Brain Tumor Detection and Classification Using Optimization and Transfer Learning Techniques

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***Abstract*—All of the body's functions are coordinated by the brain. Tumors, which are abnormal growths of tissue, are well-known. Brain tumors are characterized by uncontrolled cell growth and proliferation, resulting in abnormal lumps of tissue. The tumors are classified into many types on the basis of their characteristics, origin, growth rate, and current stage of development. Traditional methods of tumor detection are often laborious, inaccurate, and unable to scale effectively for large datasets. Therefore, the autonomous detection of brain cancers using MRI is a critical aspect of computer- assisted diagnostics. This project focus on uses of machine learning (ML) algorithms are KNN, SVM, and CNN, along with a publicly available dataset, image feature extraction, data preprocessing techniques, and principal component analysis (PCA) to enhance accuracy and reduce diagnostic time. The goal is to propose algorithms that require minimal training time. Classification is essential in diagnosing and treating brain tumors; however, the variety of MR images complicates this process. In this study, we evaluate the effectiveness of popular classification algorithms on T1- weighted, T2-weighted, and FLAIR MR images. The project's focus is on a binary classification problem aimed at identifying anomalies in brain MR images. This technique involves three tiers: feature selection, feature extraction, and fusion, which are recommended for the brain image recognition models in the study. In this project, compare the model accuracy of the three proposed methodologies to detect the most effective approach. It applies on a real-world public dataset and have the potential to advance the development of more accurate methods for disease identification and classification.**

***Index Terms*—Deep learning, CNN, Brain MRI Image classification, image recognition, Matlab Software.**

I. INTRODUCTION

Imaging technology enables physicians to visualize the internal structures of the human body, thereby facilitating diagnosis. Computed Tomography (CT) scanners, ultrasound, and MR imaging have replaced X-ray imaging, as they provide greater assistance to radiologists in diagnosing specific disorders within the human body. A body comprises a multitude of cells, each has a distinct purpose. Cells proliferate in the human body and subsequently divide to generate a new cell. These new cells are important for the correct actions of the human body. As normal cells in the human body age or sustain injury, they undergo apoptosis, and new cells subsequently replace these senescent or impaired cells. Occasionally, when new cells proliferate and injured cells fail to undergo apoptosis, the process becomes aberrant. In this scenario, if these superfluous cells proliferate uncontrollably, they lose regulation, resulting in the formation of more cells that frequently culminate in a mass of tissue known as a tumor. The Principal component of the human nervous system is the human brain. It is situated within the human cranium and is encased by the skull. The brain's job is to keep all the parts of the body in balance. It is a sort of organ that enables humans to adapt to and withstand various environmental conditions. The human brain facilitates activity and the sharing of thoughts and emotions. The brain is a fundamental component of the human Central Nervous System, with 50-100 billion neurons that constitute an extensive network of nerves. The tumor may be located in brain areas that affect the intricate functioning of the human body. The site's position and robust propagation capacity render its management exceedingly intricate

and hazardous. Currently, brain tumors are a significant cause of rising mortality rates in both children and adults. The inquiry in numerous industrialized countries has determined that during the past few decades, the annual incidence of individuals afflicted with malignancies has risen by 300 (Kshitij Bhagwat 2013). The 2011 Cancer Research UK study indicates that approximately 9,400 individuals were diagnosed with a brain tumor, and about 5,200 individuals succumbed to the disease in 2012 in the UK (Wen 2010). The likelihood of survival for an individual with a brain tumor is contingent upon the tumor's nature, size, location, individual's age and medical history.Finding a tumors are a big problem in the medical field, necessitating effective and efficient diagnostic tools, particularly during the initial stages of tumorigenesis. A brain tumor is most formidable disorders in medical research. An effective and efficient analysis is a primary concern for the radiologist during the early stages of tumor progression.

II. RESEARCH MOTIVATION

The primary goal of brain tumor detection is to detect and classify tumor types. It can be useful when we need to confirm the tumor. It can detect tumors from images and provide a positive or negative result. This project utilizes computer-based processes to discover tumor blocks and classify tumor types using Convolutional Neural Network Algorithm for MRI scans of various patients.

III. OBJECTIVES

The objective is as follows:

1. Design a feature selection model to select the significant features.
2. Explore the scheme of the homogeneous or heterogeneous approaches.
3. Creating an effective representation method for feature interaction or fusion to boost performance
4. To assess the efficiency of the suggested approach, classify brain images as normal or abnormal.

IV. LITERATURE SERVEY

Khairandish et al. (2021) employed MRI images to identify different tumor kinds using a deep learning algorithm. A CNN model was used for feature extraction through the integration of various approaches. In this model enhanced classification accuracy. Various classifiers were amalgamated to execute the classification task, and detection was conducted using threshold- based segmentation Dataset Collection and Preprocessing.

In Elazab et al. (2020) recommended a novel 3D-oriented GAN technique for the prediction of brain tumor growth. The segmented features map was used for generate the better images for prediction. The 3D U-Net architecture and skip connections were combined to generate the better images. The suggested model was tested on the gathered database. Thus, this model attained higher prediction accuracy than the other traditional works.Evaluation Metrics and Visualization

In Viji et al. (2020) addressed a novel classification and segmentation method to classify the MRI brain images. Initially, the pre-processing of images was done with a Gaussian filter, and next, the images were normalized. These were segmented with the texture and intensity oriented region growing (TIORGW) method. The author used deep learning model to categorized the 31 “normal images and abnormal images” in this work. The suggested technique was implemented with the matrix laboratory (MATLAB) and it achieved high performance. Real-Time Model Deployment.

V. PROBLEM STATEMENT

Design and develop a lightweight models for brain tumour detection and classification of MRI images using optimization and transfer learning techniques. The main consideration of this project is to improve diagnostic time and reduce medical errors by developing computational tools that physicians may employ automatically. Our goal is to achieve the ability to recognize brain irregularities, allowing doctors to focus on the most challenging diagnostic. The purpose of this project is to create an algorithms that can find automatically assist doctors with diagnosis to expedite patient care and reduce the likelihood of medical errors. This study employs

automated analysis of brain images to assess whether a patient's brain is normal or abnormal

VI. PROPOSED MODEL

Deep Learning (DL) model for brain tumor identification, abroad. The deep learning model's performance is heavily influenced by data quality. To ensure the quality of the data, the following preprocessing steps were performed: Transform to grayscale, Adjust image dimensions (e.g., 256x256), Histogram equalization for the enhancement of contrast Noise elimination with median or Gaussian filtering. The deep learning model's performance is heavily influenced by data quality. To ensure the quality of the data, the following preprocessing steps were performed: Transform to grayscale, Adjust image dimensions (e.g., 256x256), Histogram equalization for the enhancement of contrast Noise elimination with median or Gaussian filtering.

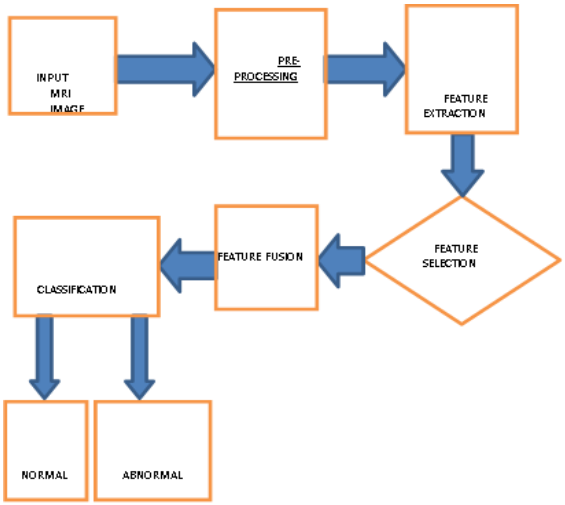


Fig 1: System Workflow

Image Preprocessing

Transform to grayscale, Adjust image dimensions (e.g., 256x256), Histogram equalization for the enhancement of contrast Noise elimination with median or Gaussian filtering.

Feature Extraction

Feature extraction in image processing involves detecting and extracting relevant visual qualities, attributes, or patterns within a picture. Feature extraction seeks to convert input image data into a more concise and informative representation, rather than processing each individual information, which can be computationally demanding and may include redundant information. This representation, consisting of "features," captures the critical details required for further analysis or actions the top in terms of inference speed and resource usage.

Feature Fusion

In machine learning for brain tumor detection, feature fusion means combining different pieces of information from brain MRI scans to make a completer and more accurate picture of the tumor. This method addresses the constraints of singular feature extraction by integrating deep learning features, shallow features, and handcrafted features, thereby utilizing both high-level patterns and low-level details, which enhances classification and detection efficacy. Techniques like as image fusion (CLAHE/DWT), attention mechanisms, and algorithms like PCA or CCA are employed to integrate and diminish the dimensionality of fused features prior to classification. Integrating attributes from various CNN models, such as EfficientNet and MobileNet, or amalgamating handmade and deep features yields a more comprehensive and robust representation of visual data by utilizing varied capabilities.

Classification

Image classification is the process of classifying or guessing the class of an object in an image based on the some information. The aim of this procedure is to accurately identify the features in an image. There are two main ways to classify things: supervised and unsupervised.

Evaluation Metrics

- Accuracy = (TP + TN) / (TP + TN + FP + FN)
- Precision, Recall, F1-score
- Confusion Matrix for the Results of the Classification.

In a binary classification task, data samples are frequently projected as either positive or negative. A positive label denotes the presence of an abnormality, disease, or other deviation, while a negative instance conforms to the baseline in this regard. The following four classifications are possible for each predicted binary label: a true positive (TP) is defined as an instance in which a positive outcome is correctly predicted, a true negative (TN) is defined as an instance in which a negative outcome is correctly predicted, a false positive (FP) is defined as an

instance in which a negative instance is inaccurately predicted as positive, and a false negative (FN) is defined as an instance in which a positive instance is inaccurately predicted as negative. A confusion matrix, which is a 2x2 matrix that contains the counts of(TP) true positives, (TN) true negatives, (FP)false positives, and (FN)false negatives.

Flow chart

A flowchart is a diagram that shows a workflow or process by depicting the phases in sequential order. It is commonly used to present algorithms, workflows, or processes, and it uses multiple symbols to represent different types of activities or conclusions.A flowchart is a graphical depiction of the decision-making and action-taking processes involved in completing a task. A diagrammatic shape is used to note each step in the process. Directional arrows and connecting lines connect the steps. Anyone can look at the flowchart and understand how everything works. An effective tool for businesses is a flowchart. With good planning and execution, it conveys the stages of a process clearly and concisely.

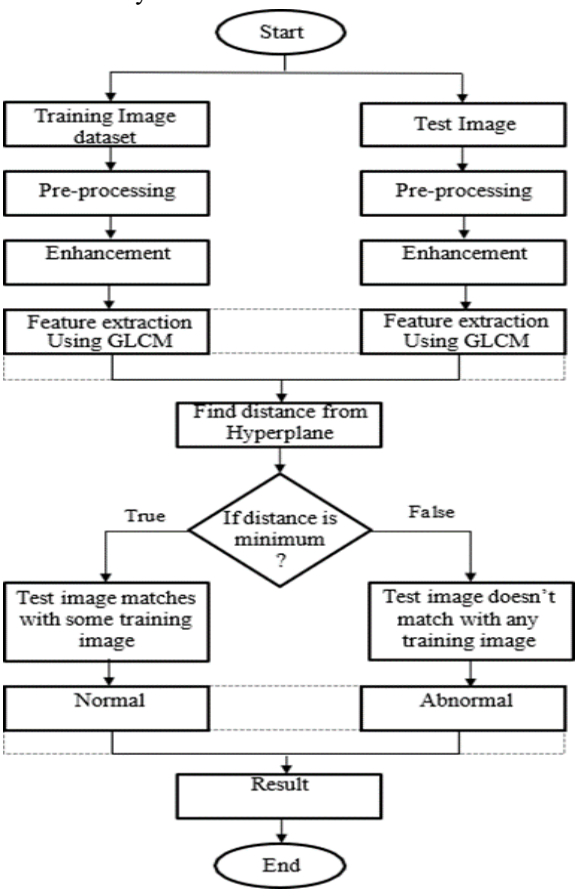


Fig 2: Flow chart of the proposed system

METHODOLOGY

T The input of video sequence detection refers to the continuous or discrete frames of a video that are fed into a computational model for analysis. These video sequences are processed to detect and classify objects, events, or abnormalities using deep learning of machine learning, or traditional computer vision techniques are illustrated in Figure 3

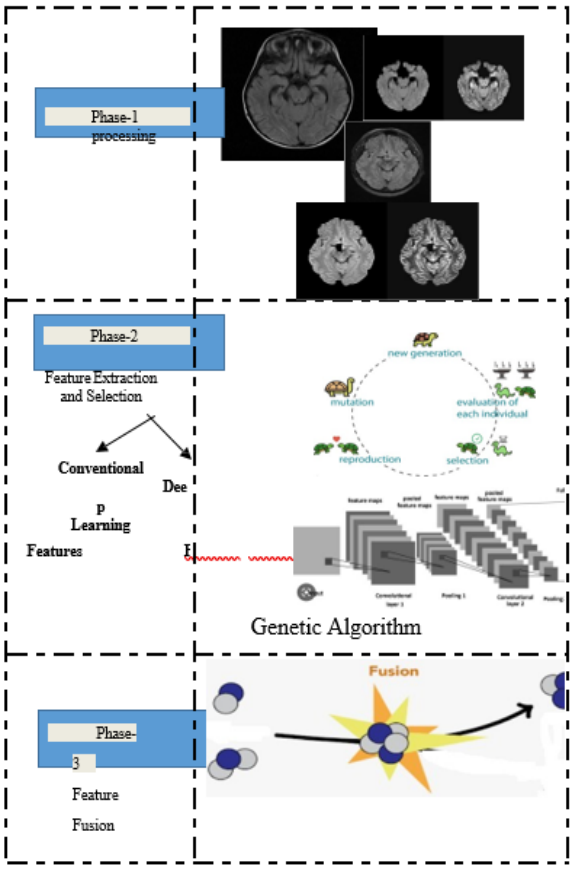
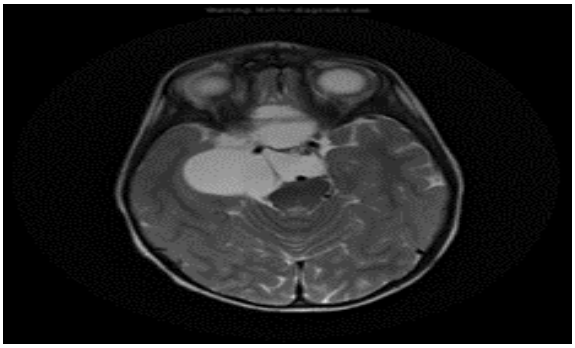
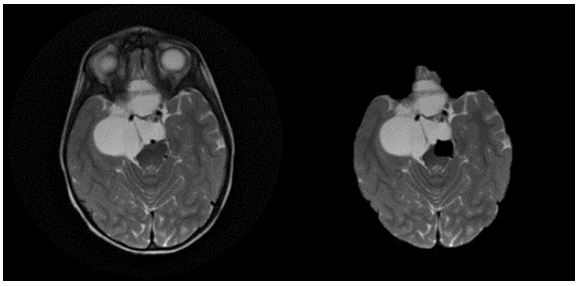


Fig 3: Proposed Methodology

VII. RESULTS



Input Image



Skull Removal

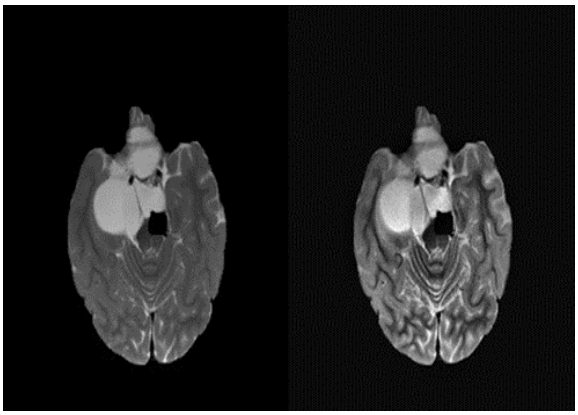


Image enhancement

Classification is a ML technique that predicts the category (label) of data points on basis of their characteristics. Binary classification is a specific type of supervised learning where the model categorizes input into two distinct classes (e.g., positive/negative, yes/no, true/false). SVM algorithm primarily used for task of classification and also used to regression. SVM works by determining the appropriate decision boundary (or hyperplane) for separating data points from distinct classes. The margin is the distance between this hyperplane and the closest data points from each class, known as support vectors.

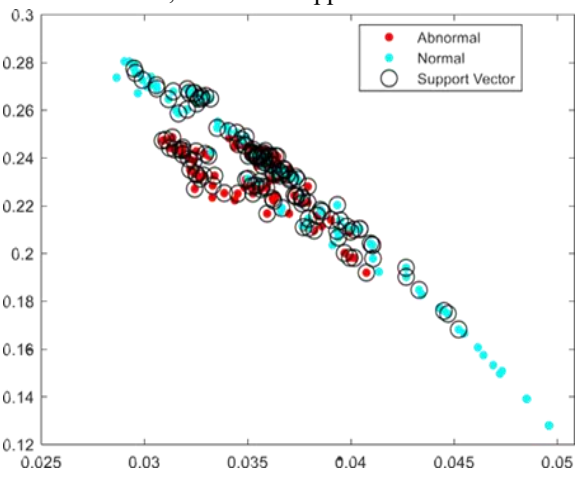


Fig 4: Prediction Result

VIII. CONCLUSION

This work presents a novel automated computational techniques for classify-ing MR brain images, which demonstrates consistent and reliable classification results across images acquired at different ages. Both the GAFS technique and the deep learning (CNN model) are designed for feature extraction and selection in all of the presented frameworks. Subsequently, a fusion technique was em-ployed to generate the paired fusion feature set, which is considered as the most important contribution of this research article. This study raises the level of nov-elty even further. The classification accuracy of 86.50%, 92.00% and 97.00% has been attained using all available T1-weighted, Flair and T2-weighted brain MR images respectively.

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