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BRAIN TUMOUR CLASSIFICATION USING CONVOLUTION NEURAL NETWORKS

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Abstract

In recent years, Brain tumour has caused a tremendous impact on the mortality rate of humans. It happened due to inefficient methodologies. Brain tumour is the development of unhealthy cells in brain which may leads to cancer. These unhealthy cells in the brain are identified with the help of MRI and CT scan images. So to decrease the mortality rate of humans, we proposed convolution neural networks model to detect tumour in brain. This convolution neural network model is integrated with transfer learning techniques such as VGG-16 to identify the tumour in brain. Transfer Learning is used to extract the features from brain MRI images to improve the efficiency of the model. This model will determine whether an individual person is having a tumour or not. The proposed model helps us to detect the tumour in earlier stages so that it can prevent the mortality rate of humans. So this approach is developed as it would save radiologist time, reduce human efforts, decrease human faults and obtain a best accuracy results.

Keywords -Brain Tumour, Magnetic Resonance Imaging (MRI), Convolution Neural Networks, Accuracy, VGG-16

I. INTRODUCTION

Brain tumour cases has been widely increased in many parts of the world like United States, North Europe, Australia and many more. Brain is the central unit for all the parts of the body and it is the most important organ which controls and coordinates all the activities. It is very difficult to survive if any part of the brain is affected. Generally, Brain tumour is the growth of cancer causing cells inside the brain. Brain tumour is not only observed in adults but also in youngsters [3] which leads to death of humans. The symptoms of brain tumour are loss of vision or double vision, blurriness, vomiting, change in pattern of headaches.

Brain tumour is basically classified in to two kinds: Benign tumour and Malignant tumour[4]. Benign tumour is a Primary stage tumour [4] which does not affect other parts of the body and it can be cured if it is detected in earlier stages. Malignant tumour is a secondary stage tumour in which it affects other parts of the body like lungs, kidneys, breast etc. [1] which is difficult to cure. So we

need to identify the tumour in earlier stages to prevent the mortality rate of humans. The impacts of a brain tumour are not only affected Physically but also affected mentally. A Primary brain tumour influences around 700000 individuals in the most evolved nations today with 85000 expected to be diagnosed in 2021[3].

By manually examining the MRI images may take long time and also lead to wrong assumptions. In Ordinary Computer aided systems the tumour mass should itself be distinguished and divided in to different types of brain tumours. These tumours are divided by using feature extraction and feature classification. MRI(Magnetic Resonance Imaging) has become the standard technique for diagnosing brain tumour due to its soft tissue which does not contain any harmful radiations like CT(Computed Tomography), X-rays etc. The MRI image is basically a matrix of pixels comprising characteristic features. Since many machine learning model requires training and it takes long time to train large amount of data. To overcome this problem, we proposed a Convolution Neural Networks (CNN) integrated with VGG-16 transfer learning technique. Transfer Learning is nothing but transferring the knowledge that it has learned in the previous operation to the current operation. Transfer Learning is mainly classified in to four fields. They are instance transfer, feature representation transfer, parameter transfer and relational knowledge transfer approaches. The main advantage of Transfer Learning is that it reduces required training time, less data and better accuracy. The remaining part of the paper consists of the following steps and let us discusses them. Section II consists of Literature Review. This is all about the works of various researchers and specialists on Convolution Neural Networks (CNN) and VGG-16 algorithms. Section III consists of Methodology. It is all about the working flow of the proposed model. Section IV discusses about the Proposed Convolution neural networks and VGG-16 model with an illustration. Section V deals with Results of this problem and it also analyses or compare the results of various algorithms. Section VI is about the conclusion of the paper.

II. LITERATURE REVIEW

According to this Paper, the classification of tumour classes takes place such as (glioma, meningioma and pituitary).The Problem of Overfitting is minimized by the use of technique known as Dropout regularization that keeps model firm[1].Deep Learning has a huge impact in people lives by providing precise outcomes with perfection in medical field and many other platforms. The reach of Machine Learning is very high as it can be able to resist to any different type of problem and it can be able to with stand. Here the work is done by the combination of convolution neural network module to predict the output that the provided subject has tumour or not[2]. Here the basic step applied is segmentation. The segmentation is in two parts i.e. having brain tumour or those do not have tumour. Then reshaped and forwarded to convolution layer, max pooling Layer and flattening (used to convert the image to vector format). It is further enhanced by the help of dropout Layer[3].Here the Technique Deep Learning is applied to classify tumour with help of convolution neural network as a technique to classify. An accuracy of 93% with a good precision, recall and F-score is achieved. The VGG-16 is a previously trained model and by the help of its architecture it helps CNN architecture by VGG-16 pretrained model as it is well efficient in classifying types of tumour[4]. Here CNN is implemented to automate the classification of the tumour into Glioma, Meningioma and pituitary without intervention of any region based preprocessing. Here the training and validation is firm and accurate at its best case [5].

III.METHODOLOGY

This section comprises the description of methodology. The Phases involved in developing this project are as follows:

Data Acquisition-Collection of data is mandatory for solving any type of problem. The brain tumour dataset is retrieved from the Kaggle comprises of both yes images and no images. After collecting the data from the Kaggle it is given to pre-processing step.

Image Pre-processing-In this step, noisy data is removed from the images collected and improves the quality of the images for further processing of the images. Since different images have different sizes, all the images are resized in to size equal to 128x128.

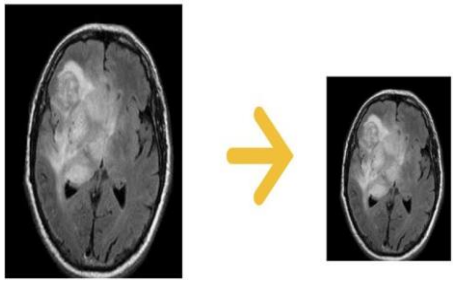

Figure 1

Image Classification- Here we use convolution neural networks(CNN) model to classify the pre-processed image data set in to train dataset and test dataset and determine whether a person is having tumour or not. Since this uses VGG-16 architecture it does not require any training, it uses the train data to train by itself. Testing- In this phase, we test the data by using various sample images to obtain the best results and accuracy, the Figure 2 demonstrates the flow of the work.

Figure 2

IV.PROPOSED

Convolution Neural Networks- CNN is one of the deep learning techniques used for processing of the image and for classification of the image. Since machine learning cannot perform operations on image datasets we use convolution neural networks for processing the image datasets. CNN is a class of Deep, feed forward artificial neural networks and it can be applied for computer vision and Natural Language Processing(NLP). Lenet was the first CNN architecture proposed by Yann Lecun in the year 1989. Later various researches has been done and Lenet is referred to as Lenet-5.It is used for character recognition or digit recognition. Convolutional neural network mainly comprises of four layers. They are Convolution Layer Pooling Layer RELU Layer Fully Convolutional neural network mainly comprises of four layers. They are

- Convolution Layer
- Pooling Layer
- RELU Layer
- Fully Connected Layer

Connected Layer Convolution Layer-This layer takes input image with dimensions of height, width and filters. This layer retrieves the features like color,edges,orientation etc. From the input image[4].It is the dot product of input image and feature map. Suppose if the input size is 4X4 and there are 3 filters then the output size is 4X4X3. Sometimes filter does not perfectly in to the image then we have to perform two steps to fit the filter perfectly in to the image. They are

i) Pad the image with zeroes. The main advantage of this zero padding is that the size of the output exactly matches the size of the original input[6].

ii) Drop or remove the part of the image where filter does not fit. Padding-It refers to number of Pixels added to an image when it is being processed by the kernel of a CNN.

RELU Layer-RELU stands for Rectified Linear Unit. It is also known as an Activation Layer. This Layer is used to add non-linearity to the network. The size of the image does not change in this layer. Pooling Layer-The size of the image reduces in this layer. Image size can be reduced by using three types of pooling. They are Min Pooling, Max Pooling, and Average Pooling. Ax Pooling gives the maximum value from the part of the image covered by kernel matrix[4].Min Pooling gives the minimum value from the part of the image covered by kernel matrix. Average Pooling gives the average of all the values of the kernel matrix. Pooling can be used with non-equal filters to give more efficiency.

Fully Connected Layer-This layer takes input from the previous layers and converts in to a single vector. Each node in the fully connected layer is the output obtained from the previous pooling layer. In this way output image is obtained.

VGG-16 -VGG stands for Visual Geometry Group.VGG-16 is one of the convolution neural network architecture which consists of 16 Layers. The significance of this model is its weights are accessible openly on the web and can be downloaded to use in their models [2].This models base image input size is 224X224 pixels with 3 channels. It can classify images into 1000 object categories. To overcome the problem of overfitting small size kernels are used. This model gives best test accuracy and results. The Figure 3 represents the architecture of VGG-16 model.

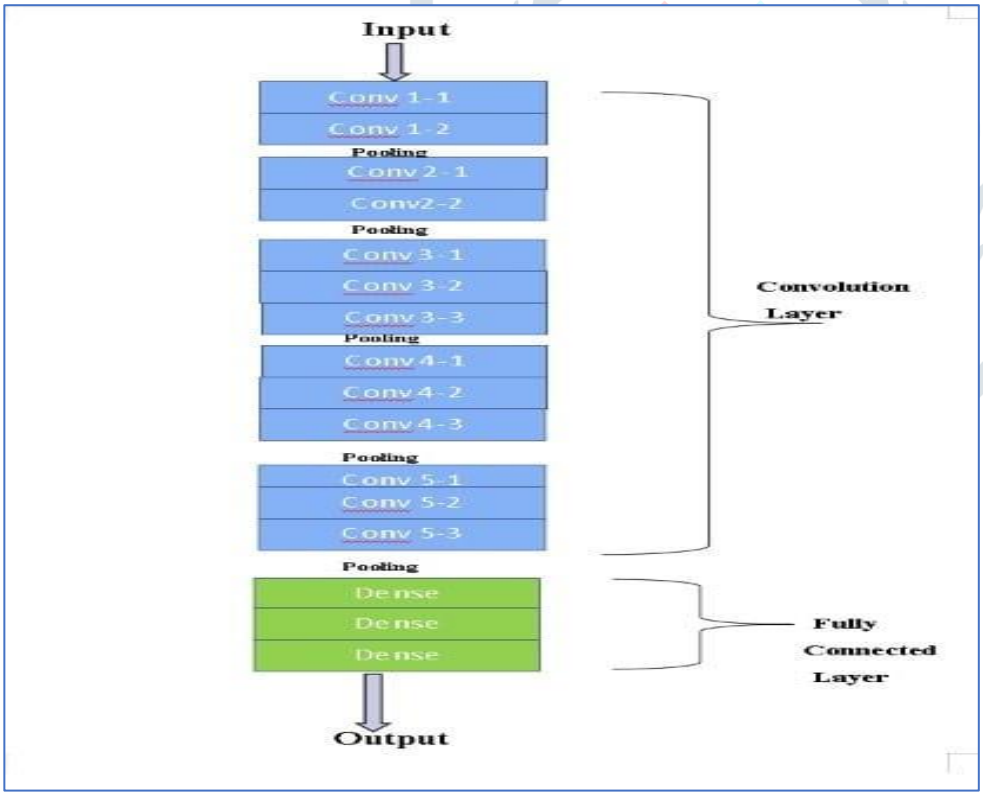

Figure 3

V. Results

In our proposed work, the model does not have either overfitting or underfitting problem. The loss of Train data is less than the loss of Test data which is equals to the entire model loss. The below graph (Fig a) is drawn between loss and epoch of train and test data to determine the model loss.

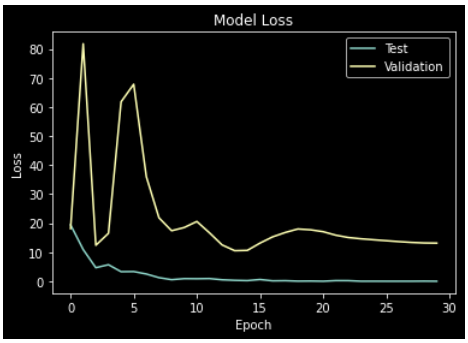

Figure a:loss vs Epoch of test and validation data

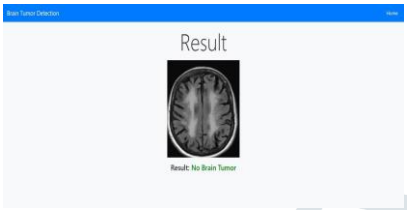

Figure b:no tumor detected image

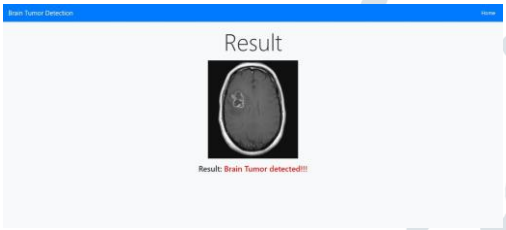

Figure :c tumor detected image

The Fig b represents that the person is not affected with tumour and the Fig c represents that the person is affected with tumour.

VI. Conclusion

In this Paper, we introduced CNN to automatically classify the three most common types of brain tumour, i.e. the Glioma, Meningioma and Pituitary. Here without pre-trained keras model, the train accuracy is 97.5% and validation accuracy is 90.0%. The validation result had a best figure of 91.09% as accuracy. It is observed that without using pre-trained keras model, although the training accuracy is >90%, the overall accuracy is low unlike where pre-trained model is used. For a large dataset, Dice loss is preferred over Accuracy. For small data, we should use simple models, pool data, clean up data, limit experimentation, use regularization/model averaging, confidence intervals and single number evaluation metric. To avoid overfitting, we need to ensure we have plenty of testing and validation of data i.e. dataset is not generalized. This is solved by Data Augmentation. If the training accuracy is too high, we can conclude that the model might be overfitting the dataset. To avoid this we can monitor the testing accuracy, use outliers and noise, train longer, compare variance by using formula train performance-test performance.

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