Escuela Superior Politécnica del Litoral

PARES & NONES Un break científico

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Anatomical Footprint of the Impulse Control Disorders in Parkinson’s Disease: a Convolutional Vision Transformers Approach

Problem Description

Impulse control disorders (ICDs) are a prevalent group of psychiatric disorders characterized by the inability to resist urges or impulses, leading to maladaptive and self-destructive behaviors. In Parkinson’s disease (PD), the prevalence of ICDs has been more commonly diagnosticated than in the general population, resulting in a substantial negative impact on patient’s quality of life and overall well-being.

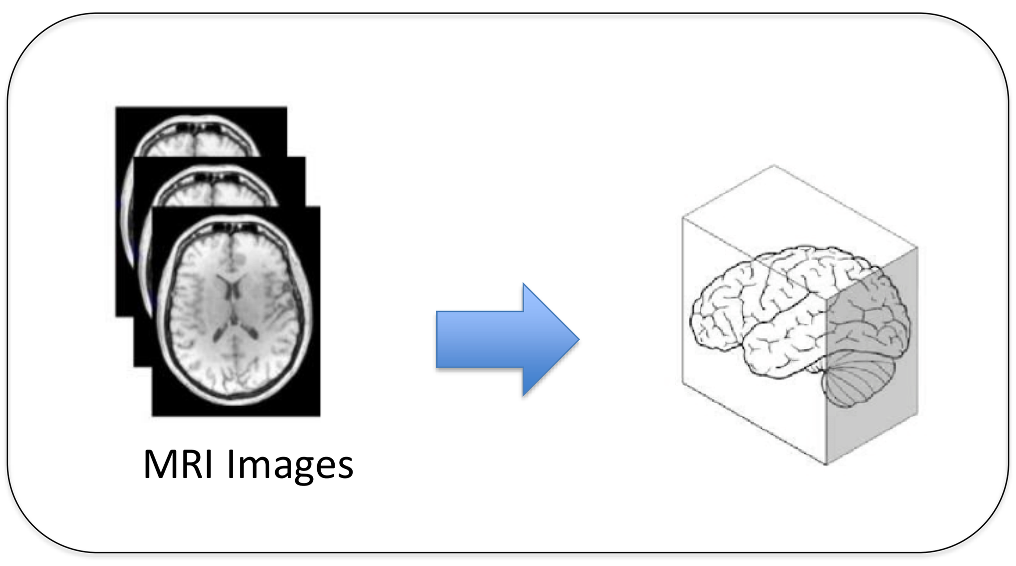


Figure 1. 3D Brain Anatomy

Objective

Generate an assistive tool to detect ICD in Parkinson patients.

Proposed System

We propose a novel approach to detect ICD in Parkinson’s patients using transformer-based models automatically.

- The proposed transformer-based model was implemented using 3D-convolutional layers to increase its respective field to identify patterns that may be indicative of ICDs in PD patients.
- The Convolutional vision Transformers (CvT) is a type of CNN that combine the attention-based modeling of transformers with the spatial shift-invariance of CNNs.
- Generally, the input image is fed through convolutional layers to extract local features, then passed to the transformer-based layers to capture global contextual information.

MRI Data Pre-processing

- MRI images were obtained from the Parkinson Progression Marker Initiative (PPMI) database.
- Denoising was performed with a Gaussian spatially adaptive filter.
- MNI registration uses a rigid body to avoid non-linear deformations and maintain the native brain shape.
- All images were brain extracted using the ANTS library.
- Images were normalized using intensity normalization based on least squares tissue normalization

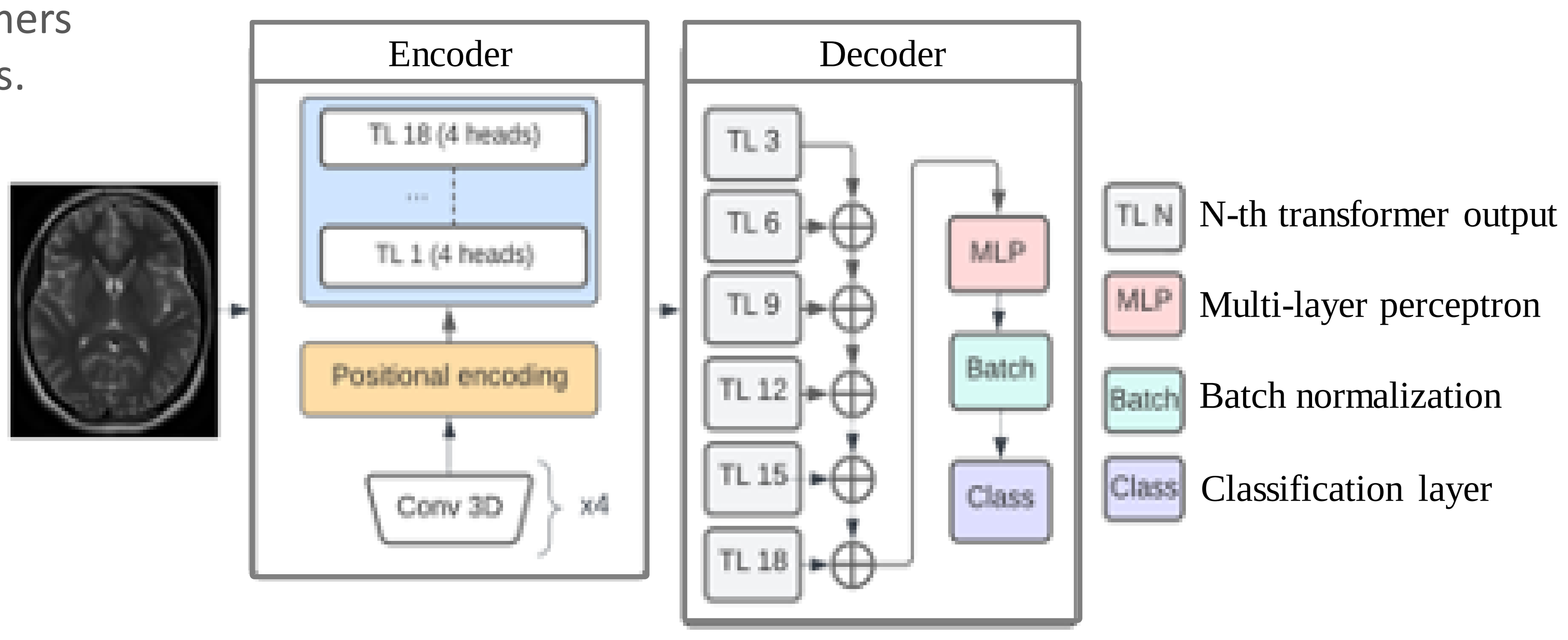
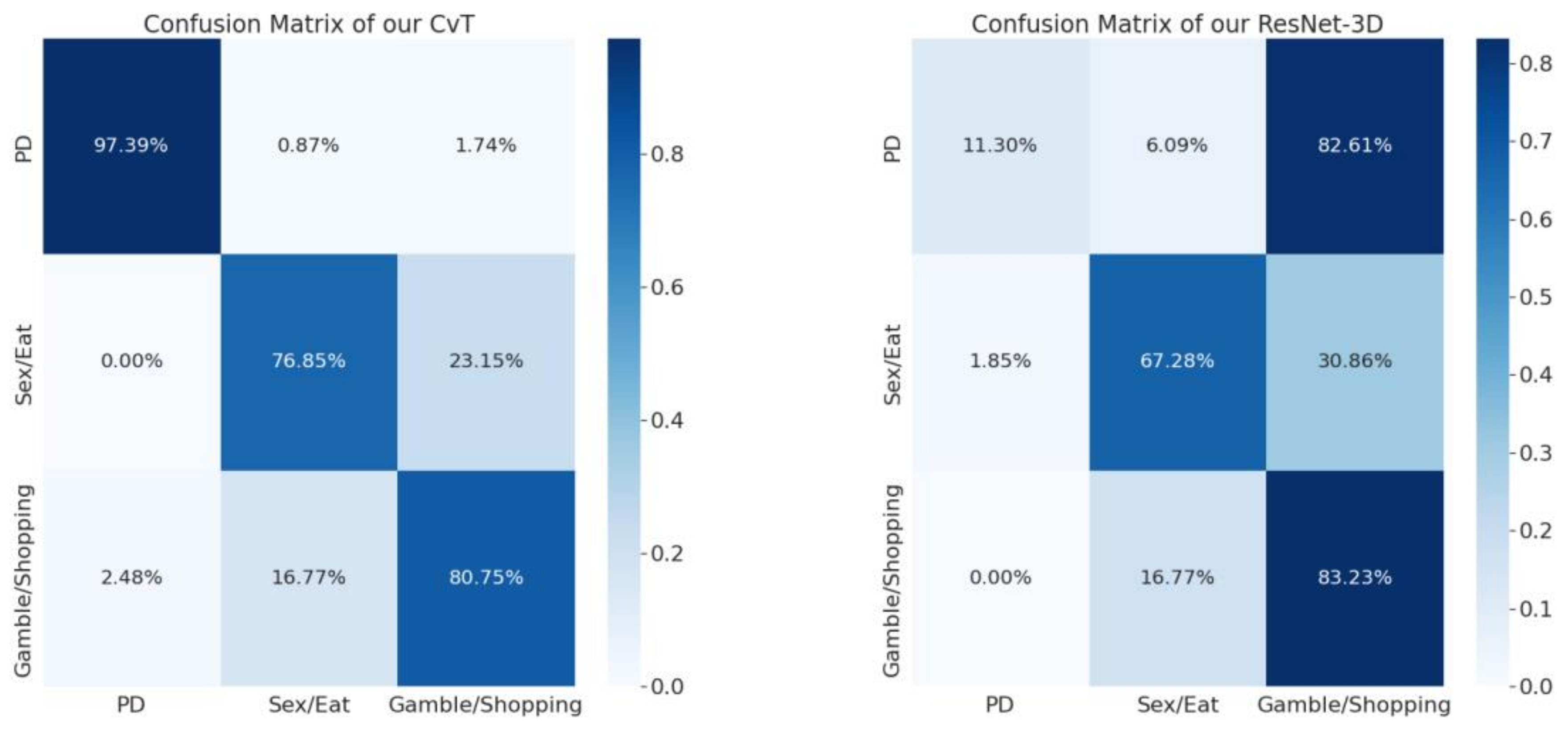


Figure 2. CvT-based architecture

Results

- 5-fold cross-validation
- Our proposed CvT achieved an accuracy value of 77% and 0.9828 of ROC-AUC. The ResNet-3D model reached 70% accuracy and a ROC-AUC score of 0.8459
- CvT completed on average 7 epochs per hour, whereas ResNet completed 3.47 epochs per hour, making the CvT training faster.



(a) Confusion matrix for CvT

(b) Confusion matrix for ResNet-3D

Figure 3. Confusion Matrices

Conclusions

- The proposed CvT model showed less miss-classification errors than the ResNet-3D model, suggesting that it learned the anatomical patterns of the patient’s brain more effectively for distinguishing between the classes.
- The CvT-based model demonstrated better utilization efficiency, potentially leading to less resource demand in future iterations or improvements of the model.