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A Brief Discussion of Functional Magnetic Resonance Imaging, Deep Learning, and Alzheimer's Disease

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DESCRIPTION

Deep learning is a popular representation of machine learning techniques that mimic the functions of the human brain to process information and create patterns to help make complex decisions. Researchers favor DL because of its ability to absorb information even from unstructured and unlabeled data. In this article, some of the most popular DL models are discussed along with the results of their implementation for AD classification. All brain magnetic resonance (MR) images are obtained from the "Alzheimer's Disease Neuroimaging Initiative (ADNI)" online data set. According to the performance comparison of all discussed models, the DenseNet-121 model achieves a convincing result with an average performance rate of 88.78%. However, one limitation of the dense network model is that it uses a large number of convolution operations, which makes the model computationally slower than many of the other models discussed. Deep convolution is a popular method for speeding up and improving the performance of a convolution operation. Consequently, in order to reduce the execution time, we proposed to replace the convolution layers of the original DenseNet-121 architecture with deep convolution layers. The new architecture also improved model performance by an average of 90.22%. Automatic detection of dementia stage using multimodal imaging modalities will aid in clinical diagnosis. In this study, we used fused Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) scanning to develop an Inception-ResNet envelope model for differentiating healthy controls (HC), mild cognitive impairment (MCI), and Alzheimer's disease (AD). T1-weighted MR and PET images of individuals aged 42 to 95 years, including patients with HC, MCI, and AD, are used. After stripping the skull, we perform 3D tissue segmentation on MR images. The PET image is fused with the MR image segmented tissue atlas. The PET images are then converted from RGB to HSI colour space, and the MRI and PET images are fused using two-dimensional Fourier and Discrete Wavelet Transforms (DWT), followed by reconstruction of the MR-PET fused image using inverse Fourier and DWT methods. After combining MRI and PET imaging modalities, we used different convolutional neural networks to train 60%, validate 20%, and test 20% of the data. When compared with existing methods, we found that the proposed model was the best classifier with accuracies of 95.5%, 94.1% and 95.9% in the classification of HC vs MCI, MCI vs AD and AD vs HC, respectively the proposed deep learning model performs well in automated classification of healthy and dementia stages using combined MRI and PET modalities.

CONCLUSION

Patients had lower FC of the intralaminar and medial nuclei with the left precuneus, but not healthy controls. Abnormal FC of the medial nuclei with the left precuneus in the patient group was correlated with the Mini Mental State Examination score. The linear support vector machine classifier performed admirably in terms of accuracy, sensitivity, specificity, and area under the curve when given FC values indicating differences between groups. Dysfunction in the FC of the intralaminar and medial thalamus with the precuneum may represent a potential neural substrate for cognitive impairment during the progression of Alzheimer's disease, which in turn could lead to dementia.

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

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