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Optimized EEG based mood detection with signal processing and deep neural networks for brain-computer interface

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Abstract

Electroencephalogram (EEG) is a very promising and widely implemented procedure to study brain signals and activities by amplifying and measuring the post-synaptical potential arising from electrical impulses produced by neurons and detected by specialized electrodes attached to specific points in the scalp. It can be studied for detecting brain abnormalities, headaches, and other conditions. However, there are limited studies performed to establish a smart decision-making model to identify EEG's relation with the mood of the subject. In this experiment, EEG signals of 28 healthy human subjects have been observed with consent and attempts have been made to study and recognise moods. Savitzky-Golay band-pass filtering and Independent Component Analysis have been used for data filtration.Different neural network algorithms have been implemented to analyze and classify the EEG data based on the mood of the subject. The model is further optimised by the usage of Blackman window-based Fourier Transformation and extracting the most significant frequencies for each electrode. Using these techniques, up to 96.01% detection accuracy has been obtained.

1. Introduction

Human brains consist of chains of interconnected neurons which transmits messages by passing electrical signals. Due to different circumstances, like hyperactive neurons, inflammation, tissue damage, etc neurons can pass abnormal impulses [1]. Electroencephalogram is a method by which specialized electrodes are connected to different parts of the brain to amplify and record the magnitude of the post-synaptic potential. Different frequencies of the electrodes decipher impulses of different neuron clusters of the brain. The recorded signals can be then visualized to extract several features helpful in understanding brain waves [2]. International measures have been implemented to standardize the electrode placement points and their identification known as Modified Combinatorial Nomenclature (MCN). Electrodes placed at Pre-Frontal, Frontal, Temporal, Parietal, Occipital and Central lobes are denoted by 'Fp', 'F', 'T', 'P', 'O' and 'C' respectively. The naming scheme of intermediate points of two consecutive major lobes has additional rules. 'AF' series lies from 'Fp' to 'F', 'FC' between 'F' and 'C', 'FT' between 'F' and 'T', 'CP' between 'C' and 'P', 'TP' between 'T' and 'P' and finally 'PO' between 'P' and 'O'. Figure 1 shows the placement position of the electrodes with naming according to MCN nomenclature that has been used for the experiment [3, 4].

As the brain controls our thinking and moods, therefore studying the brain signals can also indicate the mood of an individual. Several studies have been performed earlier to understand the brain signal to understand mood, however, there are very few approaches to establishing a smart decision-making system to understand the mood of a human [5]. Therefore with this experiment, attempts have been made to create an artificially intelligent decision-