Brain Tumor Detection and Classification

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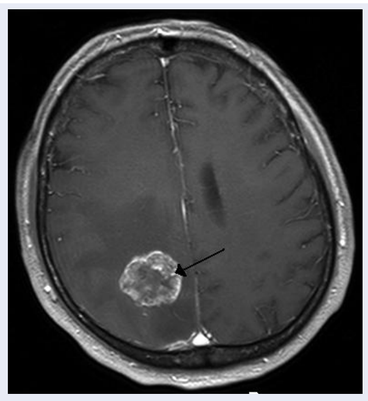
Abstract/Introduction

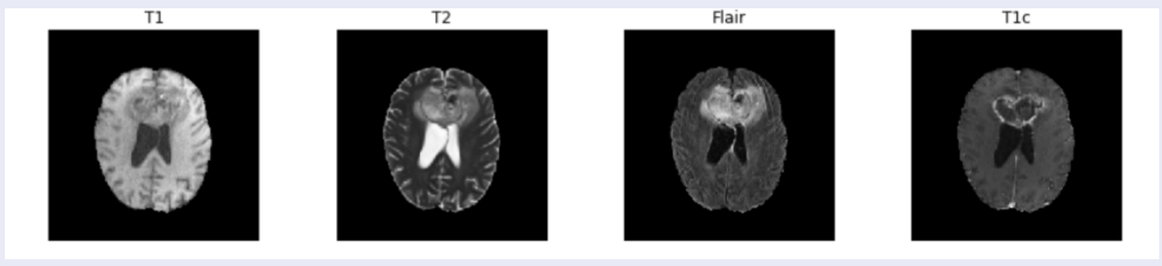
The Brain tumor is one of the most dangerous diseases which requires early and accurate detection methods. Presently, most detection and diagnosis methods depend on the decision of neuro specializes, and radiologists for image evaluation which is possible to human errors and are very time-consuming. Research shows that people affected by brain tumors die due to their inaccurate detection, the tumor is heterogeneous, and the border is difficult to localize, if the tumor diagnosed at the early stage, the disorders can be treated and can be prevented from further complications.



The National Brain Tumor Foundation (NBTF) for research in U.S estimates that 29,000 people in the U.S are diagnosed with primary brain tumors each year, and nearly 13,000 people die. In the UK, over 4,200 people are diagnosed with a brain tumor every year (2007 estimates). There are about 200 other types of tumors diagnosed in UK each year. In India, totally 80,271 people are affected by various types of tumor (2007 estimates).

MRI is one of the best technologies currently being used for diagnosing brain tumor and it creates more detailed pictures. Automatic detection in MRI is quite useful in several diagnostic and therapeutic applications

MR images come in four standard flavors; T1-Weighted, T1C-Weighted and T2- weighted and FLAIR images to improve the radiologist diagnostics that use automatic method such as Artificial Neural Networks which depend on digital image processing include filtering image, segmentation and feature extraction.



In our project, with the help of convolutional Neural Network, we are predicting whether an individual has tumor or not. This project will also categories the type of tumor person has. At last, we were able to predict whether the individual can survive for more than a year or less.

Methodology

We have divided our project in four parts that are as follows :

At first, we will take MRI scans of an individual. Using these MRI scanned images of the person we will predict whether the individual has brain tumor or not. This is possible with the help of processing the image through the Convolutional Neural Network (CNN) model and applying different image processing techniques. We have used a method named as Data Augmentation that helped us increasing the amount of Dataset that ultimately helped us getting higher accuracy. We have divided our data into three parts as Training Data (used to train our model), Validation Data (used to validate our model), Test Data (used to test accuracy of our model).In practice, very few people train an entire Convolutional Network (with random initialization), because it is relatively rare to have a dataset of sufficient size. Instead, it is common to pretrain a ConvNet on a very large dataset (e.g. ImageNet, which contains 1.2 million images with 1000 categories), and then use the ConvNet either as an initialization or a fixed feature extractor. We have used different architectures such as VGG-16, Inception v3, RESNET 50 model to obtain maximum accuracy for predicting the presence or absence of brain tumor in an individual among different architectures. After several predictions, VGG 16 architecture came out with a decent accuracy.

Next, we take the MR images of the individual in four standard flavors as mentioned above.We used the U-net architecture to segment the brain tumor from the normal brain tissues.This helped us localising the Region of Interest (ROI) of brain tumor. We combined the three manual segmentation into ROIs to extract multi-regional radiomics features. We intended to obtain information from multiple tissue types rather than single tissue type. The first region (ROI type I) was created by merging the non-enhancing tumor and necrotic region and the second region (ROI type II) was created by adding the tumor region with enhancement to the first region. The third region (ROI type III) combined the second region with the area of edema.

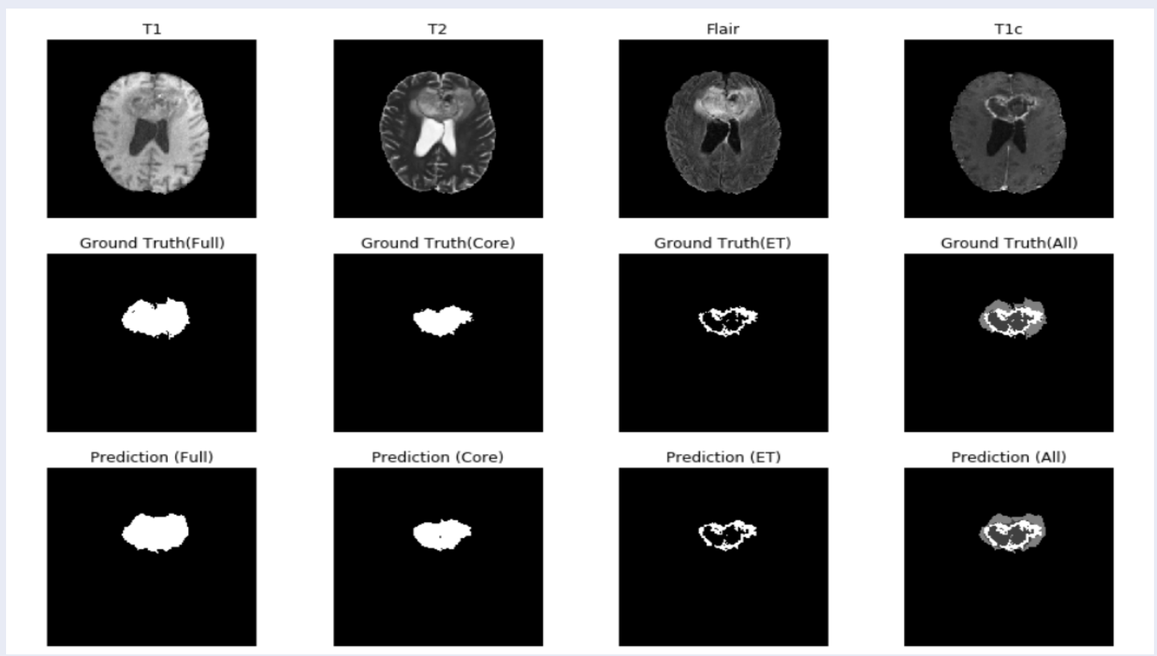
Next, we will process the MR image through another Convolutional Neural Network (CNN) model that will classify the Brain Tumor into two categories: High Grade Glioma (HGG) and Low Grade Glioma (LGG). We performed pre-processing like normalization on the MR images. We had to extract the important features from the dataset in order to avoid the condition of underfitting. This also helped us obtaining the higher accuracy. Now, we applied different machine learning models like Logistic Regression, Random Forest Classifier, KNeighbors Classifier, GaussianNB, Decision Tree Classifier. Using these models we were able to classify the tumor precisely.

Lastly, we will predict whether the person can survive for more than a year or less. We extracted the required features from the classified dataset obtained from above and combine it with the new dataset that contains age and number of days of survival. Then we applied same machine learning models like Logistic Regression, Random Forest Classifier, etc. and predict the survival of the individual as output.

Results

We are successfully able to predict whether a person has brain tumor or not. Transfer Learning helped us to train model more easily and precisely with training dataset. Different architectures such as VGG-16, Inception v3, RESNET 50 models resulted to diffferent accuracies. The most accurate model was VGG 16 that resulted to Validation accuracy of 86 % and Test accuracy of 90 %.

It can be seen in this image the precision of segmentation.All standard flavors of MRI scans are properly segmented. The all three ROIs can be easily seen. The predicted segmented images are almost similar to the real segmented images.



We have successfully classified the type of tumor the individual has.
The brain tumor is classsified with the high accuracy of 92.5 %.
Feature Extraction avoided the condition of under fitting.
Using different machine learning models helped us achieving this high accuracy.

The individual can survive more than one year or less is successfully predicted with a decent accuracy of 86.4 %.

Conclusion

The Brain Tumor is detected with high accuracy and thus we are confident that it will greatly help neuro specialists and radiologists for diagnosis of Brain Tumor at an early stage. The disorders can be treated and can be prevented from further complications.

The diagnosis and treatment depends on a mixture of factors like the type of tumor, its size, its location and its state of development. The segmentation of tumor through our project will help doctors to monitor these above factors. As per the results, the segmentation is very precise and it is very time efficient and effortless to get the segmented images through our model.

The classification of brain tumor is achieved with a high accuracy of 92.5 %.
Our model classifies tumors into two categories as HGG and LGG.
The LGG tumors are less aggressive, with slower growth rate as compared to HGG and are responsive to therapy. Thus, it can be concluded by specialists whether the tumor can be cured or not in no time.

The survival of the individual has been predicted with a decent accuracy. Knowing the age and the present state of tumor we can easily predict whether the person will stay alive for more than one year or less.

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