PTSD Detection Device

Spring Final Presentation
sdmay24-15

Our Team

Team Members

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Computer Engineer

Ben Gardener
Electrical Engineer

Andres Ceballos
Electrical Engineer

Casey Halbmaier
Software Engineer

Coby Konkol
Software Engineer

Caden Backen
Software Engineer

Our Sponsors

BAE SYSTEMS

Faculty and Other Resources

Faculty Advisor: Prof. Rachel Shannon

BAE Advisor: Ryan Littler

Special thanks to: Mike Devlin (America's VetDogs), and Mike Goderre (BAE Systems)

Our Project

Overview

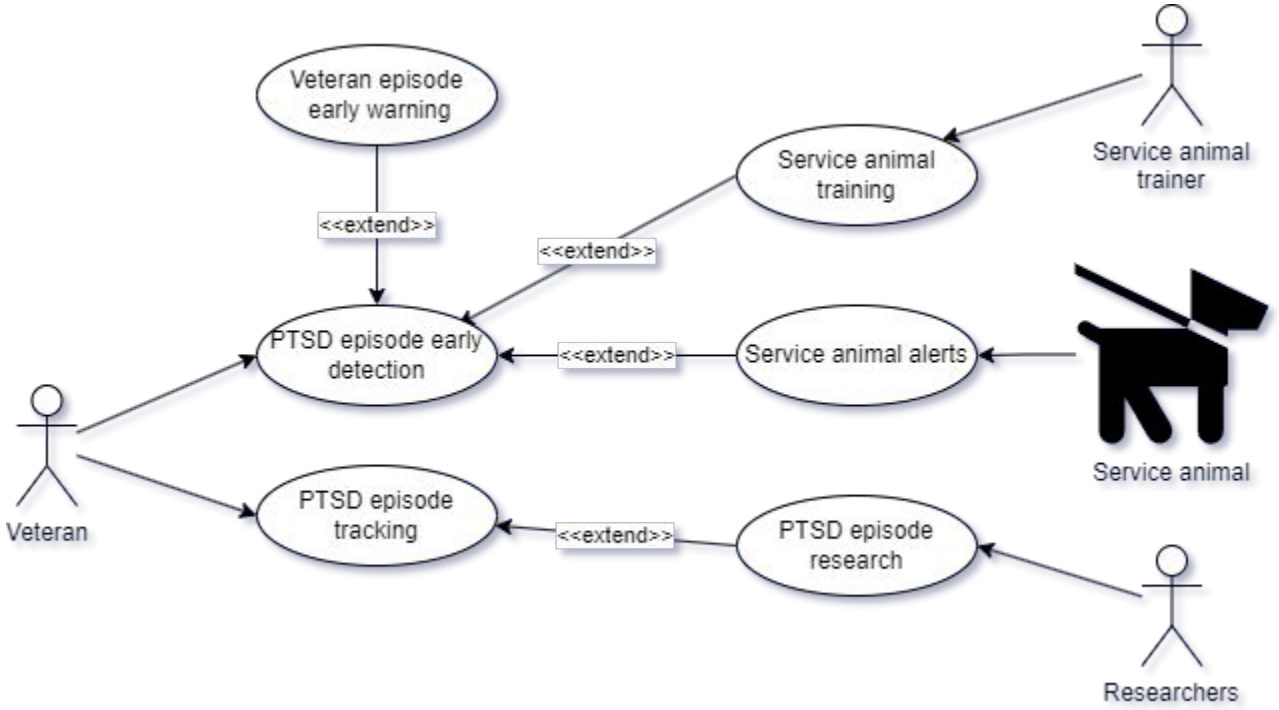
America's VetDogs, in collaboration with BAE Systems, is aiming to **create a device that monitors a user's physiological data to detect onset of PTSD intrusion symptoms (noted a PTSD episode).** This device will then alert the service animal of the PTSD episode to which it would respond accordingly.

Purpose Statement

If a discrete and wearable device existed that is capable of detecting PTSD episodes, support for veterans with PTSD would become much cheaper, accessible, and faster than it currently is.

We are challenged with designing a prototype of a system that uses environmental and physiological data, predicts onset of PTSD symptoms in advance, and alerts service animals

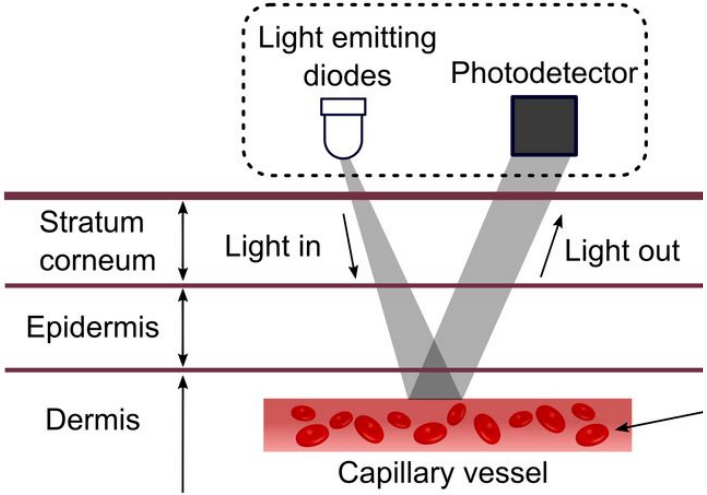
Use Cases

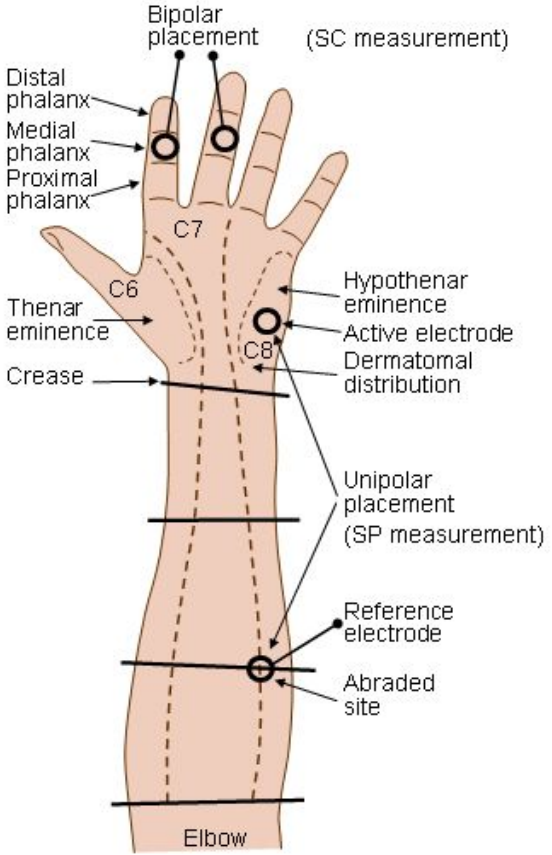

Veteran episode early warning
<<extend>>
Service animal training
Service animal trainer
<<extend>>
PTSD episode early detection
<<extend>>
Service animal alerts
Service animal
Veteran
PTSD episode tracking
<<extend>>
PTSD episode research
Researchers

Background

DSM V criteria B:

- **B3. Dissociative reactions (flashbacks)**
- **B4. Intense or prolonged psychological distress at exposure to cues that resemble the trauma**
- **B5. Physiological reaction to cues that resemble the trauma**

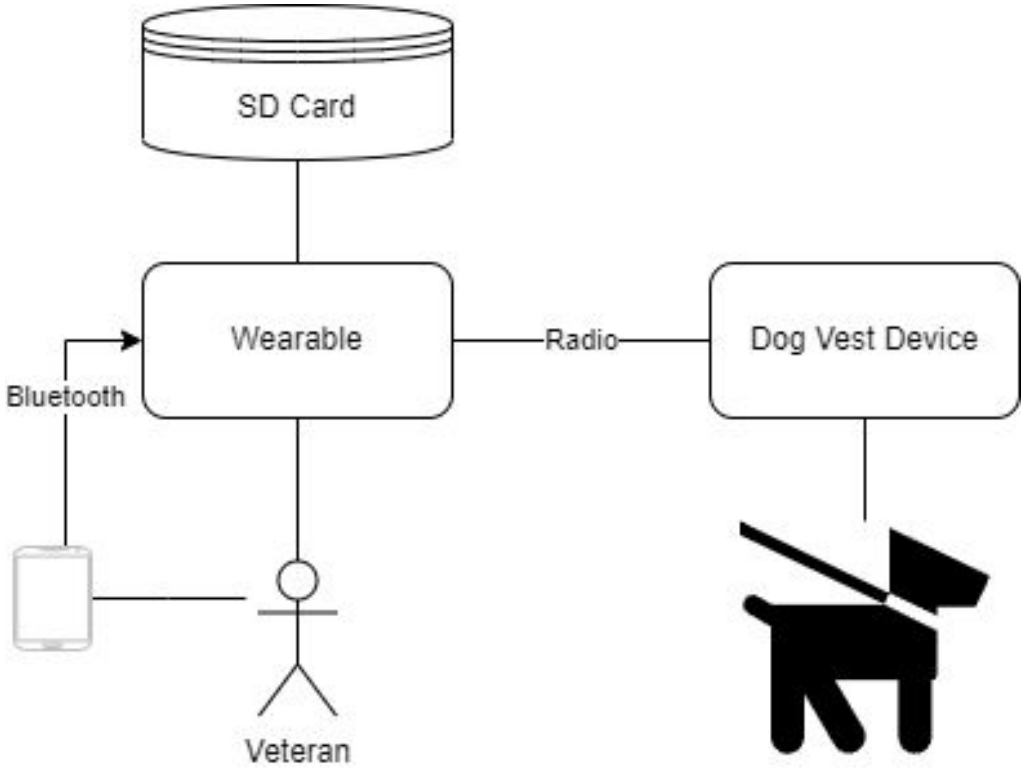




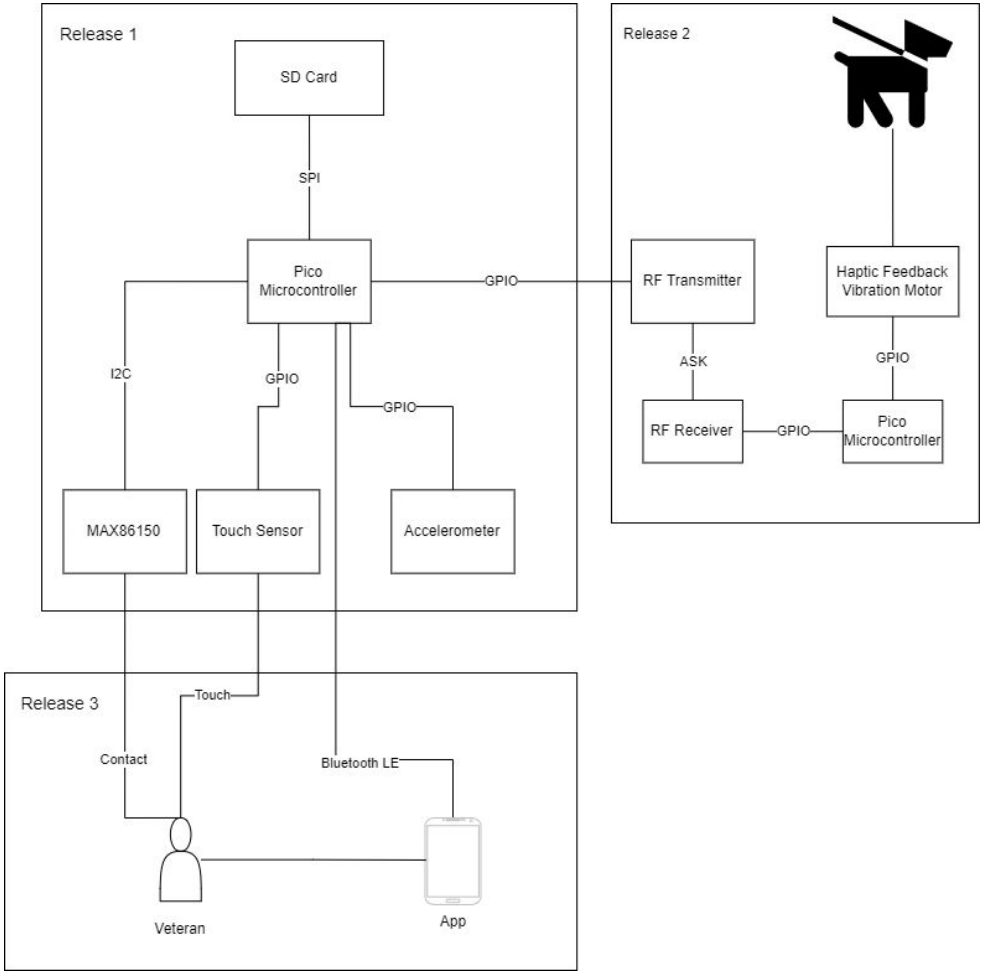
Our Initial Design

Fall Semester

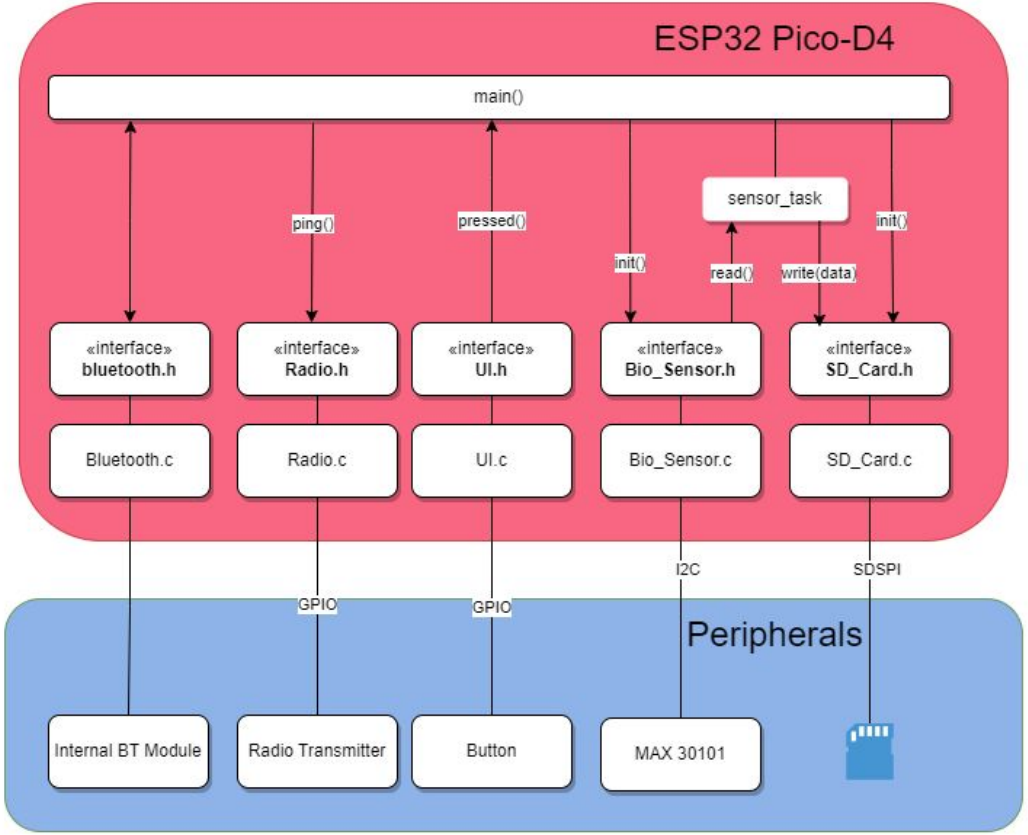
Overview



Hardware


Release 1
SD Card
SPI
Pico Microcontroller
GPIO
I2C
GPIO
GPIO
MAX86150
Touch Sensor
Accelerometer
Release 2
RF Transmitter
Haptic Feedback Vibration Motor
ASK
GPIO
RF Receiver
GPIO
Pico Microcontroller
Release 3
Touch
Contact
Bluetooth LE
Veteran
App

Software


ESP32 Pico-D4
main()
ping()
pressed()
init()
sensor_task
read()
write(data)
init()
«interface» bluetooth.h
«interface» Radio.h
«interface» UI.h
«interface» Bio_Sensor.h
«interface» SD_Card.h
Bluetooth.c
Radio.c
UI.c
Bio_Sensor.c
SD_Card.c
GPIO
GPIO
I2C
SDSPI
Peripherals
Internal BT Module
Radio Transmitter
Button
MAX 30101

Challenges

- No readily available physiological data on PTSD episodes.
- PTSD has very niche/focused research around it.
- Existing commercially available devices either have limited sensing capabilities, are very expensive, or do not disclose functionality.

Our Final Design

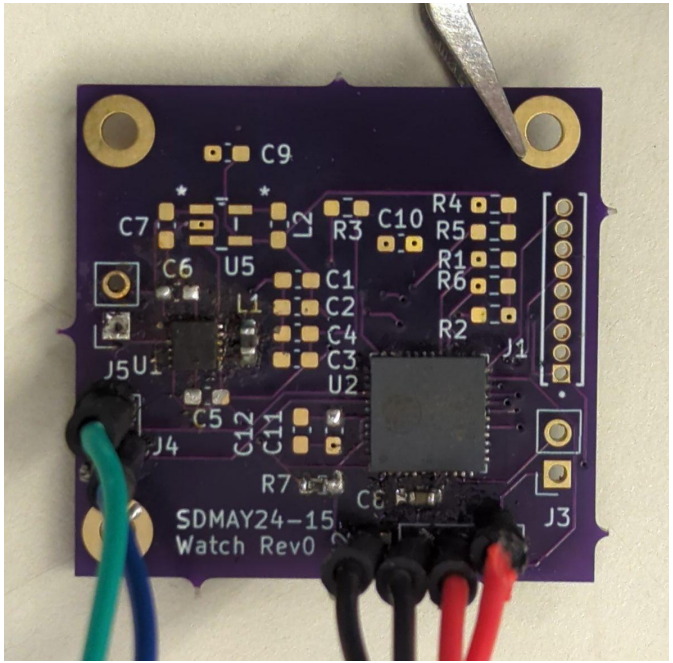
Spring Semester

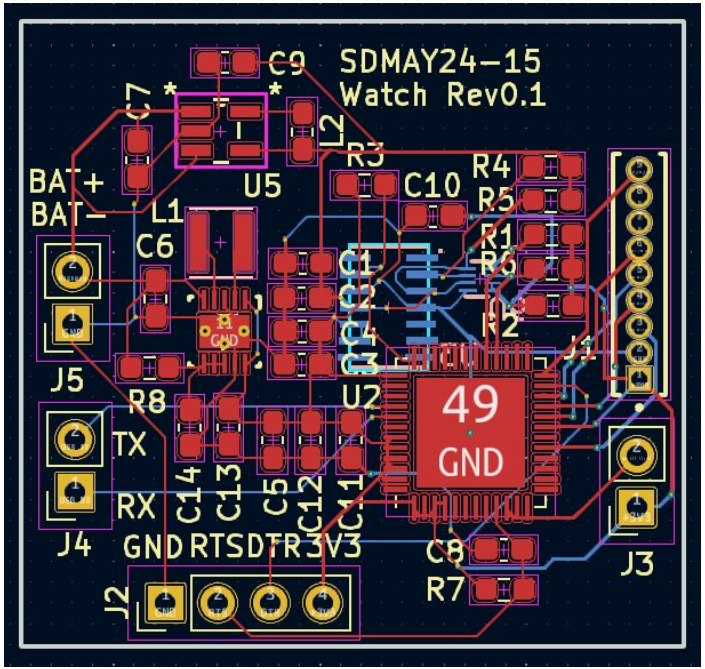
Hardware

Overview

- User Device
    1. First hardware release
    2. First release testing and results
    3. Solutions and changes
    4. Second hardware release
    5. Second release testing and results
- Feedback Device
    1. Design
    2. Testing

User Device First Release





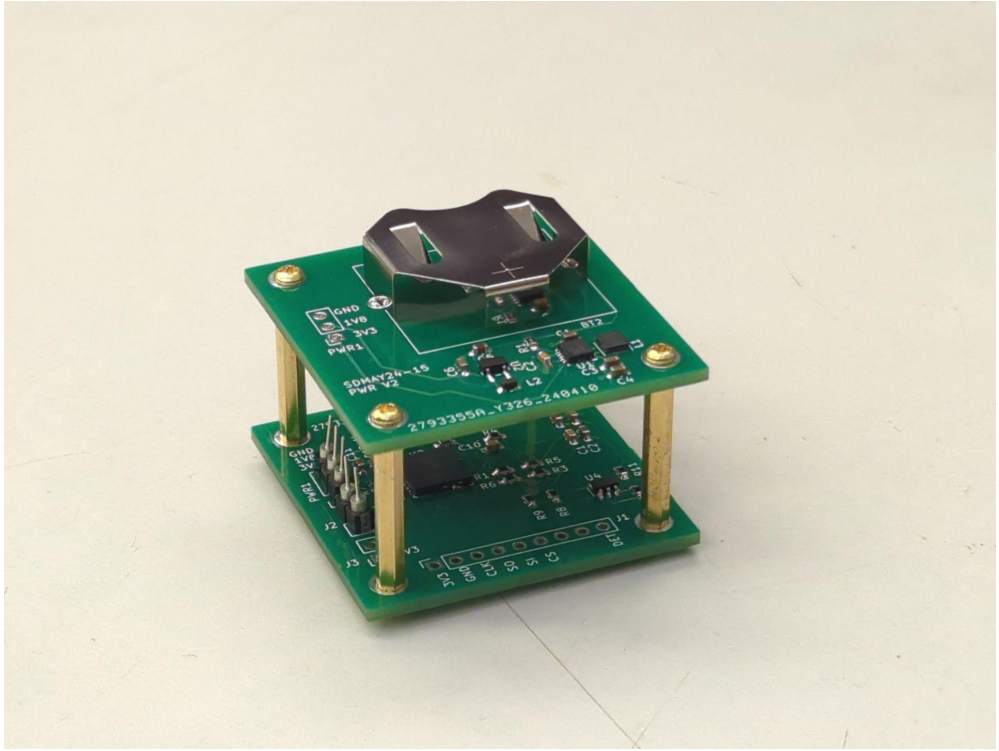
User Device First Release

- **Plan:**
  - Perform continuity tests on circuits to check for production errors
  - Verify power circuit operation using fixed input and measuring output in lab.
  - Flash code to device
- **Results:**
  - Continuity Tests: Passed
  - Power Circuit: 1.8V worked, 3.3V didn’t
  - Flashing: Failed - inconsistent fail states, got signal integrity errors

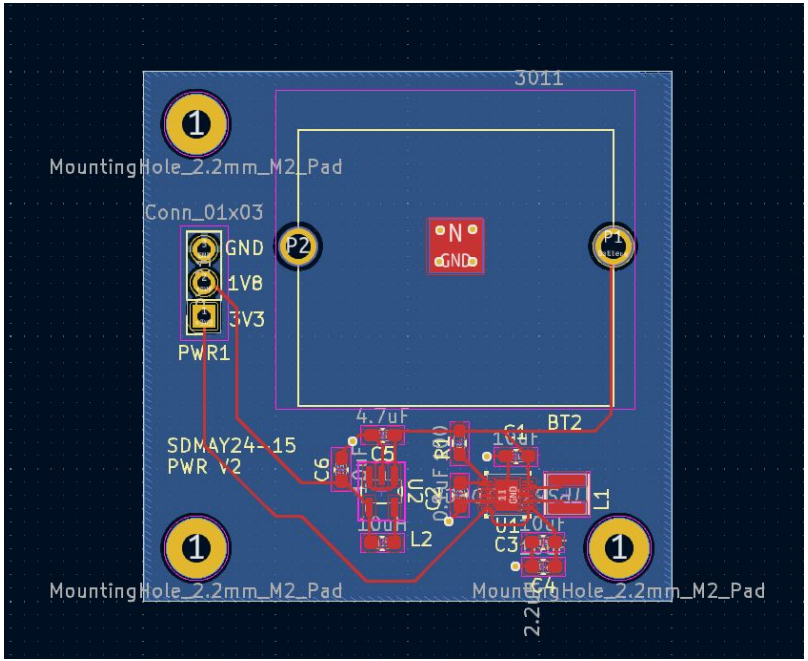
Testing First Release

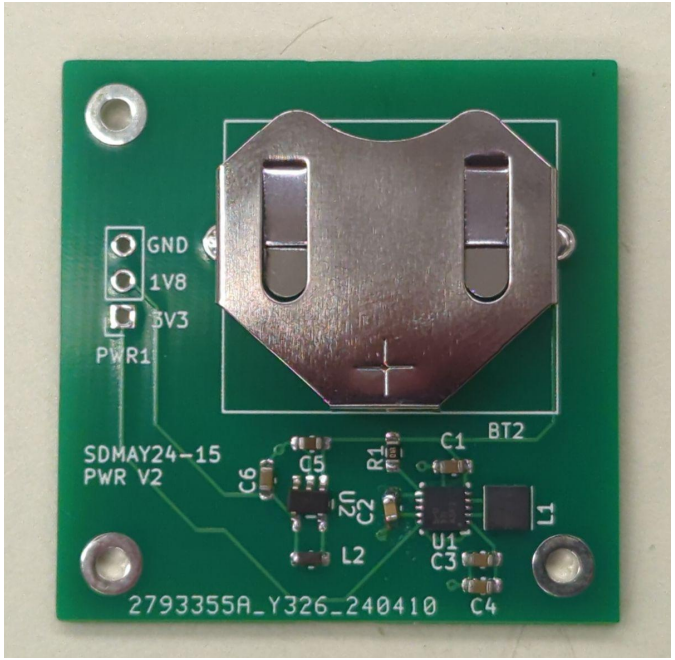
Issue	Planned Solution
Board design inhibited testing	Split design into two boards
Improperly specced 3.3V circuit components	Re-check specs on all parts, replace incompatible parts
Bad signal integrity (no ground plane, bad traces)	Add ground plane, re-route traces

User Device Second Release

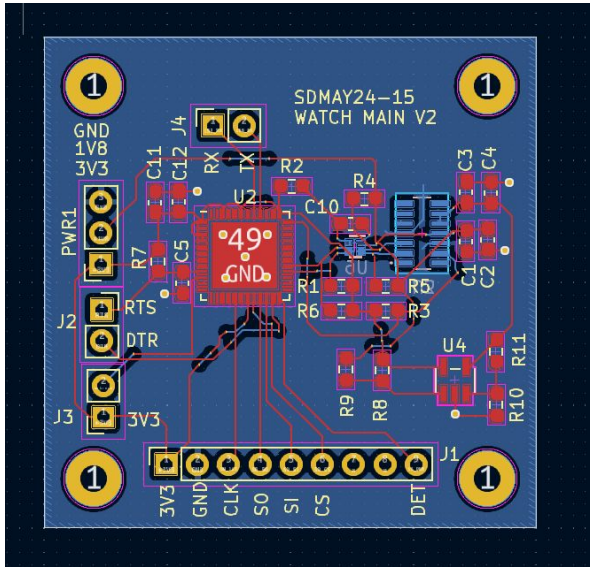


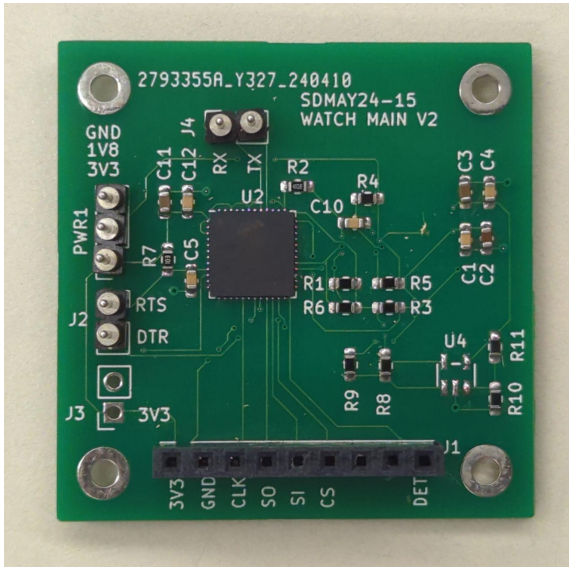
Top Board - Power

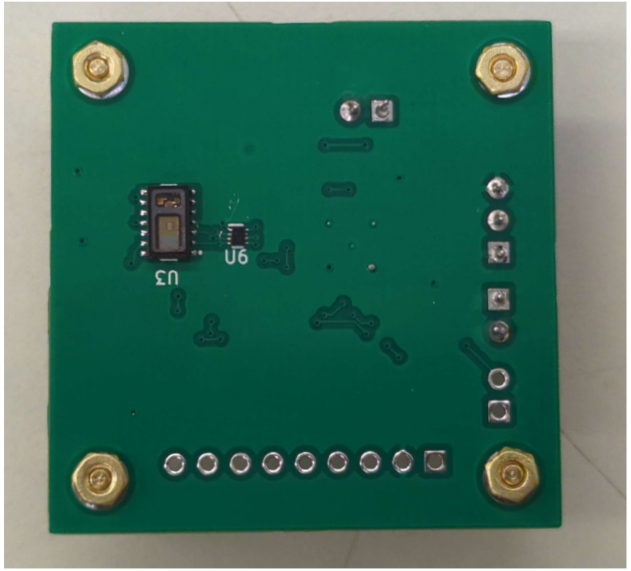




Bottom Board - Controller/Sensor







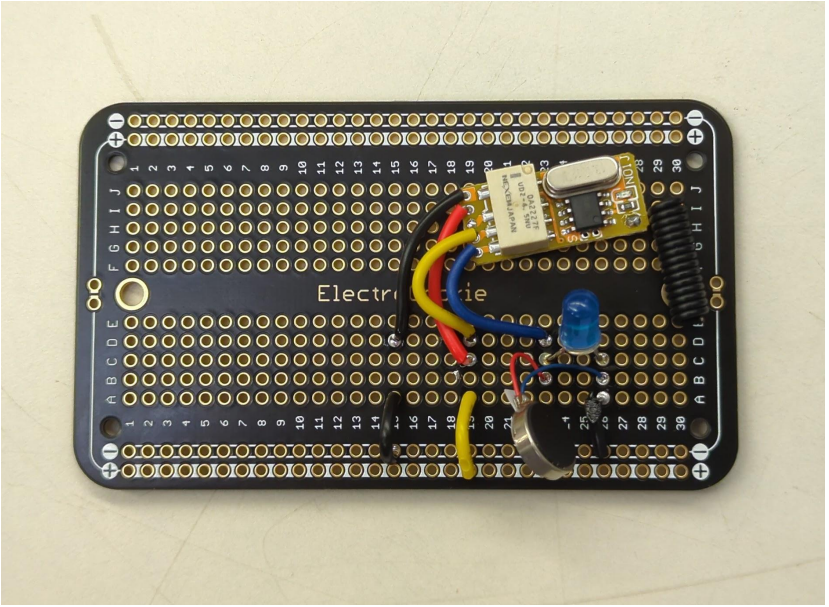
Second Release Testing

- **Plan:**
  - Perform continuity tests on circuits to check for production errors
  - Verify power circuit operation using fixed input and measuring output in lab.
  - Flash code to device

Second Release Testing

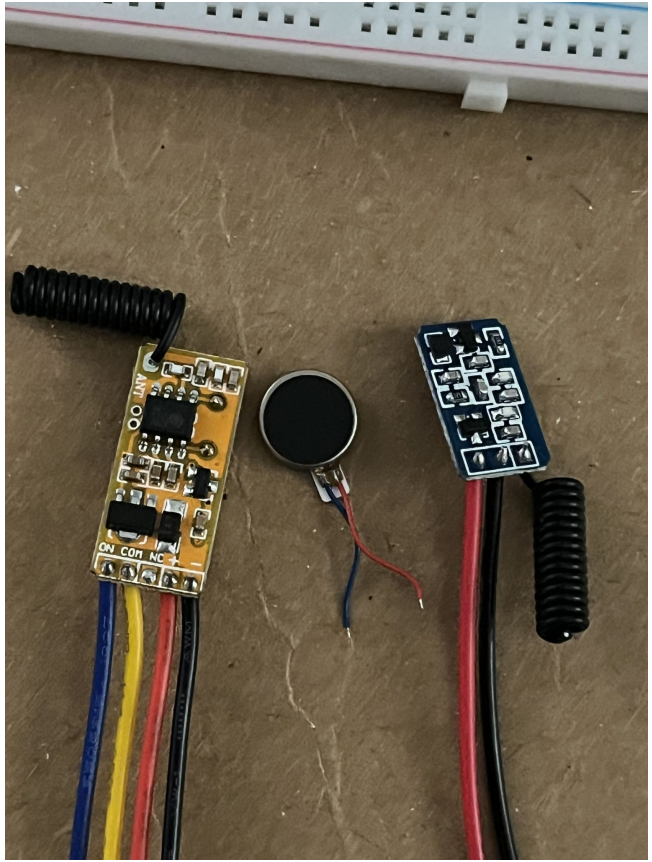
- **Results:**
  - Continuity Tests: Passed
  - Power Circuit: Passed
  - Flashing: Passed
  - Button configuration does not work with microcontroller
  - Identified points for design improvement:
    - Add 5V rail
    - Add more connections and test points
    - Change button connection to active low w/ pull-up

Feedback Device



Feedback Device Design

- Off the shelf transmitter/receiver pair
- Connect directly to 5V supply
- Small vibration motor



Feedback Device Testing

- **Plan:**
  - Verify that transmitter is communicating with the receiver
  - Integrate a vibration motor into the receiver side
- **Results:**
  - Communication between transmitter and receiver: Verified
  - Vibration motor integrated
    - Separate circuit built for receiver end
    - Used LED for visual confirmation

Hardware Design Challenges

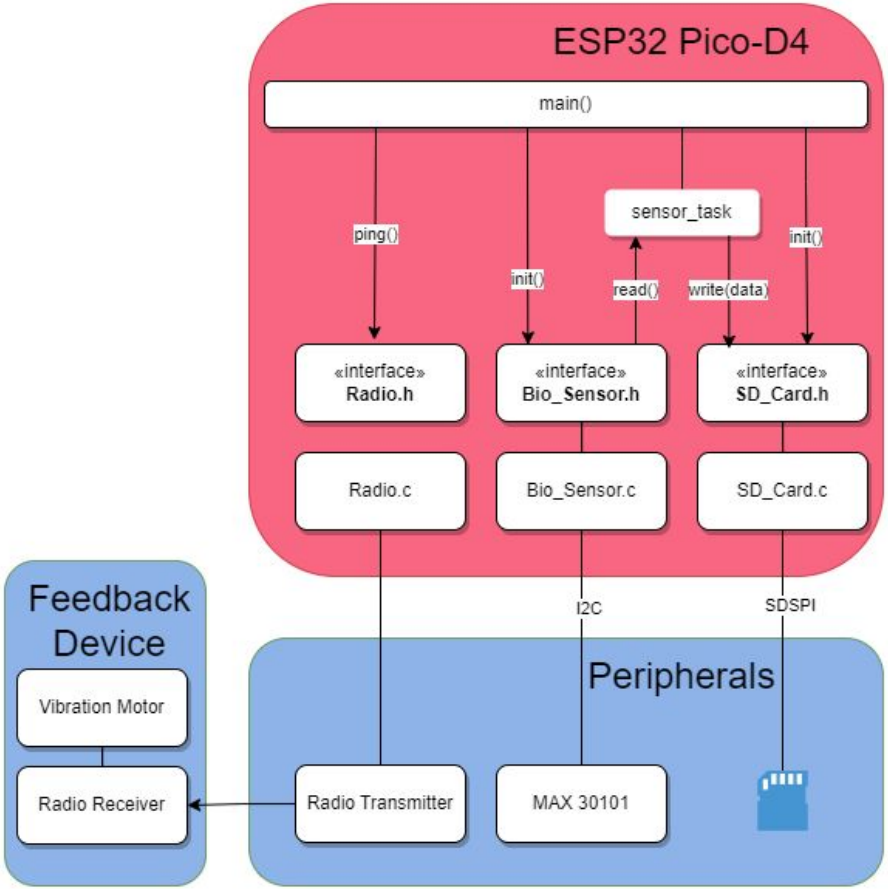
01 Relative inexperience in PCB design

02 Having to wait for prototypes then having to re-design

03 Hardware assembly bottlenecks

Software

Overview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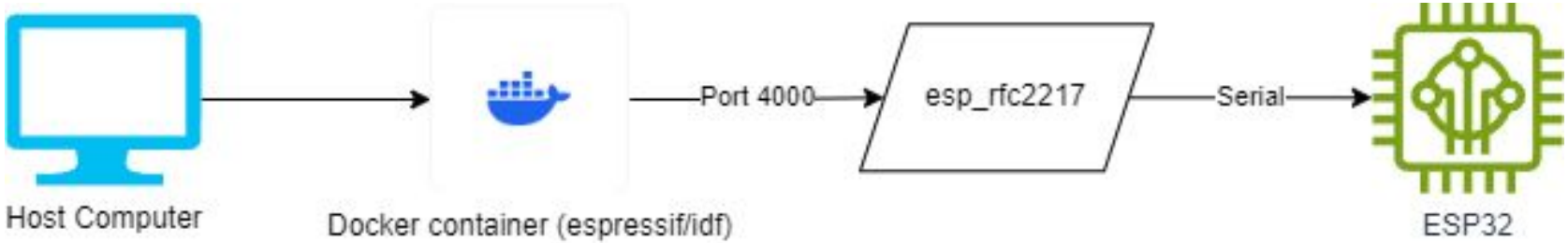
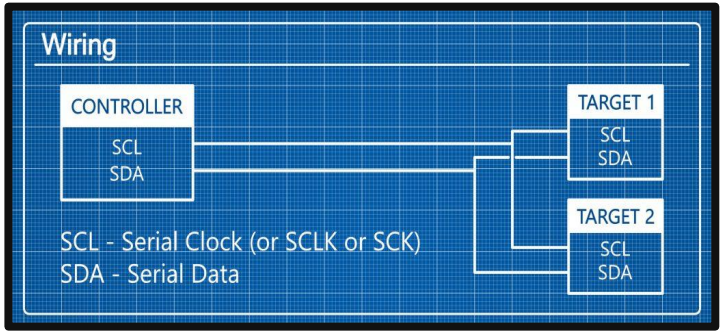
Bio_Sensor.h
«interface»
SD_Card.h
Radio.c
Bio_Sensor.c
SD_Card.c
I2C
SDSPI
Peripherals
Feedback
Device
Vibration Motor
Radio Receiver
Radio Transmitter
MAX 30101

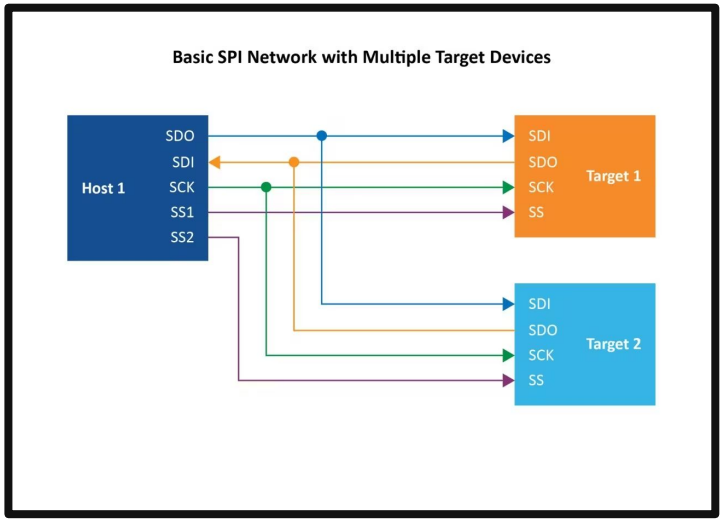
Environment Setup



Component Details

- ESP32-Pico-D4
  - Core processing component for the wearable device.
- MAX30101 Sensor
  - Communicates over I2C bus to the microcontroller.
- MicroSD Card Reader
  - Communicates over SPI bus to the microcontroller.
- Radio Transmitter
  - Sends radio signals to dog feedback device.

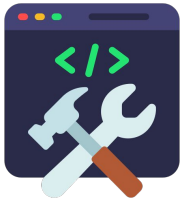




Testing Plan

Build Testing

- Docker
  - Establishes a consistent build process for each team member.
  - ESP-IDF code flashing
- GitLab CI Pipeline
  - Ensures safe merging



Device Testing

- Device Flashing
  - Breadboards
  - PCB
- “Hello World”
  - Writes a file.
- Vital Readings
  - Read vitals into a file.

Testing Results

- **MicroSD Card Reader:**
  - Successfully creates a text file and writes to said file on the microSD Card.
  - Successfully formats data to be written to the microSD card.
  - Is unable to create and work with more than one file at a time.

- **MAX30101 Sensor:**
  - Successfully wrote to and read from the sensor registers.
  - Unable to read vitals data from the sensor.

Challenges

01 Choosing platforms that support our full functionality

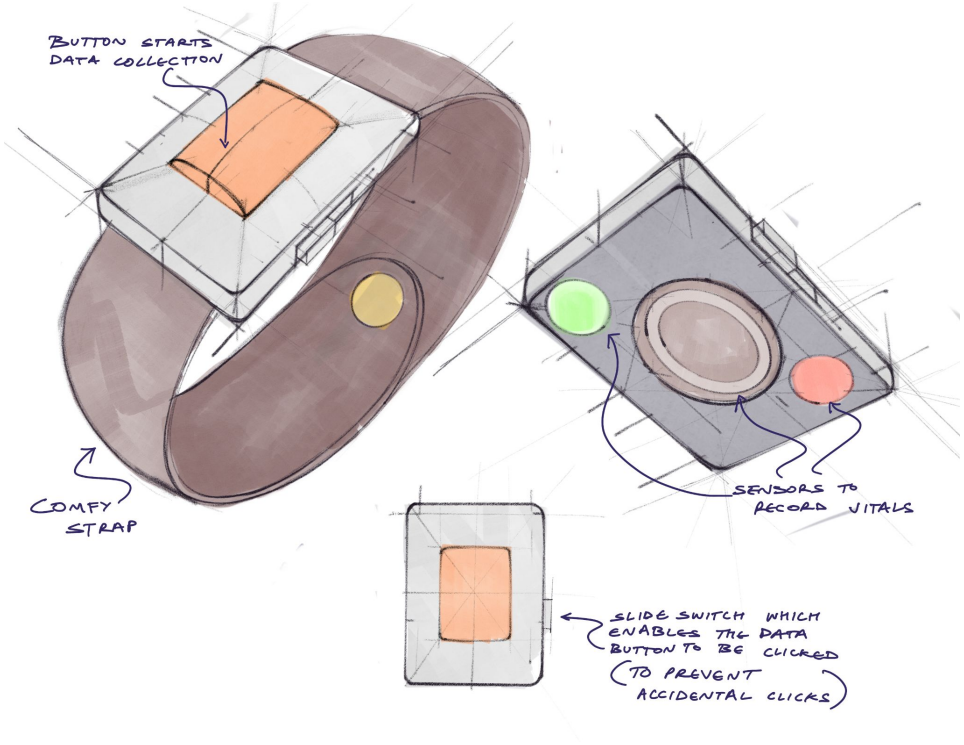
02 Compatibility for different devices

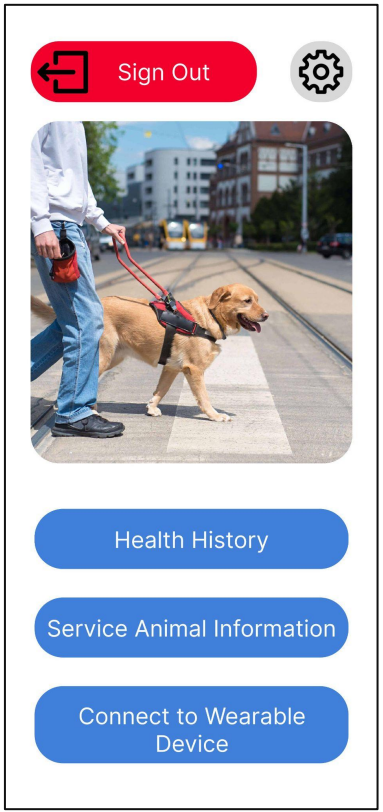
03 What colors of LEDs work for wrist-PPG/SPO2 readings?

04 How do we flash software onto a surface-mount microcontroller?

Future Plans

Final Concept





Created by: Bhavesh Sharma, Industrial Design

Prototype for Supplemental Phone Application

Potential Additions
Software

- Add bluetooth-connected app for syncing data and user interaction
- Use the app to store data on a cloud database
- Develop trainable algorithm for predicting PTSD episodes
- Modify the microSD card reader to allow for more files to exist on the microSD card
- Add different methods for users to interface with the product

Potential Additions
Hardware

- Change power delivery to accommodate 5V supply and improved sensor
- Shrink PCB size
- Integrate Radio transmitter to PCB
- Change pin layout to better accommodate stacking
- Add buttons/interfaces for user interaction
- Add accelerometer and/or temperature sensors

Handing Off the Project

America's VetDogs has expressed interest in having another senior design group continue our work from where we've left off. We are coordinating with them to make sure that our hardware and files can be given to another group and that the next group will be able to start where we left off.

Questions?