Accelerometer Based Step Count Trackers, Are They Accurate Enough?
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Introduction
Physical activity monitoring is crucial to many chronic conditions such as heart failure, diabetes, and cancer. One of the simplest approaches to measure the physical activities that people perform daily, is to count the number of the steps they take during a day. Our goal in this study is:
1. Investigating the step count accuracy on multiple activity monitor devices under various circumstances, e.g. with walker, cane, and shopping cart.
2. Developing our own step count algorithm to detect steps from the smart phone accelerometer signals.

Methods and Data Analysis

Participants:
- 14 young adults, 1 old adult

<table>
<thead>
<tr>
<th>Feature</th>
<th>All Subjects</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>21-84</td>
<td>21-44</td>
<td>23-31</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>161-187</td>
<td>161-185</td>
<td>170-187</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>56-113</td>
<td>56-113</td>
<td>65-99</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>20.3-32.8</td>
<td>20.3-32.8</td>
<td>20.7-30.8</td>
</tr>
<tr>
<td>Stride Length</td>
<td>66.7-77.6</td>
<td>66.7-76.7</td>
<td>70.5-77.6</td>
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</tbody>
</table>

Activity Trackers
- Fitbit Charge (right hand)
- Misfit (right hand)
- Apple watch (left hand)
- Microsoft band (left hand)

Activity Tracked
- Walking with a cane
- Walking with hands in the pockets
- Walking with a shopping cart
- Walking with a walker
- Walking with a shopping cart
- Walking with a shopping cart
- Walking with a walker
- Walking with a cane

Results
Performance of the trackers (except misfit) in counting steps for each activity

<table>
<thead>
<tr>
<th>Activities</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Walking</td>
<td>11.56</td>
</tr>
<tr>
<td>Walking with gaps</td>
<td>27.18</td>
</tr>
<tr>
<td>Walking with hands in the pockets</td>
<td>21.46</td>
</tr>
<tr>
<td>Walking with a shopping cart</td>
<td>72.82</td>
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<tr>
<td>Walking with a walker</td>
<td>89.42</td>
</tr>
<tr>
<td>Walking with a cane</td>
<td>86.14</td>
</tr>
</tbody>
</table>

Conclusion and Discussion
- The overall performance of the trackers wasn’t satisfying in the experiment (60.19 < RMSE < 64.19).
- The trackers were least accurate in the activities 4, 5 and 6, as hands are not involved in walking pattern.
- Misfit demonstrated a poor performance in all the physical activities.
- The steps were more accurately detected during the physical activities with pattern close to normal walking (activities 1, 2 and 3), as the trackers showed less error while walking normally, with gaps and hands in the pockets.
- RMSE for the individuals with stride length close to average stride length tends to be less.
- RMSE for the individuals with BMI close to average healthy BMI value tends to be less.
These results demonstrate the requirement for more advanced algorithms to detect the steps. 

Acknowledgement
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