

ABSTRACT

Drowsiness is a condition characterized by decreased alertness, attention, and reaction speed due to various factors such as sleep deprivation, circadian rhythm, physical fatigue, and cumulative lack of sleep. Existing drowsiness detection systems still have limitations in the ability to monitor two physiological signals simultaneously. This study designs a drowsiness detection system by simultaneously utilizing eye (EOG) and brain (EEG) biopotential signals to provide early warnings of drowsy conditions.

The system uses Ag/AgCl electrodes for signal acquisition, Biopotential Amplifier (BioAmp) circuits for signal amplification with actual gain of 855-880 times, and analog filters with bandwidth of 3.4-492.5 Hz. 4th-order IIR Butterworth digital filters are implemented to filter EEG signals (4-30 Hz) and EOG signals (1-15 Hz). Blink detection is analyzed using thresholding method, while brain activity is analyzed using Fast Fourier Transform (FFT) and Power Spectral Density (PSD). Drowsiness level classification is performed based on Relative Power Level (RPL) values from theta waves (4-7 Hz), alpha waves (8-13 Hz), and beta waves (13-30 Hz), as well as the number of eye blinks within 10 seconds, with four categories: Normal, Suspected Drowsiness, Light Drowsiness, and Heavy Drowsiness.

Test results on four subjects for five minutes showed that the system was able to detect drowsiness condition transitions every 10 seconds in real time. Out of 24 total detections during the test, the system consistently distinguished between light and heavy drowsiness conditions and recognized transition patterns based on changes in brainwave dominance.

Keywords: Drowsiness, EEG, EOG, FFT, PSD, Thresholding, BioAmp, Relative Power Level.