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**Assessment Report**

**On**

**“Brain Tumor Detection”**

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**CSE (Artificial Intelligence)**

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**1. Introduction**

This project focuses on developing a deep learning model to automatically detect brain tumors from MRI images using Convolutional Neural Networks (CNNs). By training the model on a dataset of labeled brain scans, it learns to classify images as either "tumor" or "no tumor." The goal is to assist in early diagnosis by providing fast and accurate predictions. The project also includes visualizing model performance and predictions to ensure transparency and effectiveness in real-world applications.

**2. Problem Statement**

Build a Convolutional Neural Network (CNN) model that can classify MRI images into **"Tumor"** or **"No Tumor"** categories. Visualize predictions and evaluate performance using standard metrics.

**3. Objectives**

* **To develop a CNN-based model** that can accurately classify MRI images as containing a brain tumor or not.
* **To preprocess and augment MRI image data** for improved training and generalization of the model.
* **To evaluate the model's performance** using metrics like accuracy, precision, recall, and F1-score.
* **To visualize training results and predictions** for better interpretability and model analysis.
* **To reduce diagnostic time and human error** by providing an automated solution for brain tumor detection.
* **To build a scalable and deployable model** that can assist medical professionals in real-world settings.

**4. Methodology**

* **Data Collection**: MRI images of brains with and without tumors are collected from a publicly available dataset.
* **Data Preprocessing**:  
  + Encoding labels as binary (0 = No Tumor, 1 = Tumor).
  + Classifying the dataset into tumor and no tumor.
  + Resizing all images to a consistent dimension (e.g., 150×150 pixels).
* **Model Building**:  
  + Designing a Convolutional Neural Network (CNN) architecture suitable for binary image classification.
  + Adding layers like Conv2D, MaxPooling2D, Flatten, Dense, and Dropout for optimal performance.
  + Compiling the model with the Adam optimizer and binary cross-entropy loss function.
* **Model Training**:
  + Designing a Convolutional Neural Network (CNN) architecture suitable for binary image classification.
  + Adding layers like Conv2D, MaxPooling2D, Flatten, Dense, and Dropout for optimal performance.
* **Model Evaluation**:  
  + Evaluating performance using metrics such as accuracy, precision, recall, and F1-score.
  + Visualizing training and validation accuracy/loss curves.
  + Displaying sample predictions and generating a confusion matrix heatmap for performance insight.

**5. Data Preprocessing:**

The MRI image dataset is cleaned and prepared as follows:

* **Images are resized** to a fixed dimension (e.g., 150×150 pixels) to ensure uniform input size for the model.
* **Pixel values are normalized** by scaling them between 0 and 1 to improve training performance.
* **Class labels are encoded** as binary values: 0 for “No Tumor” and 1 for “Tumor.”
* **Data augmentation** techniques like rotation, zoom, and flipping are applied to increase dataset diversity.
* The dataset is **split into 80% training and 20% testing** to evaluate model performance on unseen data.

**6. Model Implementation**

A **Convolutional Neural Network (CNN)** is implemented due to its high effectiveness in image classification tasks. The model is built using several convolutional and pooling layers, followed by fully connected layers to learn patterns from MRI scans. The CNN is trained on the preprocessed image dataset to predict whether a brain tumor is present. The model is evaluated on the test set to determine its accuracy and diagnostic reliability.

**7. Evaluation Metrics**

The CNN model is evaluated using the following metrics:

* **Accuracy**: Overall correctness of predictions.
* **Precision**: Proportion of predicted tumor cases that are actually tumors.
* **Recall**: Proportion of actual tumor cases correctly detected.
* **F1 Score**: Harmonic mean of precision and recall, useful for imbalanced data.
* **Confusion Matrix**: Visualized with a Seaborn heatmap to show true/false positives and negatives clearly.

**8. Results and Analysis**

* The CNN model showed good performance on the test set for classifying MRI images.
* The confusion matrix heatmap helped visualize the distribution of true positives, false positives, true negatives, and false negatives.
* Precision and recall reflected the model’s ability to detect actual tumor cases while minimizing false alarms.

**9. Conclusion**

The CNN model effectively detected brain tumors from MRI scans with satisfactory performance metrics. This project highlights the potential of deep learning in medical image analysis and early diagnosis. Future improvements could involve using more complex architectures, data augmentation, and addressing any class imbalance for enhanced accuracy.

**10. References**

* TensorFlow and Keras documentation
* OpenCV and NumPy documentation
* Seaborn visualization library
* Research articles on brain tumor detection and medical image classification using deep learning



