UNIVERSITI TEKNOLOGI MARA

CHARACTERIZATION OF EEG FRONTAL ENERGY RATIO AND KNN WITH ENTRAINED BINAURAL BEATS FOR MENTAL STATES CLASSIFICATION

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ABSTRACT

A binaural beat is a form of auditory stimulation on which two pure tones with slightly different frequencies are generated simultaneously in the left and right ear. The frequency difference between the two tones is the beat perceived by the brain. A binaural beat is believed to be able to entrain our cognitive and neural activities to synchronize with the perceived tone. Most research has been done only on the effects of the binaural-beats during stimulation. This research is carried out to explore the potential contributions of binaural beats to the entrained frontal Energy Spectrum Density (ESD) of alpha and beta sub waves for stressed subjects. The protocols involved 40 volunteers answering Depression Anxiety Stress Scale (DASS) questionnaires, after which they were segregated into two groups, namely Calm and Stress groups. Their EEG signals were recorded during three different sessions, namely "Resting", "Listen to Noise" and "After Binaural Beats". The frequency of the Binaural Beats used in this study was 10 Hz, which was intended to induce relaxation to the subjects. The EEG signals were preprocessed using Fast Fourier Transform to derive the ESD. The behaviors of the raw ESD for all sub waves was observed before the Alpha Beta Frontal Energy Ratio (ABFER) was calculated from the raw ESD. The ABFER feature was used to observe the pattern of alpha and beta sub waves in left and right hemisphere in both groups, namely Calm and Stress subjects, during the three mentioned sessions. The features selected were used as input in k-Nearest Neighbor (k-NN) classification, and the performance measures were used to determine whether the selected features were able to distinguish between Calm and Stress subjects in the three different sessions. The results showed the k-NN model managed to rule out the Stress subjects with a high accuracy of 87.5% during all sessions except the "Listen to Noise" session. The classification results were then validated using K-Fold Cross-Validation, with the highest accuracy of 90% obtained during "After Binaural Beats" session. In summary, the findings have shown that ABFER feature has the potential to be a marker to identify stress subjects, while the k-NN technique managed to classify calm and stressed subjects based on this feature. The novelty of this research is the analysis on the behaviors of the frontal alpha and beta ESD during noise stimulation and post binaural beats of Stress subjects.

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