AN APPROACH FOR BRAIN TUMOR DETECTION USING CNN

ONE OF THE MACHINE LEARNING ALGORITHM FOR DETECTION

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Abstract : **Adaptive brain tumor detection, Image processing and supervised machine learning concepts are used as the medical tools for detection of tumor. In this paper, we have used watershed segmentation and also we have also used object extraction for more detailed information of tumor region. To make this system more adaptive we used CNN (convolutional neural network), CNN which is a part of supervised machine learning is used here for analyzing and classification of the pattern for future use. Also, for patterns we have to find out the feature to train CNN, through the categorical dataset .Here we have gone through the Cross validation technique to evaluate generalization for the performance of learning algorithm. For that here we have gone through the different layers of CNN such as local connectivity, weight sharing and pooling. It is expected that the experimental results of the proposed system will give better result in comparison to other existing systems.**

IndexTerms **- Watershed segmentation, CNN, Pooling, Fully connected, Cross Validation.**

I. INTRODUCTION

It is important to find out tumor from MRI images but it is somewhat time-consuming and difficult task sometime performed manually by medical experts. Subsequently, over the some decade, by various research results it is being observed that it can get faster if we use image processing techniques [3]. 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 benign tumor is easier to identify than the malignant tumor. Also the first stage tumor may be malignant of benign but after first stage it will change to dangerous malignant tumor which is life threatening [12].Different brain tumor detection algorithms have been proposed in the past few years. Normally, the automatic segmentation problem is very challenging and it is yet to be fully and satisfactorily solved. The main aim of this system is to make an automated system for detecting and identifying the tumor from normal MRI. It takes into account the statistical features of the brain to represent it by significant feature points. Most of the methods which are used for tumor detection and segmentation can be largely divided into three groupings: region-based, edge-based and fusion of region and edge-based methods. Well known and broadly used segmentation techniques are Watershed segmentation technique , K-mean clustering algorithm, unsupervised method and supervised method based on neural network classifier [4]. Also, the time spent to segment the tumor is getting condensed due to the detailed demonstration of the medical image by withdrawal of feature points. Region-based techniques look for the regions satisfying a given homogeneity standards and edge based segmentation methods look for edges between regions with different characteristics [5].Convolutional layers are responsible for detecting certain local features in all locations of their input images .CNN is an effective algorithm basically used for the recognition. The pattern recognition feature of CNN makes its efficient use in image processing and pattern recognition techniques. CNN also supports some unique features like the structure is simple it has adaptability and also less training parameters.

II. LITERATURE SURVEY

SnehaKhare ,et.al [21] have proposed an algorithm to detect brain tumor from MRI. The proposed method was implemented using Optimization Technique, Machine Learning and cumorurve fitting technique to detect tumor .The proposed work has been implemented using Generic Algorithm ,Curve Fitting and Support Vector Machine .GA was used to segment image which might be losing some information of neighbouring segments so, Curve Fitting was used to improve the procedure for segmenting and features were extracted .The extracted features were then classified using Support Vector Machine .The proposed method have been proved to be efficient,16.39% of accuracy and 9.53% précised then the existing work.

R.Muthukrishnan, et.al [6] Proposed brain tumor detection in which segmentation process separates an image into its component regions or objects. Image segmentation is needed to segment the object from the background to read the image properly and classify the content of the image carefully. In this framework, edge detection was an important tool for image segmentation. This paper was made for studing the performance of most commonly used edge detection techniques for image segmentation and also the comparison of these techniques was carried out with an experiment.

M.Saritha et.al, [7] Proposed approach by integrating wavelet entropy based spider web plots and probabilistic neural network for the classification of Brain MRI. The proposed technique uses two steps for classification i.e. Wavelet entropy based spider web plot for feature withdrawal and probabilistic neural network for classification. The obtained brain MRI, the feature extraction was done by wavelet transform and its entropy value was calculated and spider web plot area calculation was done. With the help of entropy value classification using probabilistic neural network was calculated. Probabilistic neural network provides a solution for pattern classification problem and its classification accuracy is about 100%.

Neetu Ouseph C et.al [22] the paper present a reliable detection method based on CNN that reduces operators and errors. The Convolutional Neural Network was used in convolving a signal or and image with kernels to obtain feature maps. The image processing techniques such as image conversion,feature extraction and histogram equalization have been developed for extraction of the tumor in the MRI images of cancer affected patients. A suitable Fuzzy Classifier was developed to recognize healthier tissues from cancer tissues. The developed system efficiently detects and extracts the tumor from input MRI image for Brain Cancer affected patients .For input image Testing the system shows the Tumor Region which is extracted from the MRI image and area covered by the tumor.

P.NandaGopal et.al, [8] in their paper they presented a combination of wavelet statistical features (WST) and co- occurrence wavelet texture feature (WCT) obtained from two level distinct wavelet transform which was used for the organization of the abnormal brain matters in to benign and malignant. The planned system consists of four stages: segmentation of region of interest, discrete wavelet disintegration, feature abstraction, feature selection, organization and evaluation. The support vector machine was employed for brain tumor segmentation. A grouping of WST and WCT was used for feature extraction of tumor region extracted from two level discrete wavelet transform. Genetic algorithm was used to select the optimal texture features from the set of mined features. The probabilistic neural network was used to classify abnormal brain tissue in to benign and malignant and the performance evaluation was done by comparing the classification result of PNN with other neural network classifier. The classification accuracy of the proposed system is 97.5%.

Laxami et.al, [9] proposed the work on information (region of interest) in the medical image and thereby vastly improve upon the computational speed for tumor segmentation results. Significant feature points which were based on the approach for primary brain tumor segmentation was proposed. Axial slices of T1- weighted brain MR Images with contrast enhancement have been analyzed. In order to extract significant feature points in the image, applied a feature point extraction algorithm based on a fusion of edge maps using morphological and wavelet methods. Evaluation of the feature points thus obtained has been done for geometric transformations and image scaling. A region growing algorithm was employed to isolate the tumor region. Preliminary results show that our approach has achieved good segmentation results. Also this approach was reduces a large amount of calculation. Future work can be involved by an investigation of the method in automatic 3D tumor segmentation, segmentation of ROI's in other medical images, as well as the importance of implemented technique in medical image retrieval applications.

III. PROPOSED METHOD

The main purpose of this paper is to identify the region of tumor and to do the detailed diagnosis of that tumor which will can be used for treatment of cancer patient the detailed about the proposed system is given below.

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3.1 Preprocessing

In the image processing the gray scale image is processed by using different techniques like brightness, threshold and Filtering, Brightness makes the image by which white objects are distinguished from gray and light items from dark objects. Hence by changing the brightness of the image the tumor detection in the MRI image is easier.

Any grayscale image can be differentiated on the basis of low intensity and high intensity. Low intensity is called as local minima and High intensity is called local maxima. As, the intensity increases and decreases the colors are assigned respectively.

Here, Watershed concept can be understood by considering the surface water valley where there are peaks or mountains and valley region contains water. Here peaks are called maxima & valleys are called minima. So, consider bottom of water valley as we rise towards peak. At the merger point of peak & valley we built barriers , which further helps us to add boundaries or outline of our object

3.2 Marker based watershed segmentation

But with this approach we get Over-segmented image. Therefore we use marker based watershed algorithm. It is interactive image segmentation. This algorithm considers the input image as a topographic surface and simulates its flooding from specific seed points or markers. In this method we assign different labels to image .Labels are assigned on the basis of colors or intensity.

3.3 Morphological Operation

Then , we have to remove white spaces between two colors/intensity objects, where we are using morphological openings.[16]Extraction of brain tissue from non-brain tissues in MR images which is referred to as skull stripping is an important step in many neuron imaging studies. In this, we have used automatic threshold value selector to automatically choose threshold value.Mathematical morphology operations on a binaries image are applied stage by stage to achieve acceptable skull stripped brain images. The proposed skull stripping method comprises four steps. Initially image binarisation is completed using threshold value and narrow connections are removed from binarised image using morphological opening.

Thirdly, a mathematical morphology operation such as: filling holes and dilation is done by selecting largest binarised image. Finally, we found skull stripped brain image. The erosion of A by B can be given by the expression:

$$A \ominus B = \{(i , j) : B_{(i, j)}\} \quad (4)$$

Where, A= is the binary image, B= is the structuring element,

(i, j)= the center pixel of structuring element

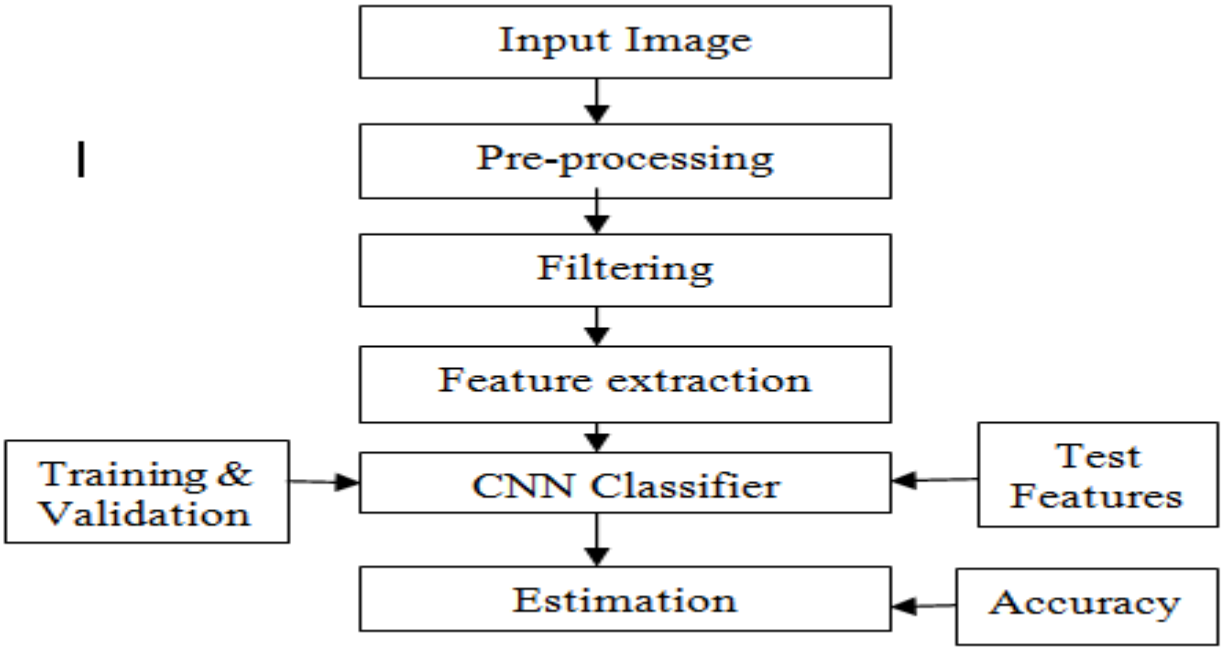

Figure 1: Flow diagram of proposed system

3.4 Object Extraction

Now, next step is to extract boundary of the shapes. Erosion is used to extract the objects. Next , we label the objects depending on the intensity/ color and leave the other as zero. Now, we will apply watershed were our boundaries will be marked correctly .

In our Watershed Segmentation, watershed function returns a label matrix containing non-negative numbers that corresponds to watershed regions .Pixels that do not fall into any watershed region are given a value 0. A good way to visualize a label matrix is to convert it into a color image , using the label2.rgb function .In ,the color version of the image ,each labeled region displays in a different color and the pixels that separate the regions displays white.

The area of the tumor region can be calculated by the following equation: Tumor area= Axtotal number of pixel in the tumor region A= V x H ,Where, A=the area of each pixel H=horizontal dimension of the image V=vertical dimension of the image H=1/horizontal resolution of the image V=1/vertical resolution of the image[31].

Step wise procedure for implementing watershed algorithm:

1. You need to mainly import packages like CV2, numpy, Scipy.
2. Adjust sharpness, contrast and brightness of image.
3. Load the image and perform pyramid mean shift filtering, to help the thresholding step.
4. Convert the mean shift image to grayscale image and then apply Otsu's thresholding.
   gray = cv2.cvtColor(shifted, cv2.COLOR_BGR2GRAY)
5. Compute the exact Euclidean distance for every binary pixel to the nearest zero pixel, then find peaks in this distance map.
6. Perform a connected component analysis on the local peaks, using 8-connectivity, then apply the Watershed algorithm.
7. If the label is zero, we are examining the 'background', so simply ignore it. Otherwise, memory can be allocated for the label region and draw, it on the mask.
8. Detect contours in the mask and grab the largest one and then, draw a circle enclosing the object.

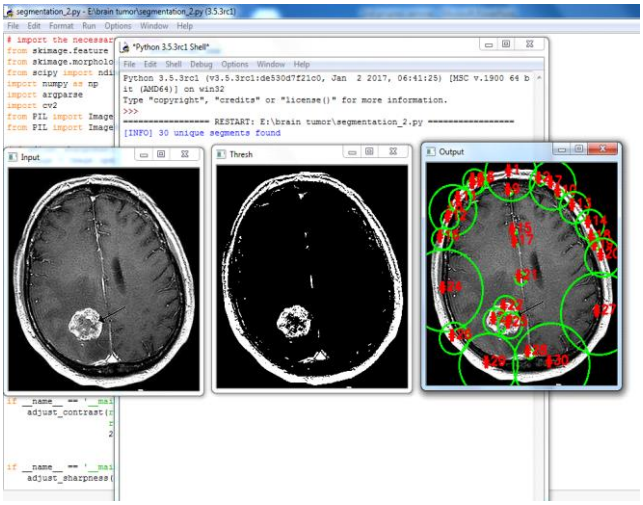

Fig 2: Output of Segmentation

IV. CONVOLUTIONAL NEURAL NETWORK: CNN

It is an artificial neural network that is so far been most popularly used for analysis images. Although image analysis is most widely used for image analyzing, they can also be used for other data analysis and classification problems. CNN ie convolutional neural network is a combination of neural network which are composed of artificial neurons , which stimulate biological neurons in a limited way and the convolutions .It is also an artificial neural network that has some type of specialization which is able to pick the patterns and make some predictions out of it.

Let's see what is artificial neuron , below we can see set of elements that are represented by set of inputs of

X=(x1,x2,……xN) which are connected to f , but the connection between the input and the activation function , is by a set of weights which are represented by (w1,w2,….wN) besides this we have a biase which is b and the output can be seen below as z.

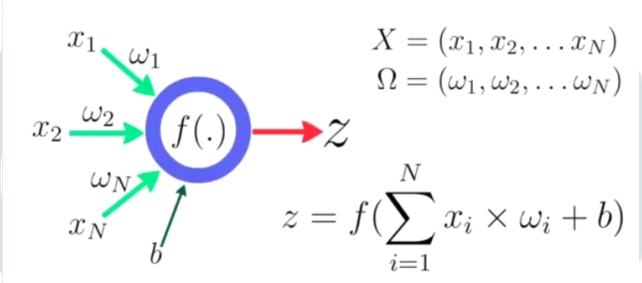

Fig 3: Artificial Neuron

4.1 Architecture: [26] CNN architecture is a sequence of feed forward layers with convolutional filters and pooling layers, after last layer CNN uses fully-connected layers that work on converting the 2D feature maps of last layers into 1D vector for categorizing.[29] CNN comprises of one or more convolutional layers frequently with sub sampling steps and then followed by fully connected layers as in standard multilayer neural network. It is designed to take advantage of the 2D structure of an input image.[24]CNN has three layers: Input layer for capturing input image for further processing ,Feature extraction layer for extracting local features after extraction relationship is determined, Feature map in which each unit is composed of multiple feature maps. Each feature map is a plane in which weights of neurons are equal it uses the sigmoid function as activation function.[28]The general architecture of CNN consists of an input map such as image ,a number of hidden feature maps and an output processing layer.[27]CNN consists of three architectures such as Baseline Convolution Network, Fully Image convolutional network and Fully Convolutional Network.

4.2 Convolutional layer: which is the first layer to extract features from an input image. Convolution preserves the relationship between the pixels by learning image features using small squares of input data. It is mathematical operation that takes two inputs such as image matrix and a filter or kernel.

- An image matrix (volume)having a dimension (h x w x d)
- A filter (fh x fw x fd)
- Outputs a volume dimension (h-fh+1)x(w-fw+1)x1

Consider , a image matrix whose image pixel values are 0,1 and filter matrix .Then the convolution image matrix multiplied by filter matrix which is called" Feature map" as output. Convolution of an image having different filters can perform operations such as edge detection, blur and sharpen by applying filters.

4.3 Activation function (ReLU) : ReLU stands for Rectified Linear Unit for a non-linear operation. The output is f(x) = max(0,x). ReLU purpose is to introduce non-linearity in our ConvNet. Since, the real world data would want our ConvNet to learn about non-negative linear value. There are other non linear functions such as tanh or sigmoid which can also be used instead of ReLU. But since performance wise ReLU is better than other two.

4.4 Pooling: Pooling layers reduce the number of parameters when the images is too large.[23]In the brain tumor field ,the use of CNNs, used a shallow CNN with two convolutional layers separated by max-polling.[27]Maximum pooling with stride proposed as a pre-preparing step which mean to address heterogeneity information caused by multi-site and multi-scanner acquisitions of MRI pictures.[25]It combines spatially nearby feature objects in the feature maps. It makes the representation more compact, invariant to small image changes, and decreases the next stage computational load. Max pooling or average pooling is most commonly used to join features.

4.5 Fully Connected : Neurons in a fully connected layer have full connections to all activations in the previous layer, as seen in regular Neural Networks. Their activations can hence be computed with a matrix multiplication followed by a bias offset.Here, we flatten our matrix into vector and feed it into a fully connected layer like neural network.

4.6 K-Fold Cross Validation Technique : Cross-Validation is a resampling procedure used to evaluate machine learning models on a limited data sample. Through cross validation accuracy can be improved. The dataset should be decided and divided for training and testing process very properly and this can be one of the major point for proper use of dataset.

The procedure has a single parameter called k that refers to the number of groups that a sample is to be split into.This k-fold cross validation technique is one of the best validation technique. This are the Steps for k-fold cross validation.

- Splits sample in k-equal Sub samples.
- Prediction error= Average (error)
- If k=6 divide entire sample each having h/6 samples.

- Advantage over other cross validation techniques:
- Doesn't matter how data get divided
- Selection bias will not be present.

V. EXPECTED OUTCOMES

The accuracy of the project can be known in training process and also in testing process. In training the dataset is trained and allowed to learn and the accuracy can be known. The testing accuracy will decide the quality of the project. The training is done for 60 epochs .Epoch is when an entire dataset is passed forward and backward through the neural network once. We need to pass the full dataset multiple times to the same neural network for better results. The major question arises is why don't we use 1 epoch only, and the answer is because one epoch leads to under fitting problem .As, the number of epoch increases , more number of times the weight are changed in the neural network and the curve goes from under fitting to optimal to over fitting.

In other words, if a layer has weight matrices, that is a "learnable" layer.Basically, the number of parameters in a given layer is the count of "learnable" (assuming such a word exists) elements for a filter aka parameters for the filter for that layer.

VI. CONCLUSION AND FUTURE WORK

Hence, we have seen a procedure to detect brain tumor from image. We have studied image processing along with machine learning approach. In this paper, brain tumor is detected by using thresholding segmentation, watershed based segmentation method and with the help of some morphological operators. Watershed segmentation gives very good segmentation results, and meets the criteria of less computational complexity. We have used supervised machine learning algorithm , CNN which is one of the deep learning methods, which contains sequence of feed forward layers. The training is performed for only final layer. Also raw pixel value with depth, width and height feature value are extracted from CNN. The training accuracy, validation accuracy and validation loss can be calculated. The test dataset and whole dataset accuracy is found to be 99.9% .

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