Deep Brain Stimulation Monitor with Galvanic Vestibular Stimulation Device to Reduce Parkinsonian Tremors and Imbalance

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A device that counters tremors and improves balance in patients with Stages 3-4 Parkinson’s Disease to allow them to perform everyday tasks.

Need Specifications

<table>
<thead>
<tr>
<th>Must Have</th>
<th>Measurable Quantity</th>
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<tbody>
<tr>
<td>Detects and Corrects Tremors</td>
<td>Detects tremors with 90% accuracy and successfully subdues episodes</td>
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<tr>
<td>Detects and Corrects Imbalance</td>
<td>Detects imbalance with 95% accuracy and is successful in its correction</td>
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<tr>
<td>Long term use</td>
<td>Sustainable and fully functioning for up to 3-5 years</td>
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<tr>
<td>Affordable</td>
<td>Under $1000</td>
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<tr>
<td>Comfortable</td>
<td>Minimal average comfort rating of 8/10 based on user survey</td>
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<tr>
<td>Non-invasive (no surgery)</td>
<td>Does not require the use of surgery nor invasive procedure for use</td>
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<tr>
<td>Portable</td>
<td>Capable of being easily worn by patient throughout everyday tasks</td>
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Technology Analysis

(2) Deep Brain Stimulation
- Expensive and invasive surgery that implants two electrodes into the motor cortex to reduce tremors
- Short battery life because constantly on
- Risk of overstimulation

(3) Galvanic Vestibular Stimulation
- Sends electric signals to electrodes on the mastoid process to alter sense of balance
- Bulky and non-portable
- No clinical application

Concept Analysis

Motor cortex

- GVS component detects and corrects imbalance
- Wristband analyzes arm and hand tremors and controls GVS system
- Electrical components connected via Bluetooth

Data Collection

To collect data about tremors, we simulated daily tasks with and without tremors. By using a mobile app (Vibsensor) that performs Fourier Transform to graph the accelerometer data in the frequency domain, we determined that the approximate frequency of Parkinsonian tremors is 5 Hz.

Competitor Analysis

(4) LaserCane
- Improves balance and freezing but not tremors
- Higher risk of falling since patient must focus downwards

(5) GyroGlove
- Improves tremors but not balance
- Expensive
- Bulky and uncomfortable

Prototype

Functional Tremor-detecting Wristband:
- Due to time constraints, we were not able to program our device to perform Fourier Transform to detect tremors. However, we wrote a program that takes a different approach: it calculates the rate of change of the acceleration in order to distinguish tremors.
- Blue LED turns on when tremors are occurring
- White LED simulates the electric signal being sent to the implanted DBS system; turns on only when tremors persist for longer than 6 sec and stays on for an a designated time

Adjustable elastic waistband holds power source for GVS system and connects via wires to electrodes behind the ear

Conclusions and Future Work

Our device improves current DBS technology by successfully distinguishing tremors from ordinary hand movements and syncing directly to the DBS system to activate it only when necessary, thus enhancing battery life and reducing overstimulation. In addition, it includes a more portable and compact GVS system. As a result, our device improves the detection and correction of tremors and imbalance, enabling Parkinson’s patients to live without feeling as severely handicapped by their condition.

Future Work: Connect DBS wristband to implanted DBS system wirelessly (via Bluetooth, WiFi, IR, magnetic induction, etc.)
Program GVS Arduino to send electric current proportional to imbalance

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References


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