Speed Classification of Upper Limb Movements Through EEG Signal for BCI Application

ABSTRACT

Brain-Computer Interface (BCI) systems have obtained remarkable results in rehabilitation and robot control processes by converting brain signals into control commands. The quantity of movement speed is the fundamental issue in BCI that requires additional research. This paper investigated the classification of the slow and fast speeds of eight different upper limb movements through electroencephalogram (EEG) signals and information about the values of speed and maximum angle of movements from the MPU6050 module. Datasets were obtained by recording the EEG signals from 10 subjects and the module information connected on their right hand during movements. This study used Filter Bank Common Spatial Pattern (FBCSP) and Wavelet-Common Spatial Pattern (W-CSP) methods to extract speed features of movements. In both methods, features selected by the Mutual Information (MI) were sent to the Convolution Neural Network (CNN) and various machine learning classifiers. Due to the results of subject-independent speed classification, the FBCSP-CNN method obtained the highest accuracy of 90% with a Kappa coefficient of 0.8 for flexion/extension of the shoulder. Results from our proposed method demonstrate the ability to introduce a refined set of control commands into the BCI system by recognizing the features associated with the speed of movement parameters.