

Project Proposal

Project Title Advanced deep learning approaches for Alzheimer's Disease Classification

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1. Overview of the Project

Eventually, Alzheimer's disease causes the brain to shrink and affects memory and thinking. It is a degenerative brain disorder that progressively results in the loss of memory and hinders the thought processes of an individual. There is no known cure yet, but early detection can significantly improve patients' lives with better management of symptoms. Conventional tests tend to miss the disease when it is still in its early stages.

This project will make use of MRI brain scans and deep learning for detecting Alzheimer's disease across six stages, from normal cognition to advanced disease. Most studies look at only healthy versus advanced cases, but this project will include the middle stages, like MCI, to provide a more realistic view.

2. Goal of the Project

The goal is to construct a deep learning model that can classify brain MRI scans into six stages of Alzheimer's. Key points:

- Building a CNN that can detect small changes in the brain as the disease progresses.
- Handle data imbalance so that all stages are treated fairly.
- Reach good accuracy and reliability using metrics such as accuracy, sensitivity, specificity, and F1-score.
- Create a simple automatic system to assist doctors in early detection and management of Alzheimer's disease.

3. Approach

The project will make use of publicly available MRI datasets, primarily ADNI, which has scans labeled for six groups:

- CN (Cognitively Normal)
- SMC: Significant Memory Concern
- EMCI: Early Mild Cognitive Impairment

MCI (Mild Cognitive Impairment)

- LMCI: Late Mild Cognitive Impairment
- AD (Alzheimer's Disease)

ADNI provides MRI images together with clinical information, which is perfect for creating a deep learning model. Additional optional extra data could be provided by OASIS in order to increase variety.

4. Data Processing

Before training, MRI scans will be preprocessed:

- Normalize image intensity for consistent contrast.
- Resize all images to a fixed size; for instance, 150×150 pixels.
- Remove skull and noise to focus on the brain.
- Basic data augmentation such as flipping, rotating, and adjusting contrast should be applied.
- Balance the dataset using class weights or sampling.

5. Model Design

A custom CNN will be used for six-stage classification:

- Convolutional and pooling layers to extract features.
- Dropout layers to prevent overfitting.
- Fully connected layers with Softmax for six classes.
- Adam optimizer with tuned hyperparameters.

Transfer learning with pretrained models (like VGG16 or ResNet50) can be tried as well for comparison.

6. Testing and Evaluation

The model will be tested with:

- Accuracy – correct predictions overall.
- Precision, Recall, F1-Score: check performance for all classes.

Confusion Matrix: This provides stage-wise performance.

- ROC Curve and AUC - measure the ability to separate stages.

Cross-validation ensures good performance on unseen data.

The goal is a model that is accurate, balanced, and clinically useful.

7. Project Steps and Timeline

Step 1: Data Collection & Preprocessing (Weeks 1–3)

- Collect ADNI MRI scans.
- Preprocess, augment, and balance data.
- Split into train, validation, and test sets.

Step 2: Model Design & Development (Weeks 4–6)

- Build and test CNN architecture.
- Try different layer setups, filters, and activations.
- Optionally, test the transfer learning models.

Step 3: Training & Optimization (Weeks 7–8)

- Train CNN and tune hyperparameters.
- Monitor validation to avoid overfitting.

Step 4: Testing & Evaluation (Weeks 9–10)

- Test on unseen data using all metrics.
- Cross-validation against robustness.
- Compare with previous studies.

Step 5: Final Adjustments & Reporting (Weeks 11–12)

- Refine model.
- Document methods and results.
- Prepare visualizations and final report/slides.

8. Anticipated Outcomes

- Better Diagnostic Accuracy: classify all six stages accurately.
- Multi-Stage Framework: automated pipeline of feature extraction, balancing, and classification.

- Early Detection Insights: Observe subtle changes in early stages.
- Clinically Useful Model: works on new MRI scans, not just research data.
- Future Research Contribution: It can be extended to other brain diseases, multimodal data, and explainable AI.

9. Resources Needed

Datasets: ADNI (main), OASIS (optional).

Tools: Python, TensorFlow/Keras, PyTorch (optional), OpenCV, NumPy, Pandas, Matplotlib, Seaborn, Jupyter/Colab, GitHub.

Computing: GPU (NVIDIA), Google Colab Pro/Kaggle, or local workstation.

Expert Support: Academic supervision and consultation with neurology/medical imaging experts.

7. References

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