Temperature Sensors For Veterans With Paralysis

DESIGN DOCUMENT

Senior Design Team 16
BAE Systems
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Team Member: Role
Evan Rosonke: Project Lead
CJ Reitz: Test Lead
Ethan Houts: Software Lead
Thomas Kivlahan: Hardware Lead
Mensanh Namessi: Hardware Lead

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Executive Summary

Development Standards & Practices Used

List all standard circuit, hardware, software practices used in this project. List all the Engineering standards that apply to this project that were considered.

- We will need to use a communication standard, most likely Bluetooth
- Commenting code for the application for others to read easily
- Document hardware as it is implemented, as well as document hardware changes
- Standardize among hardware for an easier pairing of devices and one location for purchasing

Summary of Requirements

List all requirements as bullet points in brief.

- Temperature sensors that read body and air temperature
- Means of attaching the sensor to the body
- Phone application that uses data from the sensor to alert the user if the temperature is too extreme
- Data control center to store historical data

Applicable Courses from Iowa State University Curriculum

List all Iowa State University courses whose contents were applicable to your project.

- EE285
- CPRE288
- EE330

New Skills/Knowledge acquired that was not taught in courses

List all new skills/knowledge that your team acquired that was not part of your Iowa State curriculum in order to complete this project.

- Project Management
- Communication among a large team
- IOS Development

Table of Contents

List of figures/tables/symbols/definitions (This should be the similar to the project plan)

1 Team

1.1 Team Members

Evan Rosonke, Thomas Kivlahan, Ethan houts, CJ Reitz, Mensanh Namessi

1.2 Required Skill Sets for Your Project

Electronic system integration and software development. Understanding of microelectronics and their uses within temperature sensors with Bluetooth compatibility.

1.3 Skill Sets Covered by the Team

(for each skill, state which team member(s) cover it)

Project Management- Evan Rosonke

Testing- CJ Reitz, Ethan Houts

Hardware Design- Evan Rosonke, CJ Reitz, Thomas Kivlahan, Mensanh Namessi

Software Development- Ethan Houts

1.4 Project Management Style Adopted by the team

Our team is adopting a single project manager role with leaders for each division of the project, including but not limited to a software lead, a hardware lead, a test lead, and an overall project management lead.

1.5 Initial Project Management Roles

Overall Project Management - Evan Rosonke

Software Lead - Ethan Houts

Test Lead - CJ Reitz

Hardware Leads - Mensanh Namessi and Thomas Kivlahan

2 Introduction

2.1 Problem Statement

The goal of this project is to implement a series of temperature sensors to allow individuals with paralysis in the limbs to know if their body temperature is too cold or too hot in the areas without feeling. We will then use the sensors to alert the user of any abnormality in their body temperature through a phone application.

2.2 Requirements & Constraints

Hardware Requirements

- The sensor **shall[1]** fit comfortably inside a boot
- The sensor **shall[2]** communicate via Bluetooth to a phone
- The power supply **shall[3]** last 12 hours on a charge
- The moisture sensor **shall[4]** alert the user when water is present on skin

Software and UI Requirements

- The user interface shall be simple
- the phone application shall have a notification sensor
- the application shall be able to voice-activated
- The application shall have multiple warning levels (LOLO, LO, HI, HIHI)
- The LO and HI warning levels shall be user-defined within a range
- The application shall alert users when outside acceptable temperature range
- The application shall alert instructor when users temperature is outside acceptable range
- The application shall notify a user when low battery level

Aesthetic Requirements

- The sensors shall be embedded in an insole
- The insole shall be comfortable to walk on
- The insole shall not irritate the skin
- the insole shall not interfere with sweat productions
- the power supply shall attach to the leg above the boot
-

Performance Requirements (Data rate and frequency of data collection and upload)

- Data shall be collected from the sensors once every minute
- Data shall be sent to the phone application as it is collected

Quantifiable Metric	Number needed
Sensors	6/leg
Data collection Rate	1/min
Battery Life	8 Hours

2.3 Engineering Standards

Skin Interfaced Electronics

FDA has a list of allowable chemicals that can be used in contact with the body for microelectronics

Wearable electronics (IEEE 360-2022)

Personal health devices (IEEE 11073)

2.4 Intended Users and Uses

Our project will mainly impact those with limb paralysis or loss of feeling within limps. The idea behind this is to allow these people to do the things they love without having to worry about running the risk of the body becoming too hot or too cold. One example of people would be people who go adaptive skiing and run the risk of frostbite in their toes and would not be able to feel it. This will allow them not to worry because if this were to come close to happening, they would receive an alert beforehand to know something needs to change.

3 Project Plan

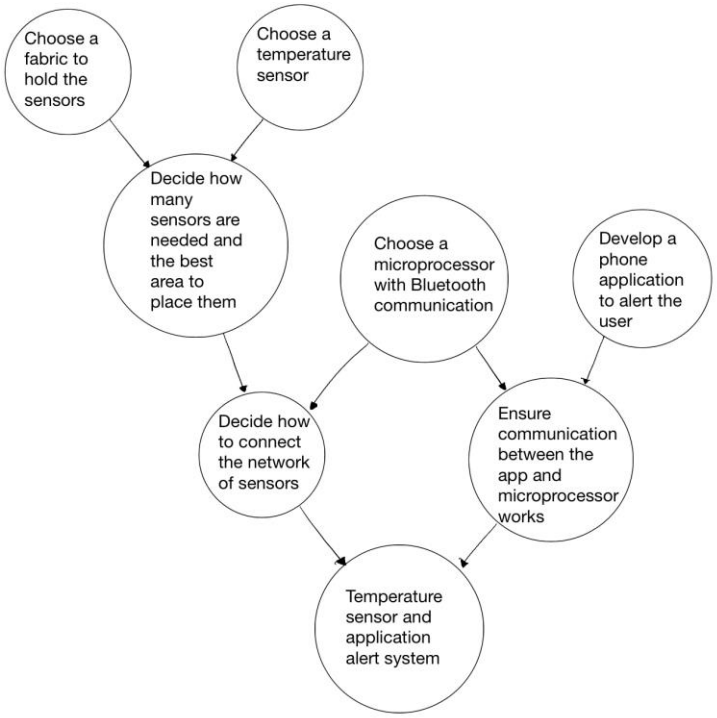
3.1 Task Decomposition

Hardware

- Temperature Sensor
    - Researching functionality
    - making sure it falls within the constraints of the project
    - has Bluetooth functionality
    - connecting sensors together
    - Power sensors
    - Test that sensors work and can last long enough
- Bluetooth device
- Attachment
    - Get design specs and see if there is a preferred method of attachment
    - Figure out the best fabrics for this method of attachment
    - research how it will interfere with the body

Software

- IPhone application
    - Bluetooth communication
    - UI design
    - Back-end
    - Optional Communication to instructor's device
    - Apple watch compatibility - tbd with pending research
- Android application
    - To be done after iOS is complete.
    - Bluetooth communication
    - UI design
    - Back-end
    - Optional Communication to instructor's device
    - Wear-OS compatibility - tbd with pending research
- Microcontroller program
    - Bluetooth communication
    - Collect sensor signals
    - Battery percentage indicators
    - Convert signals into usable forms for transfer



3.2 Project Management/Tracking Procedures

Waterfall+agile is the best option for our team as our project consists of a software application and hardware implementation. because both of these teams will need to be working forward simultaneously, we will work as an agile project management style between them but also try to follow a waterfall approach within each team to continue completing tasks in a forward manner.

Our team will be utilizing a combination of GitLab and Discord for project management. We will be using Discord for quick communication, meeting reminders, quick discussions, etc. We will be using GitLab to delegate tasks to individual team members as well as track progress.

3.3 Project Proposed Milestones, Metrics, and Evaluation Criteria

Hardware

1. Get a list of design specs.
    a. What are the functionalities they want?
    b. What are our constraints?
2. Start researching hardware components that fall within these constraints
    a. Temp Sensor with Bluetooth transmitter
    b. Data collection and control board.
    c. Wire to string together sensors

    d. Power supply/battery pack with recharging capability
    e. enclosures for hardware that needs it and ways to attach to body the parts that need it
3. Start designing layout
    a. integrate sensors together
    b. connect sensors to the power supply
    c. connect to the data control board or application
    d. make sure everything will work together
        i. power consumption
        ii. aesthetics (not too large and easily maneuverable).
        iii. The components are all within standard of skin interfaced electronics
4. Order hardware components, enclosures, and fabric once research and design are complete.
5. Start integrating sensors together and creating the circuit for all sensors and power supply.
6. Test the functionality and power of the system.

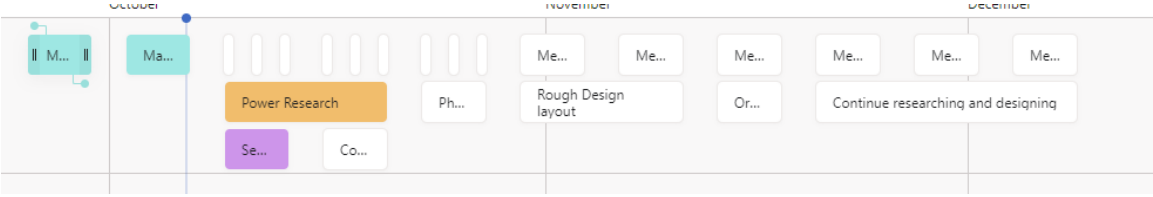
Software

1. Start development for iOS
    a. UI development
    b. backend development
2. Create a round trip to connect microcontroller to phone
    a. create basic program on chosen microcontroller to create a data transfer
    b. implement integration for bluetooth on app
3. Capture sensor data
    a. implement sensor data collection on microcontroller
    b. implement ui functionality to display recorded sensor data
4. Communication functionality
    a. some form of messaging to another nearby device
5. Create Android version
    a. Do 1-4 with the relevant portions for android development
6. Watch OS companion app
    a. A version of the app that has another way to alert the user
7. Wear OS companion app
    a. same as Watch OS but for android

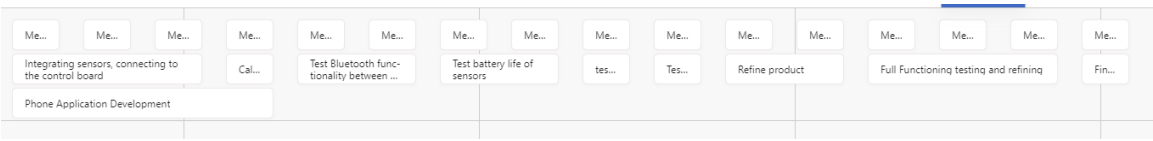
Combined - After completing hardware and software pieces individually

1. test that the sensors are reading data over Bluetooth
2. calibrate the sensors
3. check for errors in hardware or software
4. fix the issues
5. repeat until correctly functioning project

3.4 Project Timeline/Schedule



First Semester



Second Semester

3.5 Risks And Risk Management/Mitigation

Hardware

- Temperature Sensor
    - Researching functionality .2
    - making sure it falls within the constraints of the project .4
    - has Bluetooth functionality .3
    - connecting sensors together .3
    - Power sensors .3
    - Test that sensors work and can last long enough .3
- Attachment
    - Figure out the best fabrics for this method of attachment .3
    - research how it will interfere with the body .2

Software

- IPhone application
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3.6 Personnel Effort Requirements

Overall, this project should count for roughly 340 total man-hours of meetings, which will be conducted on Mondays for 30 minutes, Wednesdays for 1 hour, and Fridays for 1 hour with our TA, Faculty Mentor, and Client, respectively. In these meetings, we will be discussing our weekly milestones

This project will also consist of hardware and software research, design, implementation, and testing. We estimate this will take roughly 480 total man hours averaging 20 man hours per week, roughly 4 man hours per person per week.

Research should take us around 4 weeks to complete thoroughly to where we are able to make decisions on the specifics such as what sensors and microprocessor to use which comes out to about 80 man-hours for research.

Designing should take us around 6 weeks to complete to the point where we have a very solid idea of what the final product will look like with more specific constraints. This comes out to around 120 man-hours.

Implementation and testing will go hand in hand for the most part because as we are able to implement our design, we will need to test the results to ensure that they are staying within our requirements and no problems arise. These together should take about 14 weeks, which is around 280 man-hours.

Task	man-hours
Meetings	340
Research	40
Design	120
Implementation	120
Testing	60

3.7 Other Resource Requirements

- Software to develop an application
- Temp Sensor with Bluetooth capability
- Wiring to string together sensors
- Rechargeable battery pack to provide power
- charger for the rechargeable battery pack
- Cloth or strap to attach to the body