Remote Tremor Monitoring System

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Objective

Develop a system for at-home tremor monitoring in people with Parkinson's disease and other movement disorders which cause tremor.

Background

- Parkinson's disease (PD) is a neurodegenerative disorder that causes the progressive death of dopaminergic neurons and subsequent loss of movement control.
- PD treatment is based around alleviating the symptoms and maximizing quality of life.
- Neurological evaluations of overall severity are inherently subjective and can only be based on a brief glimpse at the patient during an appointment, causing numerous problems in both research and clinical practice.

Methods

Data Acquisition

PineTime Smartwatch:

- Open source smartwatch that uses the Infinitime real-time operating system and features a Nordic nRF52832 microcontroller and a BMA425 accelerometer.
- The smartwatch samples acceleration data at 100 Hz, stores data 2 minutes at a time, and transfers the data to the SBC via Bluetooth.

Data Analysis

Libre Computer Renegade:

- Single-board computer running the Ubuntu operating system that functions as a base station for the watches.
- Receives watch data, performs signal preprocessing, and assigns a score to the tremor data based on tremor severity.
- Converts data and insights into the JSON file format, uploads it to web interface for display for health care practitioners, and stores it for future use

Data Analysis Continued

- An open-source dataset with 40 hours per patient of accelerometer data collected from the limbs of both healthy and PD patients was obtained
- Short-Time Fourier Transform was performed on the data with 4 second windows and 50% overlap, and the windows were averaged over 2 minute intervals.
- Tremor severity was calculated by finding the ratio of the peak power spectral density (PSD) value to the PSD values 2 Hz away from the peak on either side and multiplying that value by the band power of a 2 Hz band centered on the peak PSD value.

Web Interface

- The web interface visualizes the tremor data after being analyzed and going through a classifier.
- Application was developed using the Angular framework consisting of HTML, CSS, and TypeScript (JavaScript).
- Bar chart visualizes data for a 12-hour time period in that day. Each bar represents a range in severity during a 12-minute segment.

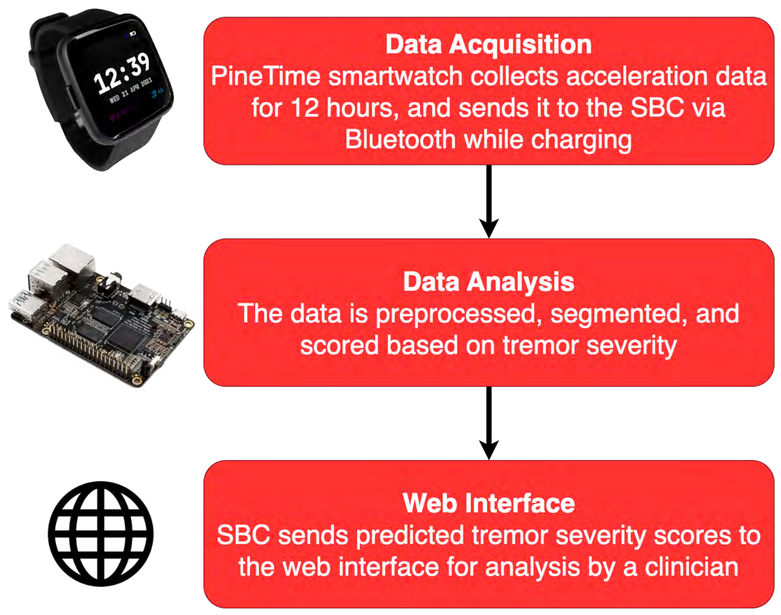

Figure 1: General system workflow

Results

- The smartwatches can successfully store and transmit accelerometer data to the SBC
- The tremor scoring method resulted in a mean of 220 intervals with a tremor score above 0 in PD patients and just 67 in controls.
- The SBC is able to convert both the raw data and tremor severity ratings to JSON format, and upload them to the web interface for display

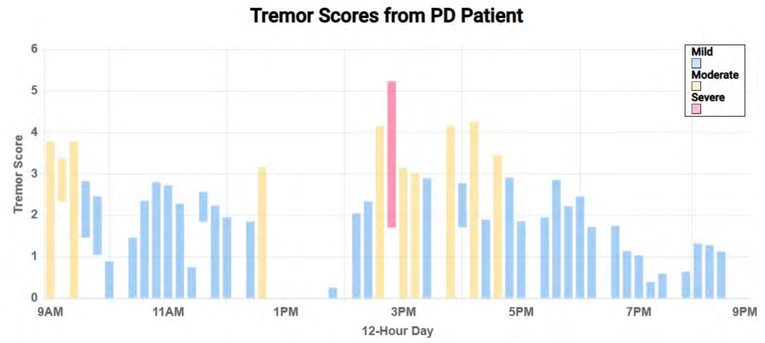

Figure 2: Tremor severity graph as depicted on the web interface

Conclusion

- This system records and classifies tremor data to allow physicians to analyze and optimize treatment for PD patients.
- By providing clinicians and researchers with access to more quantitative insights, better efforts can be made to improve the understanding and treatment of Parkinson's disease and other movement disorders.
- The system could potentially be improved by experimenting with other features, or developing a more cost-effective way of receiving, processing, and uploading the data.

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