Warfighter Analytics for Smartphone Healthcare (WASH) User Study

WPI WASH Team
Project Background
Background: Smartphone Sensing

- Smartphones have many (20+) sensors
  - accelerometer, compass, GPS, microphone, camera, proximity
- Can sense physical world, detect user behaviors, sick smartphone user, etc
US military want early signs of warfighter ailment:
- Traumatic Brain Injury (bomb blasts, explosions, fall, etc)
- Infectious diseases (E.g. tuberculosis, pneumonia, measles, meningitis, malaria, Ebola, cholera and influenza)

**WASH Concept:** Smartphone-sensible biomarkers may manifest first
- E.g. reduced mobility, sedentary, sleep problems, stay close to home

WPI received $2.8 from DARPA (military) to research smartphone biomarkers for TBI and infectious diseases
Examples of TBI, Infectious Disease Biomarkers Detectable by Smartphone

Sleep problems
Pupils dilated
Hands shaking
Walking Problems
Coughing

Slow phone interactions
Avoiding light
Slurred speech
Increased Bathroom usage
Sneezing

Traumatic Brain Injury (TBI) Smartphone Biomarkers
Infectious Disease Smartphone Biomarkers

Note: Specific tests (e.g. hands shaking) in specific situations (e.g. user holding phone)
Our Research Approach

- We now have specific list of 30 contexts in which we will run 14 specific TBI/infectious disease tests

- **Research Question 1:** Can smartphone detect when a smartphone user is in one of our specific contexts?

- **Methodology:**
  - Recruit 100 subjects
  - Run a scripted user study
  - Subjects using smartphone, enter each of 32 contexts
  - Gather smartphone data continuously in background
  - Later: analyze data (machine learning)
    - Research Question: Can user situations be reliably detected from smartphone data
Context: Definition & Final List of Contexts

Context = (User Activity, Phone Prioception, App Category, Social)

- Sitting
- Standing
- Walking
- Lying down
- Sleeping
- Awake/not sleeping
- Interacting with phone
- Coughing
- Exercising
- Running
- Sneezing
- Sitting down
- Lying down
- Standing up
- Talking into phone

Phone in Hand
- Phone facing down
- Phone on table
- Trouser pocket
- In bag
- Briefcase
- Jacket pocket

Games
- Video game

Media & Video
- Video Chat
- Video streaming

Communication
- Messaging

Social
- Messaging

Entertainment
- Video streaming

Alone
- 2 or more speakers
- More than 2 speakers
- Busy place
# 30 Contexts Needed for Our Tests

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>&lt;interacting with phone, phone in hand, *, *&gt;</td>
</tr>
<tr>
<td>2</td>
<td>&lt;* , phone in hand, *, *&gt;</td>
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<tr>
<td>3</td>
<td>&lt;lying down, *, *, *&gt;</td>
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<tr>
<td>4</td>
<td>&lt;sitting, *, *, *&gt;</td>
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<tr>
<td>5</td>
<td>&lt;standing, *, *, *&gt;</td>
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<tr>
<td>6</td>
<td>&lt;sleeping, *, *, *&gt;</td>
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<tr>
<td>7</td>
<td>&lt;awake, *, *, *&gt;</td>
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<tr>
<td>8</td>
<td>&lt;walking, in pocket, *, *&gt;</td>
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<tr>
<td>9</td>
<td>&lt;walking, in hand, *, *&gt;</td>
</tr>
<tr>
<td>10</td>
<td>&lt;walking, in bag, *, *&gt;</td>
</tr>
<tr>
<td>11</td>
<td>&lt;* , phone on table, *, *&gt;</td>
</tr>
<tr>
<td>12</td>
<td>&lt;* , phone facing down, *, *&gt;</td>
</tr>
<tr>
<td>13</td>
<td>&lt;talking into phone, *, *, *&gt;</td>
</tr>
<tr>
<td>14</td>
<td>&lt;* , *, more than 2 speakers&gt;</td>
</tr>
<tr>
<td>15</td>
<td>&lt;Coughing, *, *, *&gt;</td>
</tr>
<tr>
<td>16</td>
<td>&lt;Coughing, *, *, in busy place&gt;</td>
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<tr>
<td>17</td>
<td>&lt;Toilet, *, *, *&gt;</td>
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<tr>
<td>18</td>
<td>&lt;Toilet, Phone in pocket, *, *&gt;</td>
</tr>
<tr>
<td>19</td>
<td>&lt;sleeping, phone on table, *, 0&gt;</td>
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<tr>
<td>20</td>
<td>&lt;exercising, phone in hand, *, 0&gt;</td>
</tr>
<tr>
<td>21</td>
<td>&lt;exercising, phone on table, *, 0&gt;</td>
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<tr>
<td>22</td>
<td>&lt;exercising, *, *, more than 2 speakers&gt;</td>
</tr>
<tr>
<td>23</td>
<td>&lt;Sneezing, *, *, 2 or more speakers&gt;</td>
</tr>
<tr>
<td>24</td>
<td>In noisy/bust place</td>
</tr>
<tr>
<td>25</td>
<td>&lt;lying down, phone on table, *, *&gt;</td>
</tr>
<tr>
<td>26</td>
<td>&lt;Sneezing, *, *, alone&gt;</td>
</tr>
<tr>
<td>27</td>
<td>&lt;Sitting up, *, *, *&gt;</td>
</tr>
<tr>
<td>28</td>
<td>&lt;Standing up, *, *, *&gt;</td>
</tr>
<tr>
<td>29</td>
<td>&lt;Sitting down, *, *, *&gt;</td>
</tr>
<tr>
<td>30</td>
<td>&lt;Lying down, *, *, *&gt;</td>
</tr>
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WASH User Study Overview
Context Collection Study: Overview

- Scripted, on-campus study to cover the majority of identified contexts
- Each subject completes a carefully planned circuit, timed
- Each subject given same Essential Android phones to ensure consistent data
- Mobile app automatically gathers sensor data, labels entered manually with timestamps
Context Data Study: Route @ WPI

1. Fuller Labs
   - Briefing

2. Recreation Center
   - Walking, running
   - Bathroom

3. Morgan Hall
   - Phone call
   - Water break
   - Being in a busy place

4. Fuller Labs
   - Lying down
   - Sitting down
   - Standing up
Context Collection Study: Sensors

**Standard:**
- Gyroscope
- Accelerometer
- Barometer
- Magnetometer
- Location Services
  - Speed
  - Distance traveled over a period of time

**Experimental:**
- Audio
  - Feature extraction on phone to mitigate privacy concerns
- Ambient light
- Proximity
- Discrete sensors
  - Is the phone charging?
  - Are they interacting with it?
Main Steps for Subject
Steps for Study Subjects

- Go to this link to sign up
  - [https://docs.google.com/spreadsheets/d/1marttdu2zJxTzboOPhNW1XGaMKMVrKF2iTgQA0Wkvul/edit?usp=sharing](https://docs.google.com/spreadsheets/d/1marttdu2zJxTzboOPhNW1XGaMKMVrKF2iTgQA0Wkvul/edit?usp=sharing)

- At the time you select, go to Fuller Labs Room 319, ask to meet Luke Buquicchio and WASH students

- Student researchers will:
  - Meet you there
  - Explain the study protocol to you
  - Get your signed consent as a study participant
  - Run the study (at most 1 hour)

  **Note:** You will receive study phones and all material for this study

- If you have questions, email Luke Buquicchio (ljbuquicchio@wpi.edu)