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REVOLUTIONIZING BRAIN TUMOUR DIAGNOSIS: A DEEP LEARNING BASED APPROACH FOR AUTOMATED CLASSIFICATION AND STAGING

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ABSTRACT
Brain tumors are dangerous and serious disorders affected by uncontrolled cell growth in the brain. Brain tumors are one of the most challenging diseases to cure among the different ailments encountered in medical study. Early classification of brain tumor from Magnetic Resonance Imaging (MRI) plays an important role in the diagnosis of such diseases. MRI is commonly used for such tasks because of its unmatched image quality. Using the 2D Convolutional Neural Network (CNN) technique, this paper proposes Computer-Aided Diagnosis (CAD) a deep learning-based intelligent brain tumor detection framework for brain tumor type (glioma, meningioma, and pituitary) and stages (benign or malignant). CNN is used to classify tumors into pituitary, glioma, and meningioma. Then its classify the three grades of classified disease type, i.e., Grade-two, Grade-three, and Grade-four. **In existing system,** Manual System for brain tumor detection in MRI images typically involves a radiologist or other imaging specialist examining the images and making a visual determination of the presence or absence of tumour. Support Vector Machines (SVM**)** is a popular algorithm used in medical image analysis for classification and segmentation. It is used to classify brain tumors into different categories based on features extracted from MRI images.
The main aim of this paper is to develop an automatic CAD system using deep learning techniques for the early detection and classification of brain tumors from MRI images. A proposed model is to automatically distinguish people with brain tumors, while reducing the time required for classification and improving accuracy. We propose a novel and robust DL framework CNN for detecting brain tumors using MRI datasets.

Keywords:
Magnetic Resonance Imaging (MRI), Computer-Aided Diagnosis (CAD), Convolutional Neural Network (CNN) , Computer Tomography (CT).

I. INTRODUCTION

A brain tumour is a growth of abnormal cells in the brain. The anatomy of the brain is very complex, with different parts responsible for different nervous system functions. There are many types of brain tumours. Each type can differ in growth rate, typical location, size at the time of diagnosis, and who they affect. Brain tumours are the most common type of tumour in children, and the second or third most common type in young adults (breast cancer is highest in females). A Different types of brain tumors. Meningioma (left), glioma (center), and pituitary tumor (right) are among the most common brain tumor types. A brain tumor is one of the worst diseases among other types of tumors due to its lower survival rate and aggressive nature. There are two types of brain tumors, malignant (cancerous) and benign (non-cancerous). According to the National Brain Tumor Association, there are approximately 787,000 patients suffering from brain tumor diseases in the United States. For brain tumors, magnetic resonance imaging (MRI) and Computer Tomography (CT) scans are considered to be the best diagnostic systems for detecting brain tumors. However, compared to CT images, MRI scans based on tumor texture and shape information are more useful. MRI is preferred because it is the only non-invasive medical imaging process that provides high-resolution images of brain tissue.

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The scope of our paper encompasses the critical domain of early detection and classification of brain tumors using advanced medical imaging technologies, specifically magnetic resonance imaging (MRI). Traditional identification methods, relying on manual interpretation, often lead to time-consuming processes and errors that may jeopardize patient outcomes. This paper introduces a Computer-Aided Diagnosis (CAD) framework powered by artificial intelligence, specifically 2D Convolutional Neural Networks (CNN), to revolutionize the brain tumor detection process. The focus is on differentiating between glioma, meningioma, and pituitary tumors, while also categorizing them into benign or malignant stages. The paper's scope extends to evaluating the performance of the CNN models through key metrics such as accuracy, sensitivity, precision, specificity, and F1-score. Our proposed model, based on the Exception architecture with the ADAM optimizer, demonstrates superior performance, achieving remarkable values on a large MRI dataset. In conclusion, this paper not only holds promise in significantly improving the speed and accuracy of brain tumor classification but also contributes to the broader landscape of automated medical diagnostics. The scope extends to providing healthcare professionals with a powerful tool to enhance their decision-making processes and improve patient outcomes in the challenging realm of brain tumor detection and diagnosis
The following sections are organized as follows. Section II described with related work. Section III deals with the implementation of revolutionizing brain tumor diagnosis using deep learning Section IV discussed with conclusion and future work.

II. RELATED WORK

Segmentation of brain tumor from magnetic resonance imaging (MRI) data sets is of great importance for improved diagnosis, growth rate prediction, and treatment planning. However, automating this process is challenging due to the presence of severe partial volume effect and considerable variability in tumor structures, as well as imaging conditions, especially for the gliomas. In this paper, we introduce a new methodology that combines random forests and active contour model for the automated segmentation of the gliomas from multimodal volumetric MR images.[1]
Recent advances in machine learning and prevalence of digital medical images have opened up an opportunity to address the challenging brain tumour segmentation (BTS) task by using deep convolutional neural networks. However, different from the RGB image data that are very widespread, the medical image data used in brain tumour segmentation are relatively scarce in terms of the data scale but contain the richer information in terms of the modality property.[2]
The past few years have witnessed a significant increase in medical cases related to brain tumours, making it the 10th most common form of tumour affecting children and adults alike. However, it is also one of the most curable forms of tumours if detected well on time. Consequently scientists and researchers have been working towards developing sophisticated techniques and methods for identifying the form and stage of tumour. Magnetic Resonance Imaging (MRI) and Computer Tomography (CT) are two methods widely used for resectioning and examining the abnormalities in terms of shape, size or location of brain tissues which in turn help in detecting the tumours.[3]
In view of insights of the Central Brain Tumour Registry of the United States (CBTRUS), brain tumour is one of the main sources of disease related deaths in the World. It is the subsequent reason for tumour related deaths in adults under the age 20-39. Magnetic Resonance Imaging (MRI) is assuming a significant job in the examination of neuroscience for contemplating brain images. The investigation of brain MRI Images is useful in brain tumour analysis process. Features will be extricated and selected from the segmented pictures and afterward grouped by utilizing the classification procedures to analyze whether the patient is ordinary (having no tumour) or irregular (having tumour). One of the most dangerous cancers is brain tumour or cancer which affects the human body's main nervous system. Infection that can affect is very sensitive to the brain. Two types of brain tumours are present. The tumour may be categorized as benign and malignant. The benign tumour represents a change in the shape and structure of the cells, but cannot contaminate or spread to other cells in the brain.[4]

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III. IMPLEMENTATION OF REVOLUTIONIZING BRAIN TUMOR DIAGNOSIS USING DEEP LEARNING

The system architecture of proposed system is shown in Fig.

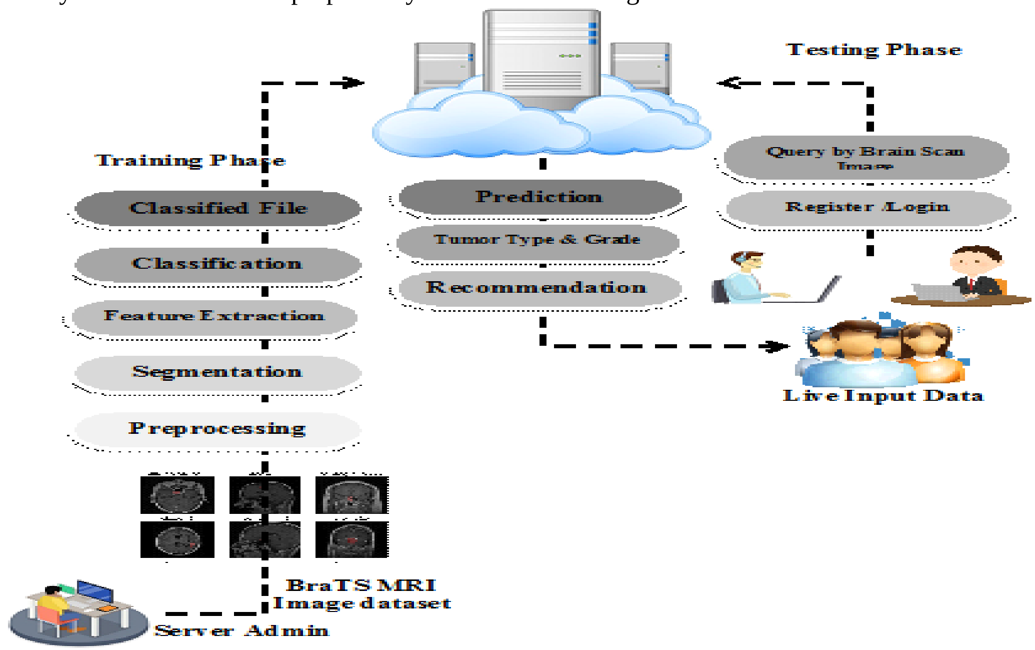

Fig. System Architecture

3.1. MODULE DESCRIPTIONS:-

The front-end development of the system using web technologies such as HTML, CSS, and JavaScript. Back-end development using Python, TensorFlow and Keras. The module would involve developing a CNN model using deep learning techniques to accurately detect the presence of brain tumor in medical images. The module would involve deploying the system to a web server and ensuring that it is secure, scalable, and accessible to healthcare professionals. The following Modules and their working processes are given below

3.1.1. Brain Tumour Diagnosing System

The system is designed to be accessible via the web, allowing healthcare professionals to upload medical images and receive automated analysis and diagnosis of brain tumor.

3.1.1.1. User Login Process

Users, including patients and doctors, can access the system through the User Login Process, which authenticates and grants access to the relevant system features.

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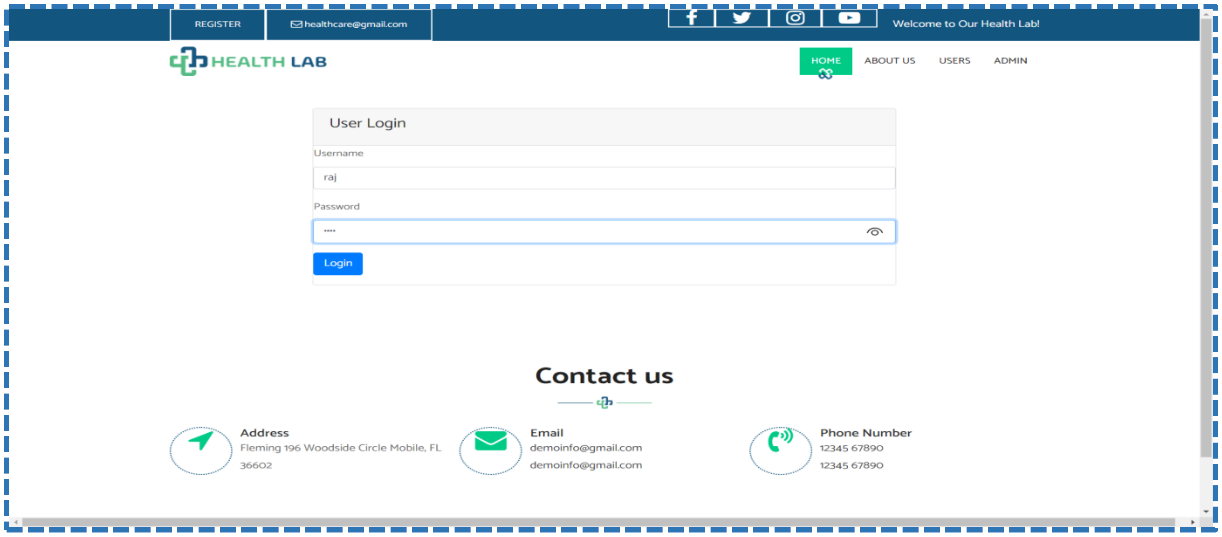
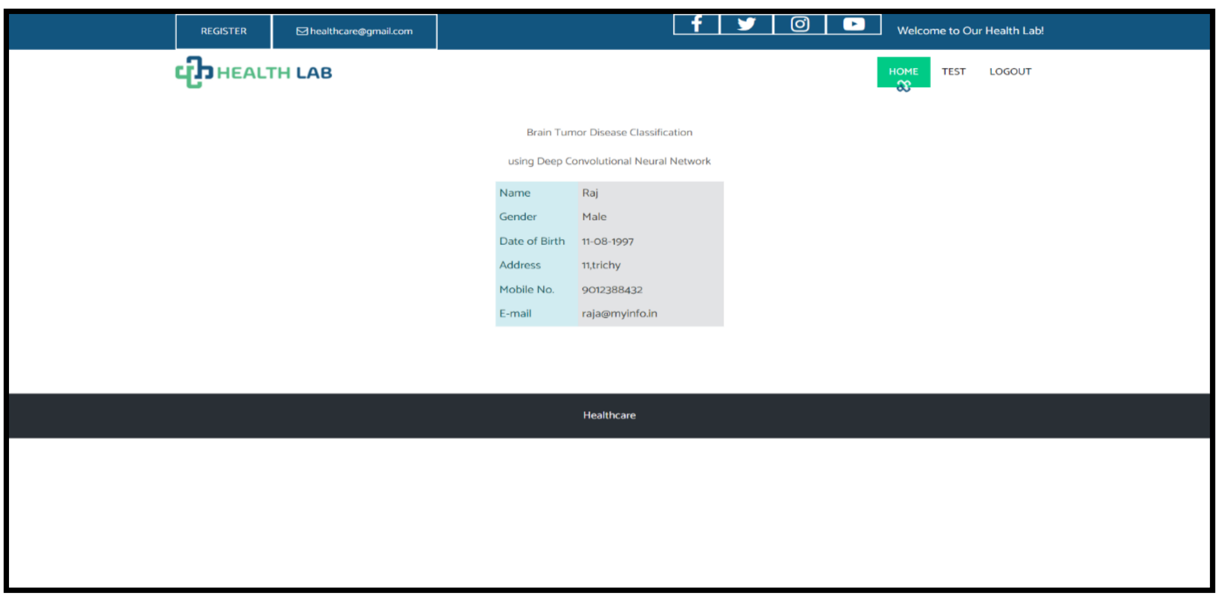


3.1.1.2 Input User Details

Upon logging in, users can input personal and medical details through the Input User Details step, which the system uses to tailor the user experience and manage patient records securely.



3.1.2. Brain Tumor Training Phase:-

3.1.2.1. Import Dataset:- Web admin annotate the collected MRI Dataset through this sub module.

3.1.2.2. Preprocessing

Brain Tumor(BT) MRI Image pre-processing are the steps taken to format images before they are used by model training and inference. The steps to be taken are

- Read Image

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- RGB to Grey Scale conversion
- Resize image
- Remove noise (Denoise)
- Binarization

3.1.2.3. Region Proposal Network Segmentation

RPN is used to generate Region of Interest and Align faithfully preserves the exact Brain Detection.These Region of Interests has the highest possibility of containing the object that the algorithm has to detect.

3.1.2.4. Feature Extraction-GLCM

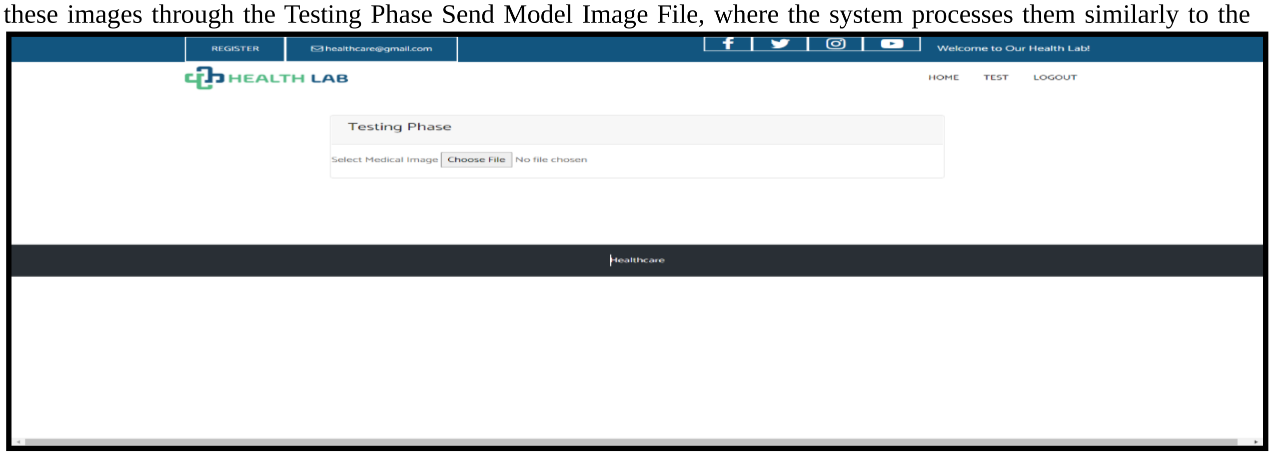
Grey Level Co-occurrence Matrix is used to extract the features for brain tumour classification. GLCM is a spatial domain technique which tabulates the difference in combination of pixel brightness in the image. The features involved in feature estimation are divided into few steps: First four co-occurrence matrices are calculated from the grey scale image. It considers the distance between the pixels to be 1 and the four directions as 0o, 45o, 90o and 135o. So, the co-occurrence matrix is computed at 00. There are four features in every computed matrix namely correlation, contrast, energy and homogeneity. Hence the feature vector will be of size.

1.1.2.5. CNN Classification

CNN is used to classify the Cancer 0-NonCancerous 1- Cancerous and its type and stages. It is a deep learning algorithm which takes an input image and assigns importance to the entities or tumor in an image which helps it to learn and detect. Even the Convolutional Neural Networks are developed based on neurons in a human brain keeping in mind, the visual cortex presents in humans.

3.1.3. Brain Tumor Testing Phase

3.1.3.1. Image Upload:-During the Testing Phase, the system receives new MRI images for analysis. Users send these images through the Testing Phase Send Model Image File, where the system processes them similarly to the training data.



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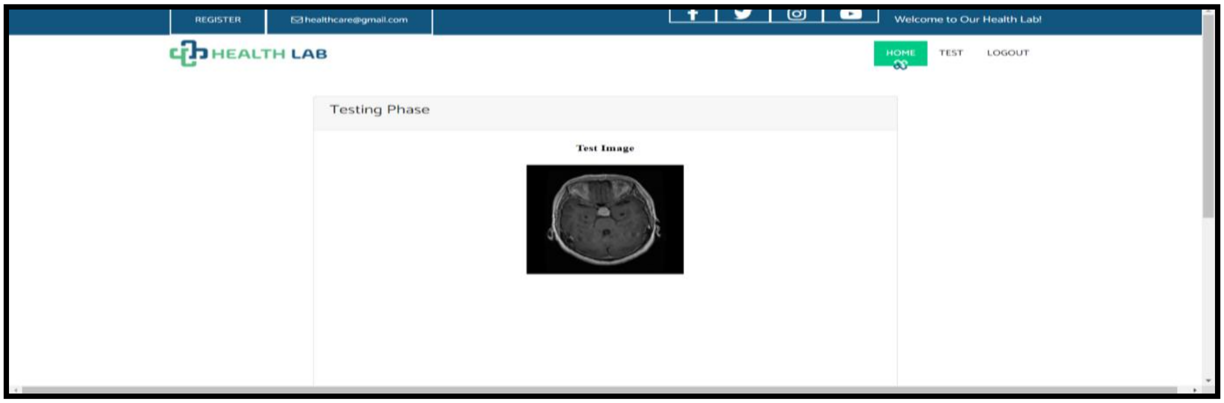
3.1.3.2. Testing Input Image

The images are of suitable quality and format in the Testing Input Image stage.



3.1.3.3. Testing Binarization Process

The system then performs Testing Binarization Process, converting the images into binary format, and conducts Feature Extraction Process to identify critical features from the new images.

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3.1.4. Brain Tumour Prediction

The Brain Tumor Prediction system, designed for simplicity and effectiveness, empowers users to submit MRI images for swift diagnosis.

3.1.4.1. Input MRI Image

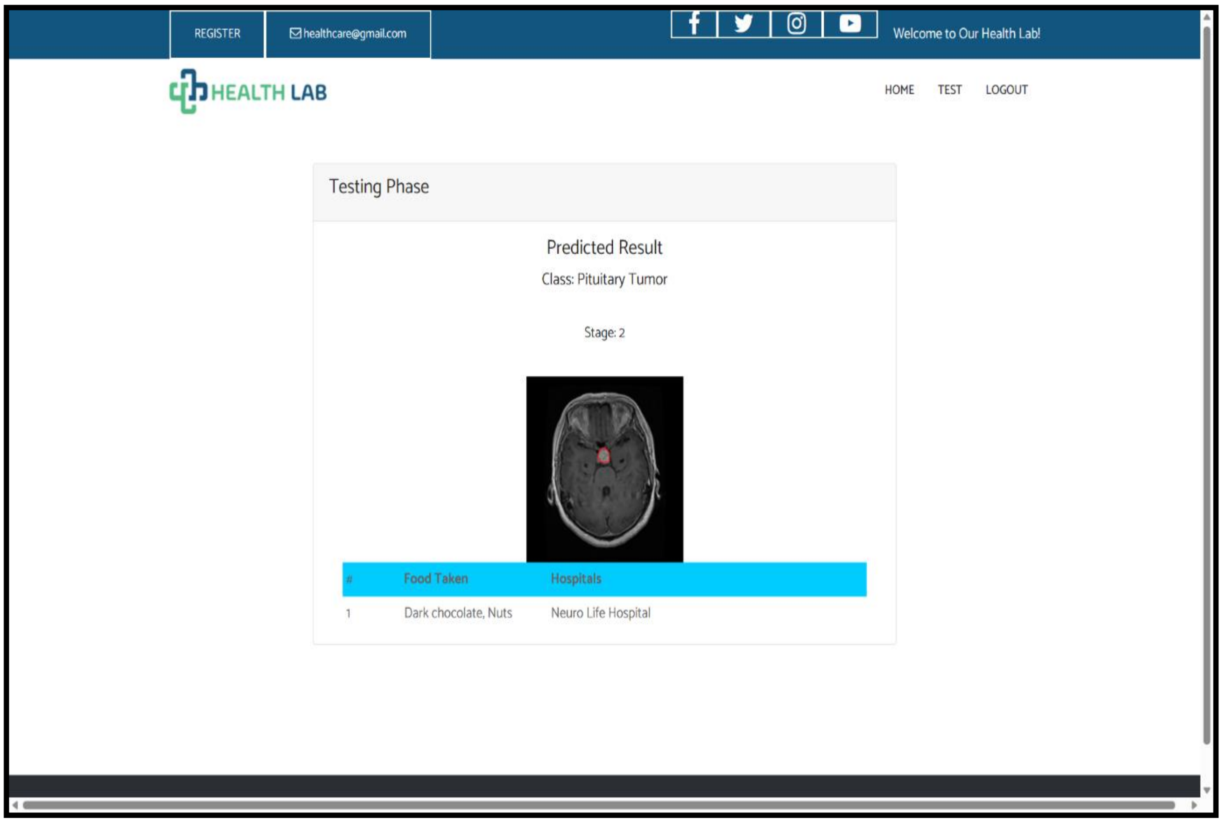
Users, including patients, can submit Brain Tumour MRI images to the system for analysis. This streamlined input process ensures accessibility for both healthcare professionals and individuals seeking diagnosis.

3.1.4.2. Tumor Prediction:

The system delivers predictions, starting with the identification of tumour presence. It further classifies the tumour into specific types such as Meningioma, Glioma, or Pituitary. Additionally, the severity prediction distinguishes between benign stages (1 and 2) and malignant stages (3, 4, and 5).

3.1.4.3. Predicted Result Process

The Predicted Result Process uses these features to predict the presence and type of any tumors.



3.1.4.4. Predicted Result Show Tumor Stage

Finally, if a tumor is detected, the Predicted Result Show Tumor Stage process does indicate the tumor's stage, providing vital information for medical professionals to assess and plan appropriate treatment strategies.

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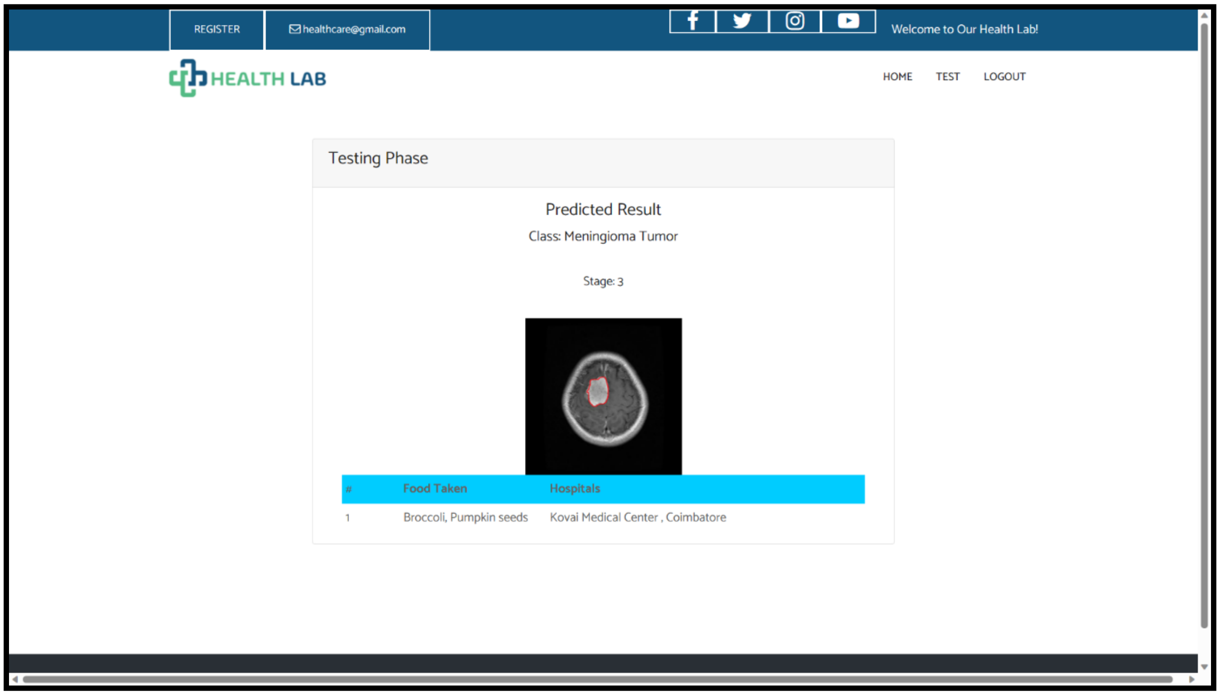

3.1.4.5. Recommendation

- Personalized recommendations: The module would involve providing personalized recommendations to healthcare professionals based on the results of the analysis and the identified patterns.
- The recommendations may include the best course of treatment, the recommended frequency of follow-up exams, and the risk of recurrence.
- Integration with the web interface: The module would involve integrating the personalized recommendations with the web-based interface of the system, so that healthcare professionals can easily access and review the recommendations.

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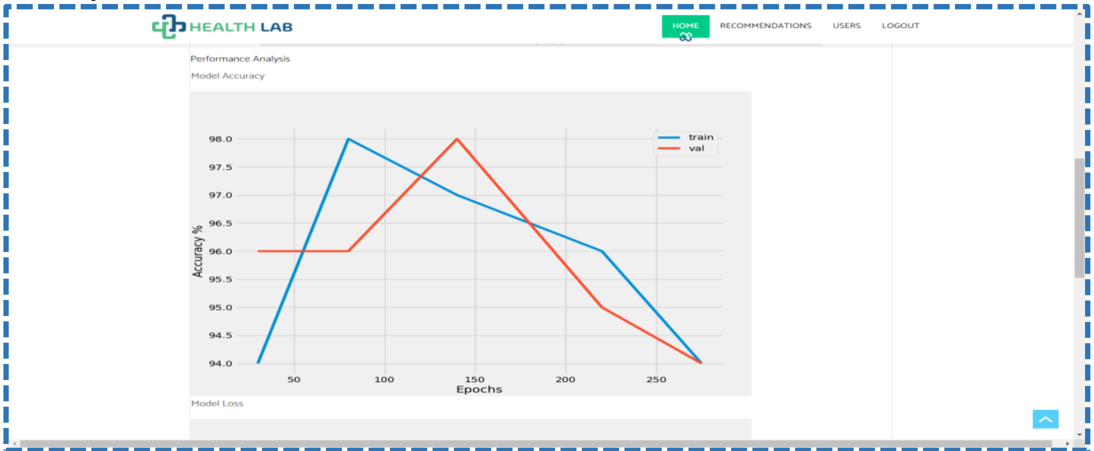
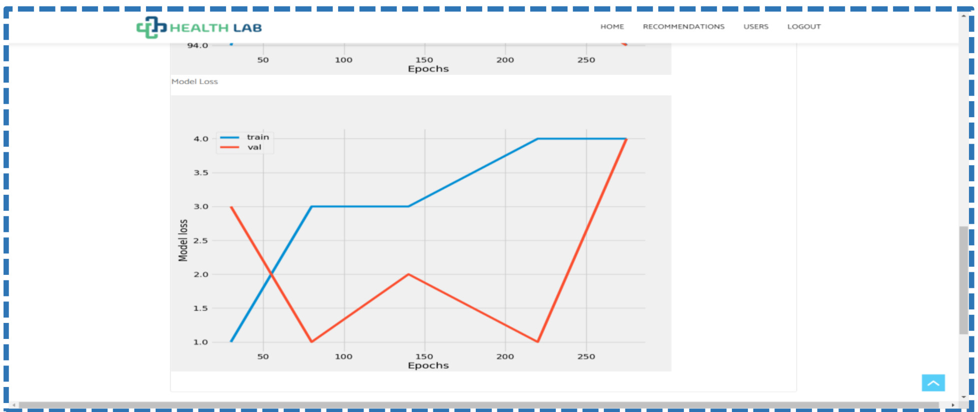
3.2. Performance Analysis

The system's effectiveness is measured in the Performance Analysis phase, where metrics such as accuracy and sensitivity are evaluated.



3.3. Model Loss Process

The Model Loss Process tracks and minimizes errors during training, improving the model's learning and accuracy.



IV. CONCLUSION AND FUTURE WORK

Furthermore, extending the proposed approach to other types of medical images, such as x-ray, computed tomography (CT), and ultrasound, presents an exciting avenue for future research. Each imaging modality offers unique insights into various medical conditions and pathologies, complementing the information provided by MRI scans. By adapting the deep learning model to analyze different types of medical images, researchers can create a versatile and comprehensive diagnostic system capable of detecting a wide range of diseases and abnormalities beyond brain tumors. Integrating x-ray, CT, and ultrasound images into the proposed CAD system requires additional preprocessing techniques, model adjustments, and validation steps tailored to each imaging modality's characteristics. Moreover, comprehensive datasets containing labeled medical images across different modalities will be essential for training and evaluating the performance of the extended model effectively.

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