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DETERMINATION OF BRAIN LESION USING DEEP LEARNING

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ABSTRACT

A brain tumor is a mass or cluster of cells in the brain or near it. These tumors may occur in the brain tissue, or nearby areas such as nerves, the pituitary gland, the pineal gland, and the membranes covering the brain's surface. Though MRI imaging is widely used to examine these tumors, manual segmentation of its extensive data requires a considerable amount of time - limiting its use.This project focuses on developing deep learning models based on convolutional neural networks and watershed algorithms to perform automated semantic image segmentation of MRI images of the brain. Such precise quantitative assessments are essential in clinical settings, however the immense spatial and structural variability among brain tumors make automatic segmentation a challenging task. Hence, dependable and reliable methods for automated segmentation must be created in order to fulfill the demand.The current state of CNNs architecture is analyzed and evaluated on the BraTS dataset. Various methods for regularization and optimization, including various values for hyperparameters, are tested and optimized to determine their effectiveness. Finally, a web application is developedand this the developed models can be used easily by medical practitioners.

Keywords: Brain Lesion, Brain Tumor, Image Segmentation

1. INTRODUCTION

A brain tumor is a development of abnormal cells in the brain that multiply uncontrollably. Since the human skull is a rigid and volume-limited structure, any unanticipated development may have an impact on a human function depending on the area of the brain involved. It also has the potential to spread to other bodily organs and have an impact on human functions. Brain tumors can be benign (non-cancerous) or malignant (cancerous). As stated in, brain and other nervous system cancer is the tenth largest cause of death, with a five-year survival rate of 34% for males and 36% for women for those with cancer of the brain. The most common type of brain tumor 2 found in adults is glioma which starts from the glial cells. According to WHO these tumors are categorized in 4 types ranging from I to IV in terms of severity. Types III and IV gliomas are highgrade gliomas that nearly always result in death, whereas Types II and I low-grade gliomas grow more slowly and have a longer life expectancy, hence vigorous treatment is frequently postponed as long as possible. As a result, earlier diagnosis of brain tumors can substantially improve options for treatment and increase the likelihood of survival.

Image segmentation is the process of partitioning an image into well-defined regions or categories, each of which comprises pixels with comparable qualities and is designated to one of these categories. Similarly, brain tumor segmentation is the process of separating the tumorous from the non-tumorous regions of the brain. MRI is the standard technique for brain tumor diagnosis as it is non-invasive and provides good soft tissue contrast with high spatial resolution. Improved disease diagnosis, treatment planning, monitoring, and clinical trials all depend on the segmentation of brain tumors from neuroimaging modalities. To determine the location and size of the tumor, accurate brain tumor segmentation is necessary. However, the characteristics of brain tumors make accurate segmentation challenging. These tumors can develop in practically any area and come in a wide range of sizes and shapes.

The intensity value of a tumor may overlap with the intensity value of healthy brain tissue, and they are typically poorly contrasted. As a result, it is difficult to tell healthy tissue from a tumor. Integrating data from various MRI modalities, such as T1-weighted X-ray (T1), T1-weighted MRI with contrast (T1c), and T2-weighted X-ray, is a typical method to address this problem. Depending on the degree of human interaction during segmentation of the scans, MRI segmentation can be divided into three classes.

It can be classified into semi-automated approaches, completely automatic methods , and manual methods. Precision and speed in treatment planning are critical for enhancing patient quality of life, however manual segmentation is time-consuming due to the enormous amount of data provided by MRI. As a result, approaches for automatic and reliable segmentation are necessary. However, developing automated brain tumor segmentation techniques is technically challenging and even professional raters' manual segmentations exhibit intra-operator variability as tumors can be ill-defined with soft tissue boundaries and lesions deform surrounding normal tissues.

The BraTS (Brain Tumor Segmentation challenge), however, has made a concerted effort in this regard. Artificial neural networks (ANN) and, in particular, convolutional neural networks have been shown to outclass humans in the task of image segmentation and classification. as illustrated by the classification of melanomas. In 2015, Ronneberger et al. published U-Net , a network for segmenting biomedical images. This method outperformed all competing network structures in the ISBI challenge, achieving exceptional results. Since then, the U-Net architecture has been implemented in a variety of fields for segmentation, including the segmentation of brain tumors, where it has demonstrated increasing performance each year in the BraTS challenge.

The purpose of this project is to develop an automated brain tumor segmentation application that uses multimodal MRI images of a patient's brain to generate the segmentation mask. The dataset employed for segmentation is BRATS 20, which comprises four distinct MRI modalities and one target mask file. The intention is to build on top of current state of the art, analyze and evaluate different medical image segmentation techniques, creating easy to use GUI for medical practitioners to performautomatic segmentation of gliomas

2. LITERATURE SURVEY

Title:A survey on brain tumor detection using image processing techniques

Authors: Luxit Kapoor; Sanjeev Thakur

Abstract: Swapnil R. Telrandhe et.al.[1], in their work titled as "Implementation of Brain Tumor Detection using Segmentation Algorithm & SVM", implemented the system for brain tumor detection from MRI images, the malignant or benign tumor region we will find by this system. The complete system includes preprocessing of MRI by using Median filtering, skull removal by morphological filtering, and segmentation by k-means algorithm; object labeling by HOG algorithm, also feature extracted by HOG, and linear SVM implementation by using extracted feature of the MRI. The proposed system is the combination of some technologies like k-means for segmentation, HOG for object labeling, median filter, morphological filter and wavelet transform for the preprocessing and skull masking. So the result of this combination is much fairer than the individual of them or some other combination. The linear SVM and HOG work with coordination because the HOG extracts the feature and SVM uses that data for learning the SVM, so the SVM will be able to make the patterns and after training in testing it will work to test the pattern and give the conclusion. The main limitation of this project is less accuracy and SVM can not work well for large data types.

Title: Feature Extraction and Classification of Chest X-Ray Images Using CNN to Detect Pneumonia

Authors: Harsh Sharma; Jai Sethia Jain; Priti Bansal; Sumit Gupta

Abstract: Ali IúÕnet.al.[2], in their work titled as "Review of MRI-based brain tumor image segmentation using deep learning methods", said that Brain tumor segmentation is an important task in medical image processing. The purpose of their paper is to provide a review of MRI-based brain tumor segmentation methods. Recently, automatic segmentation using deep learning methods proved popular since these methods achieve state-of-the-art results and can address this problem better than other methods. Deep learning methods can also enable efficient processing and objective evaluation of the large amounts of MRI-based image data.Automatic segmentation of the brain tumors for cancer diagnosis is a challenging task. The limitation of this is future improvements and modifications in CNN architectures and addition of complementary information from other imaging modalities such as Positron Emission Tomography (PET), Magnetic Resonance Spectroscopy (MRS) and Diffusion Tensor Imaging (DTI) may improve the current methods, eventually leading to the development of clinically acceptable automatic glioma segmentation methods for better diagnosis.

Title:A study on brain tumor segmentation using convolution neural network

Authors: Anil Singh Parihar

Abstract: Bjoern H. Menze et.al.[6], in their work titled "A Generative Model for Brain Tumor Segmentation in Multi-Modal Images", said that their paper introduces a generative probabilistic model for segmentation of tumors in multi-dimensional images. They present experiments on 25 glioma patient data sets, demonstrating significant improvement over the traditional multivariate tumor segmentation. Limited therapy options require a careful diagnosis for patients with brain tumors. They presented a generative model for tumor appearance in multi-modal image volumes of the brain that provides channel-specific segmentations. They derived an estimation algorithm and demonstrated superior performance over standard multivariate EM segmentation. Unlike discriminative tumor segmentation methods, their model is applicable to any set of multi-modal image volumes, and is fully automatic. The limitation of this model is considering structure of the tumor, or temporal evolution in longitudinal data sets.

3. PROBLEM STATEMENT

In the existing system they have implemented the system for brain tumor detection from MRI images. This system uses Median filtering for preprocessing of MRI images, segmentation by k-means algorithm. The linear SVM and HOG work with coordination because the HOG extracts the feature and SVM uses hat data for learning the SVM, so the SVM will be able to test the patterns

4. PROPOSED SYSTEM

The purpose of this project is to develop an automated brain tumor segmentation application that uses MRI images of a patient's brain to generate the segmentation mask and to recognize the tumor. CNN takes an input image of raw pixels, and transforms it via Convolutional Layers, Rectified Linear Unit (RELU) Layers and Pooling Layers. This feeds into a Fully Connected Layer which assigns class scores or probabilities, thus classifying the input into the class with the highest probability. Marker-based watershed algorithm is used for segmentation of the image.

4.1 ADVANTAGES

CNN can learn to classify the images directly from raw pixel values without the need for manual feature extraction. The proposed system is flexible as it uses CNN which can have multiple convolutional, pooling, and fully connected layers, with varying sizes, depths, and connectivity patterns.

5. SYSTEM ARCHITECTURE

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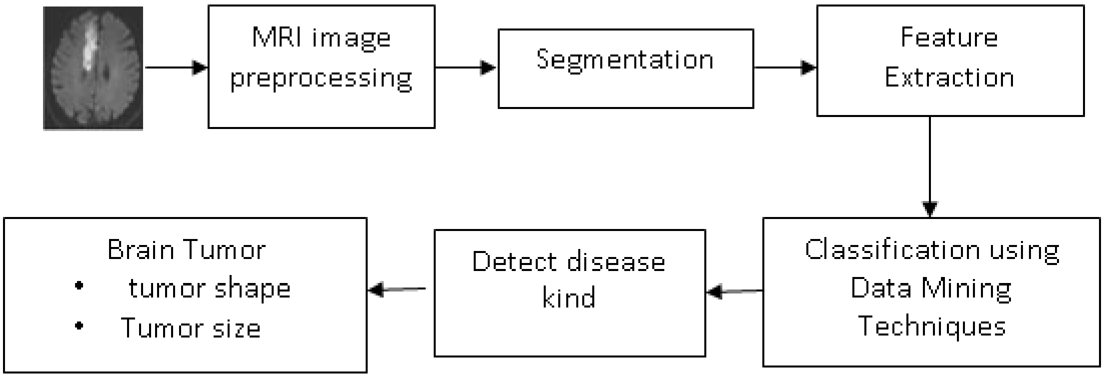

Fig 6.1: System Architecture

6. IMPLEMENTATION

6.1 Preprocessing

It is very difficult to process an image. Before any image is processed, it is very significant to remove unnecessary items it may hold. After removing unnecessary artifacts, the image can be processed successfully. The initial step of image processing is Image Pre-Processing Pre-processing involves processes like conversion to grayscale image, noise removal and image reconstruction. Conversion to grey scale image is the most common pre-processing practice. After the image is converted to grayscale, then remove excess noise using different filtering methods.

6.2 Image segmentation

Segmentation of images is important as large numbers of images are generated during the scan and it is unlikely for clinical experts to manually divide these images in a reasonable time. Image segmentation refers to segregation of given image into multiple non-overlapping regions. Segmentation represents the image into sets of pixels that are more significant and easier for analysis. It is applied to approximately locate the boundaries or objects in an image and the resulting segments collectively cover the complete image. The segmentation algorithms works on one of the two basic characteristics of image intensity; similarity and discontinuity.

6.3 Feature extraction

Feature extraction is an important step in the construction of any pattern classification and aims at the extraction of the relevant information that characterizes each class. In this process relevant features are extracted from objects/ alphabets to form feature vectors. These feature vectors are then used by classifiers to recognize the input unit with target output unit. It becomes easier for the classifier to classify between different classes by looking at these features as it allows fairly easy to distinguish. Feature extraction is the process to retrieve the most important data from the raw data.

6.4 Classification

Classification is used to classify each item in a set of data into one of predefined set of classes or groups. In other words, classification is an important technique used widely to differentiate normal and tumor brain images. The data analysis task classification is where a model or classifier is constructed to predict categorical labels. Classification is a data mining function that assigns items in a collection to target categories or classes. The goal of classification is to accurately predict the target class for each case in the data.

7.OUTPUT RESULTS

Fig: 7.1 : Brain Tumor Dataset

In the above screen we have 2 folders called 'no and yes' where no folder contains normal brain images and 'yes' folder contains Brain tumor images and just go inside any folder to view images like in the below screen.

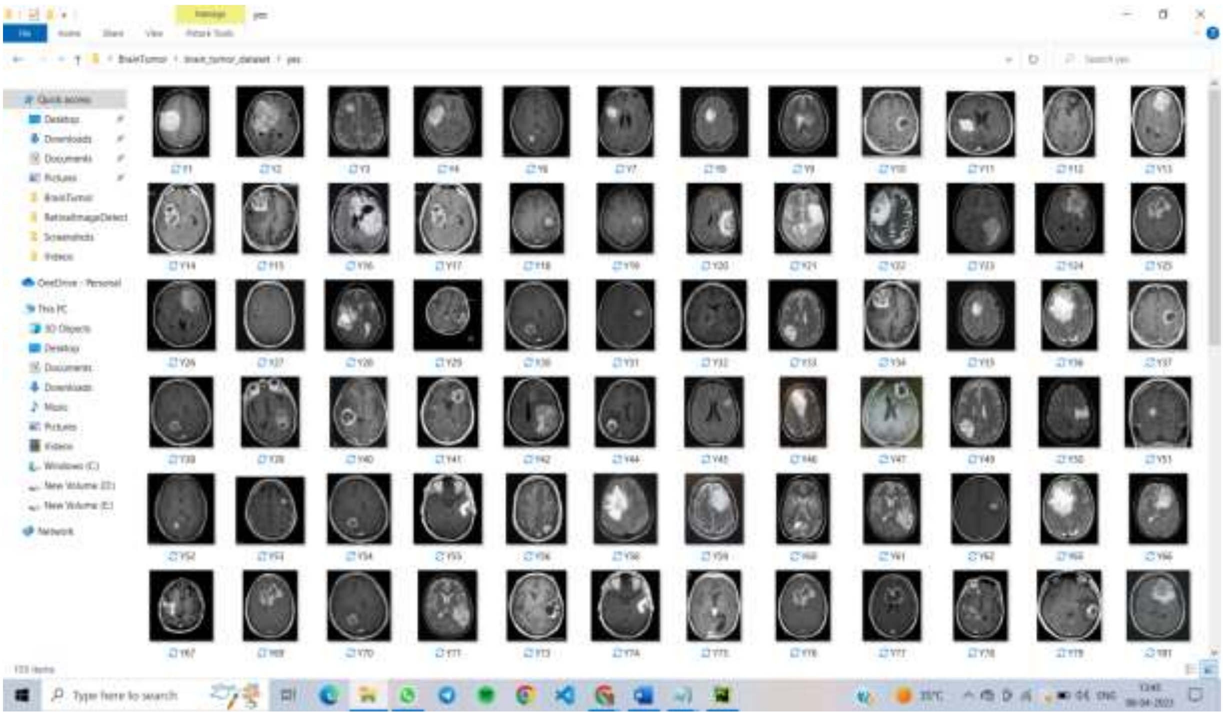

Fig 7.2: Brain Tumor Images

We are using above images to train CNN for tumor detection

To run the project double click on run.batch file to get below screen.

Fig 7.3: GUI for Brain Tumor Segmentation and Classification

In the above screen click on 'Upload Tumor X-Ray Images Dataset' button to upload X-Ray images dataset and get below output.

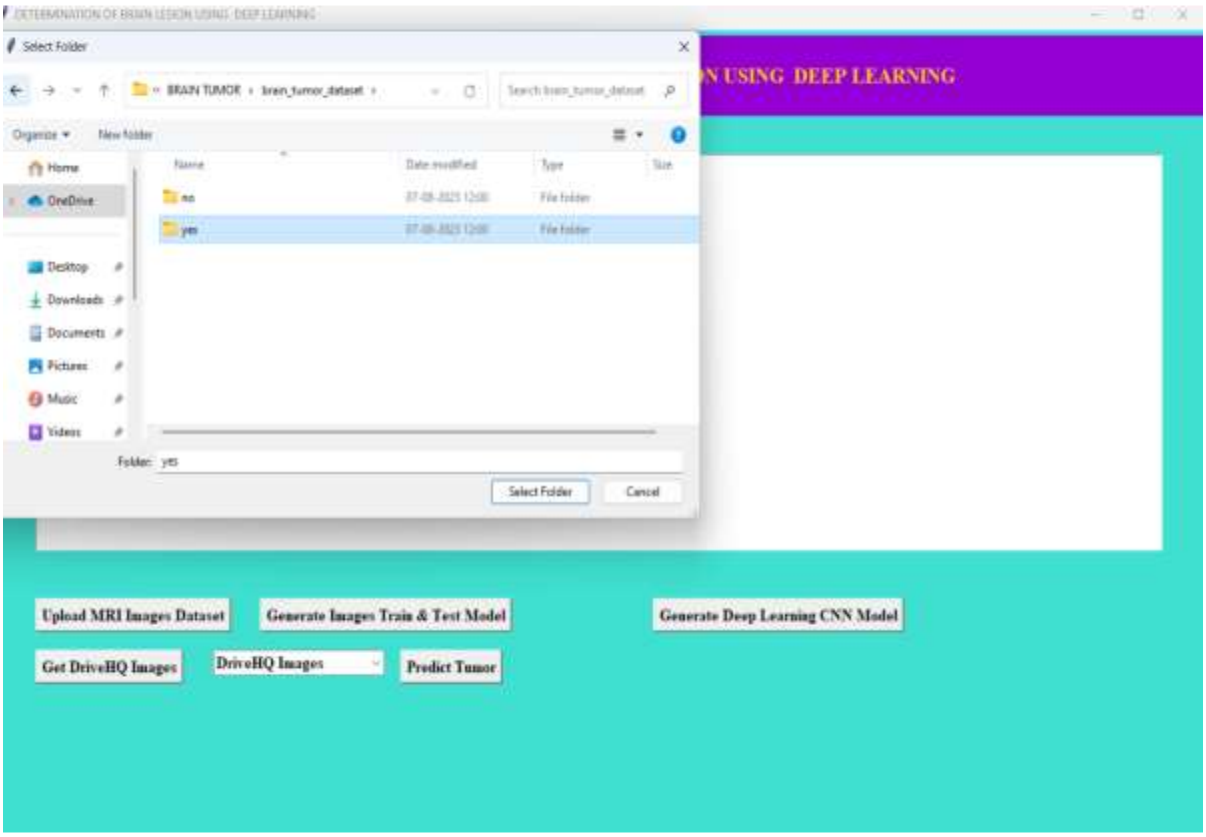

Fig 7.4: Brain Tumor Dataset Loading

In the above screen selecting and uploading brain tumor dataset and then click on 'Select Folder' button to load dataset and then get below output.

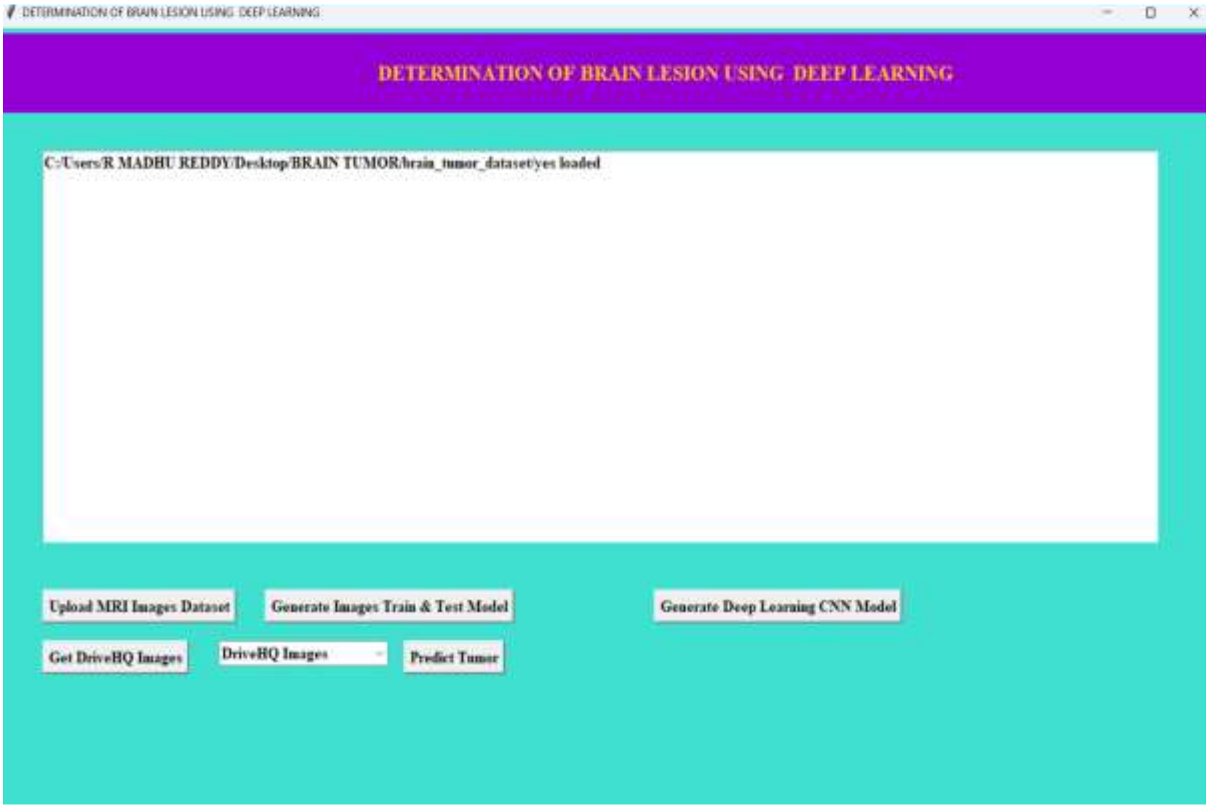

Fig 7.5: Brain Tumor Dataset Loaded

In above screen dataset loaded and now click on 'Dataset Preprocessing & Features Extraction' button to read all images and then process and extract features to train with CNN

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Fig 7.6: Dataset Preprocessing and Feature extraction

In above screen all images are processed and to check images are loaded properly so I am displaying one sample processed image and now close that image to get the below output.

Fig 7.7: Result of Dataset Preprocessing and Feature extraction.

In the above screen we can see dataset contains 253 images with and without tumor class label and now click on 'Trained CNN Brain Tumor Detection Model' button to train CNN with above extracted features and get below output.

Fig 7.8 : Trained CNN Brain Tumor Detection Model

In the above screen CNN training completed and we got it accuracy as 96% and now click on 'Brain Tumor Segmentation & Classification' button to upload the test image and get the below output.

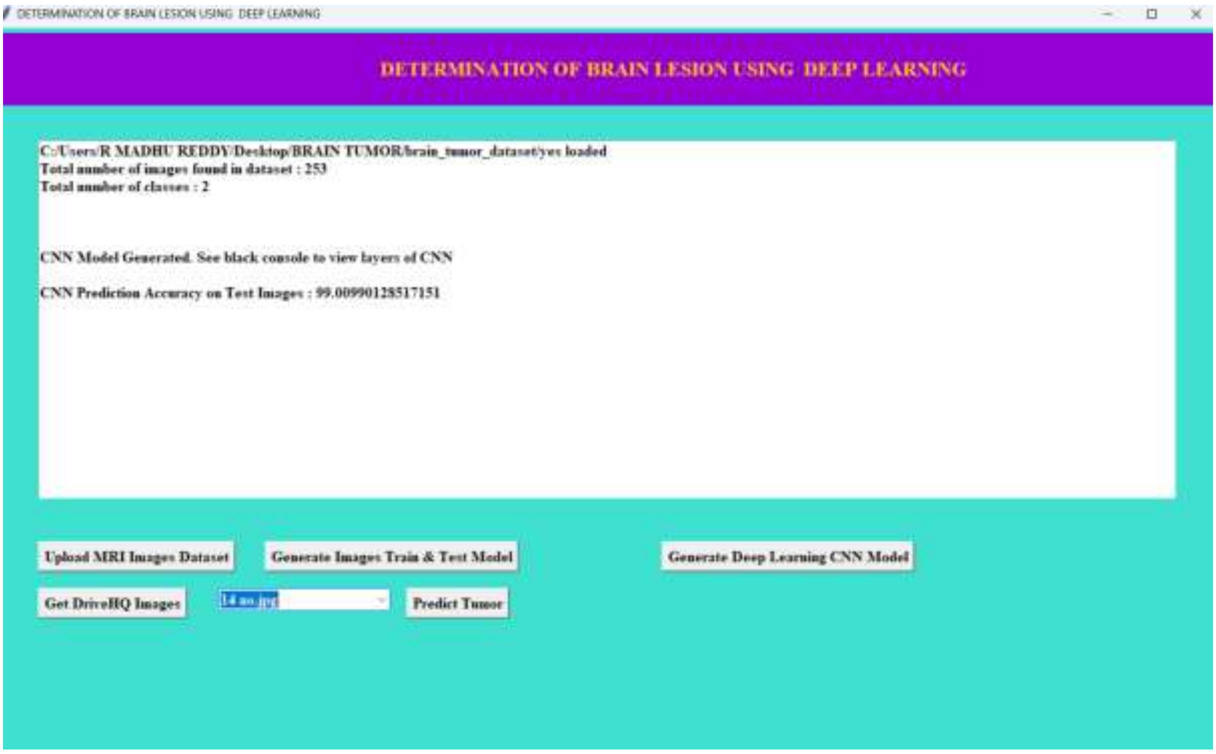

Fig 7.9 : Selecting and Uploading No Tumor Image

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In the above screen select and upload a 1.jpg file and then click on the 'Open' button to get the below output.

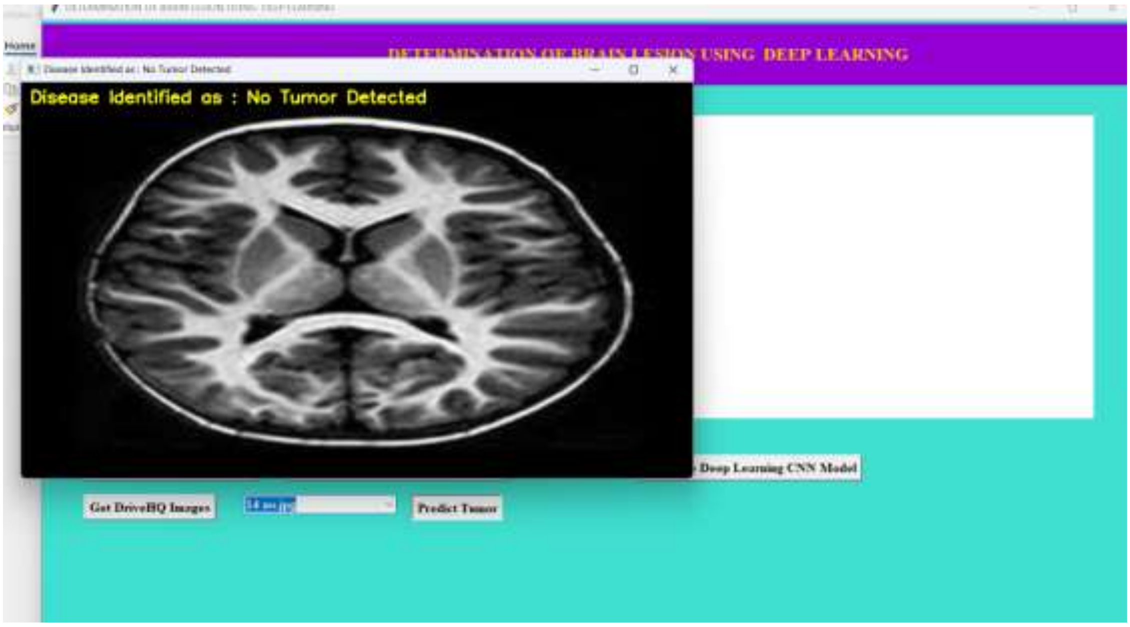

Fig 7.10: Result of No Tumor Image Detected

In the above image 'No Tumor Detected' and now try another image.

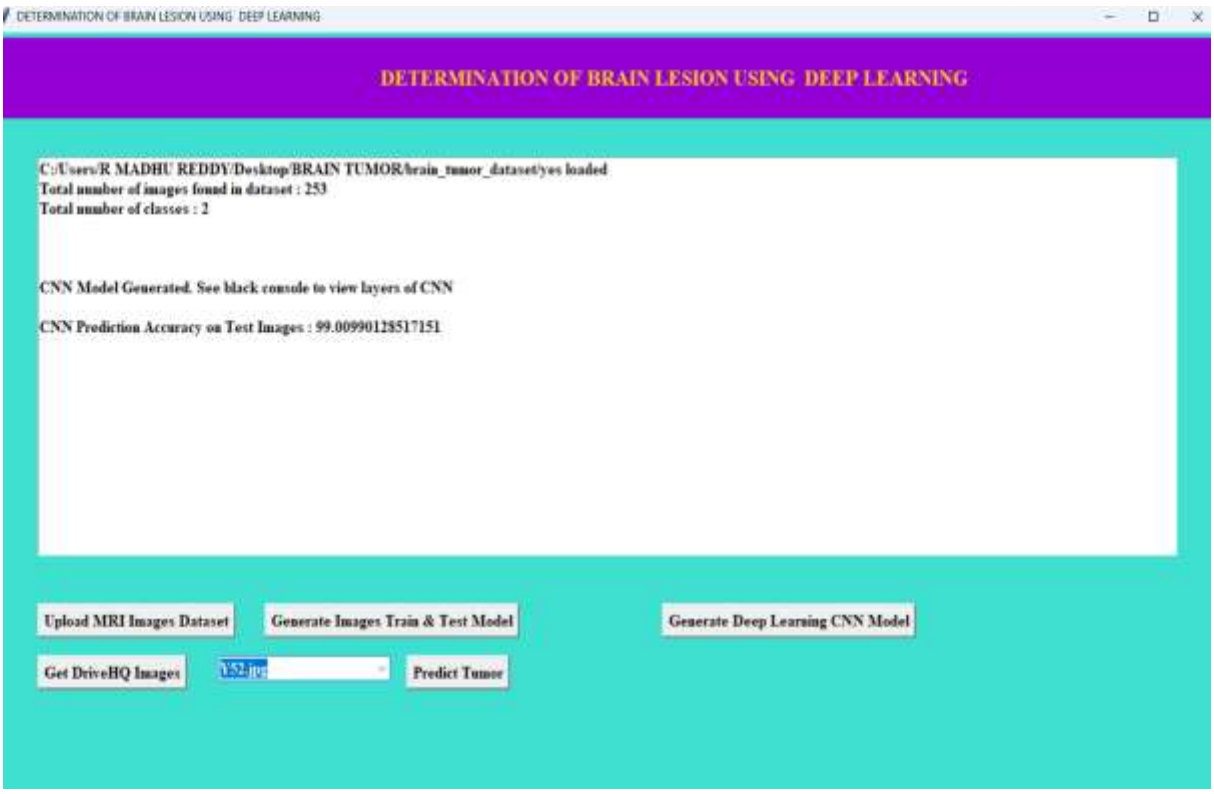

Fig 7.11: Selecting and Uploading Brain Tumor Image

In the above screen select and upload 9.jpg and then click on 'Open' button to get the below output.

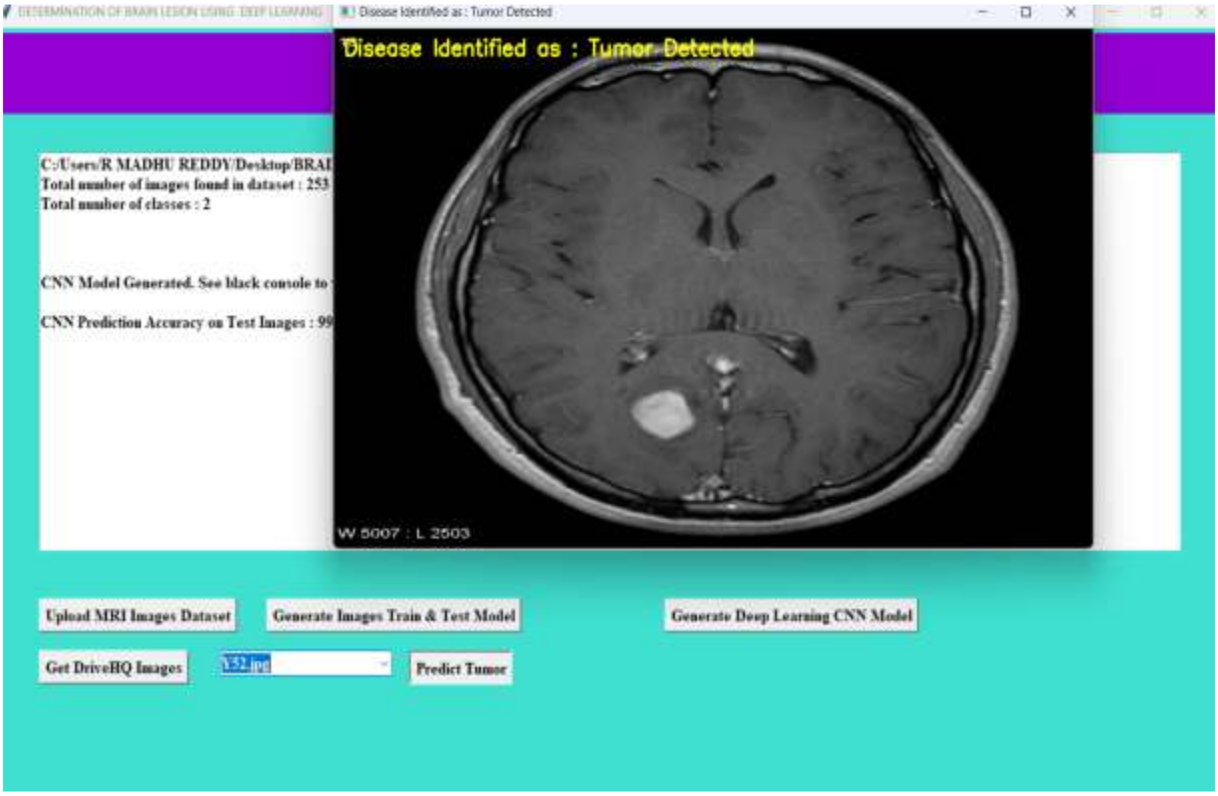

Fig 7.12: Result of Brain Tumor Image Detected

In the above screen first image is the original image which is classified as tumor detected and second image is tumor segmented image and 3rd image is the tumor edge detected image and see another image is below screen.

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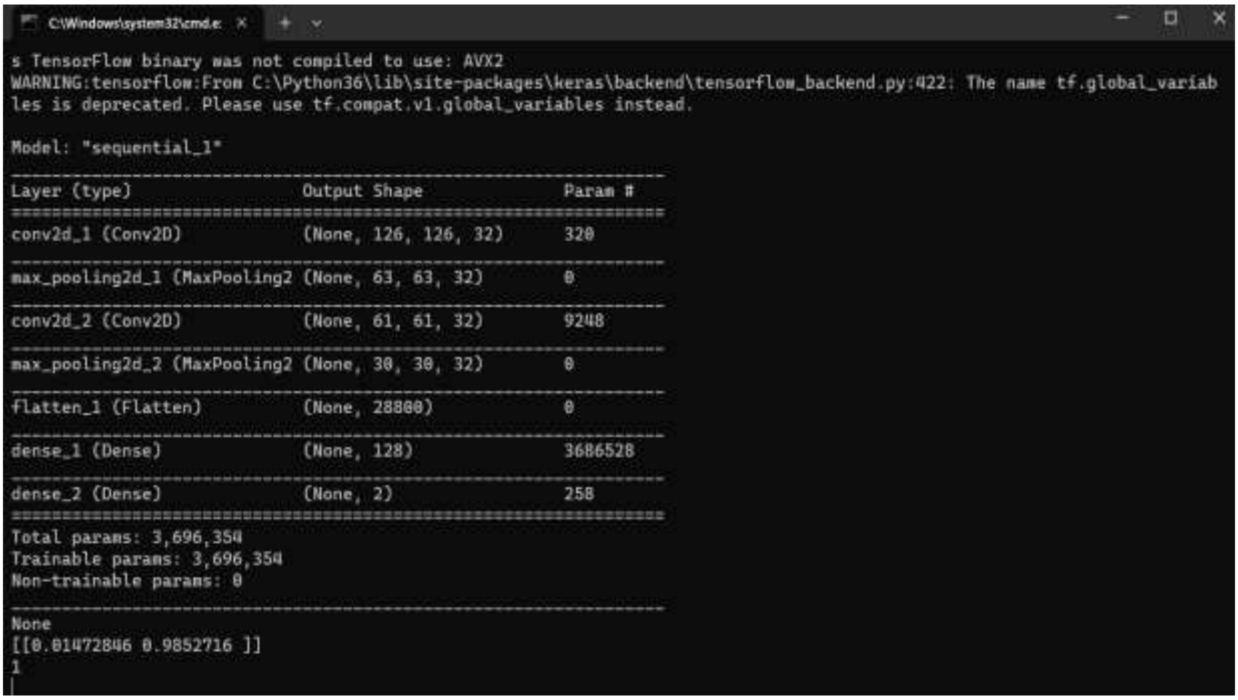

Fig 7.13: Brain Tumor CNN Model Training Accuracy

In above graph x-axis represents training EPOCH and y-axis represents training accuracy and loss values and green line represents accuracy and red line represents LOSS and in above graph we can see with each increasing epoch accuracy got increased and loss got decreased.

8. CONCLUSION

A Brain Tumor MRI image is applied to preprocessing and after that tumor is extracted morphological and watershed segmentation processes.

The medical image segmentation has difficulties in segmenting complex structure with uneven shape, size and properties. For accurate diagnosis of tumor patients, appropriate segmentation method is requiredto be used for MRI images to carry out an improved diagnosis and treatment.

The Brain Tumor detection is a great help for the physician and a boon for a medicalimaging and industries working on the production of MRI image

9. FUTURE WORK

But still, even if there is interest on the "ground floor" and one is able to get prototype systems into the hands of clinicians, there are many higher- ups to convince and regulatory, ethical and legal hurdles to overcome.

10. REFERENCES

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