Brain Tumor Classification Using Deep Learning

p poojitha sai priya nagineni | ap22110010187 3 min read · Nov 22, 2025

Introduction

Brain tumors are one of the most critical neurological conditions, where early and accurate diagnosis plays a crucial role in improving patient outcomes. Traditional diagnosis involves manual analysis of MRI scans by radiologists, which can be time-consuming and prone to human error. With the advancement of Artificial Intelligence, Deep Learning has emerged as a powerful tool to assist medical professionals by automating the detection and classification of brain tumors.

In this project, I developed a Brain Tumor Classification System using Deep Learning techniques to identify and classify MRI images into four categories: Glioma, Meningioma, Pituitary, and No Tumor. The goal was to create a reliable model that can assist in faster and more accurate diagnosis.

Problem Statement

Manual interpretation of brain MRI images requires high expertise and may lead to inconsistencies due to fatigue or subjective judgment. There is a need for an automated system that can analyze MRI scans objectively and provide accurate tumor classification to support medical decision-making.

Dataset Description

The project uses the Brain Tumor MRI Dataset sourced from Kaggle. The dataset contains labeled MRI images categorized into:

- Glioma
- Meningioma
- Pituitary Tumor

- No Tumor

The dataset is divided into Training and Testing folders, ensuring proper validation of model performance.

Methodology

1. Data Preprocessing

Before feeding the images into the model, several preprocessing steps were applied:

- Image resizing to 150x150 pixels
- Normalization of pixel values
- Data augmentation (rotation, zoom, flipping)
- Noise reduction and enhancement

These steps helped improve model generalization and prevent overfitting.

2. Model Implementation

Two Deep Learning models were implemented and compared:

Custom CNN Model

A Convolutional Neural Network was designed from scratch, consisting of:

- Convolutional layers for feature extraction
- Max Pooling layers for dimensionality reduction

- Dropout layers to prevent overfitting
- Fully connected dense layers for classification

VGG16 (Transfer Learning)

VGG16, a pre-trained model, was used with frozen base layers and custom classification layers added on top. This improved accuracy while reducing training time.

Model Training and Evaluation

The models were trained using categorical cross-entropy loss and Adam optimizer. Performance was evaluated using:

- Accuracy graphs
- Confusion Matrix
- Precision, Recall, and F1-score

The VGG16 model showed higher accuracy compared to the custom CNN, demonstrating the benefit of transfer learning in medical image analysis.

Results

The system successfully classified MRI images into the correct tumor categories with a high level of accuracy. Key results include:

- Accurate prediction of tumor types
- Visual performance representation using confusion matrix
- Reliable generalization on test data

These results highlight the effectiveness of deep learning in supporting healthcare diagnostics.

Implementation Tools & Technologies

- Python
- TensorFlow & Keras
- OpenCV
- NumPy & Pandas
- Matplotlib & Seaborn
- Google Colab

Real-World Impact

This project demonstrates how AI can assist radiologists by providing quick and reliable tumor classification. It reduces manual workload and enhances diagnostic efficiency, helping improve treatment planning and patient care.

Challenges Faced

- Handling class imbalance
- Avoiding overfitting
- Choosing optimal hyperparameters
- Ensuring model interpretability

These challenges were addressed through data augmentation and performance tuning.

Future Enhancements

- Integration of Grad-CAM for model explainability
- Deployment as a web or mobile application
- Adding multi-modal imaging analysis
- Expanding dataset for better accuracy

Conclusion

The Brain Tumor Classification System showcases how deep learning can transform medical image analysis by providing efficient, accurate, and scalable solutions. By leveraging CNN and transfer learning models, the system achieves reliable classification performance, proving its potential as a valuable tool in AI-driven healthcare diagnostics.

GitHub Repository

You can find the complete project here:
https://github.com/poojithasaipri/Brain-Tumor-Classification

p

Written by poojitha sai priya nagineni | ap22110010187

0 followers · 1 following

Edit profile

No responses yet