

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

Design Team:

- ✧ Scott Carson (Leader)
- ✧ Gustavo Zach Vargas (Communicator)
- ✧ Douglas Ciha (BWIG)
- ✧ Paul Strand (BSAC)

Advisor:

- ✧ Amit Nimunkar, Ph.D.
Associate Faculty Associate
UW Madison

Client:

- ✧ Joelle Ferron, Ph.D.
Assistant Professor of Psychiatry
Dartmouth College
- ✧ Mary F. Brunette, M.D.
Associate Professor of Psychiatry
Dartmouth College
- ✧ David Gustafson, Ph.D.
Emeritus Professor
UW Madison



Overview

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

Background

- Tobacco addiction in individuals with Severe 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



Problem Statement

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

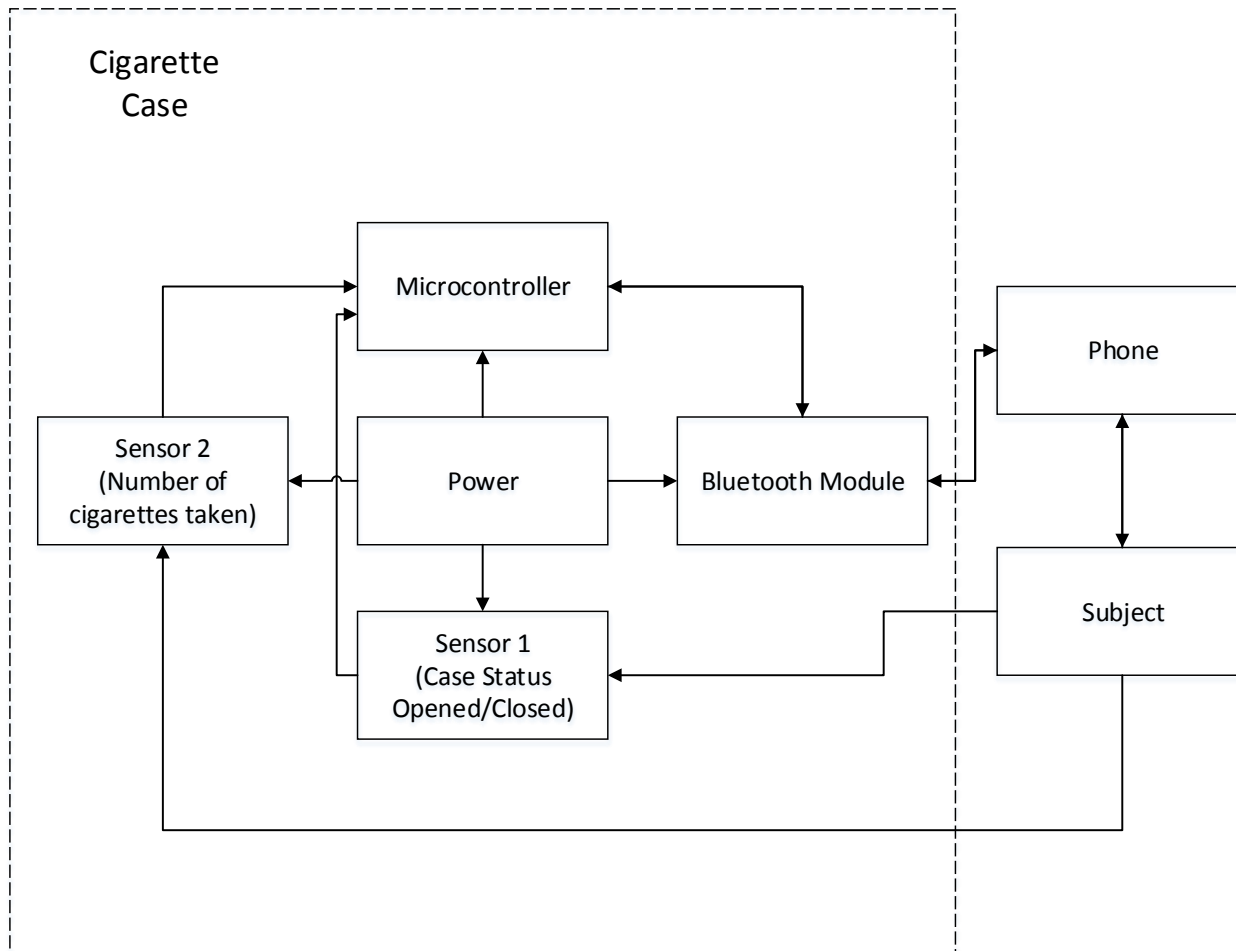
- Opening and closing of the case
- Number of cigarettes removed
 - Transmit the data to the smartphone wirelessly

□ 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

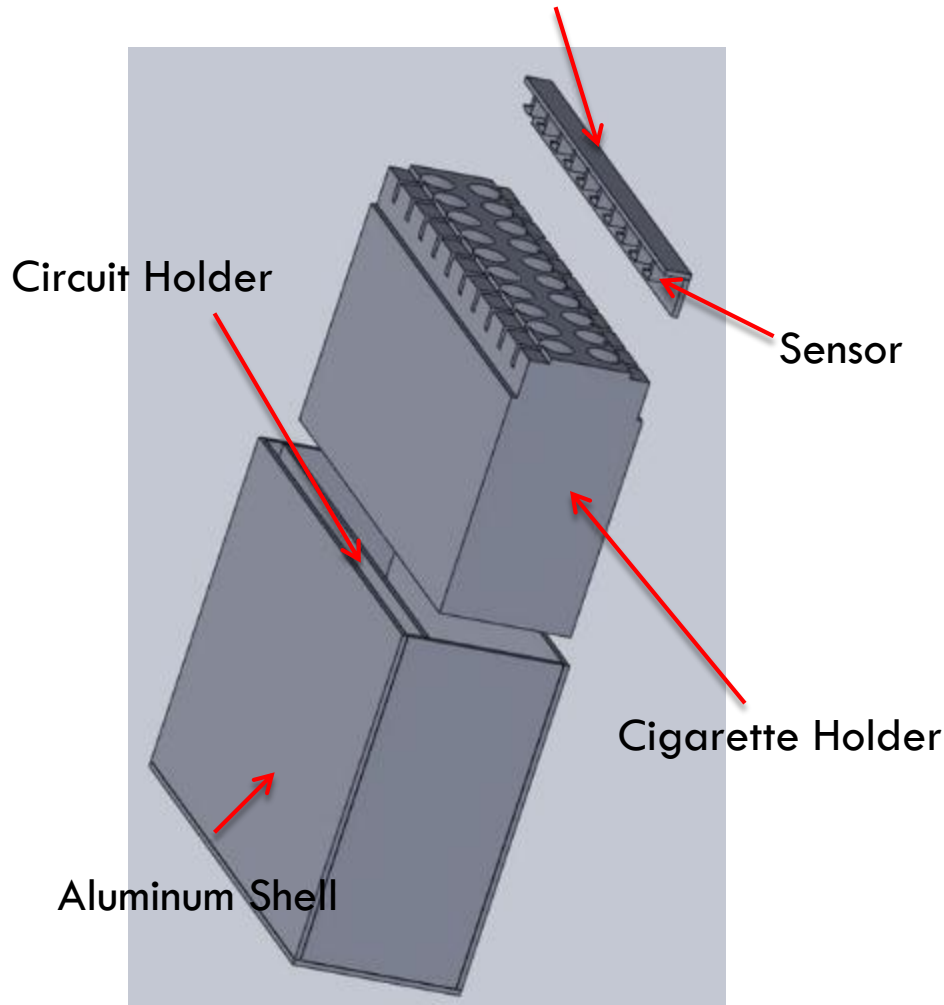
Block Diagram

Hardware



Case Design

Sensor Holder

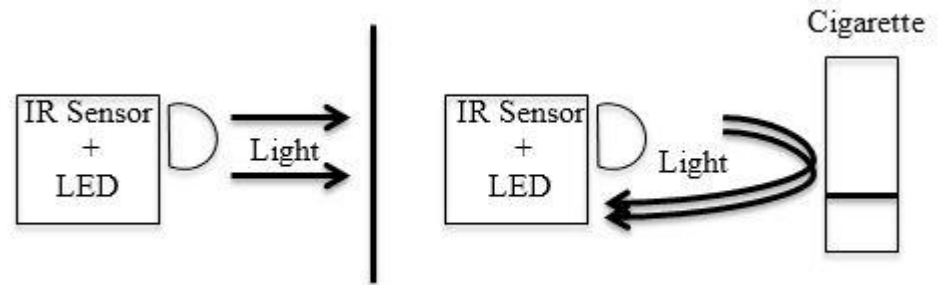


- Dimensions:
5.15" x 3.75" x 1.8"
- Cigarette Holder
 - ▣ ABS Plastic
- Future Work
 - ▣ Cover
 - ▣ Battery Holder

Cigarette Sensor Design Options

□ Cigarette Sensing

- Accuracy and consistency
- Low power consumption
- Minimize components



□ Options

- Integrated IR LED/sensor
- Depressible switch



Design Matrices

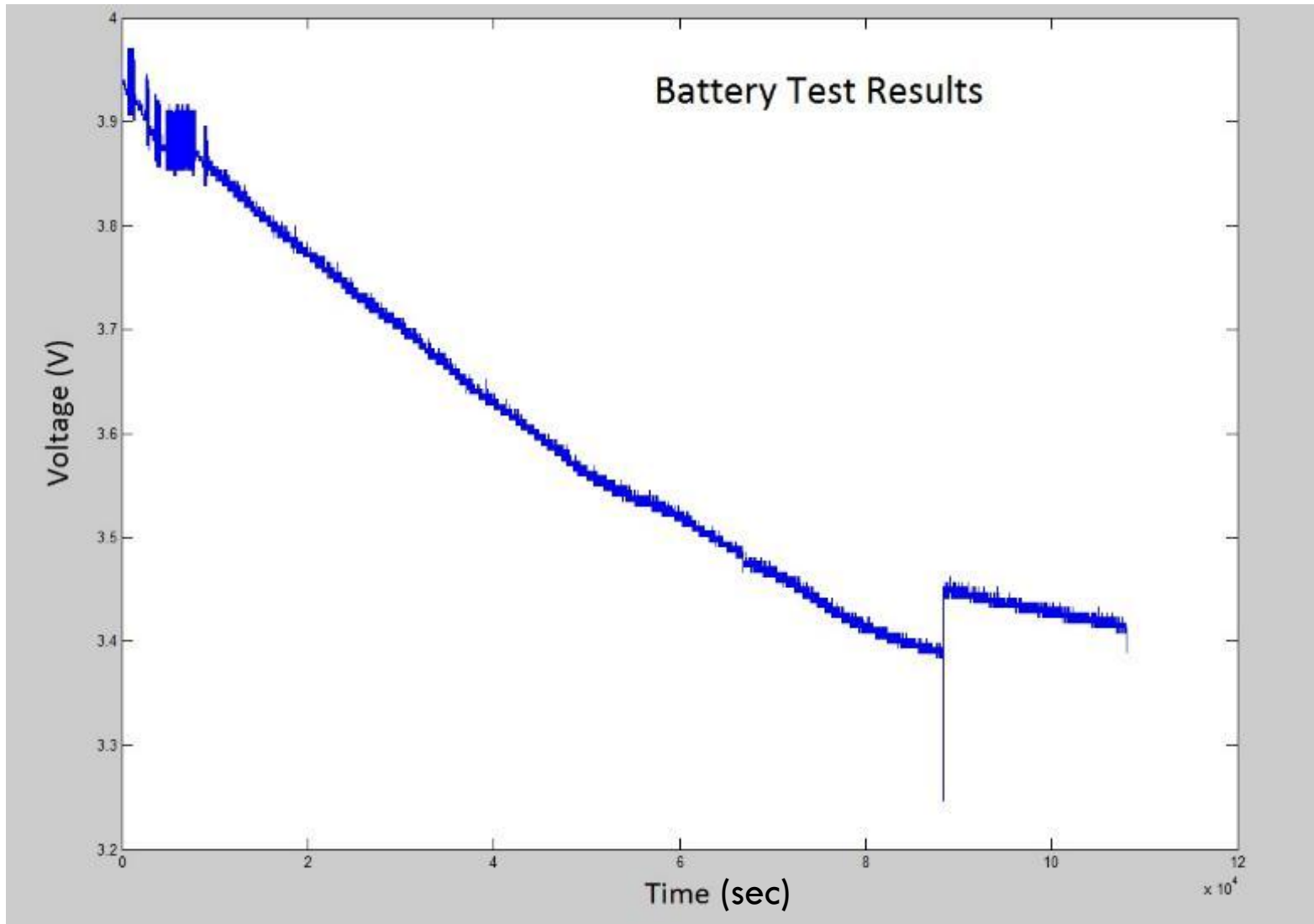
<u><i>Cigarette Sensing</i></u>	Depressible Switch	Integrated IR LED/Sensor
Power Consumption (.6)	4	1
Components (.4)	3	3
Reliability (.8)	4.5	4.5
Implementation (.3)	4	2
TOTAL	8.4	6

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

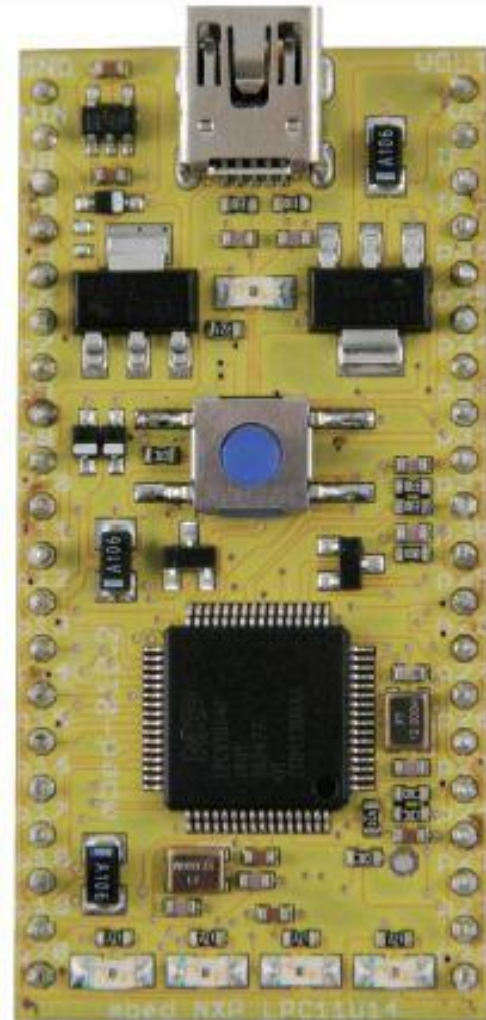


34 Hour Battery Test



Smartcase

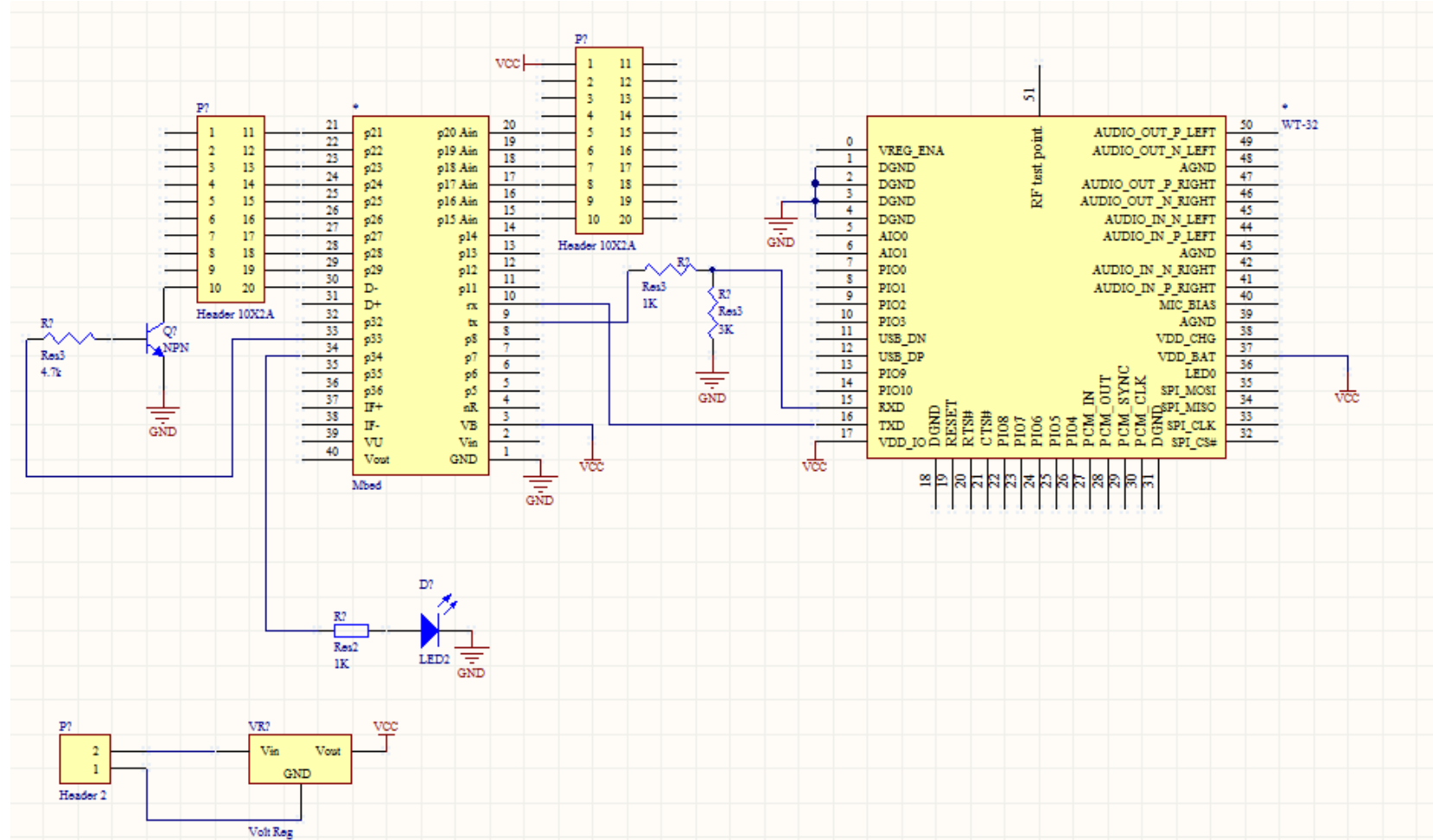
- Using Mbed prototyping board
 - ▣ Handles case state(open/closed)
 - ▣ Counts cigarettes
- Communicates with application via Bluetooth
 - ▣ Broadcasts data
 - ▣ Waits for reply



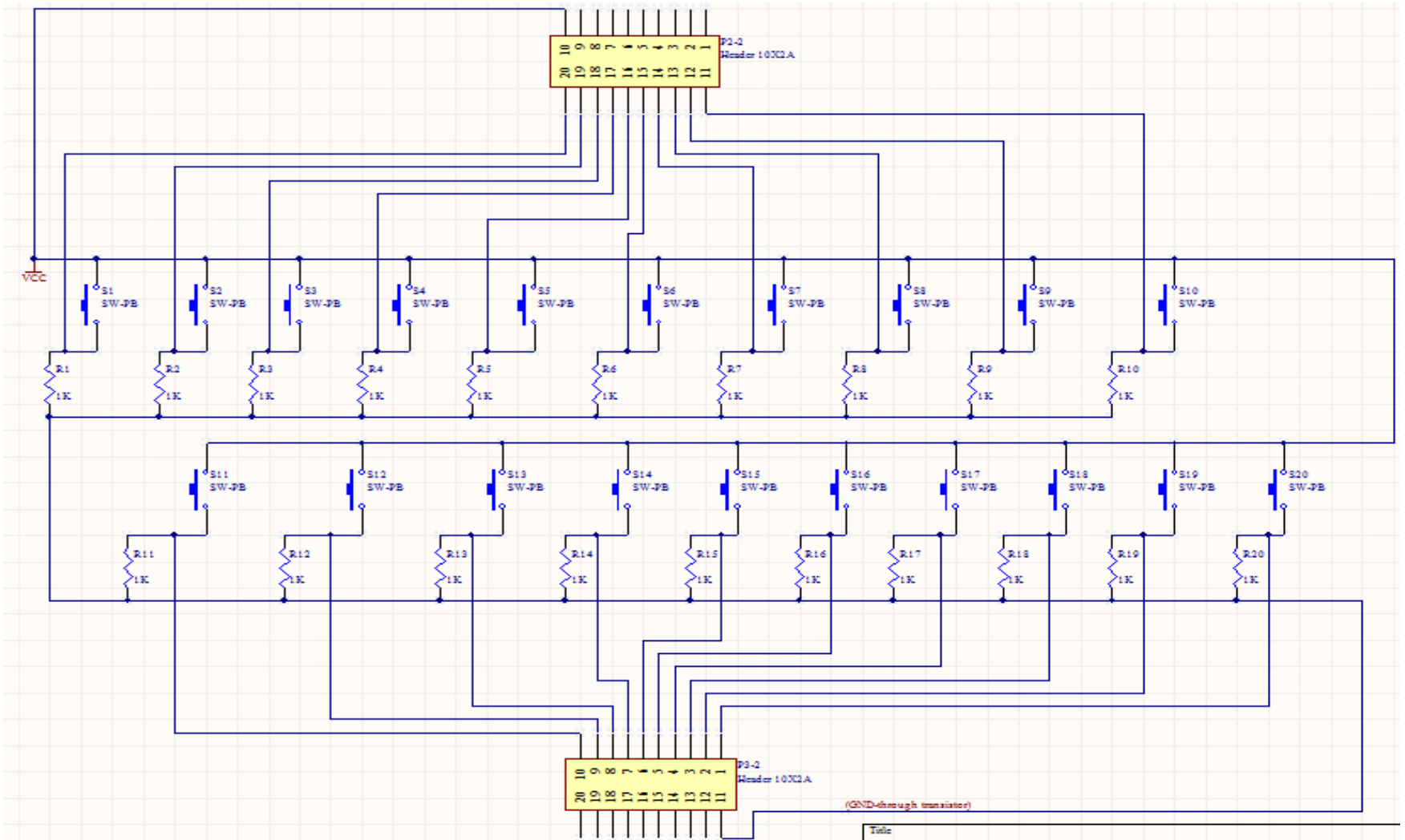
PCB Design in Altium

- Component Schematics
- Circuit Connections
- Component Foot Prints
- Board to Board Connections

Main Circuit

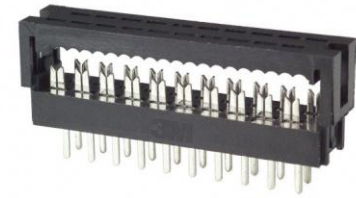
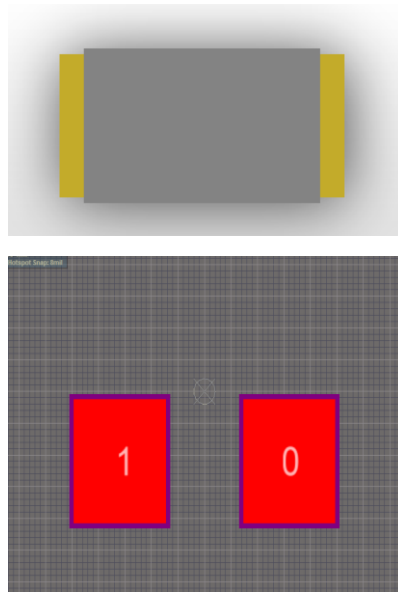
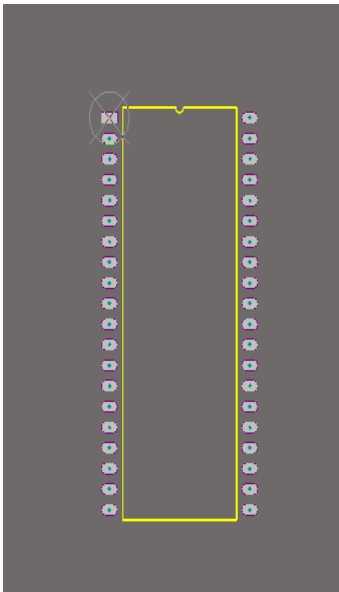


Sensor Circuit



PCB Design

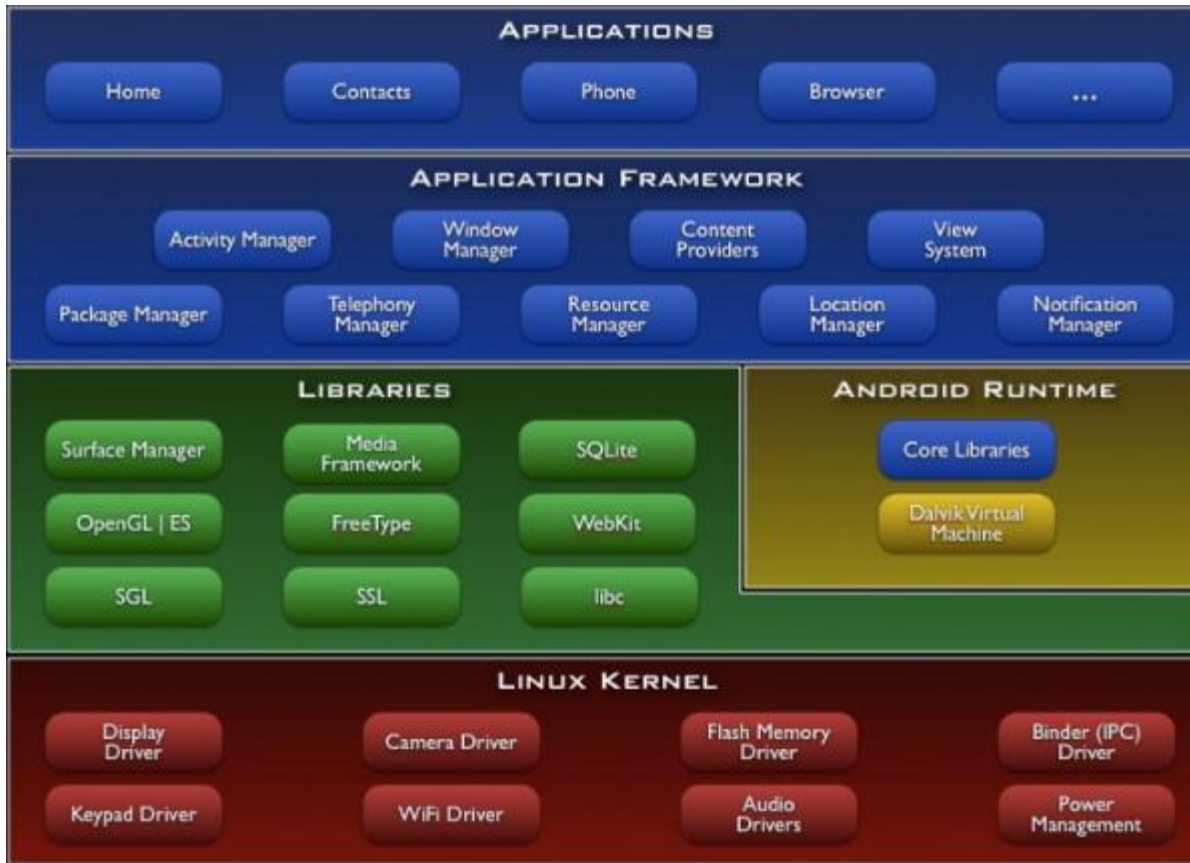
- Component Footprints
 - Standard
 - Custom



Android Application Specifications

- User interface
 - ▣ Easy to use, large buttons, explanative 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

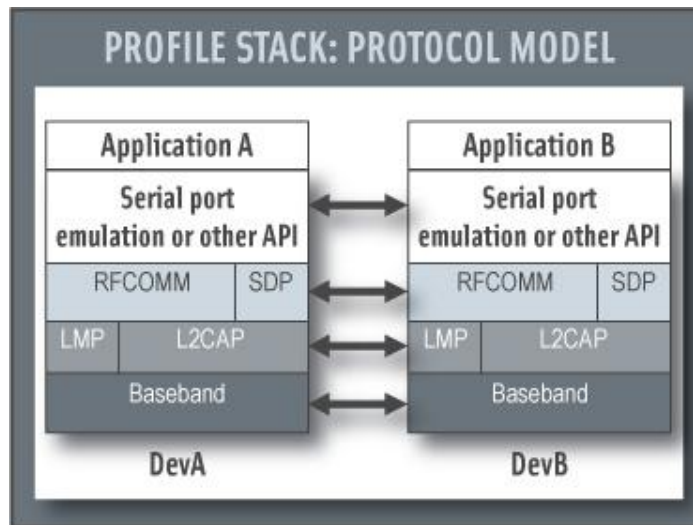
- User Interface (UI)
 - ▣ The part of the application that the user will interact with on a regular basis.
 - ▣ Assigned Views upon runtime
 - ▣ Considerations: responsiveness, intuitiveness, aesthetics
- Bluetooth Handler
 - ▣ Asynchronously handle device discovery, connection, and transmission.

User Interface Screenshots



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
 - Department of Psychiatry
- Prof. Mary Brunette (Client)
 - Dartmouth College
 - Department of Psychiatry
- Prof. David Gustafson (Client)
 - UW Madison
 - Department of Industrial and Systems Engineering
- Dr. Amit Nimunkar (Advisor)
 - UW Madison
 - Department of Biomedical Engineering

References

1. Brunette, Mary, Ferron, Joelle, Devitt, Timothy, Geiger, Pamela, Martin, Wendy, Pratt, Sarah, Santos, Meghan, & McHugo, Gregory (2011). Do smoking cessation websites meet the needs of smokers with severe mental illnesses? *Health Education Research* Vol.27 no.2 2012. Retrieved May 20, 2012.
2. Brunette, M., Ferron, J., McHugo, G., Davis, K., Devitt, T., Wilkness, S., & Drake, R.. (2011). An Electronic Decision Support System to Motivate People With Severe Mental Illnesses to Quit Smoking. *Psychiatric Services*, 62(4), 360-6. Retrieved May 20, 2012, from Psychology Module. (Document ID: 2312884271).
3. Ferron, J., Brunette, M., He, X., Xie, H., McHugo, G., & Drake, R.. (2011). Course of Smoking and Quit Attempts Among Clients With Co-occurring Severe Mental Illness and Substance Use Disorders. *Psychiatric Services*, 62(4), 353-9. Retrieved May 20, 2012, from Psychology Module.
4. Ferron, J., Brunette, M., McHugo, G., Devitt, T., Martin, W., & Drake, R.. (2011). Developing a Quit Smoking Website That is Usable by People with Severe Mental Illnesses. *Psychiatric Rehabilitation Journal* 2011, Volume 35, No. 2, 111–116. Retrieved June 6, 2012.
5. Grant BF, Hasin DS, Chou SP et al. Nicotine dependence and psychiatric disorders in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry* 2004; 61: 1107–15.
6. Lucksted A, Dixon LB, Semblly JB. A focus group pilot study of tobacco smoking among psychosocial rehabilitation clients. *Psychiatr Serv* 2000; 51: 1544–8.
7. Morris CD, Waxmonsky JA, May MG et al. What do persons with mental illnesses need to quit smoking? Mental health consumer and provider perspectives. *Psychiatry Rehabilitation Journal* 2009; 32: 276–84.
8. National Cancer Institute. Smoking. Retrieved June 5, 2012 from <http://www.nlm.nih.gov/medlineplus/smoking.html>.
9. Weinberger AH, Reutenauer EL, Vessicchio JC et al. Survey of clinician attitudes toward smoking cessation for psychiatric and substance abusing clients. *J Addict Dis* 2008; 27:55.

Any Questions?

