Applying Artificial Intelligence model in detecting and classifying mild cognitive impairment (MCI) using EEG signals

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INTRODUCTION

The stage between the natural aging-related decline in memory and thinking skills and the more severe dementia-related decline is known as mild cognitive impairment (MCI). MCI sufferers had their memory or other mental abilities deteriorated and every year, 10 to 15 percent of MCI patients develop Alzheimer's diseases (AD) dementia.

By detecting MCI and early AD in general, it is easier to deploy proper handling, provide access to early intervention, and individuals and their families may have more chances to plan and make educated decisions about care and treatment. Compared to MRI, EEG can capture subtle changes in the temporal domain, which helps detect the MCI state early. The study aimed to utilize machine learning algorithms in detecting MCI using the resting-state EEG.

RESULTS AND DISCUSSION

FAST FOURIER TRANSFORM

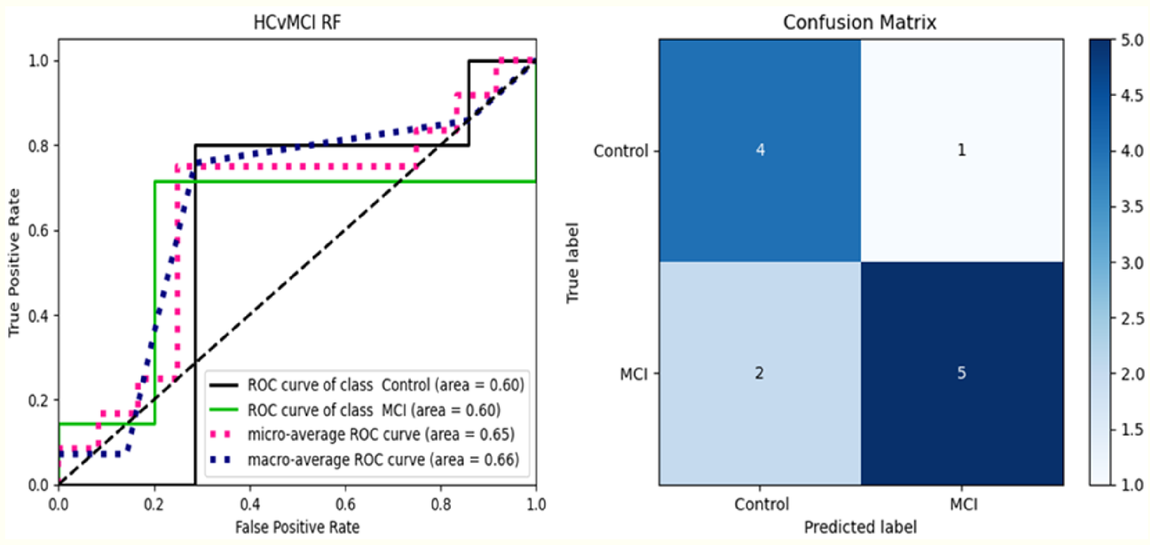

Fig. 2 ROC curves and confusion matrix of RF by FFT

FFT feature extraction	Train acc	Test acc
Linear Kernel SVM	100	58.33
Polynomial Kernel SVM	100	75
Radial Kernel SVM	62.5	58.33
SVM hyperparameter tuning	95.83	58.33
PCA - SVM	62.5	58.33
Logistic Regression	60	50
Random Forest	85	75
FDA	70	64.3
DT	65	61.11

Table. 1 Training and testing accuracy of classification models with FFT-processed data (%)

DISCRETE WAVELET TRANSFORM

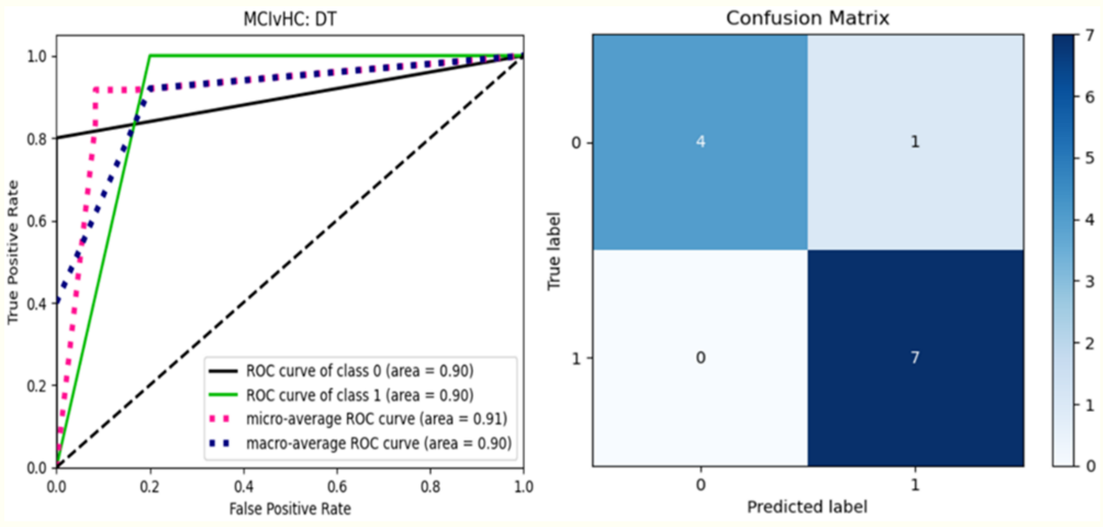

Fig. 3 ROC curves and confusion matrix of DT by DWT

CONCLUSION

In summary, this work suggested a method for classifying EEG signals from samples with neurodegenerative illnesses, which is MCI in comparison with healthy control samples (HC). The experimental samples of HC and MCI were successfully recognized with greater accuracy via the Wavelet-based signal analysis and the Decision Tree classifier than with spectral analysis with Fast Fourier Transform. The study looks forward to being broadened to include MCI, AD, and HC as the dataset used in this study also contained the data of AD patients. The analysis will also look into other kinds of classification methods such as CNN and its variations.

MATERIALS AND METHODS

CODING jupyter

DATASET **This study used the data of Fiscon et al., which comprised of EEG recordings with a total of 109 subjects: 86 patients affected by dementia (49 AD subjects, 37 MCI subjects) of which 37 men and 49 women, and 23 healthy control samples.**

RESEARCH DESIGN

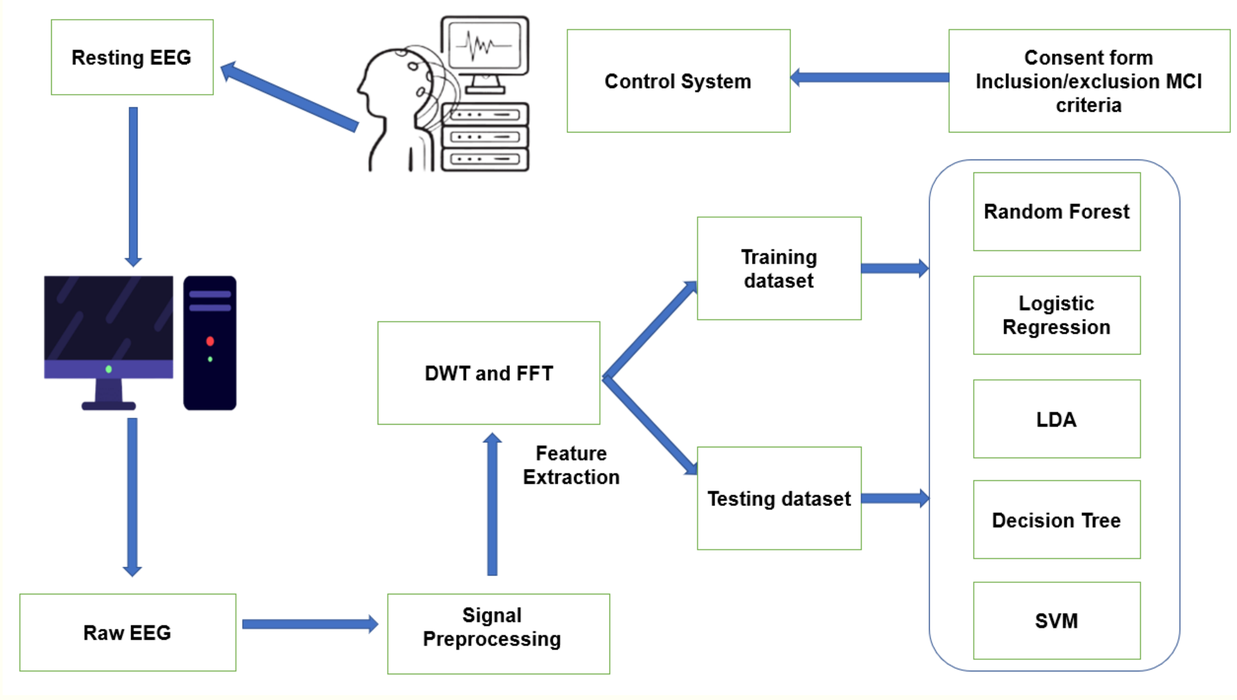

Fig 1: Overall flow of the study

FEATURE EXTRATION

16 Fourier coefficients were chosen using the FFT as the frequency domain features of EEG in each channel, totaling 19 x 16 = 304 features for each participant. By means of DWT, 48 Wavelet coefficients were chosen as the frequency domain characteristics of EEG in each channel, for a total of 19 48 = 912 features for each participant.

CLASSIFICATION

Support Vector Machine (SVM) was chosen as the mainly-focused method because it enables the regularization of hyperparameters to manage noisy datasets and over-fitting. Another method had also strongly caught this study's attention was Decision Tree (DT), as it facilitates ad hoc parameter adjustment to address noisy datasets and over-fitting. Other widely used methods for classifying EEG signals such as LR, RF and FDA were also tested.

Each method of classification listed above would go through each the extracted-features dataset of DWT and FFT for overall evaluation. The data will be split with the ratio of 80% training and 20% testing. The metrics that were utilized were accuracy score, ROC curves and confusion matrix.

DWT feature extraction	Train acc	Test acc
Linear Kernel SVM	100	33.33
Polynomial Kernel SVM	100	66.67
Radial Kernel SVM	62.5	58.33
SVM hyperparameter tuning	62.5	58.33
PCA - SVM	62.5	58.33
Logistic Regression	60	50
RF	75	66.67
FDA	53	35.7
DT	100	91.67

Table. 2 Training and testing accuracy of classification models with FFT-processed data (%)

REFERENCES

G. Fiscon, E. Weitschek, A. Cialini, G. Felici, P. Bertolazzi, S. De Salvo, A. Bramanti, P. Bramanti, M.C. De Cola: Combining EEG signal processing with supervised methods for Alzheimer's patient's classification. BMC Medical Informatics and Decision Making, 18:35, 2018.

G. Fiscon, E. Weitschek, G. Felici, P. Bertolazzi, S. de Salvo, P. Bramante, M.C. De Cola: Alzheimer's disease patients classification through EEG signals processing. In Proceedings of SSCI 2014 - IEEE Symposium Series on Computational Intelligence and Data Mining, pp. 105-112. IEEE, 2014.