Brain Tumor Detection Using Deep Learning

Detailed Report

1. Introduction

Brain tumors are life-threatening abnormalities that require early detection. This project employs a Convolutional Neural Network (CNN) to classify MRI scans as tumor-positive or tumor-negative, utilizing deep learning techniques.

2. Dataset Description

Training Data: 5012 images (Balanced: 50% Tumor Positive, 50% Tumor Negative)

Validation Data: 420 images (Unseen Data)

Data Augmentation: Applied transformations such as zoom, rotation, and flipping to enhance data variability.

3. Model Architecture

A CNN model was designed with the following layers:

Convolutional Layers: 4 blocks with increasing filter sizes (64, 128, 256, 512)

Batch Normalization & Dropout: Regularization techniques applied to prevent overfitting.

Pooling Layers: MaxPooling layers used to reduce dimensionality.

Fully Connected Layers: Two dense layers (256 and 128 neurons)

Output Layer: Single neuron with sigmoid activation (Binary Classification)

4. Model Compilation and Training

Optimizer: Adam

Loss Function: Binary Crossentropy

Metrics: Accuracy

Callbacks Used:

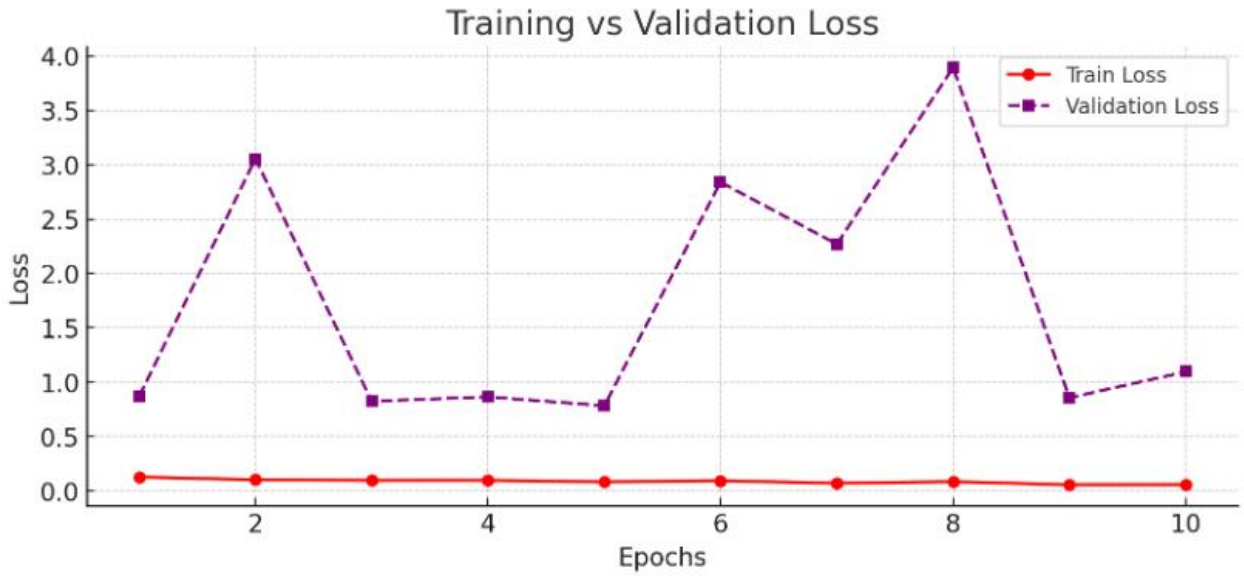
ModelCheckpoint: Saves the best model per epoch

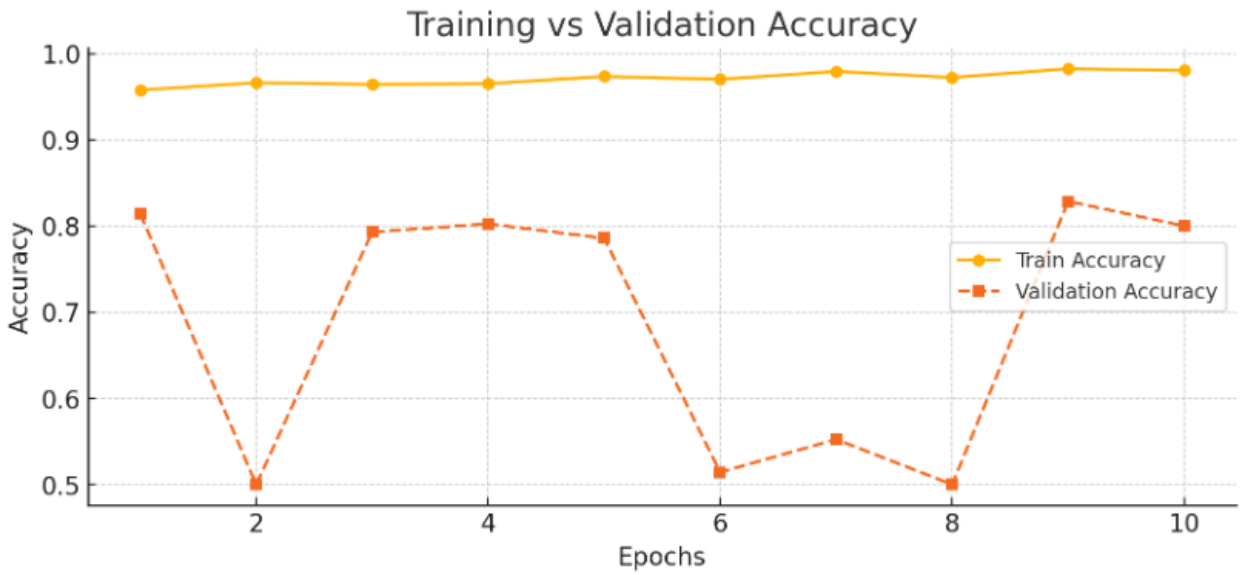
EarlyStopping: Stops training when no improvement is observed

ReduceLROnPlateau: Reduces learning rate on a performance plateau

Training Results:

Epoch	Train Accuracy	Train Loss	Val Accuracy	Val Loss
1	95.77%	0.1258	81.43%	0.8684
2	96.61%	0.1010	50.00%	3.0553
3	96.43%	0.0951	79.29%	0.8238
4	96.50%	0.0953	80.24%	0.8639
5	97.35%	0.0814	78.57%	0.7821
6	97.01%	0.0926	51.43%	2.8400
7	97.93%	0.0684	55.24%	2.2704
8	97.22%	0.0835	50.00%	3.8948
9	98.23%	0.0544	82.86%	0.8557
10	98.03%	0.0550	80.00%	1.0946





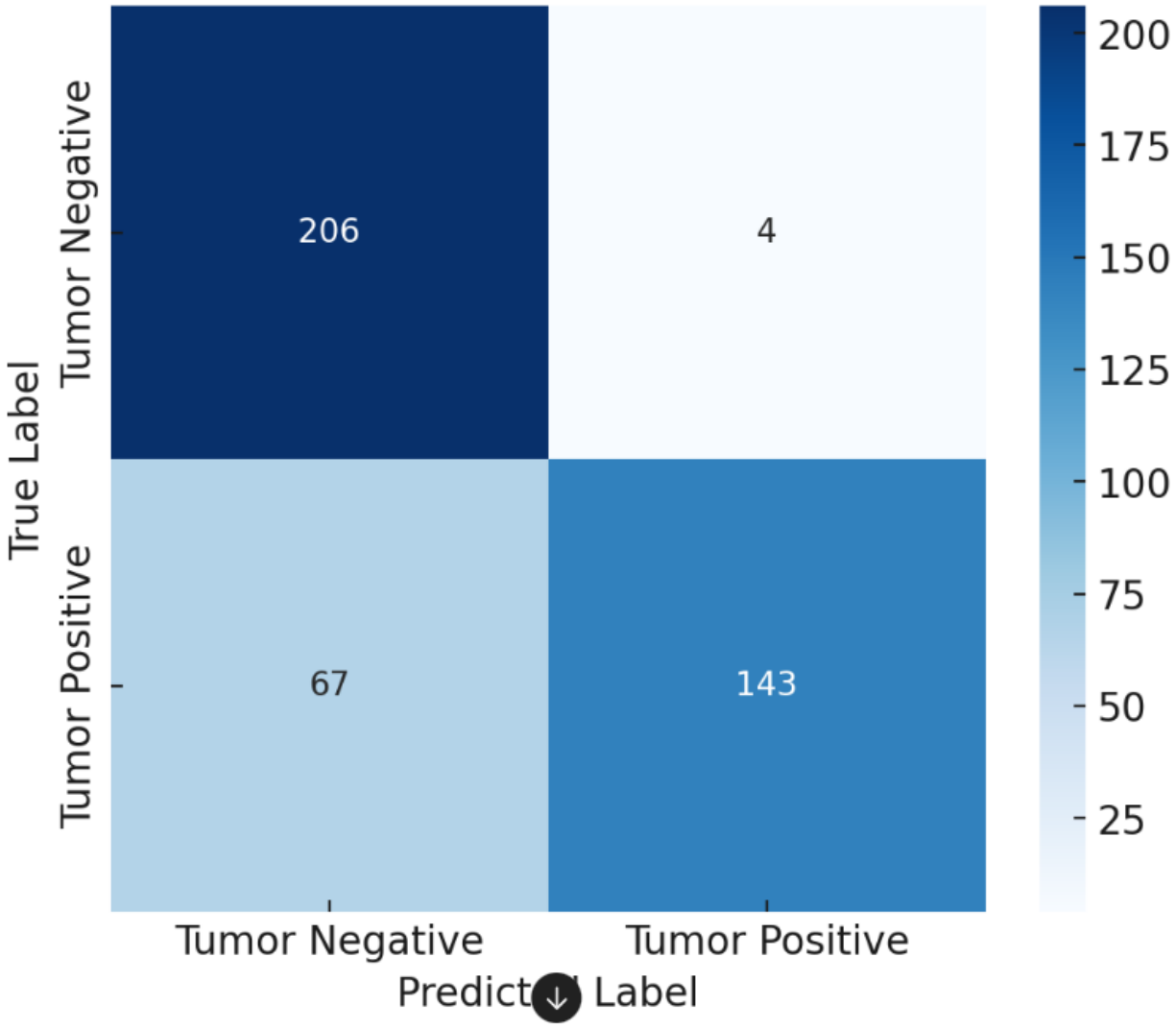
5. Model Evaluation

Confusion Matrix:

Tumor Negative: Precision = 0.75, Recall = 0.98, F1-score = 0.85

Tumor Positive: Precision = 0.97, Recall = 0.68, F1-score = 0.80

Overall Accuracy: 82.86%



6. Deployment Using Flask

After training the model on Google Colab, the best-performing model was saved and downloaded to a local computer. A Flask-based web server was implemented to integrate the model with a user-friendly interface, allowing users to upload MRI images for real-time tumor predictions.

7. Conclusion and Future Work

The CNN model achieves an accuracy of 82.86%, showing strong precision but slightly lower recall for Tumor Positive cases. Future improvements may include:

Using transfer learning with pre-trained models (e.g., ResNet, VGG)

Experimenting with different hyperparameters and augmentation techniques

Collecting more diverse data to improve generalization

This model provides a foundation for automated brain tumor detection, assisting radiologists in diagnosing patients efficiently.