Design of a Device to Help Severely Mentally Ill Patients Quit Smoking

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Overview

- Background
- Problem Statement
- **Motivation and Product Specifications**
- Physical Case
- PCB and Circuit
- Android Application
- Future Work
Background

- Tobacco addiction in individuals with Sever Mental Illness (SMI)
  (Brunette et al., Psychiatric Services, 2011)
  - Cigarette smoking rates in SMI patients: 45%–90%
  - Cigarette smoking rates in general population: 20%
Background

- **Quitting smoking in SMI patients**
  
  (Brunette et al., *Health Education Research*, 2012)

- **Difficulty:** Not using the traditional resources

- **Solution:** Using a well-designed program for the SMI
  
  - Constant (24 hours a day) monitoring
  - Access to structured computer programs
To design a cigarette case to help individuals with severe mental illness (SMI) quit smoking through a structured smartphone application interface. The complete system is known as the Pack Pal.
Motivation

- Research shows: people with nervous disorders want to stop smoking.

- No successful program/therapy to aid quitting due to resources not being targeted to individuals with SMI.

- The Pack Pal system is a coach and collects data
Design Specification

- Case Requirements
  - Sense
    - Opening and closing of the case
    - Number of cigarettes removed
      - Transmit the data to the smartphone wirelessly

- Smartphone Requirements
  - Deploy countermeasures to discourage smoking behavior
  - Record trigger and rate craving strength
  - Analyze the data from the case
  - Send weekly updates to the subject
**Block Diagram**

**Hardware**

- **Cigarette Case**
  - **Sensor 2** (Number of cigarettes taken)
  - **Microcontroller**
  - **Power**
  - **Sensor 1** (Case Status: Opened/Closed)
  - **Bluetooth Module**

- **Phone**
- **Subject**
Case Design

- **Dimensions:**
  - 5.15” x 3.75” x 1.8”

- **Cigarette Holder**
  - ABS Plastic

- **Future Work**
  - Cover
  - Battery Holder

**Diagram:**
- Sensor Holder
- Circuit Holder
- Sensor
- Cigarette Holder
- Aluminum Shell
Cigarette Sensor Design Options

- Cigarette Sensing
  - Accuracy and consistency
  - Low power consumption
  - Minimize components

- Options
  - Integrated IR LED/sensor
  - Depressible switch
## Design Matrices

<table>
<thead>
<tr>
<th>Cigarette Sensing</th>
<th>Depressible Switch</th>
<th>Integrated IR LED/Sensor</th>
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<tbody>
<tr>
<td>Power Consumption (.6)</td>
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<tr>
<td>Components (.4)</td>
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<td>Reliability (.8)</td>
<td>4.5</td>
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<tr>
<td>Implementation (.3)</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>6</strong></td>
</tr>
</tbody>
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Wall-charge Lithium Ion Battery

- Voltage: 3.7 V
- Capacity: 2600 mAh
- Chargeable without being removed from the case
- Theoretical life at 50 mA: 52 hours
34 Hour Battery Test

Battery Test Results
Smartcase

- Using Mbed prototyping board
  - Handles case state (open/closed)
  - Counts cigarettes

- Communicates with application via Bluetooth
  - Broadcasts data
  - Waits for reply
PCB Design in Altium

- Component Schematics
- Circuit Connections
- Component Foot Prints
- Board to Board Connections
Sensor Circuit
PCB Design

- Component Footprints
  - Standard
  - Custom
Android Application Specifications

- User interface
  - Easy to use, large buttons, explanatory text
- Data
  - Storage
  - Accessibility
  - Representation
- Program design and implementation
  - Always running (background process)
  - Handling Bluetooth communication
Android Application Framework

Framework Layout
(http://ows.edb.utexas.edu/site/collaborative-bluetooth-edumanet/android-sdk-2)
Major Application Components

- **User Interface (UI)**
  - The part of the application that the user will interact with on a regular basis.
  - Assigned Views upon runtime
  - Considerations: responsiveness, intuitiveness, aesthetics

- **Bluetooth Handler**
  - Asynchronously handle device discovery, connection, and transmission.
User Interface Screenshots

1. Pack Pal
   - Click here first
   - Setting up your program

2. Tracking my smoking
   - Press here to get to the next screen
   - Getting help with not smoking

3. Quit smoking as easy as 1, 2, 3!
   - Step 1
   - Welcome to your profile. This is where you create your user profile and set your quit smoking goals.

Second, make a list of your top 3 reasons to quit. We will use this list to help remind and motivate you why it's important for you to quit. Some examples of why people want to quit are:

1) To live a healthier life.
2) To live longer for someone you care about (like a child, brother, sister, or partner).
3) To enjoy excercise again.

Now it's your turn to type in your reasons to quit smoking in the boxes below and then press next.
Bluetooth Basics

- **Serial Port Profile (SPP)**
  - Application representation of virtual serial ports

- **RFCOMM**
  - Low level emulation of RS-232 serial communication

[Bluetooth Profile Stack](https://www.bluetooth.org/Building/HowTechnologyWorks/ProfilesAndProtocols/HSP.htm)
Future Work and Implementation

Future Work
- PCB Design
- Application
- Bluetooth connectivity
- Case integration

Implementation
- Participant Testing
- Clinical Trial
Acknowledgments

- Prof. Joelle Ferron (Client)
  Dartmouth College
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  Dartmouth College
  Department of Psychiatry

- Prof. David Gustafson (Client)
  UW Madison
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References


Any Questions?