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Button press detection from EEG signals using deep learning

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Motivation and Aim: Electroencephalogram (EEG) signals are mainly used for neuroscience studies and for BCI applications with a rising trend. Majority of the work includes conducting experiments with different paradigms, and studying the results of experiments for scientific discoveries or for various practical applications. It is likely that in the near future, all EEG related scientific discoveries will combine into one comprehensive automated EEG analysis framework where different paradigms can be analyzed in terms of detection of events, markers and signals of interest. In this study we created an application which estimates time of button press actions from stop-signal paradigm EEG recordings, using deep learning methods. And verified the proposed deep learning model's inter subject compatibility by using one-left-out cross validation method for 11 subjects.

Methods and Algorithms: We down sampled EEG data by 20 and added extra dimension to the data in order to allow compatibility with 2D convolutional layers. And for the model we utilized 3 convolutional layers with filter sizes of 64, 32 and 16 respectively. And as a loss function as well as accuracy metric, we used Root Mean Square Error (RMSE). To have more interpretable results we also used L1 distance as secondary accuracy metric.

Results: For intra subject experiment, we split the dataset into train and test dataset and trained it for 300 epochs. During the training, minimum RMSE were detected as 6.04 and minimum average L1 distance of 40.4 ms also observed. For inter subject experiments, we calculated RMSE and L1 for all test subjects during left-one-out iteration and take average of these results. Average min RMSE was calculated as 5 and average of minimum average L1 distance of 14.2 ms also calculated.

Conclusion: The results obtained during these experiments shows that proposed model successfully decodes spectral features related to button press task in EEG data. And it can be used without further calibration for various Brain Computer Interface (BCI) applications as well as part of experimental marker detection framework for Stop Signal Paradigm experiments.

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