Project Report: Detection of Alzheimer's Disease using CNN

1. Project Title: Detection of Alzheimer's Disease using Convolutional Neural Networks (CNN)

2. Objective: This project was undertaken to build a reliable and efficient deep learning model that can analyze brain MRI scans and categorize them into four stages related to Alzheimer's disease: - Mild Dementia - Moderate Dementia - Non Demented - Very Mild Dementia

The goal is to help medical professionals by providing a tool that supports early and accurate identification of these conditions, potentially improving patient outcomes.

3. Dataset Used: - Source: Kaggle (https://www.kaggle.com/datasets/vishal0729/alzheimer-dataset) - Number of Classes: 4 distinct categories based on dementia stages - Image Format: JPEG (.jpg) - Preprocessing Steps:

- Resized all images to 224x224 pixels to maintain consistency

- Normalized pixel values to a range of [0, 1] for better model performance

- The dataset was split into 80% training data and 20% testing data

4. Tools and Libraries: To build and train the model, the following tools and libraries were used: - Google Colab (for cloud-based development and training) - TensorFlow and Keras (for deep learning) - Scikit-learn (for evaluation metrics and data splitting) - Matplotlib and Seaborn (for visualization) - PIL and Numpy (for image and array manipulation)

5. Model Architecture (CNN): The model uses a Convolutional Neural Network (CNN), well-known for its effectiveness in image classification tasks. The architecture includes: 1. A Conv2D layer with 32 filters to extract basic features 2. A MaxPooling2D layer to reduce dimensionality 3. A second Conv2D layer with 64 filters 4. Another MaxPooling2D layer 5. A third Conv2D layer with 128 filters for deeper features 6. A MaxPooling2D layer 7. A Flatten layer to convert the feature maps into a single vector 8. A Dense layer with 128 neurons and ReLU activation 9. A Dropout layer with 0.5 rate to prevent overfitting 10. An output Dense layer with 4 neurons and softmax activation to classify the input image

6. Compilation and Training: The model was compiled with the following settings: - Optimizer: Adam with a learning rate of 0.001 - Loss Function: Categorical Crossentropy, suitable for multi-class classification - Metric: Accuracy was used to track performance - Epochs Trained: 10 - Batch Size: 32 7. Model Evaluation: After training, the model was evaluated on the test set using several performance metrics: - Test Accuracy: 99.95% (0.9995) - Test Loss: 0.0024 - Confusion Matrix and Classification Report:

- Mild Dementia: Precision 1.00, Recall 1.00, F1-score 1.00 (1000 images)

- Moderate Dementia: Precision 1.00, Recall 0.99, F1-score 0.99 (98 images)

- Non Demented: Precision 1.00, Recall 1.00, F1-score 1.00 (13,445 images)

- Very Mild Dementia: Precision 1.00, Recall 1.00, F1-score 1.00 (2,745 images)

- Overall Accuracy: 100% on 17,288 test images

- Macro Average: Precision 1.00, Recall 1.00, F1-score 1.00

- Weighted Average: Precision 1.00, Recall 1.00, F1-score 1.00

8. Image Prediction: To verify that the model performs well on individual images, a separate test was conducted. A new image was passed through the trained model, which accurately predicted the correct dementia class and displayed the image with the label.

9. Final Model: - The final trained model was saved as `my\_model.h5` - It is portable and can be integrated into applications or platforms for real-time diagnostic support

10. Conclusion: The project successfully demonstrates the ability of CNNs to detect and classify Alzheimer's stages from MRI scans. The model's near-perfect performance highlights its potential as a helpful tool in medical diagnostics. By simplifying the classification process, it may reduce the burden on radiologists and help catch early signs of dementia.

11. Future Scope: - Expand the dataset to include more diverse and balanced samples - Experiment with transfer learning using models like VGG16 or ResNet for potentially better results - Develop a user-friendly interface (web/mobile app) for doctors and researchers to use this model in practice

12. References: - Kaggle: https://www.kaggle.com/datasets/vishal0729/alzheimer-dataset - TensorFlow and Keras Official Documentation - GitHub community notebooks and tutorials - Online research articles and medical imaging studies