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Brain tumor detection using SVM classifier

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Brain Tumor Detection Using SVM Classifi

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***Abstract*— Magnetic Resonance Imaging is a standard non-invasive methodology used in medical field for the analysis, diagnosis and treatment of brain tissues. The early diagnosis of brain tumor helps in saving the patients' life by providing proper treatment. The accurate detection of tumors in the MRI slices becomes a fastidious task to perform and therefore, by this proposed system, the classification and segmentation the tumor region can be done accurately. Segmentation and 3D reconstruction also uses the detection of tumor from an MR image. The manual tracing and visual exploration by doctors will be restrained in order to avoid time consumption. The brain tumor detection allows localizing a mass of abnormal cells in a slice of Magnetic Resonance (MR) using SVM Classifier and segmentation of the tumor cells to know about the size of the tumor present in that segmented area. The extracted features of the segmented portion will be trained using artificial neural network to display the type of the tumor. These features will also be used for comparing the accuracy of different classifiers in Classification learner app. The scope of this project is helpful in post processing of the extracted region like the tumor segmentation.**

Keywords*— *Segmentation; Brain tumor; SVM Classifier; artificial neural network; Magnetic Resonance Imaging; Classification learner app.

I. INTRODUCTION

The cell is the fundamental structural unit of our body. There are about hundred trillion cells and they normally divide in a controlled way. The uncontrolled or abnormal division leads to the formation of tumor cells [1].

Brain tumor also called intracranial neoplasm, is one such kind of tumor where the abnormal cell division occurs inside the brain.

Classification of brain tumor:
Brain tumor is classified on many bases. Based on the origin of the tumor, it is classified as given below

Primary tumor: The origin of the tumo itself.

Secondary tumor: It is known as me tumor. The origins of the tumor cell are the body where it finally reaches the bra most common type of brain tumor.

Based on the malignancy, it is classified as given

Benign tumor*:* The tumor cells are nonc are normal in size and growth. They d invade the other parts of the body.
Malignant tumor*:* The tumor cells are ca that are abnormal in size and growth. invade the neighboring healthy cells.

Based on the appearance, the tumor cells During the period of treatment, this grade measu the information about the rate of growth of tumor

TABLE 1. Grades of brain tumor

Grade	Appearance	Gr
1	Nearly normal	
2	Slightly abnormal	
3	Abnormal	Acti
4	Most abnormal	Qui

A benign tumor can become malignant lat grade tumor can turn into a higher grade tum knowledge about the exact grade or stage of necessary for the proper treatment.

The diagnosis of brain tumor can be achi various images such as CT (Compute ultrasound, PET (Positron Emission Tomography

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(Magnetic Resonance Imaging), Spectroscopy, Fusion, etc. Among all the Imaging techniques, MRI is preferred as it effectively detects the following given conditions: cysts, tumor, bleeding, swelling or infections.

One of the main problem in medical analysis is the segmentation of obtained image where the boundaries of objects such as abnormal region or organs are identified in the images. Results obtained from the segmentation process is useful in obtaining features of segmented tumor region such as

threshold, edge, pixels, cluster, and neural network.

Processing of image based on shapes is called morphology. Structuring element is applied to the preprocessed input image which creates output image of the same size. Every pixel of the input image is compared with all the neighboring pixels and the compared result is the values of the corresponding output pixel.

Dilation and erosion are the basic operations of morphology. Pixels are added to the boundaries of the objects in dilation operation while they are removed in the erosion operation depending on the size and shape of the structuring elements. During the comparing process, dilation operation returns the highest value of the surrounding nearby pixels to the output whereas the erosion operation returns the lowest value of the surrounding nearby pixels to the output.

There are different types of clustering that includes mountain, K- means, fuzzy C- means and subtractive clustering method. The k-means clustering is the common clustering technique that is used. It is a simple, straightforward and quicker than the hierarchical clustering that can work for large number of variables [4].

The process of separating an image into various parts or regions is called image segmentation. The major goal is to simplify or change the representation of the image into something else which is easier and more meaningful to analyze. It is used to locate objects and boundaries in images. Every pixel in an image is assigned a label such that the pixels having the same label share certain characteristics in common.

One of the classical problems in image processing is image classification. The major goal of image classification is to predict the input image categories by using the features. There are various classifiers such as ANN (Artificial Neural Network), SVM (Support Vector Machine), Random Forest, Decision Forest k-NN (k Nearest Neighbor), Adaptive boost (Ada boosted) etc.[5].

One of the best methods for classifying any image or pattern is SVM. SVM is used to split a set of images into two various classes. The classification is done by finding the hyper-plane that differentiate the two classes very well as given in Fig. 1.

Fig. 1 Classification using SVM

It builds a hyper plane based on a kernel fur shown in Figue.1, feature vectors on left side o belong to class -1 and the feature vectors on the hyper plane belong to class +1.

In neural network, the dataset of MRI imag by iteration method. Therefore, when a new ima the neural network, it is trained by neural comparing the iteration value of the previously t After the training is complete, if any changes ne to the training process, the network architectur sets can be determined using the network perf Fig. 2 shows that the test curves and the validati very similar. If the test curve gets increased before the validation curve is increased, then it i an over fitting might have occurred. The relatior the targets and the resulting output of the ne compared by plotting the regression plot [6]. I was perfect, the network output and the target w as shown in Fig. 3.

Fig. 2 Performance of training process

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B. Convolution filtering:

The MRI Images acquired from various so noises due to random movement of patient du and external noise, etc. The above mentioned noi removed and the image perceptual quality have t for efficient brain tumor detection [8].

Fig. 3 Regression plot

Classification Learner app is used to train the database for classifying the obtained data by supervised machine learning. The tasks involved in this app includes:

- uploading the data
- selecting the features
- training the database
- obtaining the results

Types of classification includes SVM (Support Vector Machine), K-nearest neighbors (k-NN), decision tree. This app performs model assessment and comparisons using confusion matrix and scattering plots. There are two types of classifier training:

- Manual classifier training
- Parallel classifier training

Manual classifier training: It is used to explore individual model types or if we already know what type of classifier we need. Thus, Manual classifier training classifies one at a time or a group of the same type.

Parallel classifier training: Using Parallel computing tool box we can train classifiers. Thus this app starts a parallel pool of works automatically until and unless we turn off the default parallel preference. Thus Parallel classifier can train multiple classifiers at once. In this project we are using Parallel classifier training.

II. METHODOLOGY

The flowchart of various steps involved in the proposed system is shown in Fig. 4.

A. Acquisition of input image :

The dataset of MRI Images are acquired from publicly available sources such as hospitals, laboratories and medical institutions and colleges which is saved in .jpg format.

1) RGB to Gray-level conversion: The image is gray scale image from RGB model.

2) Edge detection: The edges present in the gray s detected using canny method. The Canny smoothens the gray scale image by convoluting it w filter. Both the x and y direction derivatives are co on the resulting smoothed image. The gradient ma image is computed with these derivatives. If constitute a local maximum, then the pixels of suppressed. The final step is performed using operator, where the pixels are marked as either edg or between the edges and non- edges, based upon values. If the in-between pixels are connected w pixels, they are also considered as edge pixels. A b obtained as the result, where the white pixels closel the true edges of the original image.

3) Image resizing: The gray scale image is resized to a size of 200×200.

4) 2D convolution masking: In this step, the valu is given in matrix format (mostly 3x3 matrix) a matrix is created as shown below.

```
hN = [0 1 0; 0 -1 0; 0 0 0];
```

This masking matrix and the matrix form convoluted as shown below.

```
nablaN = imfilter(diff_im,hN,'conv');
```

Perona- Malik Diffusion equation and PDE dir used for the filtering of image.

Perona-Malik Formula:

```
g=1/(1+(x/k)^2) .*a
g=exp(-(x/k)/2).*a
```

PDE Direct Method:

```
Img= Img + dt*(CN.*GN + Cs.*Gs + Ce.*Ge + C
```

The 'Result 1' and 'Result 2' in respectively refer to the type of the tumor and th result of classifiers.

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Image acquisition

Pre-processing

boundaries are checked for the subscripts of the then the indices of the eight neighbors are found central derivative. The derivatives of SDF at x, y

```
π_x = - π (a)+ π (b);
π _y = - π (c)+ π (d);
```

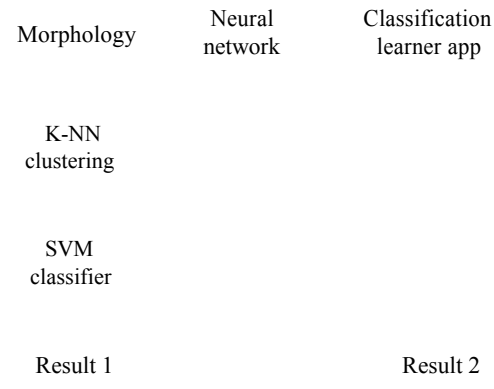

Fig. 4 Flow chart of the proposed system

C. Neural Training:

After the pre-process operation on the image, the dataset of the image along with its extracted features are trained using the neural network. The performance of the training operation is validated and is plotted in a graph with mean square error in y-axis and iteration values in x-axis.

D. Morphology:

The morphology operation is performed on the preprocessed image using the 'disk' structuring element. The image is first closed and the small objects on the image are removed. Then a boundary is plotted around the area of tumor.

E. Clustering:

The morphed image is then clustered using the same 'disk' structuring element. The clustering includes the process of dilation and erosion followed by 'open' operation. After all these operations, the connected components found on the image are returned.

F. Segmentation:

A signed distance map (SDF) is created for masking purpose. Interior and exterior points of the mask are found and using these points, their mean values are calculated. The kappa value is then calculated by setting a threshold point. The

+0.25* π (h)+0.25* π (i);
π _x2 = π _x.^2;
π _y2 = π _y.^2;

The kappa value is calculated using central
follows
Kappa= ((π _x2.* π _yy+ π _y2.* π _xx-* π _x
_xy)./..(π _x2+π_y2+eps).^(3/2).*
+π_y2).^(1/2);

G. Classification learner app:

For comparison between various classifiers su
SVM, and Trees, classification learner app is
training each classifier, both the correct and
results are plotted in the scattering plot.
confusion matrix displays the result in matrix
above process, the efficiency of each classifier
are compared with one another.

III. EXPERIMENTALRESULTS

The GUI menu option opens as in Fig. 5.

Fig. 5 GUImenu

The options are selected in order. On selecting
"TESTING INPUT", the input image can be choo
number of images. The input image is displayed as

On selecting the option "NEURAL NETW
PREPROCESSING", the unknown input image is
when it is simultaneously added as a dataset to the

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network. The neural network training dailog box opens and the iterations starts as shown in Fig. 7.

"RESULT", the result of the tumor either being n
benign or malignant is displayed as in Fig. 9.

Fig. 6 Image acquisition

Fig. 7 Neural network training

The performance of the validation can be viewed in the form of graph as in Fig.8.

Fig. 8 Performance of traing process

After the process of morphology and clustering, the tumor part is alone segmented and is displayed along with its properties as in Figure.7. Also, on selecting the option

Fig. 9 Final segmentation result

Then the classification learner app is opened a for the given input image is plotted as a graph as

Fig. 10 Scatter plot

The scatter plot and the confusion matrix of the Linear SVM classifier is displayed as in Fig. 11.a ar

Fig. 11.a Scatter plot of Linear SVM classifie

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Citations (18) References (7)

... The classification techniques, consisting of the following classifiers, such as Least-squares Classifier; used to calculate probability model when the training data are not linearly separable [7], Maximum-Likelihood Classifier; in which a pixel with the maximum likelihood is popularly classified into the corresponding class in remote sensing [10], Radial Basis Function Network Classifier; which transforms the input signal into another form to get linear separability [5,15] and Support Vector Machine Classifier; a discriminative classifier formally defined by a separating hyperplane which categorizes new examples [11, 16]. These classifiers are experimented by using different percentages of training data set at 20%, 35%, 65% and 80% in order to collect the different perspectives of data classification. ...
... In this paper the higher-order Hazard descriptor introduced as our new extended Hjorth parameter was compared to those Hjorth descriptors with less parameter orders formerly reported in the past. It was found out that the Hazard parameter shows a very similar tendency like Chaos parameter in a case of CHF class but much less quantitative amount among three different ECG classes (see figures [11] [12]. When making a comparison between different Hjorth descriptors, the Hazard of CHF differs significantly from those of AF and NSR ECG classes. ...

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... Previous research has conducted several methods to detect brain tumors. Some of them are using classification techniques, such as K-Nearest Neighbor [5], ANN [6], SVM [7] , and particle swarm optimization (PSO) [8]. In this research, the preprocessing of data is done first by making a segmentation using histogram selection, then forming a model using CNN. ...

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... The unsupervised model, such as fuzzy c-means [19], k-means [20], and principal component analysis (PCA) [21,22], do not need a training procedure. The supervised model, such as random forest (RF) [23], markov random field [24], support vector machine (SVM) [25] , extreme learning machine [26] and deep learning [7], need to first train a classification or segmentation model, then feed a new acquired MRI into the trained network to obtain a segmented contour of the brain image. A late example is by Yang et al. ...

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... To make it more accurate, we propose an incremental learning algorithm based on Learn++ [8] to detect or classify

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... However, accuracy was good but sensitivity and specificity were poor. In [7] , the authors had proposed a model that detects tumors using SVM algorithm. They hade used an artificial neural network (ANN) to train the network and SVM was used to segment and detect the tumor. ...

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