BRAIN TUMOR CLASSIFICATION USING CONVOLUTIONAL NEURAL NETWORK

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ABSTRACT

Brain cancer is one the largest medical problems faced today. Therefore, it is an area where building new tools to more effectively diagnose the disease and cure the disease can have a major impact on a large proportion of the population. Today we have a lot of data at our disposal about the patient about the tissue sample and our goal is to use this data effectively to provide the most accurate diagnosis for the patient. The conventional method involves the classification of brain tumors by inspecting the MRI images of the patients. However, large amount of data available for different specific types of brain tumors makes this method very time consuming and prone to human errors. In the paper, we tried to design a model using convolution neural network to identify the tumor and non-tumor MRI images. The architecture proposed in the paper consisted of one of each convolution layer, max pooling layer, fully connected layer and hidden layer. The model was trained on Brain tumor dataset (BRATS 2017) consisting of 320 images in the training set and 80 images in the test set .We were able to achieve the training accuracy of 89.25and validation accuracy of 97.5 using this simple architecture.

Keywords: *- Convolutional Neural Networks, MRI, Brain Image.*

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1. INTRODUCTION

Brain tumor is one of the essential organs in the human body, which consists of billions of cells. The abnormal and unstable group of cell is formed from the uncontrolled division of cells, which is also called as tumor. Brain tumor are divide into two types such as low grade (Grade 1 and Grade 2) and high grade (Grade 3 and Grade 4) tumor. Low grade brain tumor is called as benign. Similarly, the high grade tumor is called as malignant. Benign tumor is not cancerous tumor, hence it doesn't spread other parts of the brain. However the malignant tumor is cancerous tumor. So it spreads with indefinite boundaries to other region of the human body easily which leads to immediate death.

Brain tumor has already become a huge reason of deaths and disabilities globally in body. In the last few years, ALO of research work has been carried out for the detection of cerebral cancer. This disease of brain tumor is now achievable with the proper development of image processing technique, and with the help of image processing and image enhancement tools it can performed easily. Medical Image processing technique improves the prior medical diagnosis of patients who survived with brain tumor diseases. To sum up this survey, the important goal is to show that machine learning and deep learning techniques have influenced the field of medical image processing.

1.1 PROPOSED SYSTEM

We know that the convolutional neural network is similar to neural networks that is they are made up of neurons that have learnable weights and biases. The human brain as we know is modeled by using design and implementation of these neural network. A study showed that neural network is mainly used for vector quantization, approximation, data clustering, pattern matching, optimization functions and classification techniques. The neural networks are broadly divided into three types on the basis of their interconnections. These three type of neural networks are feedback, feed forward and recurrent network. The Feed Forward Neural network is further classified into single layer network and multilayer network. In the single layer network, there is only one layer that is the output node and therefore the inputs are directly fed to the outputs via weights and also the hidden layer is absent. However, the multilayer consists of multiple layers of computational units, usually interconnected in a feed-forward way i.e. it contains input layer, hidden layer and the output layer. The closed loop based feedback network is referred as recurrent network. In this type of networks sigmoid function is used as an activation function.

In the normal neural network, images are not scalable but in convolution neural network, image can be scalable (i.e.) it can take 3D input volume to 3D output volume (length, width and height) and the dimensions are in 3D because we are going to deal with color pictures. The Convolution Neural Network consists of input layer, convolution layer, activation function of Rectified Linear Unit (ReLU) layer, max pooling layer and fully connected layer also known as dense layer. In the convolution layer, the spatial dimensions are preserved and the given input image is separated into various small regions or we can say feature maps. These layers convolve the input and pass its result to the next layer. Element wise activation function is carried out in ReLU layer which basically applies the non-saturating activation function $f(x) = \max(0, x)$. Then the max pooling layer is applied for extracting the part which has highest features. For your information pooling layer is optional we can use it or skip. In the final layer (i.e.) fully connected layer is used to generate the input for the future ANN and class score or label score value based on the probability in between 0 to 1.

Fig 1. Shows the basic block diagram of brain tumor classification using convolutional neural network. The brain tumor image classification using CNN is divided into two parts that is training part and testing part. The dataset is divided into different category by using labels name such as tumor and non-tumor brain images. In the training phase, preprocessing, feature extraction and classification with loss function is performed so as to make a good prediction model. Firstly we label the training image set containing two groups of tumor and non-tumor images. In the preprocessing, Image resizing is done so that every image in the training set should contain images with same pixel value and same size.

Finally, this convolution neural network is used for brain tumor classification. The loss function is generally calculated by using gradient descent algorithm. It is important to map the raw image pixel with class scores by using a score function. To measure the quality of particular set of parameters we use loss function. It is based on how well these induced scores satisfies the ground truth labels in the training data.

Calculation of the loss function plays a very important role in improving the accuracy. High loss function means poor accuracy. Similarly, high accuracy means the loss function is very low. The gradient value is further calculated for loss function to compute gradient descent algorithm. Repeatedly we evaluate the gradient value to compute the gradient of loss function for better predictions.

Algorithm for CNN based Classification

1. Firstly, we perform convolution operation by adding activation function (RELU) on the image to reduce its image size and pixel value between 0 and 1. With this we create feature maps to obtain our first convolution layer
2. Then max pooling is applied to the output of convolution operation for extracting maximum features
3. After obtaining the max pooled features we apply flattening to this pooled feature map to convert 2-D array to a single array.
4. To fasten the training period we apply activation function i.e. Rectified Linear Unit (RELU)
5. The neurons in proceeding layer is connected to every neuron in subsequent layer and this term is called Fully Connection.
6. During training Loss layer is added at the end to give a feedback to neural network whether the predictions are accurate or not.

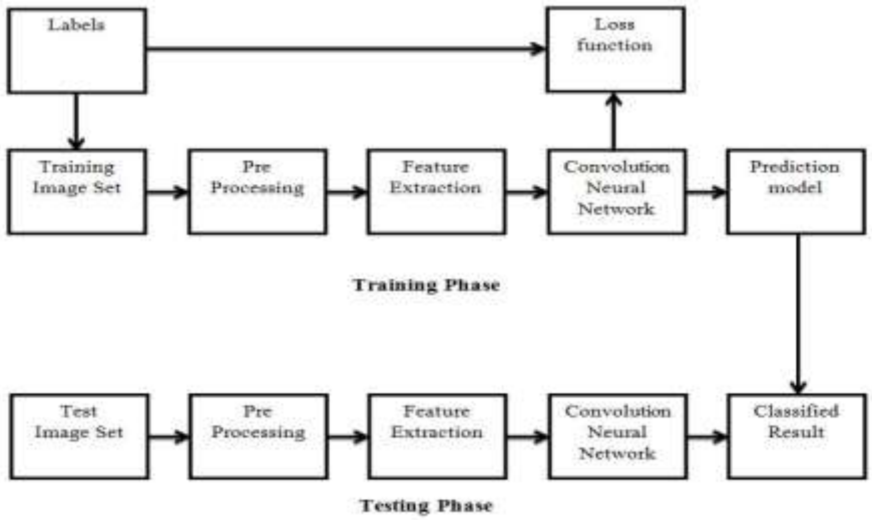

Figure 1: Block diagram of proposed brain tumor classification using CNN

1.2 RESULT AND DISCUSSION

Our Dataset contains tumor and non -tumor brain images and collected from different online resources mainly from Kaggle. Brain tumor classification is performed by using convolution neural network. Simulation is performed by using python language, backend used is tensorflow, the development environment is spyder and the optimizer used is Adam (It is an adaptive learning rate optimization algorithm that's been designed for training deep neural networks) . The main motive is to calculate accuracy. The training accuracy, validation accuracy and validation loss are calculated to check the efficiency of proposed brain tumor classification model.

In this convolutional neural network based classification separate feature extraction step is not required. The feature value is taken directly from the convolutional neural network itself. Fig 2 shows the classified result of Tumor and Non-tumor brain image using CNN. Hence the complexity and computation time is comparatively low and accuracy is high as needed. Finally, the classification results as Tumor brain or non-tumor brain based on the probability score value is obtained. It showed that the normal brain image has low probability score as compared to the tumor brain which has highest probability score value.

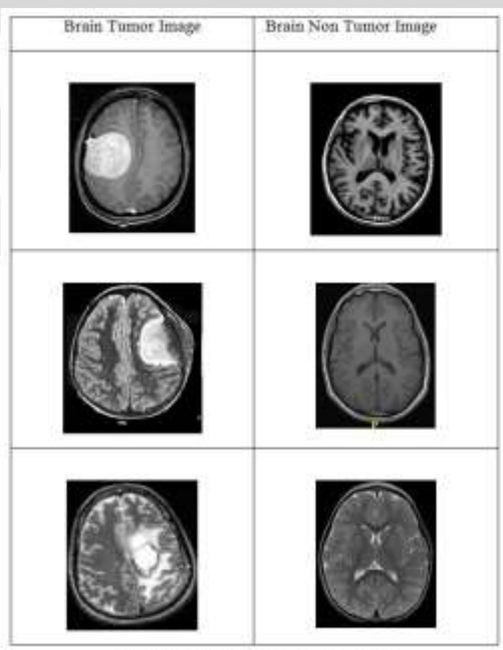

Figure 2: CNN based classified results

4. CONCLUSIONS

In this proposed paper, the model successfully classifies the tumor and non-tumor images of brain with the help of MRI images from Kaggle. The network was trained end to end using Adam with default parameters β1=0.9 and β2=0.999. The complexity is low. But the computation time is high is the mean time accuracy is low. Further to improve the accuracy and to lessen the computation time, a convolution neural network based type is introduced in the purposed scheme. The model was trained with a batch of 32. Initially, the learning rate was 0.0001 and a factor of 10 decayed it each time the validation loss plateaus after an epoch, and chose the model with lowest validation loss. Also the classification consequences are given as tumor or normal brain images. Also Python language is used for implementation. Image net database is used for classification mainly. It is one of the Pre-skilled models. So the training is performed on the final layer. Also, we have used image augmentation to increase the dataset and for better training. Finally, to achieve high accuracy Gradient decent based loss function is used. The training accuracy, validation accuracy and validation loss is to be calculated as, the training accuracy is approximately 98% and validation accuracy is 89.25%. Further, we can work to improve the classification of the present model. This could be done by combining over one classifier and feature selection techniques for the classification of different classes of brain tumor.

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