Improved Detection of Gait Abnormalities in Parkinson’s disease using IMU Sensors

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Objective
To evaluate the ability of IMU sensor-based metrics to identify gait impairments associated with body bradykinesia in patients with Parkinson’s disease during unscripted activities of daily living.

Approach
- Body bradykinesia assessment during gait was based on impairments listed in Item 31 of UPDRS.
- An automated classifier (neural network) was designed to isolate gait activity from other activities based on leg sensor data.
- Five gait metrics were analyzed using angular velocity (gyroscope) and compared during presence and absence of bradykinesia.

Methods
- Gait impairment metrics were calculated on the basis of angular velocity magnitude and range of movement from gyroscope data. [Refer to Analysis section]
- Statistical comparisons (Mann-Whitney-U/Wilcoxon test) were computed to test the discriminability of gait impairment metrics for bradykinesia and Non-Bradykinesia portions of the gait data. [Refer to Results section]

Data Collection

PD Subjects Demographics

<table>
<thead>
<tr>
<th>Measure</th>
<th>n (%)</th>
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<tbody>
<tr>
<td>Male/Female</td>
<td>4/2</td>
</tr>
<tr>
<td>Disease Duration</td>
<td>8.6 ± 5.4</td>
</tr>
<tr>
<td>Total Data</td>
<td>1000 ms</td>
</tr>
<tr>
<td>Bradykinesia Prevalence*</td>
<td>58.7</td>
</tr>
<tr>
<td>Hoehn Yahr</td>
<td>2.4</td>
</tr>
</tbody>
</table>

* % of Total Data w/ bradykinesia

Sensor Placement Location: Dominant TA and EDS muscles

Results
- The numbers [1–5] identify the bradykinesia gait impairments described in the Analysis. Corresponding raw angular velocity for instances with and without bradykinesia are analyzed.
- The results demonstrate that IMU sensors provide objective gait metrics with significant discriminability for bradykinesia.

Gait Cycle and Corresponding Sensor Metrics

![Gait Cycle Diagram](image)

Analysis
- The numbers [1–5] in the figure refer to the five sensor-based gait metrics that were derived to quantify gait impairments associated with bradykinesia.
- Raw gyroscope data from upper and lower limb are compared with raw Accelerometer data for the same IMU recording.
- These comparisons illustrate the greater precision in identifying data features from the angular velocity plots compared to accelerometer plots.

Conclusions
- The work demonstrates the viability to develop robust and clinically-relevant metrics for improved detection of gait abnormalities in PD.
- A subsequent study (see Adjacent Poster: Roy et al. “Automated Tracking of Body Bradykinesia...”) utilized these impairment metrics as features to train a neural network classifier to detect body bradykinesia and achieved <5% error during unscripted activities in a population of n=16 PD subjects.

Acknowledgments
Research supported in part by the De Luca Foundation and by the National Institute of Neurological Disorders and Stroke of the National Institutes of Health under award #R01NS083088.

References