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AUTOMATIC DETECTION AND SEGMENTATION OF BRAIN TUMORS USING CONVOLUTIONAL NEURAL NETWORK

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Abstract

In many clinical applications, Brain MRI is an essential task as the result of the entire diagnosis is influenced by MRI segmentation. Magnetic Resonance Imaging (MRI) has made enormous progress in retrieving brain damage and inspecting brain analysis. The advancements in brain MRI have allowed huge amount of datasets that are extremely good in quality. These kinds of huge and compound MRI dataset analysis have become a tiresome task for clinicians, one who physically takeout the essential information from the datasets. Inventions in computerized methods have been made to overcome the brain MRI data analysis difficulties. High tissue contrast and fewer artifacts are found in MRI images. The tumor detection demands diverse actions on MRI which includes image pre-processing, image classification and segmentation. In our proposed work image processing methods gray scale conversion is implemented. In this, whether a person is diseased or not is concluded by the final classification process using neural network algorithm like Convolutional Neural Network (CNN) algorithm. The proposed CNN can be outperforms than the existing machine learning algorithms. The identification process of two-dimensional image information is carried out by a special design such as Convolution Neural Network algorithm. CNN is a multilayer perceptron as it contains three different kinds of layers like Convolution layer, Fully connected layer, Pooling layer through which the diseases can be classified accurately. Keywords--Classification, Segmentation, Pre-processing, Conversion, Convolutional Neural Network.

I INTRODUCTION

Encephalon is the centre of peripheral nervous system. It consists of 50 to 100 billion neurons and hence considered as a complex organ. Brain tumor is the growth of abnormal cells that grows within and outside the brain. Brain tumor is due the cells that grow abnormally. Malignant and benign are the major classification of brain tumor .Benign is a non cancerous brain tumor. The benign tumors are less harmful and does not affect the other parts of the body. Cancerous tumors are malignant tumors and are treatment resistant. Malignant tumors easily affects other brain tissues and health is also affected which also leads to death. In many clinical imaging fields the detailed information about the brain internal tissues is provided by the Magnetic Resonance Imaging. Figure 1 represents the MRI scan of the healthy brain of human. Image Segmentation plays a powerful role in brain tumor spotting.

In this proposed work the brain tumor from the MRI scan is detected and the affected area is segmented. Figure 2 shows the human brain that is affected by the tumor scanned using MRI. The following steps are used to detect the brain tumor Pre-processing, Feature extraction, classification using CNN, Segmentation.RGB to Gray Conversion and filtering process are done in pre-processing, Feature extraction is done by extracting the GLCM features, classification of brain tumor whether a person is

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affected by cancerous or non- cancerous tumor is performed using Convolutional Neural Network (CNN), and then affected region is segmented from the MRI image.

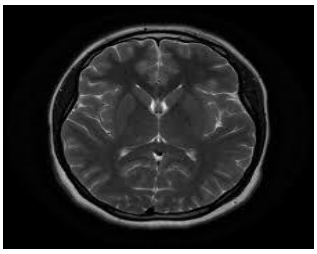

Figure 1: MRI image of a normal brain

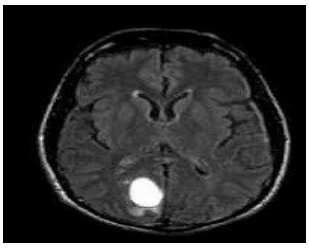

Figure 2: MRI of human brain with Brain tumor

II RELATED WORKS

In [1] the input image is pre- processed in the first step, followed by feature extraction using MGH and GLCM. Finally the images are classified using CNN and then segmented. In [2] segmentation and detection of brain tumor is done by using Fuzzy C Means (FCM) algorithm. Classification is done by two deep learning (CNN) and machine learning algorithms. In [3] Morphological operations and pixel subtraction are the two steps involved in pre-processing. Segmentation involves maximum thresholding. In [4] first step of pre-processing is done by using Daubechies, Morlet, Symlet and Haar transform. Segmentation is performed by using Otsu's method. Finally Support vector Machine is used for classification. In [5] liver tumour is detected from the MRI scan. Support Vector Machine is used for tissue classification. In [6] after pre-processing initial segmentation is carried out by K- means clustering, followed by HMRF-EM (Hidden Markov Random Fields- Expectation Maximization). EM algorithm is used to derive the relevant parameters. In [7] first average intensity of the pixels is calculated. Average intensity of the pixel is taken as the maximum threshold value. In [8] the steps such as segmentation, pre-processing and feature extraction are performed at input image. Extracted features are compared with ID3 algorithm. In [9] this proposed work is a combination of SVM and FCM. Contrast improvement and mid-range stretch, followed by skull striping are the techniques used to enhance the image. Suspicious region is segmented using FCM clustering. Features are extracted by GLRLM (Grey Level Run Length Matrix). Classification is done by SVM. In [10] datasets are trained using transfer learning concepts. AlexNet is used for classification along with Region Proposal Network (RPN) by using Faster R-CNN algorithm.

III. PROPOSED MODEL

In our proposed system the detection and segmentation of brain tumor is carried out by the following process. They are pre-processing, image classification using Convolutional Neural Network and segmentation. Figure 4 represents the block diagram of our proposed work.

A. PRE-PROCESSING

Pre-processing has two steps RGB to gray conversion and removal of noise using median filter. In general the image uploaded to the network is in the form of RGB image format. The RGB image is converted into a greyscale image which has only one channel. For better results the image should have maximum quality with minimum noise. The edges are preserved when the filtering process is used.

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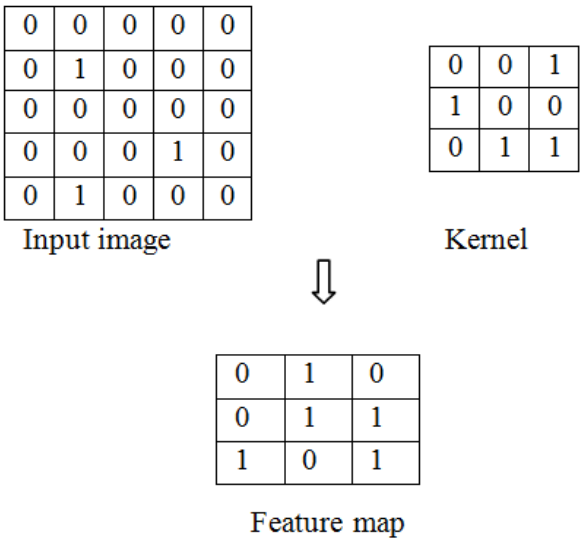

Figure 3: Operation of Convolution layer

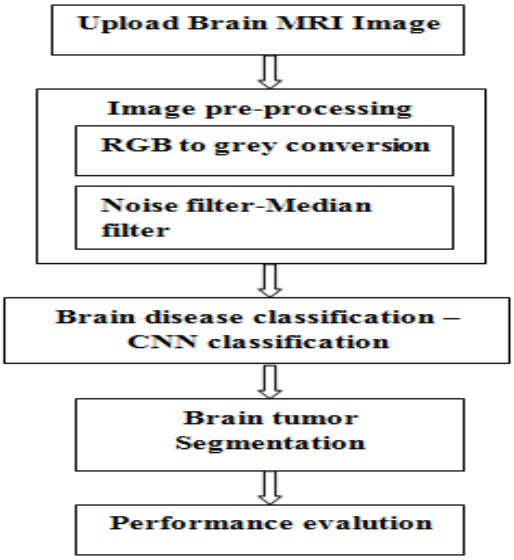

Figure 4: Block diagram of the proposed work

B. CONVOLUTION NEURAL NETWORK

Convolution Neural Network architecture is composed of a group of forward layers such as fully connected layer, convolution layer and pooling layer. In Convolution Neural Network the input of a layer is fed by the output produced from the past layer in which the feature extraction is performed by pooling layer and convolution layer. The constituent elements are converted into one single vector by using fully connected layer. Architecture of the proposed CNN is shown in Figure 5.

i. CONVOLUTION LAYER

Convolution layer plays a notable role in the Convolution Neural Network and performs mathematical operation like convolution. While convolving the input image with the kernel a feature map is produced it is in two dimensional formats. Figure 3 is example of convolution operation that has a 3 X 3 kernel size, without zero padding, and stride 1.

To obtain the feature map, product of each element is performed between the input tensor and kernel element and to obtain the result of the output tensor and they are summed up. The kernel size (generally 3 X 3, 4 X 4) determines the depth of the constituent element. The dimension of the constituent element is reduced by the convolution operation. The stride (usually 1) is defined as the distance between the positions of two kernels. The characteristic maps are down sampled by using the stride with high values.

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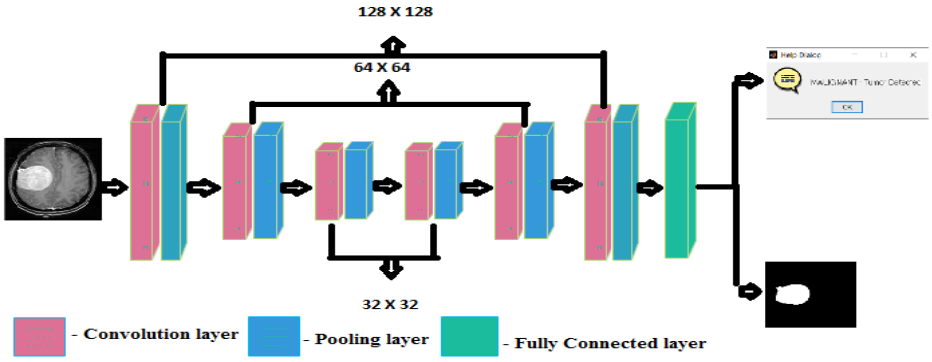

Figure 5: Architecture of CNN

ii. POOLING LAYER

The result produced in the convolution layer is given as the pooling layer input. In order to downsample the images, the pooling layer is placed after the convolution layer. The utility of the pooling layer is to downsample the feature maps in space dimensions.

The main two sakes of the size reduction of pooling layer requires less calculation overhead for the forwarding layers and the ability of work opposed to overfitting. Various types of pooling is used in CNN. In our proposed work max pooling is used. Figure 6 shows the max pooling with stride 2.

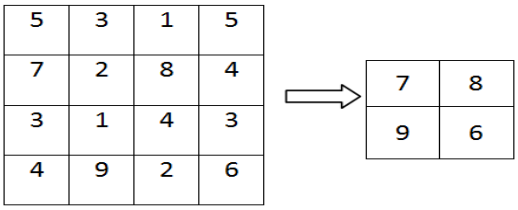

Figure 6: Max pooling with stride 2

iii. FULLY CONNECTED LAYER

The result produced in the pooling layer is fed as input to the fully connected layer. The fully connected layer allows the transformations of the feature maps got from the previous layer into one dimensional vector. In the fully connected layer every node in the second layer. The result of the layer is flattened by the fully connected layer. Activation function is used in this layer. In this proposed work, activation function used is ReLU (Rectified Linear Unit) .

After classification process, Segmentation is performed. Segmentation involves partitioning an image into multiple segments. Mostly segmentation is used for localization of objects and boundaries. Usually image segmentation are based on two properties such as similarity and discontinuity. Segmentation is done by Convolutional Neural Network. Upsampling and Downsampling is performed in the segmentation process. In downsampling the sizes are reduced and in the upsampling process the image sizes are increased.

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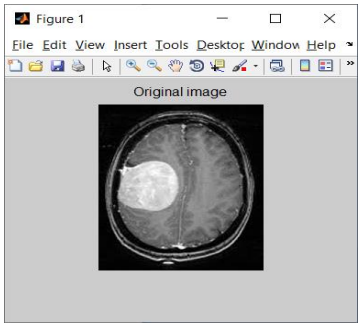
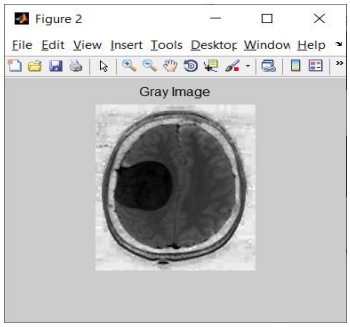
IV EXPERIMENTAL RESULTS

In our automated system, Brain MRI images are classified using Convolutional Neural Network algorithm and segmentation of the tumor is done by thresholding methods





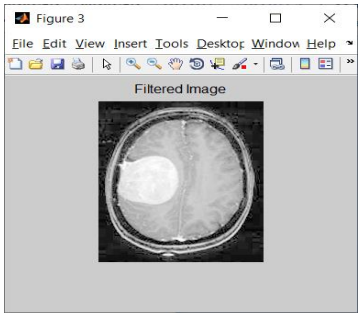
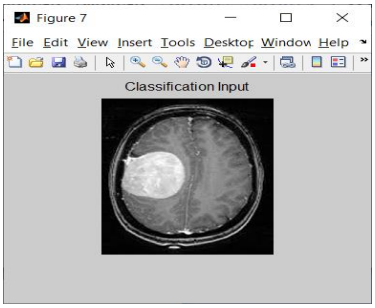


Figure 7: Input MRI image Figure 8: RGB to grey Conversion Figure 9: Median Filter Output

The Noise in the input image is reduced by preprocessing steps which is carried out by median filters. Figure 7 shows the input MRI image. Figure 8 involves the preprocessing steps such as RGB to grey conversion. In Figure 9 median filtering is applied to process the MRI image without noise.



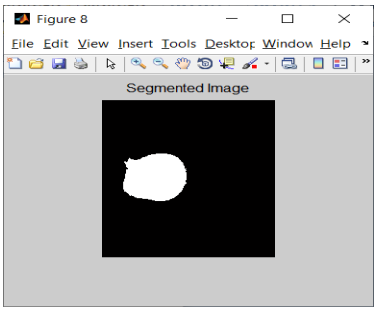


Figure 10: Convolutional Neural Network input. Figure 11: Segmented image.

The Convolutional Neural Network input image is shown in Figure 10. Figure 11 represents the segmented image of the brain tumor. Thus the proposed system has the improved accuracy rate and reduced error rate. Table 1 shows the of the parameters obtained in this proposed work.

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S.No	Parameters obtained	Values obtained
1	Success rate	99.9900
2	Sensitivity	0.5000
3	Specificity	0.5000
4	False score	0.0196

Table 1: Parameters obtained

IV. CONCLUSION

This proposed system uses classification techniques based on deep learning algorithms. The aim of this proposed system is to provide an early judgement on diagnosis, tumor monitoring and treatment planning to the physician. In manual MRI Brain Tumor segmentation, time is consumed more. The fully automated segmentation techniques are worse in various cases. Therefore the important parameters like robustness and computation time are improved for the accuracy and valid result of fully automatic segmentation technique. This proposed system has less computational time and high robustness. The proposed CNN algorithm is a intelligent system which is automated to produce results with the improved success rate and the false rate of MRI brain tumor is reduced.

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