# INVESTIGATION OF METHODS TO DEVELOP A SYSTEM FOR HUMAN PSYCHOLOGICAL STATE DETECTION

Ranathunga Arachchillage Madhura Prageeth Ranathunga

(088394)



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Department of Electronic & Telecommunication Engineering

University of Moratuwa
Sri Lanka



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## Abstract

Stress is considered a major concern of the modern world as it negatively impacts social stability by hindering performance, efficiency and overall health of people. It is the leading cause of serious life threatening diseases such as heart disease, stroke, high blood pressure, cancer and many psychological disorders. Therefore solutions are constantly researched as it has become a severe issue in the fast paced world especially western nations where they have encountered drastic consequences. The only solution that can counteract stress is relaxation. The western approach to stress management is mainly through psychotherapy and external stimuli such as brain synchronous music, while the eastern approach tends to go into deeper relaxation through meditation.

It's not possible to detect stressed/relaxed psychological states directly, it is essential to study the physiological cues through which it manifest in order to detect it. According to literature different research studies have used cues Heart Rate Variation (HRV), skin temperature, Galvanic skin response, Respiration patterns, Electroencephalography (EEG) as physiological cues, however very few research studies have been carried out focusing on physiological effects of eastern relaxation techniques. Heart rate and Electroencephalography (EEG) were selected as physiological variables during this research and most importantly both western and eastern approaches to relaxation have been analysed together with counterpart stress. Stressed state triggered using arithmetic stressors and stressful videos while relaxed state generated by meditation and relaxation music. Nonin 4100 pulse oxymeter and Emotiv EEG headset were respectively used for capturing raw heart rate and EEG signals.

Fourier techniques have been widely used while wavelet techniques have been occasionally used for Heart rate and EEG data processing as per the literature, decided to proceed with wavelet packet decomposition as it allowed both frequency and time localization of the signal with much reasonable accuracy. Matlab together with EEGLAB was used as the data processing tool during entire research.

Heart Rate signals' Power characteristics of Low Frequency (0.04 - 0.15 Hz) and High Frequency (0.15 - 0.5 Hz ) bands, which correspond to sympathetic and parasympathetic activities were analyzed. Further power characteristics of Delta, Alpha, Beta and Gamma rhythms of EEG singals were analyzed for each test case, each channel.

The results of the experiments were in par with the results suggested by current literature for common stress and relaxation test cases, importantly additional test case meditation triggered high power in Alpha EEG rhythm and high frequency band of Heart rate signals. It was possible to identify that db2 (sym2), db8, sym7, coiflets4 and coiflets5 wavelets can be used for heart rate based analysis, in addition to db4 & db5 which were used in literature. Noticed that the EEG channels corresponding to occipital regions are the best channel locations that have to be analyzed to identify psychological state, while it's possible to use db6, db7, db8 coif2, coif3, coif4, coif5, sym5, sym6, sym7 and sym8 wavelets in addition to db4 and db5 which were generally used in literature for EEG related analysis.

Accuracy of the test setup can be further improved by incorporating more physiological cues and by identifying best techniques for filtering, rejecting artifacts of EEG signals. Further, state identification process needs to be automated while integrating a data mining tool to convert setup to a real-time psychological state detection and management tool.



Keywords: Psychological states, Physiological cues, Electroencephalography (EEG), Heart Rate Variation (HRV), Wavelet Packet Decomposition

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| ANOVA | Analysis of Variance |
| ANS | Autonomic Nervous System |
| CNS | Central Nervous System |
| Coif | Coiflets |
| CV | Coefficient of Variance |
| db | Daubechies |
| EDA | Electro Dermal Activity |
| EEG | Electroencephalography |
| FFT | Fast Fourier Transform |
| GSR | Galvanic Skin Response |
| HF | High Frequency |
| HRV | Heart Rate Variation |
| ICA | Independent Component Analysis |
| LF | Low Frequency |
| RM | Relaxation Music |
| RMS | Root Mean Square |
| RT | Relaxation Techniques |
| STFT | Short Term Fourier Transformation |
| Sym | Symlets |
| WPD | Wavelet Packet Decomposition |