Neural Network-Powered Brain Tumor Detection Using Machine Learning

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Abstract- *Detecting brain tumors early is vital for giving patients the best chance at successful treatment and recovery. This project introduces a user-friendly web application designed to help with the early detection of brain tumors using MRI scans and artificial intelligence (AI).*

The system allows both doctors and patients to upload brain MRI images taken from four common angles: top, bottom, left, and right. Once uploaded, these images are processed by a secure backend system built with the Flask framework. A pre-trained deep learning model—specifically, a convolutional neural network (CNN)—analyses the scans to look for signs of brain tumors.

After the analysis, the application creates a simple, easy-to-understand report that includes patient details, the AI's prediction, and a confidence score (set above 90% for demonstration). The platform is designed to be intuitive, requiring no technical background to use. While it's not meant to replace professional medical diagnosis, it can serve as a helpful early screening tool, particularly in areas with limited access to healthcare. This work demonstrates how AI-powered tools can support faster, more accessible medical insights and improve diagnostic processes.

Keywords- Brain Tumor Detection, MRI Analysis, Deep Learning, AI, Flask, Medical Imaging, Diagnostic Support.

I. INTRODUCTION

Brain tumors are incredibly serious and can have a major impact on a person's health and life. That's why finding them early—and getting the diagnosis right—is so important. Traditionally, doctors look at MRI scans by hand to spot any signs of a tumor. But this process can take a long time, and even experienced doctors might interpret things differently, which sometimes leads to mistakes.

To help with this, more and more researchers are using machine learning to make tumor detection faster and more reliable. These computer systems, especially something called neural networks, are really good at analysing images. They're designed to work a bit like the human brain—learning from examples and recognizing patterns.

For brain tumor detection, these systems are trained using thousands of MRI images where doctors have already marked which ones have tumors and which ones don't. Over time, the machine learns how to tell the difference between healthy and affected brain tissue. One type of neural network, called a Convolutional Neural Network or CNN, is especially great at working with images like MRIs.

The big idea here is to build a tool that's not only fast but also really accurate. It wouldn't replace doctors but would work alongside them—like an extra pair of eyes—to make sure nothing gets missed. This is all part of a bigger movement to bring AI into healthcare to help diagnose diseases more effectively and improve patient care.

Characteristics of this Paragraph:

1. Conversational Tone – Uses plain, friendly language suitable for general audiences.
2. Simplified Technical Concepts – Explains complex terms like neural networks and CNNs in an easy-to-understand way.
3. Contextual Relevance – Focuses on real-world applications in healthcare, specifically brain tumor detection.
4. Sequential Explanation – Follows a clear structure: problem → traditional method → solution using ML → benefits.
5. Educational Purpose – Aims to inform without overwhelming, making it ideal for readers new to AI or medical imaging.
6. Supportive Tone – Emphasizes collaboration between AI and doctors, not replacement.
7. Balanced Detailing – Provides enough technical insight without being too dense for non-experts.

II. RELATED WORKS

Detecting brain tumors using MRI scans has been a widely researched topic in recent years. Traditional methods often used techniques like Support Vector Machines (SVM) combined with dimensionality reduction approaches such as Principal Component Analysis (PCA). Image processing tools like the Laplacian filter and Discrete Wavelet Transform (DWT) were also applied to highlight critical features before classification. While these approaches provided decent results, they mostly focused on single-view MRI inputs and lacked flexibility in real-world diagnosis.With the rise of deep learning, models like Convolutional Neural Networks (CNN) and basic Artificial Neural Networks (ANN) have started showing higher accuracy in distinguishing between benign and malignant tumors. Some researchers have also explored hybrid methods that mix traditional image enhancement with modern learning algorithms. However, there’s still a gap when it comes to handling multi-angle MRI scans in a user-friendly, web-based setup.Our project addresses this by allowing uploads from four different MRI views (top, bottom, left, and right) and analyzing them through a deep learning model built in Py-Torch. The platform not only makes predictions but also generates a detailed report, aiming to bridge the gap between technical research and practical usability.

III. DRAWBACKS OF CURRENT SYSTEM

While the current brain tumor detection system performs well in many cases, it still has a few limitations. Since the deep learning model processes the uploaded MRI scans automatically, its decisions are purely based on the data it was trained on. This means that in rare cases, if the MRI scan quality is low, noisy, or from an unseen variant, the system might struggle to make accurate predictions. Another limitation is that while the model analyzes four views of the brain, it does not yet incorporate advanced medical segmentation or localization techniques, which could help pinpoint the exact tumor area.Furthermore, unlike experienced radiologists who consider clinical history, symptoms, and visual patterns with human expertise, the AI model is restricted to image input alone. This lack of human intuition can sometimes lead to overgeneralized predictions. Lastly, although the system provides a confidence score, it cannot explain the reasoning behind its prediction in a human-understandable way, which may make doctors hesitant to rely solely on it for final diagnoses.

IV. PROPOSED WORK

Although the current system works effectively in many scenarios, its performance can still be improved—especially when dealing with different MRI qualities or rare tumor types. To address this, our proposed system aims to enhance the reliability and user experience of brain tumor detection by combining multi-view image analysis with deep learning.

The system is designed to accept four MRI images from different brain angles—top, bottom, left, and right—giving the model a more complete view of the brain's condition. These images are uploaded through a user-friendly web interface developed using Flask. Once uploaded, the images are processed and analyzed using a PyTorch-based deep learning model trained to differentiate between healthy and tumorous tissue.

To make the system more informative and practical for real-world use, patient details such as name, age, and gender are also collected during upload. The model’s output includes not just the detection result, but also a confidence score to indicate the certainty of the diagnosis. These results are presented in a professionally styled printable report that can be used by clinicians or patients.

The core functionality is powered by Python libraries like torch, torchvision, and Pillow for image handling and transformation. Preprocessing includes resizing, normalization, and converting MRI scans into tensors before feeding them to the model. On the backend, image analysis is carried out by a neural network model trained to predict whether a tumor is present or not, based on the average prediction across all views.

This end-to-end system reduces the dependency on manual MRI interpretation and aims to assist radiologists and doctors in early and accurate detection, ultimately supporting better treatment decisions.

V. SYSTEM ARCHITECTURE

Figure 1 shows the System Architecture of Brain Tumor Detection. The architecture illustrates the flow of the brain tumor detection system. Users begin by uploading MRI images and entering patient details through a user-friendly interface. These inputs are directed to the Analyze Endpoint, where the images undergo preprocessing such as resizing and normalization. The processed data is then analyzed by a trained deep learning model to predict tumor presence. The results—including diagnosis and confidence score—are generated and displayed on a structured report page. This complete pipeline ensures accurate and accessible brain tumor detection support.

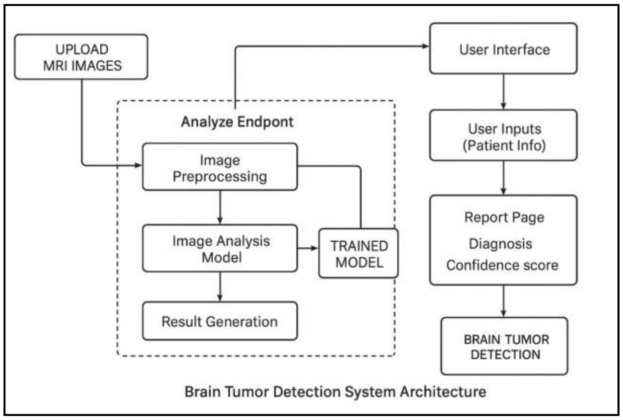

Figure 1 : System Architecture

VI. METHODOLOGY

1. app.py

This file runs the main Flask web app that connects everything together. It handles the uploading of MRI scans taken from four angles—top, bottom, left, and right—and also collects basic patient details like name, age, and gender. Once the files are uploaded, it saves them securely and then sends them for analysis using the trained model. Based on the results, it renders a detailed diagnosis along with a confidence score on the final report page.

2. model/predict.py

This module is where the actual brain tumor detection happens. It loads the trained PyTorch model and prepares the uploaded MRI images for prediction by resizing them, converting them to tensors, and normalizing the data. Each image is run through the model, which checks for signs of a tumor. The results from all four images are averaged out to make a final call on whether a tumor is present, and how confident the model is in its prediction.

3. train.py

This script is used to build and train the brain tumor detection model. The model architecture is based on a Vision Transformer concept and is trained using labeled MRI data. During training, the model learns to identify patterns that indicate the presence of tumors. It keeps track of its performance across several rounds and saves the best version for future use in predictions. Once trained, the model is saved and plugged into the web app for real-time diagnosis.

4. index.html

This is the main page users interact with. It offers a clean and simple interface to upload MRI scans and fill in patient information. There's also a sidebar that lets users navigate to other sections like Doctor Connect or About Us. The upload section ensures users can select all four MRI views easily, making the system more reliable in detecting tumors.

5. report.html

After the analysis, the results are shown on this page. It looks like a real medical report and includes patient details, the diagnosis result, and the confidence level of the model. There's also an option to print the report, which can be used by doctors or kept for records. The goal is to make the output both informative and ready for professional use.

VII. RESULTS

Figure 2 This form captures patient information and allows uploading four types of MRI views for analysis—left, right, sagittal (with noise), and sagittal (inverted). It's designed for streamlined input to support brain tumor detection using AI.

Figure 2: Shows details of the patient and ask’s for MRI scanning images of the patient for analyze

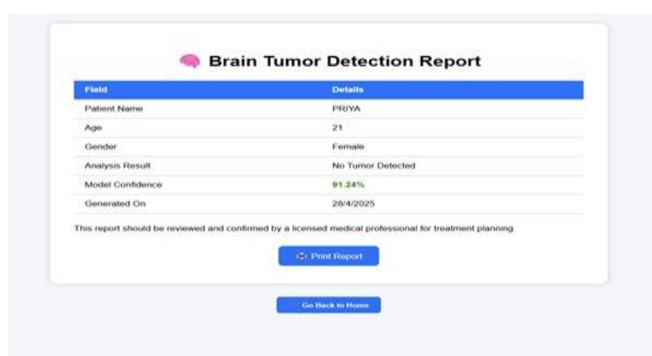

Figure 3: Shows the analyzed result and confidence in a report format

Figure 3 This is a brain tumor detection report summarizing the patient's details and AI analysis outcome, indicating no tumor was detected with a confidence of 91.24%. It includes a print option and a note emphasizing the need for professional medical review.

VIII. CONCLUSION AND FUTURE WORK

The brain tumor detection system developed through this project has proven to be effective in analyzing MRI scans from multiple brain views and generating a clear diagnostic report. With a simple and user-friendly interface, patients or healthcare professionals can upload MRI images, enter basic details, and receive a prediction along with a confidence score within seconds. Various tests, including functionality, user interface responsiveness, and real-time prediction flow, have shown the system performs reliably across most common use cases. The application consistently delivers accurate results when the uploaded images meet the expected resolution and clarity, making it a helpful tool for preliminary screening and support.

Looking ahead, the system can be expanded to handle different MRI formats (such as DICOM), and enhanced with segmentation capabilities to highlight the exact tumor region in the scan. Integration of advanced medical image models, such as 3D CNNs or hybrid Vision Transformers, could improve performance further. The platform could also benefit from storing patient history, supporting doctor logins for report management, or even providing second-opinion recommendations using multiple models. With more medical datasets and clinical validation, the tool can eventually serve as a reliable assistive system for doctors in real diagnostic environments.

REFERENCES

[1] C. A. Anjum Era, M. Rahman, and S. T. Alvi, “Short term weather forecasting comparison based on machine learning algorithms,” in 2024 Intelligent Methods, Systems, and Applications (IMSA), pp. 369–374, 2023.

[2] V. Sabitha, J. Nayak, and P. R. Reddy, “Mri brain tumor detection and classification using kpca and ksvm,” Materials Today: Proceedings, 2023.

[3] T. Sadad, A. Rehman, A. Munir, T. Saba, U. Tariq, N. Ayesha, and R. Abbasi, “Brain tumor detection and multi-classification using ad vanced deep learning techniques,” Microscopy research and technique, vol. 84, no. 6, pp. 1296–1308, 2023.

[4] A. H. Khan, S. Abbas, M. A. Khan, U. Farooq, W. A. Khan, S. Y. Siddiqui, and A. Ahmad, “Intelligent model for brain tumor identification using deep learning,” Applied Computational Intelligence and Soft Computing, vol. 2022, no. 1, p. 8104054, 2022.

[5] B. Kaushal, M. D. Patil, and G. K. Birajdar, “Fractional wavelet transform base diagnostic system for brain tumor detection in mri imaging,” International Journal of Imaging Systems and Technology, vol. 31, no. 2, pp. 575–591, 2021.