

ALZHEIMER'S DISEASE SEVERITY ASSESSMENT FROM EEG

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Abstract – Alzheimer's Disease (AD) is the most common type of dementia with world prevalence of more than 46 million people. The Mini-Mental State Examination (MMSE) score is used to categorize the severity and evaluate the disease progress. The electroencephalogram (EEG) is a cost-effective diagnostic tool and lately, new methods have developed for MMSE score correlation with EEG markers. In this paper, 13 statistical and spectral features are extracted from EEG recordings acquired from 14 patients with mild and moderate AD and 10 control subjects. Multiple linear regression analysis showed highly correlation of MMSE score variation with Relative θ power, Relative β power, Multiscale Entropy and Relative α power. Also, the best statistically significant regression models in terms of R^2 were obtained at O2 (0.417) and T5 (0.390) electrodes.

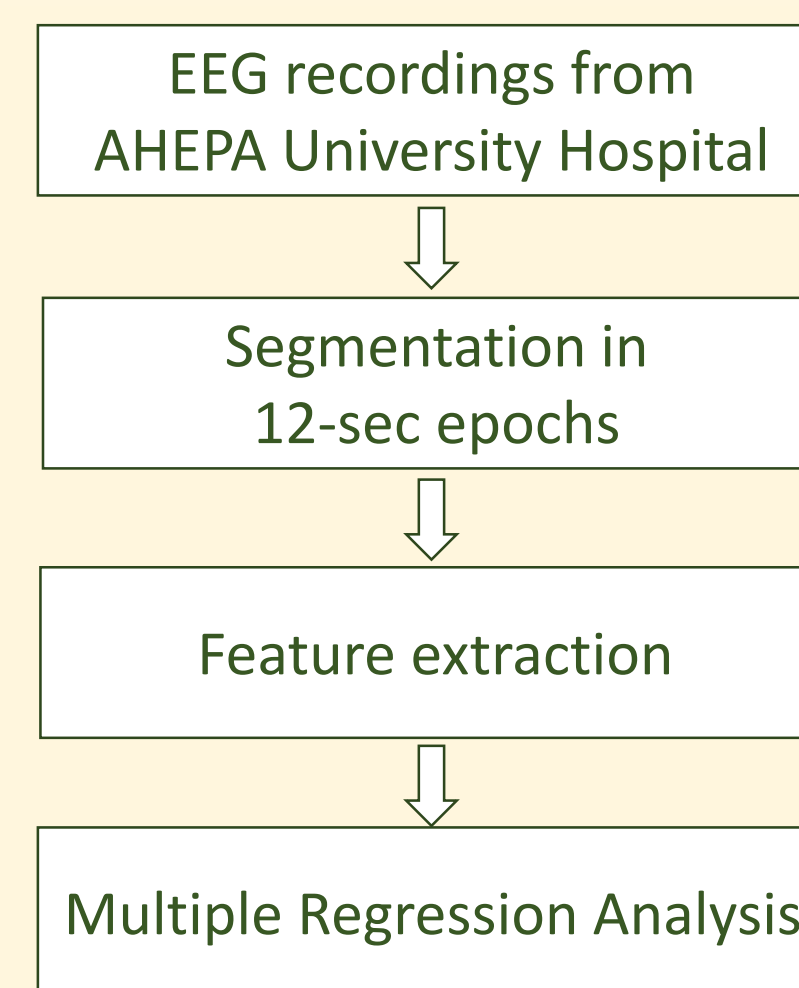
Background

- Over 46 million patients suffer from dementia worldwide.
- The Mini-Mental State Examination (MMSE) score is a 30-point cognitive questionnaire employed to assess the severity of AD, with lower score indicating more severe cognitive decline.
- Research studies have shown that there is a decrease of high-frequency EEG band power and an increase of the power of lower bands mainly at the occipito-parietal and temporal regions.

Aim

To investigate the correlation of the cognitive decline through the MMSE score with a group of statistical and spectral EEG features from AD patients. Features are extracted from EEG recordings acquired from clinical EEG recordings.

Methodology



1. Relative δ power
2. Relative θ power
3. Relative α power
4. Relative β power
5. Relative γ power
6. Shannon entropy (ShanEn)
7. Multiscale Entropy (MSE)
8. Mean
9. Variance
10. Standard Deviation (STD)
11. Interquartile Range (IQR)
12. Skewness
13. Kurtosis

Results

- ✓ The best square value of Multiple Correlation Coefficient (R^2), is obtained for O2(0.417), followed by T5(0.390). (Fig.1)
- ✓ Relative band power of all rhythms, MSE, ShanEn, Mean, and Kurtosis are the predictors that were participated in most of the regression models. (Fig.2)

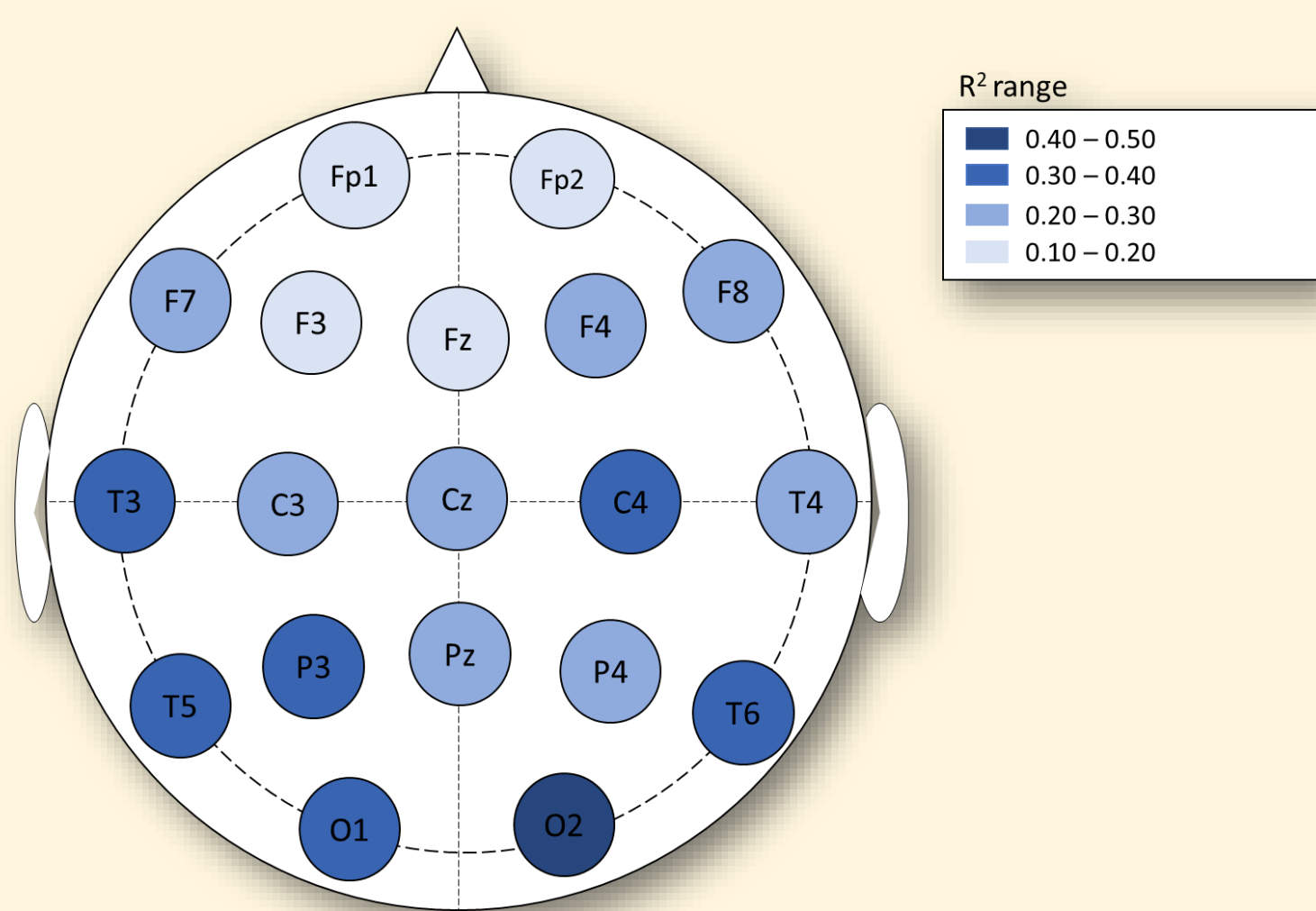


Fig.1 The contribution of each electrode site in the prediction of MMSE score.

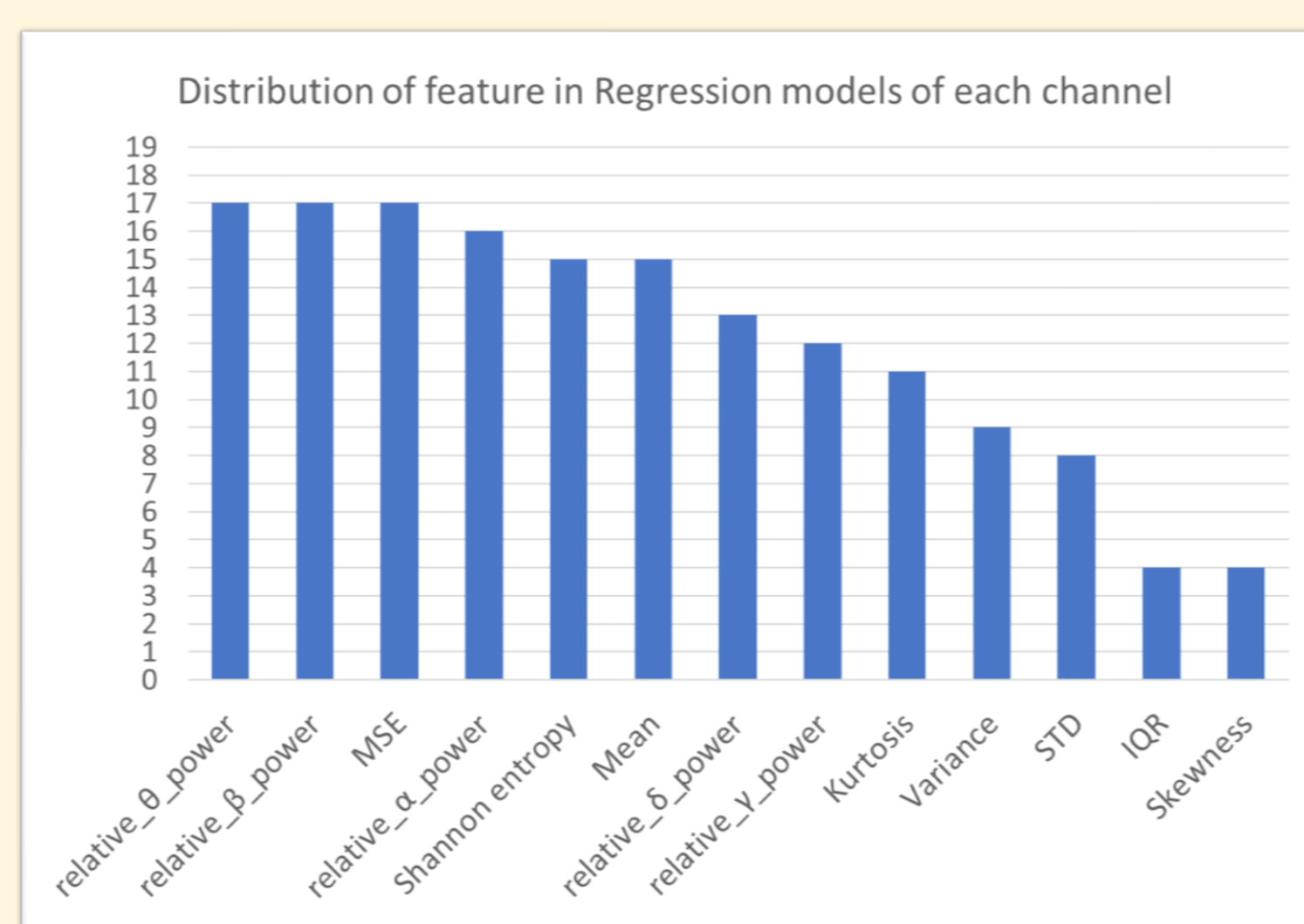


Fig.2 Representation of the contribution of significant predictors in the regression model of 19 electrodes.

Table I. Regression results in terms of R^2 for each electrode

Electrode	highest R^2	P-value
Fp1	0.147	0.002
F3	0.190	0.017
Fz	0.191	0.004
Fp2	0.103	0.032
F4	0.213	0.000
P3	0.313	0.000
O1	0.312	0.007
Pz	0.269	0.014
P4	0.272	0.002
O2	0.417	0.001
C3	0.265	0.000
Cz	0.266	0.000
C4	0.301	0.001
T3	0.317	0.000
T5	0.390	0.000
F7	0.270	0.000
T4	0.267	0.044
T6	0.356	0.018
F8	0.240	0.004

The Database

In this study, 24 subjects participated. 14 patients were diagnosed with AD, from which 6 patients with moderate AD (MMSE score 14 – 16) and 8 with mild AD (MMSE score 18 – 23), whereas 10 subjects formed the control group (MMSE score 30).

The EEG recordings were performed in the 2nd Department of Neurology of AHEPA University Hospital and 19 electrodes were used and placed according to the 10-20 International System. Participants were in an upright seated position, in a resting state with their eyes closed. Each recording was sampled at 500 Hz and lasted approximately 14 minutes forming a database of 6 hours.

Discussion

- Channels from occipital, parietal and right temporal regions showed the highest association with MMSE score variation.
- Spectral features were the best predictors.
- Statistical features (i.e. Mean and Kurtosis) were also good predictors.
- The combination of several linear and non-linear features can provide complementary information about the association of EEG markers with MMSE score.
- An extension of the study to Mild Cognitive Impairment (MCI) patients may be useful for the progression of the disease.