PhD Thesis Title: **Analysis of Electroencephalogram as a pre screening tool for identification of Schizophrenia**
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Abstract:

Schizophrenia (SCH) is one type of psychiatric disorder and it is characterized by either positive or negative psychotic symptoms. The diagnosis of SCH is completely based on the Diagnostic Statistical Manual for Mental Disorders IV (DSM-IV). Many researchers began to investigate SCH using a variety of noninvasive brain imaging methodologies. But these methodologies are not fully incorporated into the clinical practice. Therefore, this research motivation is to find a suitable clinical diagnostic tool to assist the existing diagnostic methods. Electrical activity of the brain can be studied using Electroencephalogram (EEG). An EEG has some advantages over other imaging methods in terms of low cost, high temporal resolution and non-invasiveness. It does not expose the subject either to high-intensity magnetic fields or ionizing radiations. Therefore, the objective of this thesis is to analyze the EEG of SCH to determine whether it can be used as a pre-screening tool to identify SCH.

The protocol involves recording conventional EEGs and recording EEG during mental activity. The conventional method of EEG recording follows these conditions: resting with eyes closed, Hyperventilation (HV), Post-Hyperventilation (PHV), and photic stimulation (PS) where the PS is performed at various frequencies. Two modified visual odd ball stimuli are designed to record EEG during mental activity, and they are named as Stimulus1 and Stimulus2. In both stimulus1 and stimulus2 baby pictures are used as target and pictures like flowers, animals, sceneries are used as non-target. Stimulus1 is designed to induce more mental activity than stimulus2, therefore it is referred as strong stimulus whereas stimulus2 is called as weak stimulus. An EEG is recorded totally from 52 SCH and 29 normal subjects during the four conventional conditions and during the presentation of two stimuli. Eye blink artifacts in the EEG signal were removed using ICA LAB with AMUSE algorithm.

Initially, the EEG signal is analyzed using power spectrum analysis. The power spectrum study is carried out in two ways: absolute power analysis and peak power and frequency analysis. To study the characteristic changes of EEG, absolute power of delta (δ), theta (θ), alpha (α), and beta (β) band were calculated and they are the selected features. The EEG signal is filtered with a band pass filter, then the Welch power spectrum is used to estimate the power for each EEG band. These power values are analyzed between the two groups in various recording conditions. The student's t-test is used to find statistically significant features. In each recording conditions, some features were statistically significant. However, α_{pr}($p<0.0001$) was found to be more discriminative in all recording conditions used. Peak power and peak frequency of δ, θ, α, and β bands were also considered as features and analyzed. Out of eight features analyzed, θ_{PF} ($p<0.0001$) becomes statistically significant in all recording conditions used. The non-linearity of brain signal was studied by finding Information Entropy (InEn), Shannon Entropy (ShEn), Spectral Entropy (SpEn), Higuchi's Fractal Dimension (HFD), Kolmogorov Complexity (KoC) and Approximate Entropy (ApEn). In this complexity analysis, HFD ($p<0.0001$) was identified as a discriminative feature used in all the recording conditions.

The significant features from absolute power, peak power and the corresponding frequency and complexity analysis in each recording condition were grouped according to the recording conditions (rest, HV, PHV, PS, Stimulus1 and stimulus2). Thus totally six feature sets were formed. In addition to that, five feature group combinations such as the 'st12' (stimulus1+stimulus2 features), 'con (all conventional condition features)', 'const1 (conventional and stimulus1 features)', 'const2' (conventional and stimulus2 features) and 'All'(all recording condition features) were formed. Then, it was tested initially with a Back Propagation Network (BPN) classifier. 70 % of the data set was used for training, whereas the remaining 30% were used for testing purposes. The significant features from all three analysis, were joined according to the 11 feature set combinations. The BPN feature was designed to set the corresponding to 'All'. This produced a maximum a sensitivity of 96 % and a specificity of 90 %. Another widely used classifier namely, the Support Vector Machine (SVM) was also used. The SVM produces the highest sensitivity of 98 % and a specificity of 95 %, for the feature set corresponding to 'const1'. Thus it can be concluded that the SVM classifier is better than the BPN for the const1 feature set for discriminating SCH from normal.

The 'const1' feature set consists of significant features obtained from the conventional EEG and stimulus1 EEG recorded. Thus, it can be concluded that, EEG during mental activity strongly support with routine clinical EEG for discriminating SCH. Therefore, the EEG can be used as a pre - screening tool to identify SCH.

References to author publications that relate specifically to the dissertation:

1. **Thilakavathi B,** Shenbaga Devi S, Malaiappan M, Bhanu K. "Power spectrum analysis of Schizophrenia during relaxed condition with eyes closed". Global academic network conference Proceedings, Science and Technology, Chicago, USA. 2014**;** 3, pp 99-110.

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