

Introduction

Electroencephalography (EEG) plays a crucial role in the study of sleep by monitoring brain activity and distinguishing various sleep stages. Sleep can be divided into rapid eye movement (REM) stage and non-rapid eye movement (NREM) which is further divided into stages N1, N2, and N3 each characterised by distinct EEG patterns. This project aims to detect and classify sleep stages based on EEG signal characteristics, focusing on variations in frequency, amplitude, and rhythmic patterns.

Materials and Methods

The signal provided was a one overnight single lead EEG recording of about 6 hours and 15 minutes, acquired at 100 Hz, by a device placed on the forehead in an adult subject.

The signal was pre-processed using MATLAB software, applying filters at specific frequencies (including a Notch filter to remove artefacts at 1 Hz and 2 Hz and band-pass filter between 0.5 Hz and 30 Hz to enhance the relevant information of EEG) followed by the division into 30 seconds epochs of the EEG data. For each epoch the Fast Fourier Transform (FFT) was computed and the percentage of each rhythmic pattern was calculated.

This frequency analysis allowed the detection of delta, theta, alpha, and beta activity that needed an overfitting so that the threshold frequencies were adjusted in order to have the values indicated in the literature for each sleep stage.

Results and Discussion

Distinct changes in EEG signal characteristics were observed across the different sleep stages.

During wakefulness, the brain shows mainly alpha waves. As sleep begins, in stage N1, alpha waves decrease, giving way to slower theta waves. In stage N2, theta waves dominate, accompanied by decrease of alpha and delta waves. Stage N3, or deep sleep, is predominantly marked by delta waves, the slowest and highest amplitude brain waves. Finally, REM sleep involves mixed frequencies, with theta and beta waves which resemble wakefulness.