High-accuracy Discrimination of Parkinson’s Disease Participants from Healthy Controls Using Smartphones

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Aim

To assess the practicality and effectiveness of inexpensive, commercially available smartphones to discriminate Parkinson’s disease (PD) participants from healthy controls.

Methods

We conducted a one-month controlled study with twenty participants, comprising 10 PD participants and 10 controls.

Using smartphones, participants conducted self-administered, short (less than 5 minutes) controlled gait and postural sway tests.

We objectively measured and quantified key movement severity symptoms of PD and analysed a wide range of summary measures extracted from the accelerometry data.

For data analysis, we used a statistical technique called Random Forest.

Participant Characteristics

Baseline characteristics of study participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Parkinso’s disease participants (n=10)</th>
<th>Control participants (n=10)</th>
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</thead>
<tbody>
<tr>
<td>Age (SD)</td>
<td>65.1 years (9.8)</td>
<td>57.7 years (14.3)</td>
</tr>
<tr>
<td>Percentage women</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Percent taking levodopa</td>
<td>90%</td>
<td>0%</td>
</tr>
<tr>
<td>Baseline motor UPDRS score (SD)</td>
<td>19.6 (6.7)</td>
<td>NA</td>
</tr>
<tr>
<td>Baseline Parkinson’s Disease Questionnaire 39 score (SD)</td>
<td>18.5 (16.9)</td>
<td>NA</td>
</tr>
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Data Collection

Data for gait and postural sway tests was collected using smartphones (cost: $30 each) that ran a specialized software program developed by the team that was capable of recording tri-axial acceleration.

For the gait test, participants were instructed to walk twenty steps forward, turn around, and return back to the starting position.

For the posture test, participants were instructed to try and stand upright for about thirty seconds at end of the gait test.

Feature Extraction

We derive useful features/summary measures from the data for analysis. We plot two features: Teager-Kaiser Energy Operator (TKEO) and Detrended Fluctuation Analysis (DFA).

Results

The 20 participants performed an average of 2.53 tests (63.25% adherence) per day for an average of 31.6 days.

To quantify classification accuracy, we use Sensitivity (true positive rate) – proportion of PD participants correctly identified, and Specificity (true negative rate) – proportion of Control participants correctly identified.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Accuracy</th>
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<tr>
<td>Sensitivity</td>
<td>98.5 ± 1.3%</td>
</tr>
<tr>
<td>Specificity</td>
<td>97.6 ± 1.8%</td>
</tr>
</tbody>
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Conclusions and Future work

Using consumer-grade smartphone accelerometers, it is possible to distinguish PD from healthy controls with high accuracy.

Future studies could investigate monitoring and predicting the severity of PD (as quantified using UPDRS or PDQ-39) using smartphone data.

Bibliography