Human Behavior Recognition Ssing Brain LFP Signal in the Presence of the Stimulation Pulse

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Comments

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Design and Methodology

This study concentrates on human behavior classification task using local field potential (LFP) signals recorded from three subjects with Parkinson's disease (PD). Existing approaches mainly employ the LFP signals acquired under the stimulation/off condition. In practical situations, however, it is necessary to design a classification method capable of recognizing different human activities under the stimulation/on condition, where the classification task is more complicated due to the artifacts imposed by the high amplitude stimulation pulse (~1-3volts). We utilize the time-frequency representation of the acquired LFPs in the Beta frequency range (~10-30Hz) to develop a feature space based on which the classification is efficiently performed while the high frequency stimulation pulse (~130-180Hz) has no/limited impact on the classification performance.

Original Data and Results

All three participants had undergone DBS surgery with implanted DBS leads (Medtronic 3389, Minneapolis, MN, USA) in the subthalamic nucleus of the brain. The recording sessions required the participants to do several repetitions of designed "button press" and "reach" trials under the condition of stimulation on/off. On average, 60 recordings were performed for each trial. Our analysis on the power spectral density (PSD) of the data showed that the stimulation pulse mostly impacts the frequency components around the stimulation frequency (~140Hz). Using a linear-kernel SVM classifier for classifying the aforementioned trials based on the proposed feature space, we obtained a classification accuracy of ~88% and ~87% respectively for stimulation off and on cases.

Conclusion

PD incidence increases with advancing age and peaks among people in their 60s and 70s. The cost of PD in the United States is estimated to be $25 billion per year. Thus, advanced techniques to improve the performance of existing devices are highly demanded. Human behavior classification from brain signals is essential in developing the next generation of closed-loop deep brain stimulation (DBS) systems. A closed-loop DBS system that utilizes appropriate physiological control variables may improve therapeutic results, reduce stimulation side effects, and extend battery life of pulse generators.

References

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