Brain Tumour Detection using Convolutional Neural Network

P.V. Rama Raju, G. Bharga Manjari, G. Nagaraju

Abstract: ***In the field of human health care computer vision is playing an important role. The use of mainframe perception techniques in health care has one of the aim to decrease manual understanding in identification. Consequently manual error in understanding might be decreased. Brain associated diagnosis demands more care and a period of error in judgement might be harmful. Medical imaging is very important field in brain related diagnosis. More secured information about brain tissues provides by Magnetic Resonance Imaging. This paper presents an automatic segmentation technique based on convolution neural network, patch, analyzing 10*10 kernels using matlab. The main use of CNN's their accuracy in image detection problems. Input image is changed into a specific number of patches for easy processing.***

Keywords— Convolution neural network, patch, kernel, brain tumour, MRI.

I. INTRODUCTION

A pivotal organ of the human body is brain, which comprises of billions of cells. The irregular set of cells is generated because of the unbounded separation of cells, known as tumour. Brain tumours are categorized as low grade and high grade. The low grade is again branched to grade 1 and grade 2, they are known as benign. Likewise the high grade tumour is branched to grade 3 and grade 4, known as malignant. Benign tumour is non toxic, and does not cause any damage as they will not transmitted to other brain parts. Malignant tumours are toxic, and they will be transmitted to other parts which causes immediate death.MRI image is primarily used to identify tumour and the progress of tumour. This knowledge is used for tumour recognition and healing process. As compared to the ultra sound or CT, MRI contains added information regarding the tumour.

Gabor, median, gaussian, mean filter and many more are the different kinds of filters. For texture analysis Gabor filter is used and it is a linear filter [6]. To decrease the contrast, noise and edges are blur by using the gaussian filter [3]. PCA and LDA are two linear transformation performances for proportionality contraction. To improve the quality of results and convergence of time by using PCA. PCA is unsupervised learning [2].

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In CNN ReLu non linear activation function is used. ReLu function is better as compared to the tanh and arched functions in calculating the sudden changes [4]. In primary way segmentation is used to study the images. Using clustering algorithm different types of segmenting techniques are compared [6][1]. Support vector machine and artificial neural network are two prominent methods for classification. Support vector machine uses a method known as kernels to alter the data [3][4][6]. Neural networks deals with non aligned and complex relation between input and output [1]. Morphological operation and fuzzy transform are used in detection process[7]. New mean shift fuzzy c-means algorithm is used for low computational time compared to other methods[8]. Segmentation, pre-processing and edge detection are three steps used in detection of tumour[9].

The major aim of this proposed methodology is, by using the different image processing techniques to locate the tumour in brain. Input is taken from the MRI images and then pre-processing is applied. To the input image 10*10 patch is applied for easy processing. K means clustering used for specified results. Convolutional neural network is used, in this training and testing are performed to data. Performance characteristics are calculated for the given input image.

II. PROPOSED METHOD

The important blocks of the proposed methodology are:
A. Pre-processing
B. Patch process & pre-processing
C. CNN Training & Testing
D. Detection Process
E. Post Processing
F. Performance metrics

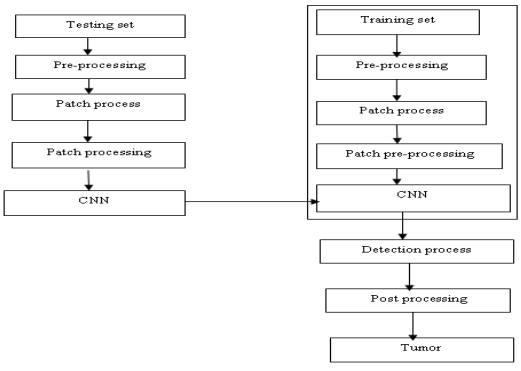

Fig. 1. Proposed Method Block Diagram

By using Convolutional Neural Network a kernel-based novel brain MRI image segmentation

is employed. The aim of the segmentation is image is partitioned into segments (set of pixels). Segmentation helps to analyze the object or more related data content in digital images. In image segmentation different ways of segmentation techniques are used. In image analysis process segmentation plays a key role. Image editing, image compression, image recognition etc could be used in image segmentation.

In this project, we used image segmentation inorder to classify a disease or detect a tumour, image is divided into corresponding pixels using clustering. Abnormal portion of the brain from bio-medical images to cluster these images, an efficient MRI image segmentation using convolutional neural network have been used. A kernel based segmentation is used to extract the portion from the image. Training and testing are performed separately with the small image kernels. One of the vital part of the segmentation is its performance. Segmentation performance is the measure of accuracy. Sensitivity analysis consists of false positive(FP), true positive(TP), true negative(TN), false negative(FN). In sensitivity analysis ground truth image is used. The segmented output is match with the reference image. In this project accuracy is increased by using the conventional neural network, a novel method of brain MRI segmentation is used. In figure1 proposed methodology steps are shown.

A. Pre-processing

Pre-processing operation is one of the fundamental step in image processing. In pre-processing step MRI image is taken as input as shown in figure3. The location of tumour information gives the MRI image. Pre-processing step is used to resized the image and remove the noise. Resizing and RGB to grey conversion is takes place in this step. After resizing and conversion of MRI image. Salt and pepper noise, speckle noise etc are present in the MRI image median filter is used to remove these unwanted noise in the input image. In modern MRI scan noise arrival possibilities are very less. In figure4 median filter output image is shown.

B. Patch process and patch pre-processing

In patch processing step the input image is transforrmed into small image blocks of size 10*10 is shown in figure5. These small size of image patches are also called as image blocks. The image is dividing into these small patches and each patch is then processed individually using patch based approach in image processing. The final output image is reconstructed out individually processed patches after processing step. Sliding window technique is used to extract the image blocks. Histogram equalization is used in patch processing. To enhance the image histogram equalization is a approach for modifying the image intensities. In figure6 patch pre-processing output is shown.

C. Convolutional Neural Network Training and Testing

Convolutional neural network is used to process pixel data used in image processing and recognition. To analyze optical imagery convolutional neural network is used, it is a type of deep neural networks. Image cannot be scalable in neural network. Image is scalable in convolutional neural network. Height, depth and width are 3 dimensions are arranged in the layers. Input layer, output layer and an multiple hidden layer are contained in a convolutional neural network. The word convolution specifies the mathematical merging of two functions the outcome is third function. Two sets of information is combined in it. To give the feature map the convolution is functioned on the input data by using the kernel or a filter. Input layer, convolution layer, rectified linear unit layer (ReLu), pooling layer and fully connected layer are the layers of convolutional neural network.

Input layer is first layer in the convolutional neural network. It contains a set of neurons. A convolutional layer contain neurons that associated to subregions of the input image or outputs of the preceeding layer. A set of independent filters are present in the convolution layer. Given input image is partioned into different small regions in convolution layer. In cnn pooling layer is another building block. Pooling layer operation is tolerantly decrease the spatial size of the depiction to minimize the amount of computations and parameters in the network. On any feature map pooling layer operates individually. Max pooling is one of the most frequent approach in pooling. Without any additional parameters a pooling layer can reduce the size of the preceding layer. Pooling layer helps to combines the several values into a unique one.

In cnn relu is not a independent component. In neural networks relu is a type of activation function. It maintaining the positive values and mapping negative values to zero. Relu is just a non linearity which is utilised relate to neural networks. At the edge of the convolutional neural network fully connected layers of neuron. To entire activations in the earlier layer have a full connections in a FC layer. There is a explicit relationship between a entire pairs of node in a fully connected layer, is a complete topology or a mesh topology.

Classification and feature extraction are the two basic elements in a convolutional neural network. Fully connected layers are usually consists in a classifier. Activation function and max pooling includes many convolutional layers in feature extraction method.

D. Detection Process

Clustering is used in the detection process. In clustering, k means clustering is a prominent approach. To detect the tumour part of the brain k means clustering is used. To divide the image into k number of clusters, k means algorithm is one of the technique. K means algorithm is a unsupervised machine learning algorithm. To divide a set of data into a specified number of groups in clustering method. It divides a number of data into a k number group of data in the k means clustering. Two separate phases consists in a k means algorithm. Calculating the k centroids in first phase. Each point to the cluster neighboring centroid from the corresponding data point in the second point. Euclidean distance calculates the neighboring centroid cluster to the every data point in the cluster. A centroid updation is done in the clustering process. In figure7 clustering output is shown.

E. Post Processing

Post processing is done after the detection process. In this some part of the tumour is imperfectly classified into small clusters. Tumour part is classified and removing the clusters in segmentation by using the convolutional neural networks. The tumour part is obtained in

this post processing step. In figure8 tumor localization and post processing output is shown.

F. Performance Metrics

Performance metrics are shown in below. Pixels that are correctly segmented as foreground which indicates the true positive (TP). The pixels that are incorrectly segmented as foreground which means false positive (FP). Pixels accurately detected as background that means true negative (TN). Pixels erroneously detected as background that indicates false negative (FN). In figure9 performance metrics are shown. In table I performance metric characteristics are tabulated.

1) Specificity:

Specificity indicates the test's potentiality to perceive the negative results.

specificity = TN/(TN+FP)

2) Sensitivity:

Sensitivity analysis calculates the performance of the system. Sensitivity calculates the test's potentiality to perceive the positive results.

sensitivity = TP/(TP+FN)

3) Accuracy:

Accuracy is the combination of specificity and sensitivity metrics.

accuracy = (TP+TN)/(TP+FP+TN+FN)

4) PSNR:

PSNR between the two images and is abbreviated as peak signal to noise ratio, measured in decibels. The higher the psnr, improved the nature of the reconstructed or compressed image. Peak error measured in psnr.

5) MSE:

MSE stands for mean square error. MSE and PSNR are two error metrics. MSE is used to differentiate the image compression quality. The cumulative squared error between the compressed and original image in mse.

6) SSI:

SSI stands for structure similarity index, is used to calculate the similarity between the two images. It is also used to compare the one of the viewed image quality to the other image as perfect quality image.

7) Entropy:

Inage information content is present at the entropy. Entropy means the individual pixels can adapt from the related states of intensity level.

$$S=\sum\sum p(x, y) \log p (x, y)$$

8) Correlation:

Correlation operation is used to extract the image to get the information. It represents the sameness of two input signals at that process they are one another shifted.

$$C=\sum\sum((x- \mu x)(y-\mu y)p(x , y)/\sigma_x\sigma_y))$$

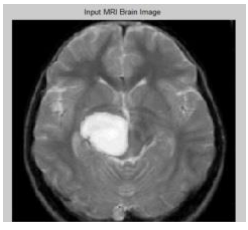

Fig.2 Tumour Image

Performance metrics	Image
Tumour area	13.4924
Sensitivity	50
Specificity	88.5250
Accuracy	88.5237
Entropy	0.4351
Correlation	0.1435
SSI	0.0275
MSE	13.1398
PSNR	36.9449
TP	1
TN	55838
FP	7238
FN	1

Table 1 : Performance Metrics

III. RESULTS

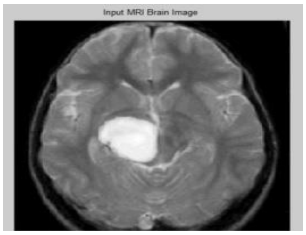

Fig. 3. Input Image

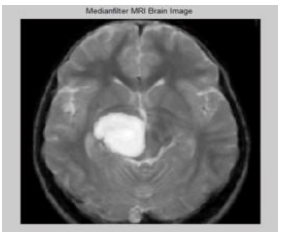

Fig. 4. Median Filter Image

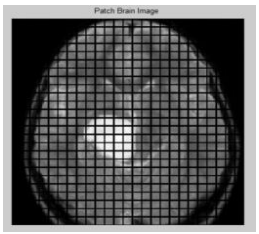

Fig.5. Output of applying patch to input image

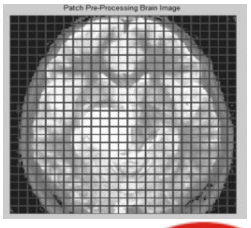

Fig. 6. Output of patch pre-processing image

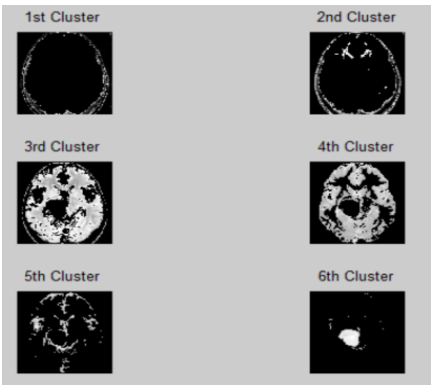

Fig. 7. Output of clustering

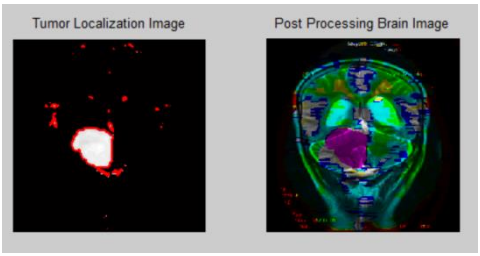

Fig. 8. Final output

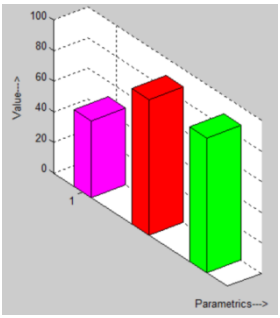

Fig. 9. Performance Characteristics

IV. CONCLUSION

Segmentation of brain tumour of MRI images is accomplished using convolutional neural network in the projected method. As compared to other methods the present model reduces the computational time. Inorder to identify the tumour or classify a disease. Segmentation is applied for the extraction of segments.

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