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| **Abstract:** |  |
| **Electroencephalogram (EEG) is the most significant signal for brain-computer interfaces (BCI). Nowadays, motor imagery (MI) movement based BCI is highly accepted method for. This paper proposes a novel method based on the combined utilization of principal component analysis (PCA), wavelet packet transformation (WPT), and two-stage machine learning algorithm to classify four-class MI EEG signal. This work includes four-class MI events by an imaginary lifting of the left hand, right hand, left foot, and Right Foot. The main challenge of this work is to discriminate the similar lobe EEG signal pattern such as left foot VS left hand. Another critical problem is to identify the MI movements of two different feet because their activation level is very low and show an almost similar pattern. This work firstly uses the PCA to reduce the signal dimensions of the left and right lobe of the brain. Then, WPT is used to extract the feature from the different class EEG signal. Finally, the artificial neural network is trained into two stages – 1st stage identifies the lobe from the signal pattern and the 2nd stage identifies whether the signal is of MI hand or MI foot movement. The proposed method is applied to the 4-class MI movement related EEG signals of 15 participants and found excellent classification accuracy (>74% on average). The outcomes of the proposed method prove its effectiveness in practical BCI implementation.** | |