Comparing Tremor Detection Algorithms Using Acceleration Data from an Android Smartphone

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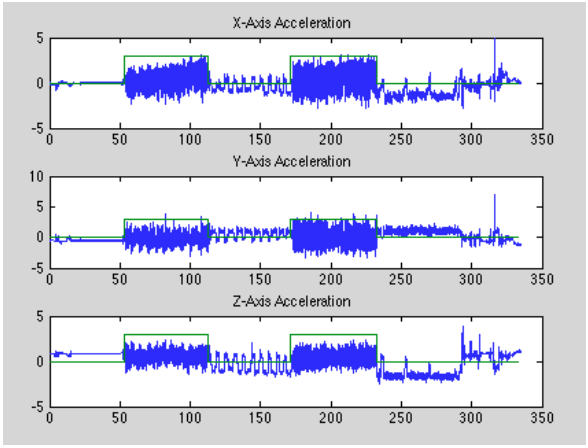
PEOPLE with Parkinson's disease (PD) often exhibit tremors on one or both sides of their bodies. These tremors are seen especially in the arms and hands, and their severity changes based on a host of factors such as stress, alcohol consumption, and medical treatment. Currently PD specialists do not have the resources to monitor patient symptoms over an extended period of time, and, in many cases, intermittent clinical visits do not provide enough information on patients' responses for effective treatment management. A system that continuously monitors patients' signs and conveys such information to a physician would result in improved treatment strategies.

In this study, we collected and analyzed tri-axial accelerometer data and timing information from an Android device using a custom "app." We collected data from the movements of five healthy adults as well as data from subjects who simulated symptoms of Parkinson's.

The data was bandpass filtered to suppress signals outside of the frequency range of a Parkinsonian tremor, 4 to 6 Hz. Sections of the signal were integrated over running intervals. If the integrated signal exceeded a certain threshold, then the presence of a tremor was indicated. ROC analysis was used to observe how the probabilities of true and false detections changed as a function of the threshold value. The green lines in the accompanying figure indicate times that were determined to be part of a tremor for one example sequence of filtered data. Of particular interest was the determination of which type of bandpass filter allowed the fastest and most effective detection of tremor.



The above figure shows tri-axial z-scored accelerometer data over 5.5 minutes with two 30-second tremors at 50 and 175 seconds. Movement at other times is healthy. The green lines indicate the detection of a tremor.

Parks-McClellan, Hamming Window, and Least Squares designed filters were compared. The Least Squares and Hamming Window bandpass filter yielded fewer false tremor detections than did the Parks-McClellan filter. The Least Squares filter is 30% slower than the other two filters, making it less suitable for large amounts of data. Our analysis strongly suggests that data collected using an Android accelerometer app and analyzed with a bandpass filter should be able to provide an accurate log of tremor signs. Further, based on our limited dataset, a bandpass filter using a window design appears to be the best choice.

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