

Geometric Deep Learning and Anatomical Landmarking for Improved Preclinical Alzheimer's Disease Diagnosis

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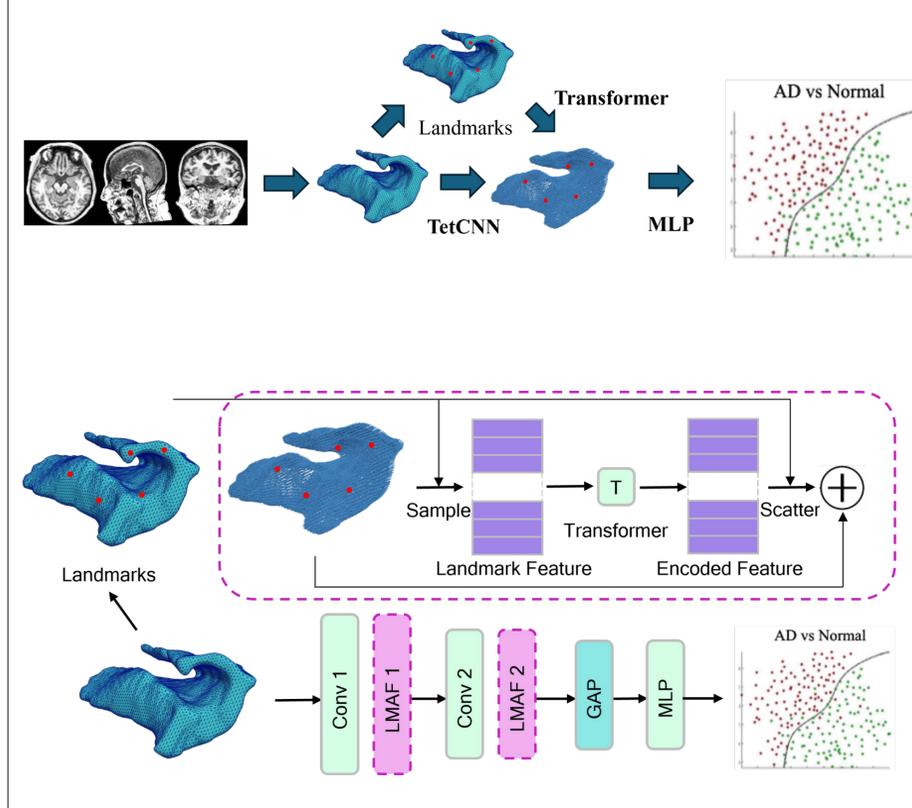
ABSTRACT

In this study, we develop a preclinical Alzheimer's disease screening method by applying geometric deep learning to hippocampal structures. We first extract the hippocampal structures from the MRI images and build volumetric meshes with existing tools. In our model, traditional graph convolution is enhanced by our customized volumetric Laplace Beltrami Operators (LBOs). Moreover, we extract anatomical landmarks using hierarchical Bayesian networks, which are then integrated into our model with a cross attention mechanism. As a result, our model achieves higher classification accuracies among all diagnosis groups.

METHODS

Hippocampal shape and thickness analysis (HIPSTA) pipeline for hippocampus segmentation was adopted [1]. Surface meshes were then constructed from the segmented voxel images. Anatomical landmarks were then generated using a Gaussian process-based pipeline [2]. We built upon TetCNN [3] backbone and implemented a landmark fusion (LF) layer, which is the graph version of the keypoint-augmented fusion (KAF) layer [4]. The resulting architecture includes a graph neural network encoder, followed by a 2-layer MLP for classification.

METHODS



EXPERIMENTATION

AD vs CN classification using ADNI dataset. The dataset consists of 523 individuals with Alzheimer's disease (AD) and 328 cognitively normal (CN) individuals. The model performance was evaluated with classification accuracy and compared against those of PointNet, PointNet++ and TetCNN.

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N (AD)	N (CN)	Total
523	328	851

RESULTS

Our proposed model outperforms state-of-the-art models in classification accuracy.

PointNet	PointNet++	TetCNN	Ours
0.90 ± 0.023	0.867 ± 0.020	0.864 ± 0.049	0.908 ± 0.014

FUTURE WORK

The model will be refined via better pretraining methods and its applicability will be expanded to additional disorders, such as Parkinson's, TBI, and Multiple Sclerosis (MS).

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