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Alzheimer Disease Classification and Progress Prediction Using Neuroimaging Data

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Early detection of Alzheimer's Disease (AD) plays a critical role in slowing disease progression and improving patient outcomes. This study presents a deep learning-based framework for the classification and progression prediction of Alzheimer's Disease using magnetic resonance imaging (MRI) data. A dataset comprising 6,400 MRI images obtained from the Alzheimer's Disease Neuroimaging Initiative (ADNI) repository on Kaggle (2010–2020) was utilised, covering four diagnostic clusters: Non-Demented, Very Mild Demented, Mild Demented, and Moderate Demented stages. Data preprocessing included intensity normalization, spatial smoothing, and image resizing to ensure consistency and noise reduction. Several Convolutional Neural Network (CNN) architectures, including standard CNN, ResNet, VGG, and DenseNet, were evaluated to identify the optimal feature extraction method. In addition, Support Vector Machine (SVM) classifiers were employed to assess the separability of extracted features. To leverage the strengths of both paradigms, a hybrid CNN and SVM model was developed, integrating deep feature extraction with robust margin-based classification. The hybrid model achieved a 99% overall accuracy and 98.05% cross validation accuracy, outperforming standalone CNN and SVM approaches. These results demonstrate that combining deep and classical machine learning techniques enhances diagnostic precision and generalization capability. The study highlights the potential of hybrid architectures in medical image analysis for accurate, automated, and early-stage Alzheimer's detection. Future work will explore model interpretability and longitudinal prediction to support clinical decision making.

Keywords: Skin disease detection, Image processing, Feature extraction, Segmentation, Classification, Machine learning.