

Sensor and wearable/ambulatory technology and applications

ADJUSTING DBS SETTINGS TO OPTIMIZE PARKINSON'S CONTROL THERAPY

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AIMS:

Parkinson's Control Therapy by Deep Brain Stimulation (DBS) is used to reduce Parkinsonian symptoms in late stage Parkinson's Disease. Clinicians adjust pulse amplitude, pulse width, frequency, and electrode selection to maximize symptom suppression while minimizing side effects. There is a need for developing a quantitative method for performing these adjustments. The aim of this study was to characterize the effects of DBS parameter adjustments through the use of wearable sensors in order to optimize Parkinson's Control Therapy.

METHODS:

Five subjects with implanted DBS for Parkinson's Control Therapy were recruited in the study. Single-axis accelerometers were placed on the lateral aspect of the upper and lower arms, thighs, and shins and were oriented in the anteroposterior direction. EMG electrodes were attached to the biceps, triceps, finger flexor, and finger extensor muscles on the more affected side and to the tibialis anterior and the gastrocnemius medialis muscles on both legs. Subjects performed selected tasks from the UPDRS for 30 s including finger tapping, finger to nose, heel tapping, and walking. Tests were performed with the DBS on, immediately after turning the DBS off with more tests every 30 min afterward, and finally after the DBS was turned on again. Five-second windows were selected to extract features including the RMS value, the dominant frequency, an index of periodicity, the range of the autocovariance function, the approximate entropy, and cross-correlation coefficients for pairs of sensors. Data visualization was obtained using Principal Component's Analysis (PCA) combined with Sammon's Mapping to identify trends in the severity of symptoms.

RESULTS:

Significant changes in tremor, bradykinesia, dyskinesia, and gait patterns were seen between tests with the DBS on and off. In addition to these drastic changes, the system was also able to detect small changes between the tests where the DBS remained off. Figure 1 shows the difference in tremor between the on and off states for one subject. Tremor can be seen in both the accelerometers and EMG when the DBS is off while no tremor is visible when the DBS is on. These changes are captured by the dominant frequency, index of periodicity, and RMS values. Visualizations of these features showed the severity of the tremor changing between tests as the DBS remained off.

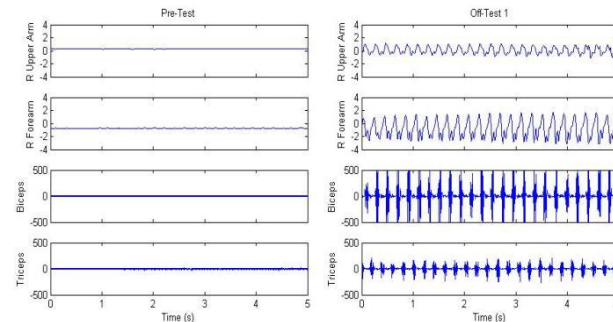


Figure 1. Patterns associated with tremor with the stimulator on (left panel) and the stimulator off (right panel).

CONCLUSIONS:

This work shows the ability of our system to detect changes in Parkinsonian symptoms caused by turning the DBS on and off. The system showed the ability to detect small changes in symptoms while the DBS remained off. This observation suggests that the system has the potential to detect changes in symptoms caused by DBS parameter adjustments. Future work will focus on predicting clinical scores based on features extracted from the sensor data.