

Abstract

Alertness in human beings is the state of paying close and continuous attention and/or the cognitive process of selective concentration on one aspect of the environment. Maintenance of a performance level over time calls for sustained vigilance, selective attention and complex decision-making abilities. Fatigue is a significant cause of drop in alertness levels. Several approaches for tracking change in level of alertness of human beings using physiological signals have been reported, of which Electro-encephalogram (EEG) and blood biochemical-based methods have reported the best accuracy. EEG is sensitive to decreasing alertness and decline in vigilance and has been shown to predict performance degradation due to continuous mental work. EEG has widely been used to judge the alertness level of an individual during monotonous tasks or tasks requiring sustained attention or response to specific stimuli. The present thesis deals with the use of EEG-based methods for the study of drop in alertness levels in human subjects due to fatigue. The work includes results of experiments to induce fatigue by sleep deprivation and due to continuous and repetitive performance of cognitive tasks. A complex brain network structure has been developed for study of fatigue and sleepiness at different stages of a sleep-deprivation experiment and analysed using standard network parameters. An experiment design for the study of fatigue induced due to continuous and repetitive performance of cognitive tasks has been presented and a multimodal scheme for the detection of alertness level of a subject based on EEG, speech and ocular features has been proposed. A novel scheme for analysis of dynamic characteristics of brain networks using Motif Synchronization has been presented. A method for calculation of EEG complexity using a combination of a motif series and the effort-to-compress technique has also been proposed.

Keywords: Alertness, EEG, Visibility Graph, Complex Network, Motif Synchronization, EEG Complexity.