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Brain Tumor Detection with Deep Learning on MRI Image Dataset

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Abstract: ***Tumor is an unusual growth of the tissues in any part or organ of the human body. A brain tumor is an abnormal growth of cells in the brain or central spine canal. Brain tumors can be malignant (cancerous) or benign (non-cancerous) and have different treatments. Any extra growth of cells in the brain can result in pressure inside the skull as it is rigid and hence damages the brain. In the recent years, a progressive research has been done in this medical imaging field to more accurately detect the brain tumors. This is very important for early treatment. The proposed model detects the location and dimensions of the tumor present in the brain of a patient accurately using deep convolutional neural networks. In this paper we have presented the two models, Inception V3 and VGG-Net. The main aim of this paper is to find the best technique to detect the brain tumor from the MRI scanned images. The proposed models have given good results with good accuracy.***
Keywords: Brain Tumor, deep learning, feature extraction, Inception-V3, MRI image, VGG-Net

I. INTRODUCTION

Brain Tumor Detection is one of the critical tasks in the analysis of medical images. When the cells presented within the human brain increases unusually or abnormally, then this condition is known as brain tumor. In general cases its growth starts from the nerves coming out of the brain, brain cells and the vessels of blood. Tumors can be categorized in two forms and they are malignant (cancerous) and benign (noncancerous) tumors. Benign tumors are considered as slow increasing tumors. The benign tumors do not extend in the adjoining brain tissue. These tumors will only apply potentially harmful pressure. The malignant tumors are described as fast increasing tumors. These tumors are capable to extend in the surrounding brain. The normal brain cells can be destructed by the tumors because of the generation of inflammation, applying pressure on the brain parts and rising pressure into the head.

Brain tumor has already become a very big reason of deaths and disabilities globally. In the last few years, a lot of research work has been carried out for the The National Cancer Institute (NCI) estimated that 22,070 new cases of brain and other central nervous system(CNS) cancers would be diagnosed in the US in 2009. The American Brain Tumor Association(ABTA) clarifies this statistic further by estimating that 62 ,930 new cases of brain tumors have been diagnosed in 2010. A Brain Tumor is a collection, or mass of abnormal cells in our brain. Our skull which encloses our brain, is very rigid. Any growth inside such a restricted space can cause problems. Brain tumors can be cancerous or non-cancerous. When cancerous or non-cancerous tumors grow, they can cause the pressure inside or skull to increase. This can cause brain damage, and it can be life threatening.

Today, most medical institutions use the World Health Organization (WHO) classification system to identify brain tumors. The WHO classifies brain tumors by cell origin and how the cells behave, from the least aggressive (benign) to the most aggressive (malignant). There are three common types of tumor: Benign tumor, Pre-Malignant tumor, Malignant tumor.

A benign (non-cancerous) brain tumor is a mass of cells that grows slowly in the brain. It usually stays in one place and does not spread. The symptoms of a benign brain tumor depend on how big it is and where it is in the brain. Some slow-growing tumors may not cause any symptoms at first. Common symptoms include severe, persistent headaches, seizures (fits), persistent nausea, vomiting and drowsiness. PreMalignant Tumor: A precancerous condition or pre malignant condition, sometimes called a potentially precancerous condition or potentially pre malignant condition, is a state of disordered morphology of cells that is associated with an increased risk of cancer. If left untreated, these conditions may lead to cancer.

II. LITERATURE SURVEY

One of the challenging and also high demanding tasks is to segment region of interest from the object and segmenting the tumor from an MRI Brain image is an ambitious one. Researchers across the globe are working in this area to get the best-segmented region of interest and various approaches simulated from a distinct perspective. Now a day Convolution Neural Network based segmentations gives very much prominent outcomes, and the flow of using this CNN model is augmenting day by day. B.Devkota et al. [1] established the entire segmentation process depends on Mathematical Morphological Operations and also spatial FCM

algorithm that improves the performance, but the proposed approach has not been tested and outcomes as- Detects cancer with 92% and classifier has an accuracy of 86.6%. Song,Yantao et al. [2] resembled the Histogram based segmentation technique. Regarding brain tumor segmentation task as a 3-class (tumor including necrosis, edema and normal tissue) classification problem and regarding two modalities namely FLAIR and T1. The unusual regions were discovered by using a region-based active contour model on FLAIR modality. The edema and tumor tissues were distinguished in abnormal regions based on contrast enhancement T1 modality by k-means method and accomplished a Dice coefficient and sensitivity of 73.6% and 90.3% respectively.

Based on the edge detection approaches, Badran et al. [3] adopted canny edge detection technique accumulated with the Adaptive thresholding to extract the ROI. The dataset consists of 102 images. The Images were preprocessed first and then for two sets of a neural network, for the 1st set canny edge detection model was applied, and for the 2nd set, the adaptive thresholding was applied. The segmented image is then denoted by a level number and the characteristics features are extricated by the Harris method. Then two neural networks are employed, first for detection of healthy or tumor holding the brain and second one is for the detection of tumor type. The canny edge detection model showed better results in terms of aperformance. Pei et al. [4] proposed a method which uses tumor growth patterns as new features to improve the texture based tumor segmentation in longitudinal MRI. The Label maps are being used to find tumor growth modeling and predicts cell density after extracting the textures (e.g., fractal, and mBm) and also intensity features. The Performance of the model is reflected as the Mean DSC with tumor cell density- LOO: 0.819302 and 3-Folder: 0.82122.

Dina et al. [5] introduced a novel model which is based on the Probabilistic Neural Network model and related to the Learning Vector Quantization. This model was evaluated on the 64 MRI images, among them 18 MRI images were utilised as the test set, and the remaining were used as the training set. The Gaussian filter was used for smoothing of the images. Almost 79% of the overall processing time was reduced by this modified PNN method. A Probabilistic Neural Network PNN based segmentation method implemented by Othman et al. Principal Component Analysis PCA was utilized for the extraction of features and also to minimize the large dimensionality of data [6]. The dataset MRI images are first converted into matrices, and then Probabilistic Neural Network PNN is utilized for the classification. Finally, the performance analysis is was done. The training phase dataset consists of 20 subjects, and the testing phase dataset includes 15 subjects. Based on the parameter spread value, the accuracy ranged from 73% to 100%.

Focusing on Region based Fuzzy Clustering & deformable model, Rajendran et al. [7] achieved 95.3% and 82.1% of ASM & Jaccard Index based on the Enhanced Probabilistic Fuzzy C-Means method with some morphological operations. Zahra et al. [8] performed with the LinkNet network for the tumor segmentation. In the beginning, they used a single Linknet network and dispatched all the training seven datasets to that network for the segmentation. They did not examine the view angle of images and introduced a technique for CNN to intuitively segment the most regular types of a brain tumor which don't require the preprocessing steps. The Dice score of 0.73 is achieved for the single network, and 0.79 is achieved for multiple systems.

III. METHODOLOGY

The main idea of the project is to label the input MRI sequence with one of the two basic labels: Image having tumor and image not having tumor. The proposed system contains the following modules: Dataset Collection, Data Augmentation, Training and Classification. The flow of project execution of both training and testing phases given in figure1.

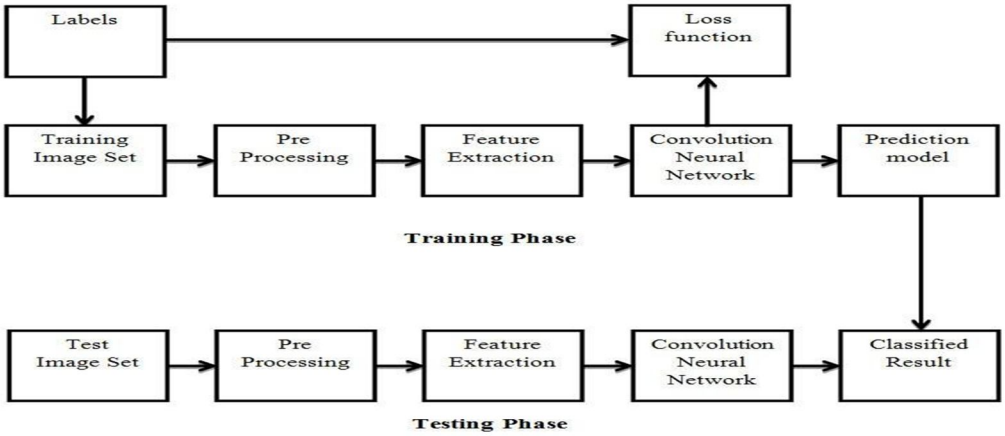

Figure 1: Flow chart of the proposed system

Training was completely done on a cloud based platform called as google COLAB as it provides free GPU access for faster computations. The training was separately done on two different kinds of convolution architectures: Inception-V3 and VGG-Net.
These two variants of CNN are basically trained on the image-net dataset of google which contains almost 1 million images of 1000 object categories. Hence, the knowledge acquired by these networks can be used to classify almost any category by the technique of transfer learning.

IV. RESULTS

We have tested our two models i.e. Inception-v3 model and VGG-Net model with image-net dataset images and some of the test cases are shown below:
The images predicted to be containing tumor and not containing tumor using Inception-V3 model are shown in figures 2 and 3 respectively.

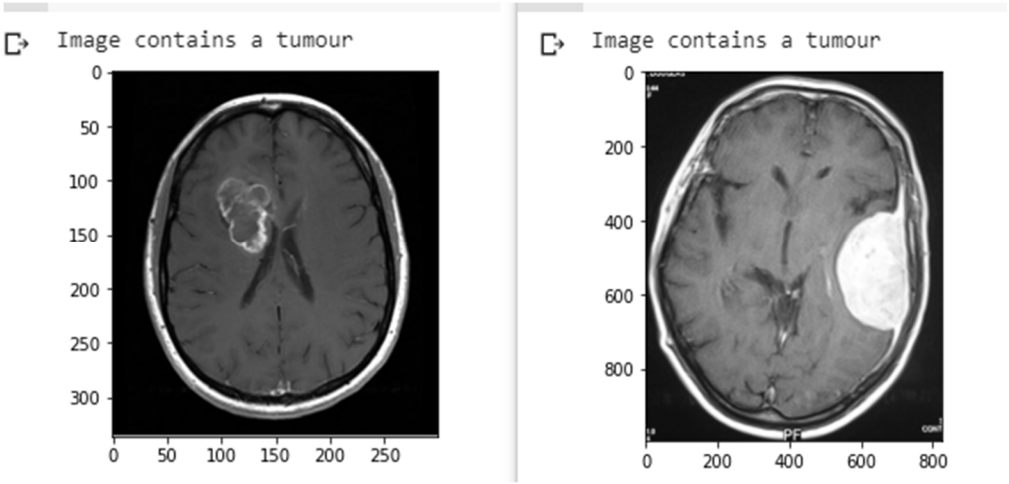

Figure 2: Images predicted to be containing tumor by Inception-V3

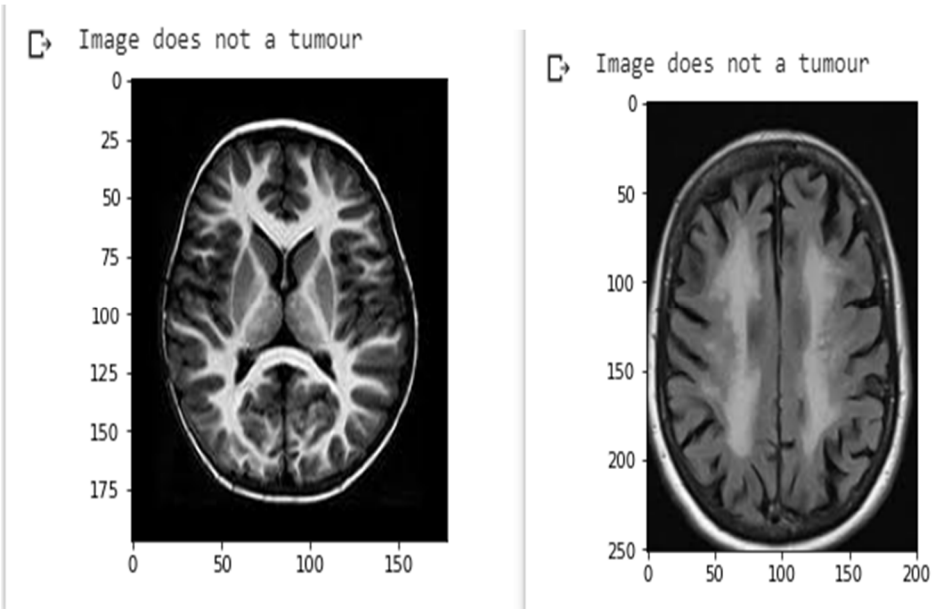

Figure 3: Images predicted to not have tumor by Inception-V3

The images predicted to be containing tumor and not containing tumor using VGG-Net model are shown in figures 4 and 5 respectively.

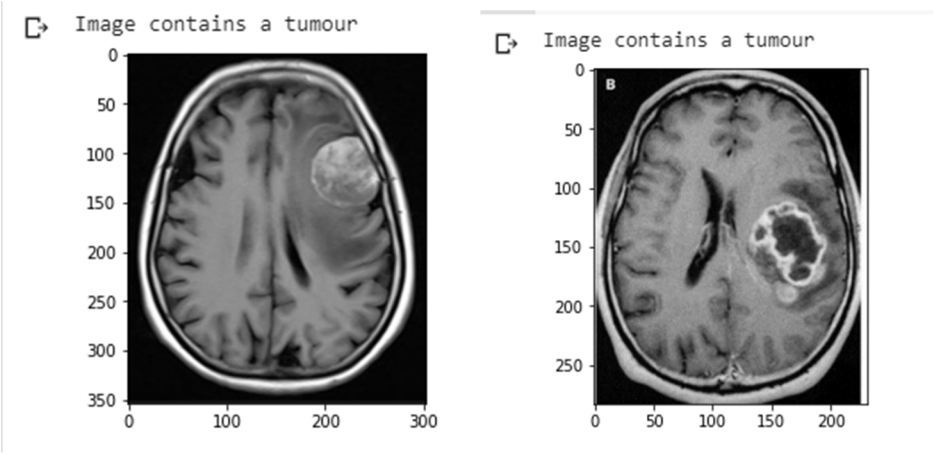

Figure 4: Images predicted to be containing tumor by VGG-Net

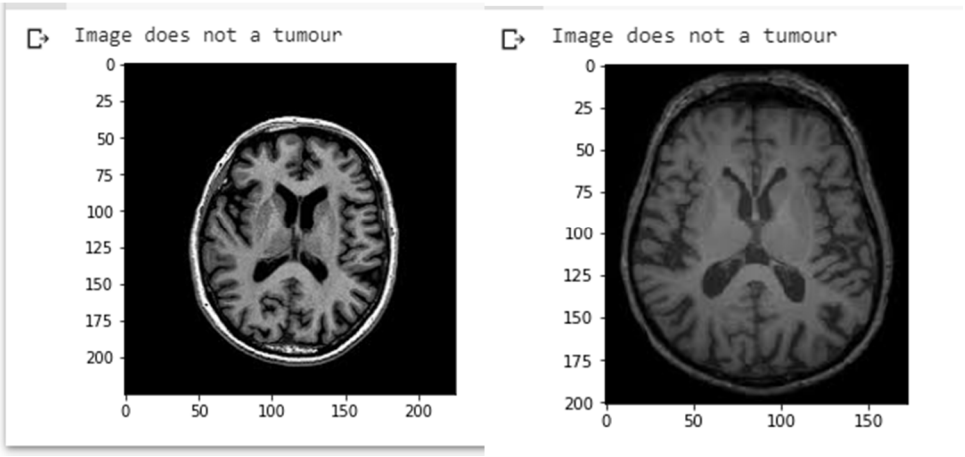

Figure 5: Images predicted to not contain tumor by VGG-Net

We have also measured the performance accuracies of both Inception-V3 and VGG-Net models and these are listed in table1, and the maximum accuracy we got using VGG-Net model i.e 93%, So we are concluding from our research that the best technique used to detect brain tumor from MRI images was VGG-Net Model.

Table 1: Accuracies Comparison of Inception-V3 and VGG-Net Models

Model	Fine tuning	Training Accuracy	Testing Accuracy
Inception-V3	Not Applied	86%	85%
Inception-V3	Applied	89%	88%
VGG-Net	Not Applied	89%	91%
VGG-Net	Applied	90%	93%

V. CONCLUSION AND FUTURE SCOPE

MRI is used by radiologist /doctors to examine the location of tumor in brain but this process is time and energy consuming if done manually as MRI sequences are huge to analyze. So, the main objective of this work is to develop a technique which reduces the efforts of a radiologist in detection of the tumor.

This report presents a fully automatic brain tumor detection using VGG-Net and Inception-V3 based deep convolution neural networks. Based on a well-established custom dataset, which contains both tumor and non-tumor patients' MRI sequences. The proposed method can provide an efficient detection of brain tumor when compared to the manual segmentation method and also compared to the other classifier techniques like CNN, K-Means Algorithm, SVM classifier etc.

So, we can conclude that, the deep convolution neural networks approach can achieve comparable results for the automatic brain tumor detection and also the VGG-Net model is the best model with accuracy of 93%. In the future we can still improve the performance accuracy.

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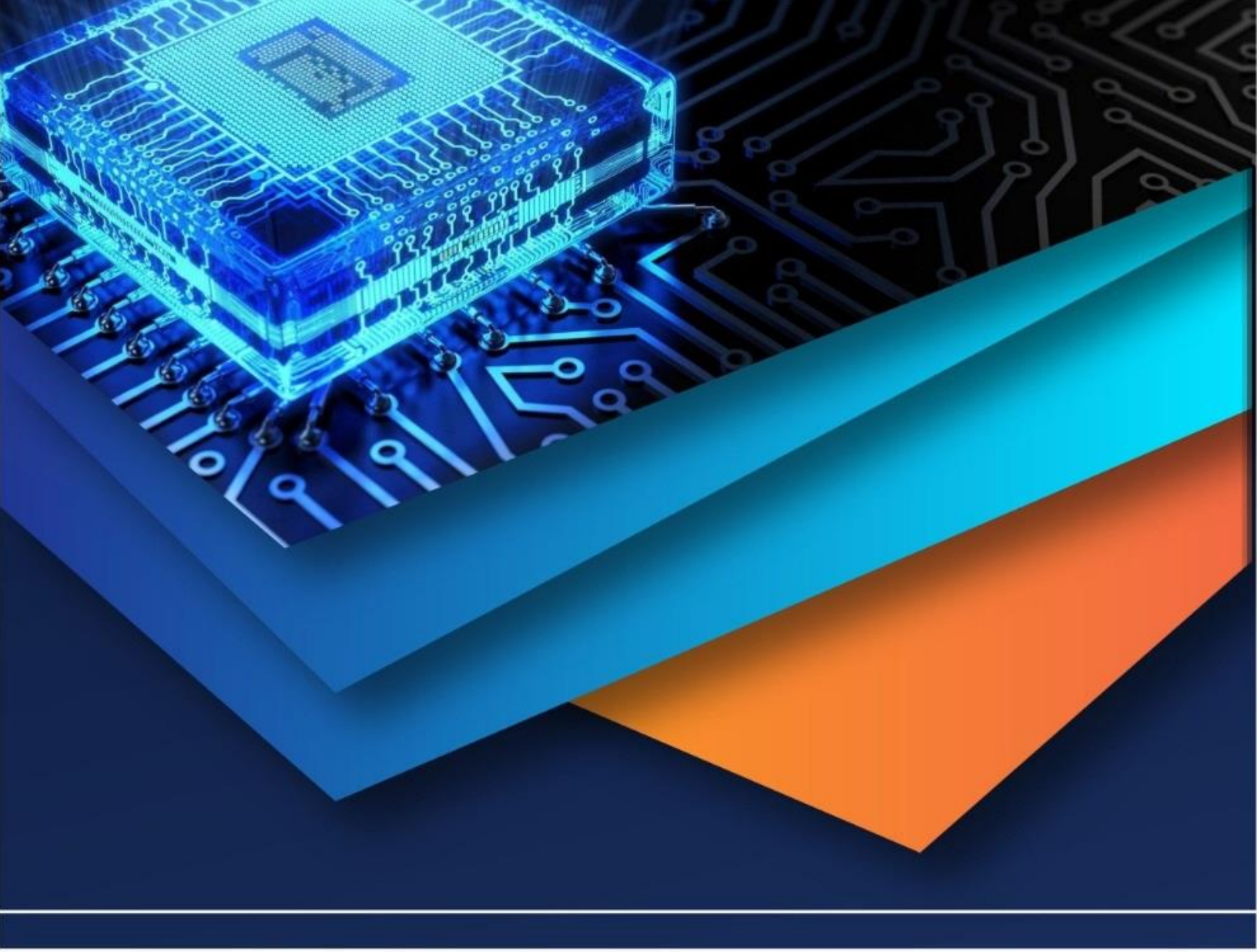

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