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Brain Tumor Analysis using Convolutional Neural Network with MRI Images

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ABSTRACT

Brain Tumor Analysis plays a vital role in detecting the tumored cells of the brain. Brain tumor can become very lethal at its advance stages. It can easily spread to other parts of the brain and affect the healthy cells of the brain as well. They reproduce uncontrollably. Hence, detection at early stages is very essential in treatment for improvement of the life expectancy of the patients. However, the detection of tumor is a difficult and a challenging task since tumor possesses complex characteristics in appearance and boundaries. Magnetic resonance imaging (MRI) is being used extensively for the detection of brain tumors that requires segmenting huge volumes of 3D MRI images which is very challenging if done manually. It is the mostly commonly used medical image for brain tumor analysis. So, we are using MRI images for detecting the brain tumor. In this system, we are going to use Keras and Convolutional Neural Network (CNN) for the automatic segmentation and detection of a brain tumor using MRI images. It is considered as one of the efficient methods for detection of brain tumors. It has one or more convolutional layers and are used mainly for image classification and segmentation techniques. It helps in achieving high accuracy and is optimal as well.

Keywords— *Brain tumor, Magnetic resonance Imaging (MRI), Convolutional Neural Network (CNN), Keras*

1. INTRODUCTION

Brain Tumor Analysis plays a vital role in many areas such as detection of various stages of tumors in hospitals, clinics and so on. They are used primarily in medical research and analysis. Since Deep learning technique is used, the number of MRI brain images needed for the analysis increases to a great extent. Traditional computer techniques may detect the tumor but not accurately. It lacks Robustness, which is one of the major characteristics. So, we have developed a robust system which would accurately detect the brain tumor. Some of the modules used in our system are (i) Preprocessing (ii) Feature extraction and selection (iii)Classification (iv)Segmentation. Published research work also provides a great advantage in recognizing one's potential. Now, here we enlist the proven steps to publish the research paper in a journal.

In this first module, we have collected 1030 brain MRI images consisting of tumor and non-tumor images. Then we have loaded those images into jupyter notebook by integrating the colab with drive. The splitting of dataset is done into training set and testing set. Once loading the input dataset containing training and testing sets is completed, Preprocessing is that the next step which is completed to get rid of unwanted noise and distortions within the image. Bilinear interpolation is the interpolation technique which is used to resize the image in preprocessing.

Here Gaussian blur has been applied to remove the unwanted noise in the image. Then the preprocessed image will be returned to the next module which is feature extraction and selection.

In the third module the preprocessed image will be feed into another module where we need to train the model using CNN. The classifier that we are going to use is K-Nearest Neighbours algorithm because this algorithm is simple to implement, robust to noisy training data, and effective if training data is large. Hence it is considered as one of the best classifiers for classifying the various stages of brain tumor. The activation function that we are going to use is Rectified Linear Unit (**ReLU**). Once classification module is completed, the next step is to perform the segmentation process which involves various morphological techniques for segmenting the images.

In the final model the segmentation is done by using U-Net Architecture. It does image segmentation and yields better results compared to other segmentation techniques. I t is especially good with segmentation tasks because it can localize well to provide high resolution segmentation masks.

Additionally, it works well with small datasets and is comparatively robust against overfitting because the training data is in terms of the number of patches within a picture, which is way larger than the amount of coaching images itself.

2. RELATED WORK

In this Section we have studied few papers which show that deep learning has a strong connection towards the Brain Tumor Analysis system.

A. Alpana Jijja and Dr. Dinesh Rai proposed "Efficient MRI segmentation and detection of brain tumor using convolutional neural network". It developed an automated method for the segmentation and detection of a brain tumor. It used WCA optimization algorithm for optimal clustering of the images.

B. Muhammad Imran Razzak, Muhammad Imran, Guandong Xu proposed "Efficient brain tumor segmentation multiscale two-pathway—group convolutional neural network". It presented a fully automatic brain tumor segmentation technique using two pathway group CNN.

C. Hossam H.sultan , Nancy M. salem , and walid al-atabany proposed "Multi classification of brain tumor images using deep neural network" where he presented a CAD system for the classification of brain tumor MR images.

D. Sanjay M.Shelke and Sharad W. Mohod proposed "Automatic segmentation and detection of brain tumor from MRI" which is used to provide an early preliminary judgement on diagnosis and tumor monitoring.

E. Liya Zhao and Kebin Jia proposed "Multiscale CNN's for brain tumor segmentation and diagnosis" here it can support only fixed size of input images and is not optimal.

3. DATASETS

The dataset for brain images is not available in plenty. So, the datasets are collected manually at various places such as clinics and other medical institutions. The images of the brain with their tumors are captured and stored for dataset. We have captured around 1,030 images of brains in different perspectives in which some of the images are having tumor while others are not having tumor. When the data's are collected the different lighting, conditions observed and collected such as images of brain at the light and dark intensity.

Some of the images are collected from NBIA Archieve while few other images are directly collected from the medical institutions. The collected images are segregated and split into tumor and non-tumor brain images. Based on the segregation, training and testing sets are made for further processing. Since we are using deep learning techniques, the dataset which is needed for processing is plenty. Hence, we need large datasets for performing the deep learning techniques.

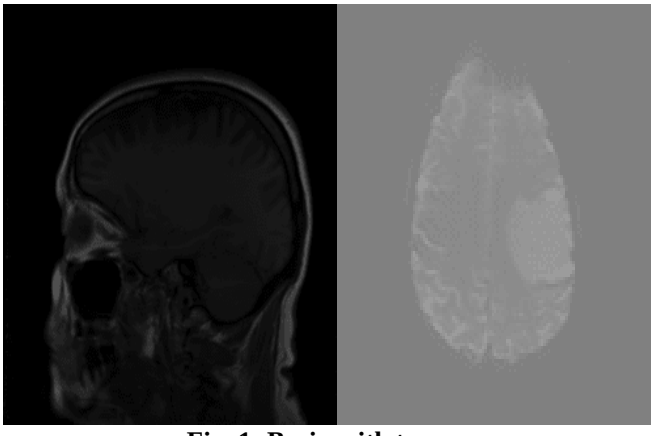

Fig. 1: Brain with tumor

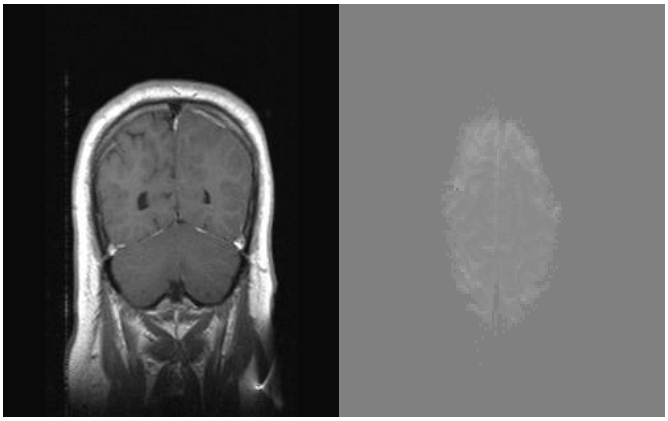

Fig. 2: Brain without tumor

4. PROPOSED SYSTEM

The proposed Brain Tumor Analysis system consist of 3 main modules: Preprocessing module, Classification module and Segmentation module. In the experiment of locating brain tumor 1,030 images were taken from various locations under different condition were employed in which 500 images has been successfully located the tumor in brain and segmented from image which is 98% of accuracy and the cross entropy is found to be 0.097. Finally, the validation accuracy is found to be 71%. The proposed system focuses on improving the efficiency and accuracy of the system compared to other systems and helps in developing a robust system.

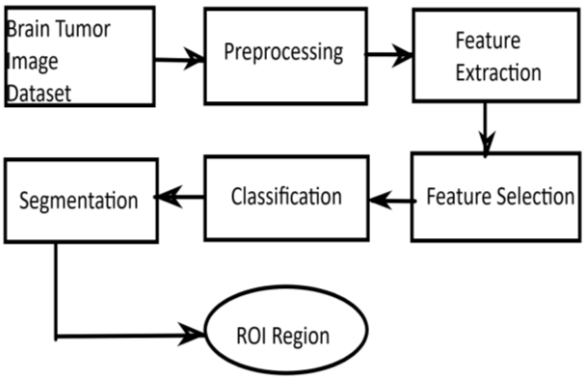

Fig. 3: Flow diagram of the proposed system

5. MODULES

a. Input module
b. Preprocessing module
c. Feature extraction and selection module
d. Classification module
e. Segmentation module
f. Output

1.1 Input Module

The input is taken from the dataset containing tumored and non-tumored brain images collected from various sources.

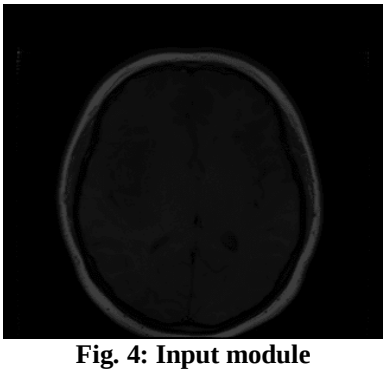

Fig. 4: Input module

1.2 Preprocessing Module

After obtaining the input image, it needed to be preprocessed to increase its size and remove the noise. Preprocessing is the next step which is completed to get rid of unwanted noise and distortions within the image. Here the images will be converted into gray scale for better processing. Then the contrast of the image will be saturated using the Morphological processing methods. Bilinear interpolation is the interpolation technique which is used to resize the image in preprocessing. Then the Gaussian blur is applied for smoothing the image. Then Again morphological filter will be applied for removing the small noise to smooth the image.

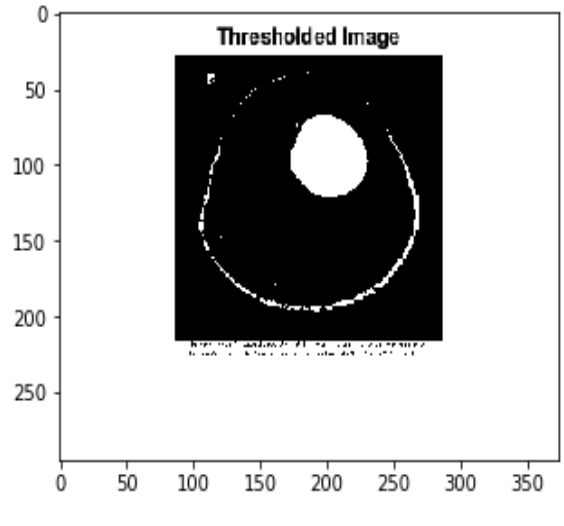

Fig. 5: Pre-processing module

1.3 Feature extraction and selection module

Feature extraction and selection is done exactly after the preprocessing step where, the unwanted noises and distortions are removed from the image. Now, only the needed features and elements are extracted from the image so that it can be made easy for classification purpose. After feature extraction, the extracted features needed to be selected based on certain criteria. Once selection is done, it is then sent to the next module for classification and processing.

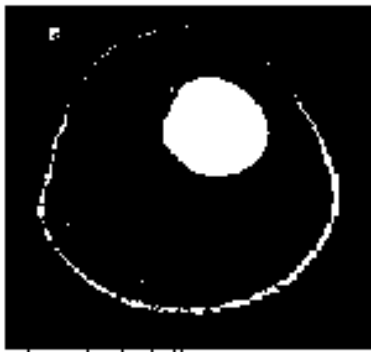

Fig. 6: Feature extraction and selection module

5.4 Classification Module

In the third module the preprocessed image will be feed into another module where we need to train the model using CNN. The classifier that we are going to use is K-Nearest Neighbour algorithm because this algorithm is simple to implement, robust to noisy training data, and effective if training data is large. Hence it is considered as one of the best classifiers for classifying the various stages of brain tumor. The activation function that we are going to use is Rectified Linear Unit (**ReLU**).

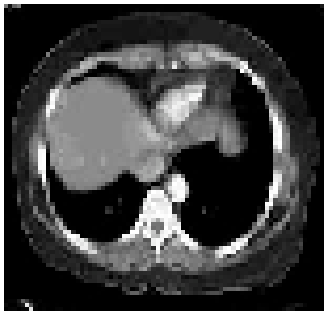

Fig. 7: Classification Module

5.5 Segmentation module

In the final model the segmentation is done by using U-Net Architecture. It does image segmentation and yields better results compared to other segmentation techniques. I t is especially good with segmentation tasks because it can localize well to provide high resolution segmentation masks. Additionally, it works well with small datasets and is comparatively robust against overfitting because the training data is in terms of the number of patches within a picture, which is way larger than the number of coaching images itself.

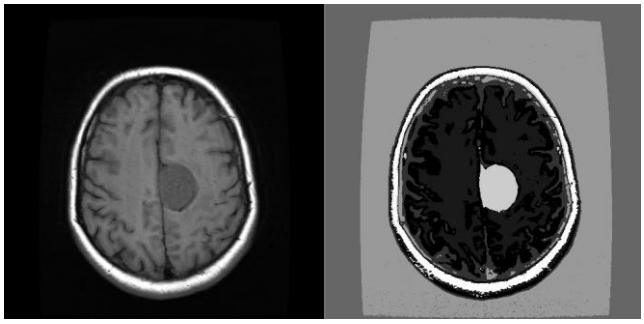

Fig. 8: Segmentation module

5.6 Output Module

We have developed the CNN model in keras with tensorflow as backend. It has been trained with medical tumor dataset with 1,030 images. Here the training and validation accuracy will be considered.

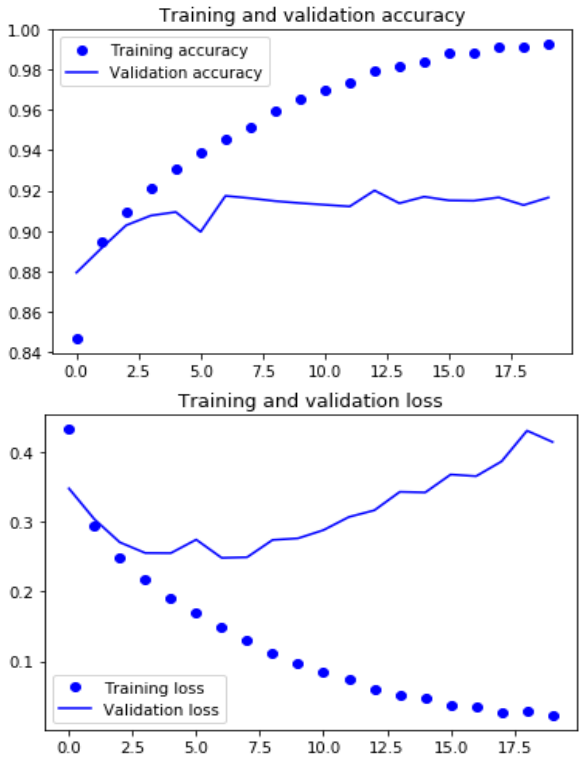

Fig. 9: Output Module

6. RESULT AND FUTURE WORKS

In this paper, we proposed an automated brain tumor analysis system which will be useful in many places, the important part in our system is that we have used CNN model, which not only used for detection process also for segmentation process. The efficient part is that the neural network used. UNet in Deep Neural Network plays vital role in our system. The future work could be that, is can be used in various places and it will be cost effective and time efficient process.

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