x_i+b=0) to the origin is $\frac{-b}{\|w\|}$, where $\|w\|$ is the norm of w. The distance from the hyper-plane to the origin is: M=$\frac{-2}{\|w\|}$.

In this classifier it shows the result weather the tumor is found in the MRI image or not as show in the fig 9 and fig 10. And it also classifies the tumor type. Classification is the operation where a given test sample is assigned a class by the classification used in the SVM classifier [8].



(a) (b)

Figure 9: (a) Normal MRI Image (b) Tumor Decision Box



(a) (b)

Figure 10: (a) Tumor MRI Image (b) Tumor Decision Box

VI. PERFORMANCE MEASURES

Classification,. True Positive (TP), True Negative (TN), False Positive(FP), False Negative(FN) are the confusion matrix features that is used for calculating the accuracy and the classifier system [8, 15].

- *True Positive (TP):* The number of pixels that the extracted region and the ground truth consider it as a tumor.
- *True Negative (TN):* The number of pixels that the extracted region and the truth consider it as not tumor.
- *False Positive (FP):* The number of pixels that the extracted region considers it as a tumor and the ground truth considers it as not tumor.
- *False Negative (FN):* The number of pixels that the extracted region considers it as not tumor and the ground truth considers it as a tumor [7].

Accuracy=TP + TN/ TP + TN + FP + FN * 100

Some, Features are involves in this performance measures concept, they are Mean, Standard Devation, Smoothness, Contrast, Energy, Krutosis, Variance, RMS are confusion matrix methods used to calculate the classifier technique.

Mean: $\bar{X}=\frac{\sum x}{N}$

Standard Deviation: $\sqrt{\sum|\boldsymbol{X}-\overline{\boldsymbol{X}}|^{\mathbf{2}}}$/n,

RMS: $X_{RMS} = \sqrt{\frac{1}{N}\sum_{n=1}^{N}|X_n|^2}$

Variance: V= $\frac{1}{N-1}\sum_{i=1}^{N}|A_i-\mu|^2$

Energy: E=T$\sum_{n=0}^{N-1} x^2\,[n]$

Kurtosis: K= $\frac{E(x-\mu)^4}{\sigma^4}$

Skeweness: S= $\frac{E(X-\mu)^3}{\sigma^3}$,

Smoothness: w_i=$(1-\left|\frac{X-X_i}{d(x)}\right|)^{3)^3}$

VII. EXPERIMENTAL RESULT:

The clustering is done using the Fuzzy c means algorithm. In FCM clustering, the data elements can exist in more than one cluster and a set of membership levels is set to each element. This enhance the tumor part present in the segmented image. Support Vector Machine technique with Fuzzy c means clustering is used for segmentation and classification of MRI images of brain, MRI images have been used to detect tumor and non-tumor MRI images. The brain MRI images are segmented with the thresholding and fuzzy c means algorithm clustering, SVM classifier is done with MRI images and calculating the accuracy and performance measures of the image. Accuracy of different images shown in table 1 and Performance Measures are shown in table 2.

VIII. CONCLUSION

Brain tumor is an abnormal growth of the cells in brain which affect the functioning of the brain. If we find tumor in early stages, we can stop further growth of the tumor and proper treatment is undergone for the tumor. So, here we made an attempt for finding the tumor in brain MRI images. For Pre-processing, used the methods like Gray Scale Contract, Thresholding etc,. For clustering, used the FCM classifier and Performance Measures.

Table 1: Shows accuracy results for different images

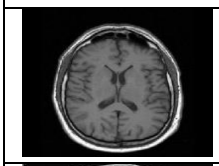
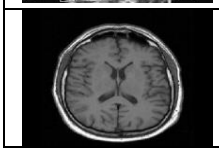
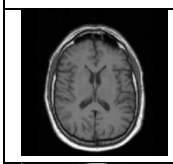
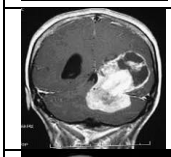
Image	RBF acc	Linear acc	Quadratic	Polynomial	Predicted Result
	82.5	91	86.5	86.5	Normal
	90.5	85.5	87.5	87	Malignant
	89.5	86	87	86.5	Benign

Table 2: Shows results of images performance measures

Image	Mean	Kurtosis	Variance	Standard Deviation	Smoothness	Contrast	Energy	Skewness	RMS
	$-3.31276e^{-1}$	4.62223	7.519	2.719	$-1.9984e^{-15}$	18.5484	0.13	-0.4248	2.69
	$-1.43255e^{-1}$	1.81825	49.66	6.9894	$-8.88178e^{-1}$	32.4516	0.2799	0.24767	6.912
	$-2.29207e^{-1}$	1.75113	55.45	7.38546	$-1.42109e^{-1}$	23.2903	0.2445	-0.5401	7.299

REFERENCES

[1] Neeraja Menon and Rohit RamaKrishnan "Brain tumor segmentationin MRI images using unsupervised Artificial Bee Colony algorithm and FCM Clustering" IEEE ICCSP 2015.
[2] Arshadeep Kuar "An Automatic Brain tumor Extraction System using different Segmentation Methods" second international conference IEEE 2016.
[3] Accesed by http: // sisu.ut.ee/ image processing/ block/ 1 University of TARTU.
[4] Accessed by J.Verne www. embedded- vision.com /sited/ defaut /files/après/ computerversion metrics/ chapter 2/cho 2.
[5] Sheela.V.K Dr.S.Surech babu" Pre-processing technique for Brain tumor detection and segmentation .Volume 2,June 2015.
[6] Karishma Sheikh, Vidya Sutar, Silkesha Thigale, "Clustering bases Segmentation Approach to Detect brain tumor from MRU scan" International. Journal of Computer applications.8,May 2015.
[7] E.El-khang, Rowady da A.sedek , Mohamed An Efficient Brain Tumor Mass Dection with Adaptive Clustered based Fuzzy c-means and Tresholding. International journal of computer application 2015.
[8] Praveen, AMriptal sing." Detection of Brain Tumor in MRI Images using Combination of Fuzzy c-means and SVM.2015 IEEE.
[9] Chinnu A ."MRI Brain Tumor Classification using sum and Histogra Based Image Segmentation "International Journal of C.S.E vol 6(2) 2016.
[10] Md.Abdullah Al Mahmud, A.HM Radidul Kadim. Brain Tumor Detection using MRI images through pixel based Methodology. Global Journel of C.S and Technology 2015.
[11] Anupurba Nandi Detection of human brain tumor using MRI image Segmentation and Morphological Operatiors by International Conference IEEE 2015.
[12] Arashdeep kaur "An Automatic Brain Tumor Extraction Sysytem Using different Segmentation meyhods" IEEE 2016.
[13] Lakshmipriya sahoo,prem such yadav,sk MD ali "Alternate Machine Validation of Early Brain Tumor Dection."25th july, IEEE 2016.
[14] Praveen G.B,Anitha Agrea. Hybrid Approach of Brain Tumor Detection and Classification in Magnetic Resonance Images.. International Conference (CCIS) 2015.

[15] G.M.N.R Gajanya Comparision of Standard image Segmentation Methods for Segmaentation of Brain Tumors from 2D MR Images IELLS 2009.
[16] Hari babu Nandapuru,S.S.Salankar,V.R. Bora. "MRI brain cancer classification using SVM"24th april IEEE 2014.
[17] K.Jolly Francics,M.S Godwin Premi "Kernel Weighted FCM Based MRImage Segmentation Using FCM".16 july IEEE 2014.
[18] Jin Liu, Min Li, Jianxin Wang, "Automatic Brain MRI Image Segmentation Methods for Tumor Detection in MRI Images".vol 19 december , IEEE 2014.
[19] R.preetha. "Performance Analysis of Fuzzy c-means Algorithm in Automated Detection of Brain Tumor" World congrees on computing and communication technologied 2014.
[20] saharif Halfizah Sy Ahmand Ubaidillah, "Cancer Detection Using artifiacal Neural network and Support Vector Machine" A Comparative Study Journel Technology (Science & Technology