PTSD Detection Device

Panel Presentation
sdmay24-15

All sources / citations can be found on our Final Design Document located on our Team Website:

sdmay24-15 • PTSD Detection Device (iastate.edu)

This presentation can also be found on our Team Website.

Our Team

Team Members

Caden Backen - Software Engineer

Casey Halbmaier - Software Engineer

Coby Konkol - Software Engineer

Andres Ceballos - Electrical Engineer

Ben Gardner - Electrical Engineer

Nihaal Zaheer - Computer Engineer

Cumulative Skill Set

Skill	Team Members
High-Level programming	Casey, Coby, Caden
UI design	Caden
Low-level programming	Nihaal, Coby
Circuit/hardware designs	Ben, Andres
Computer aided design (CAD)	Andres, Coby
Team/project management	Casey
Operating systems/infrastructure	Coby

Our Sponsors

BAE SYSTEMS

EST. 2003

AMERICA'S

VETDOGS®

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

Post Traumatic Stress Disorder (PTSD)

Qualifying intrusion symptoms (from DSM 5):

B1. Recurrent, involuntary, and intrusive distressing memories of the traumatic event

B2. Recurrent distressing dreams in which content and/or affect of the dream are related to the traumatic event

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

Overview

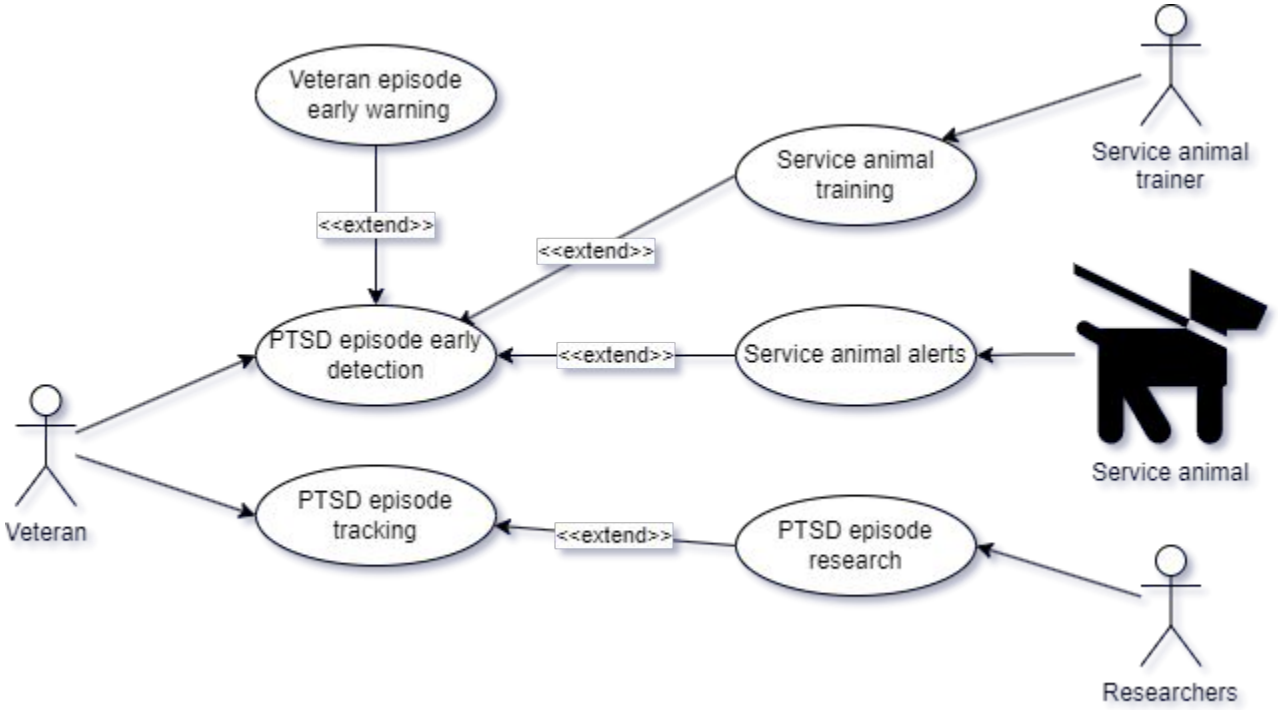
America's VetDogs, in collaboration with BAE Systems, is aiming to **create a device that monitors a user's physiological data to detect onset of PTSD intrusion symptoms (noted a PTSD episode).** This device will then alert the service animal of the PTSD episode to which it would respond accordingly.

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
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Service animal training
Service animal trainer
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PTSD episode early detection
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Service animal alerts
Service animal
Veteran
PTSD episode tracking
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PTSD episode research
Researchers

Our Design

Summary

Our design approach addresses the challenge of a lack of data, and a lack of devices, by building a single device which can aid in veteran treatment, and researchers' data collection alike.

Requirements

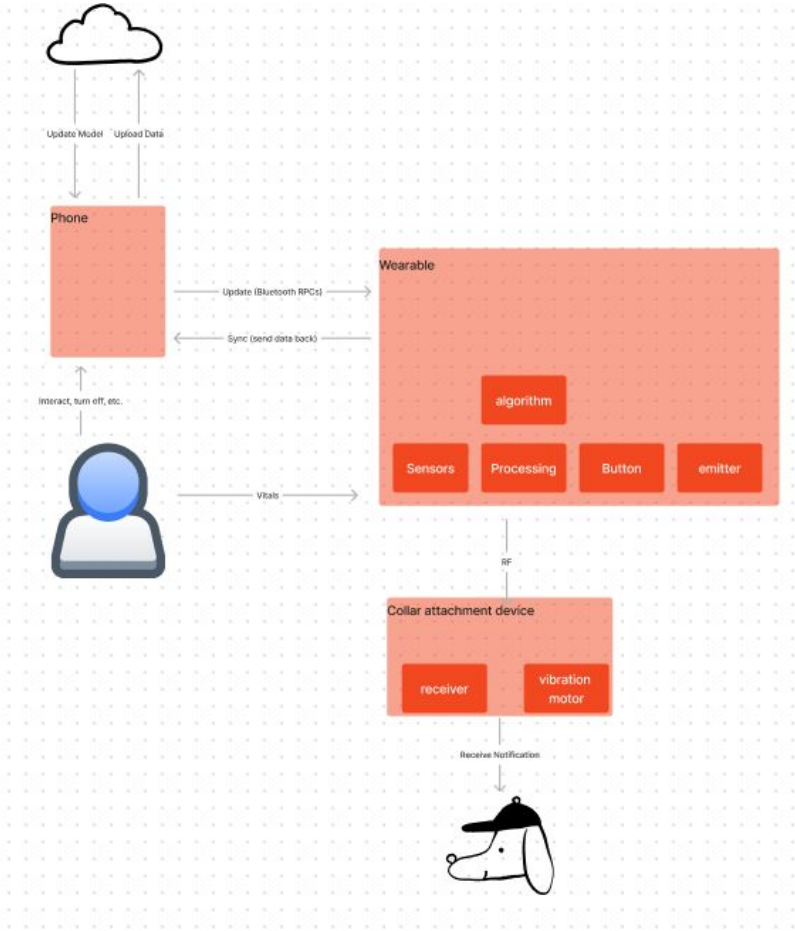
Functional Requirements:

- Reliably monitors the user's physiological and environmental data (1)
- Detect any abnormal behavior in data consistent with PTSD (2)
- Upon PTSD episode symptoms, alert the service animal of upcoming episode. (3)
- The user should be able to dismiss the device before the dog is notified (4)
- The user should be able to power off and on the device (5)

Design Evolution

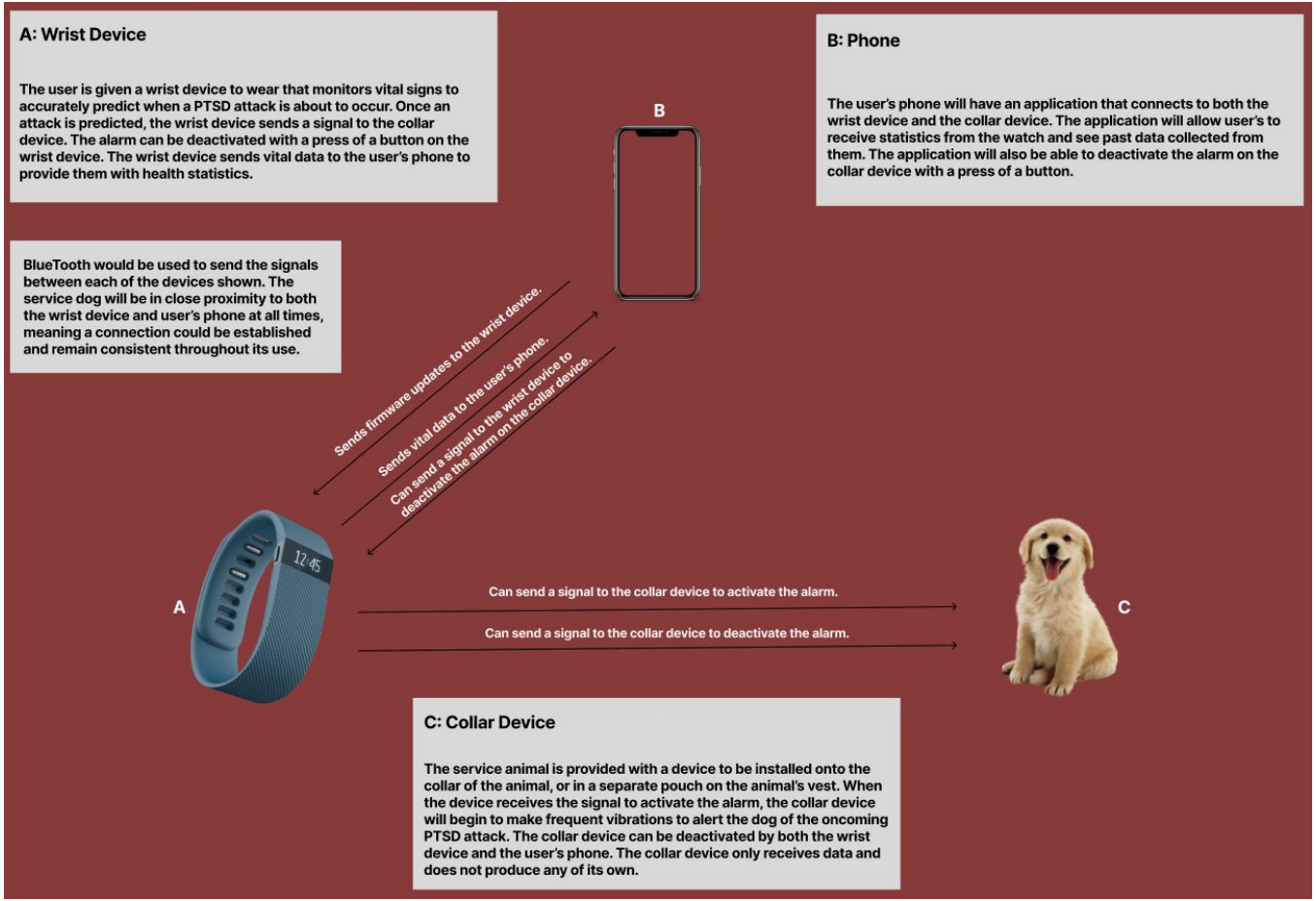
Iteration 0

Iteration 0: Phone app, wearable, and collar are interdependent



Iteration 1

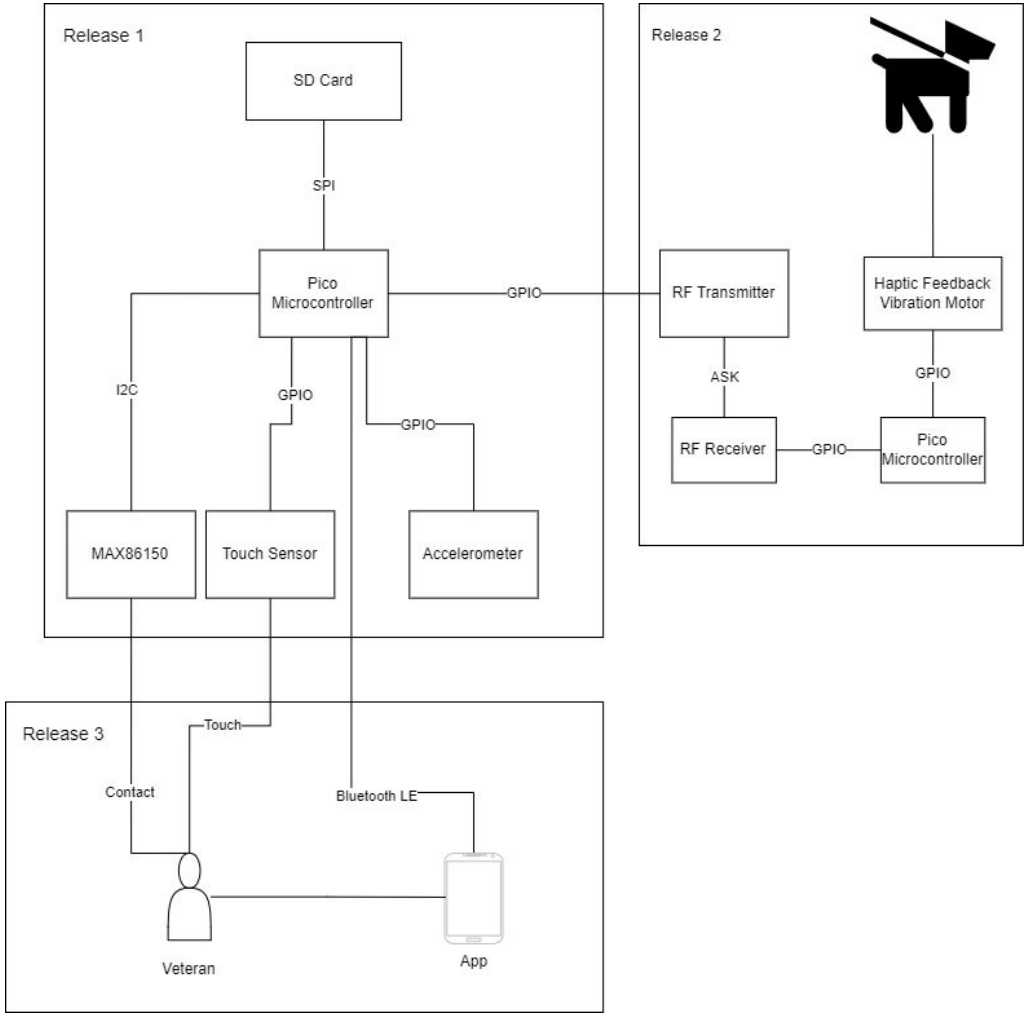
Iteration 1:
Decoupling of app from system functionality



Iteration 2 (Current)

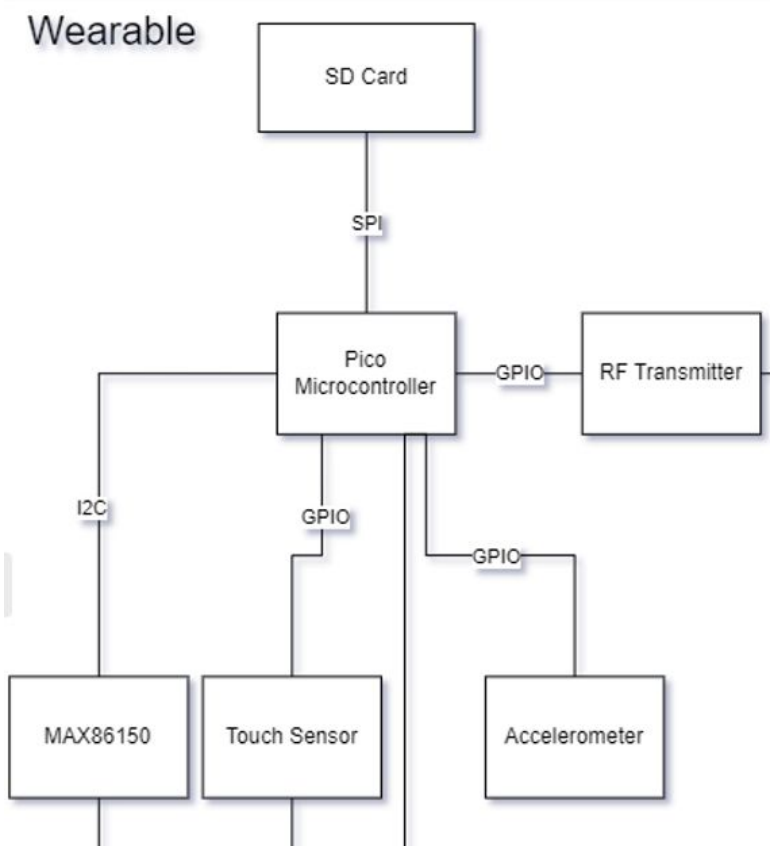
Iteration 2 (Current Design):

Decomposition of features into multiple phases of a single wearable design



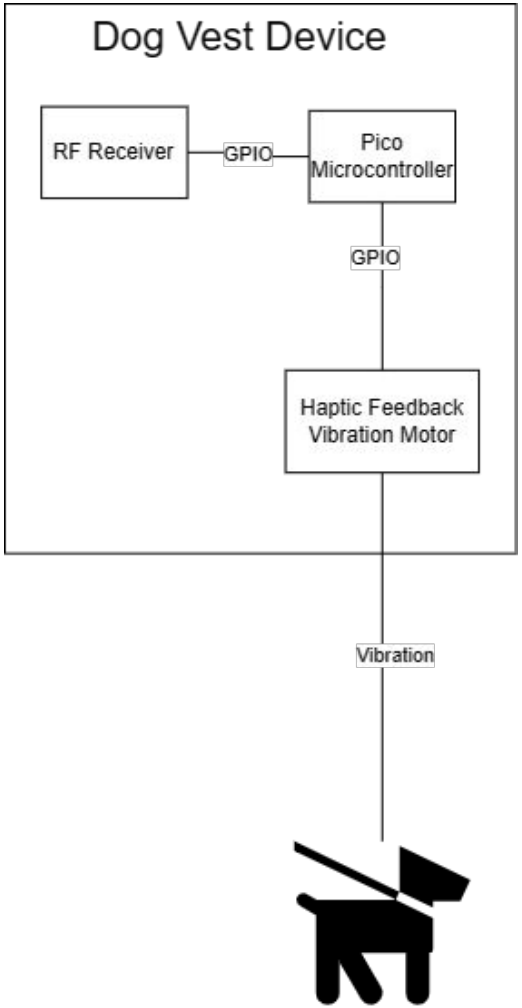
Consumer Wearable Device

- Sensors to detect vitals.
- 2 or more IR, red, and green light sensors used for PPG, and SPO2 measurements
- Accelerometer to verify PTSD episodes by the algorithm.
- Processing of algorithm done in wearable device for early PTSD detection.
- Manual recording of PTSD symptoms felt by the user using a button.



Feedback Device

- The feedback device receives a signal to tell the service animal to go to the user.
- The dog is trained to go to the veteran and notify them the potential oncoming episode.
- The functionality of the device will be similar to that of a pager and will buzz whenever signaled by the user's wearable.



Phone Application

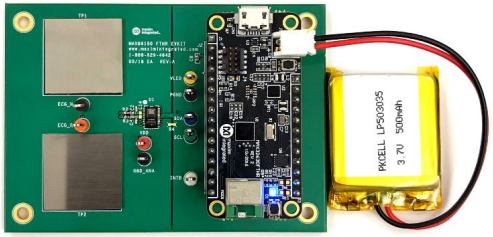
- The application will send configuration information to the wearable.
- It will provide the availability to turn the device on and off.
- The communication between the wearable and application will be via bluetooth.
- This application is **NOT** required for the main functionality of the wearable itself.

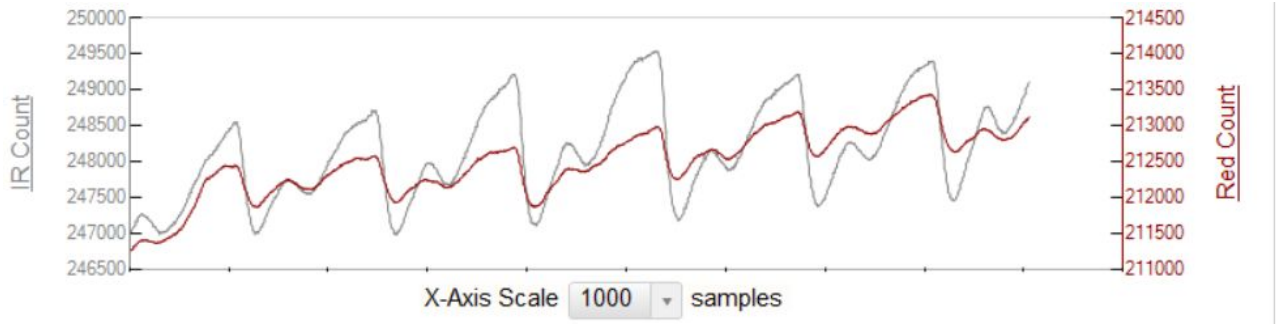
- A short UI demo has been created for this presentation.

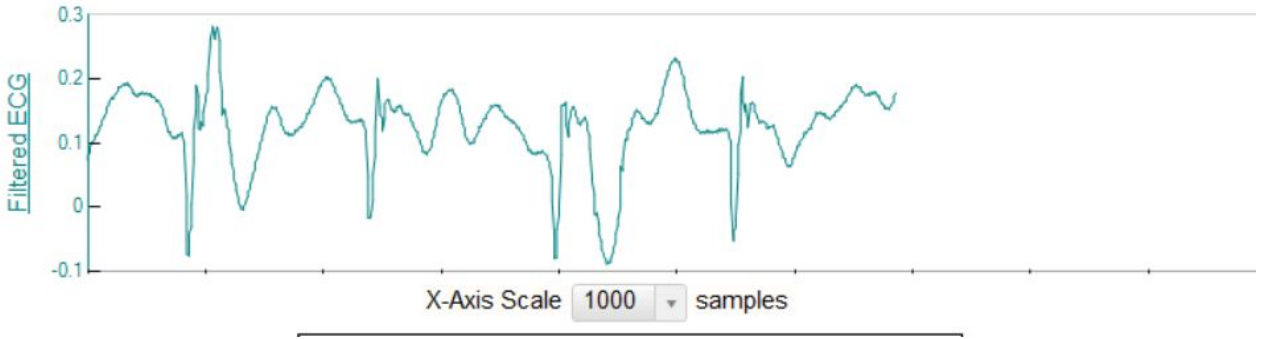
Prototype only, final results may vary

Prototyping

MAX86150 breakout board output







Design Complexity

Design obstacles:

- There is not much accessible data on physiological symptoms of PTSD episodes
- Most commercially available devices have limited capabilities and breadth of physiological data available
- Existing wearable devices for obtaining biological data are expensive and difficult to obtain

Project Plan

Quantitative Assessments:

- Algorithm classification of PTSD episodes with 80% accuracy, or time prediction with 80% accuracy

Qualitative Assessments:

- Wearable device is unobtrusive/comfortable
- Feedback device “buzzes” sufficiently strongly
- Feedback device is small enough to fit in a pocket
- Feedback must be discrete
- Wearable device must be discrete

Project Plan

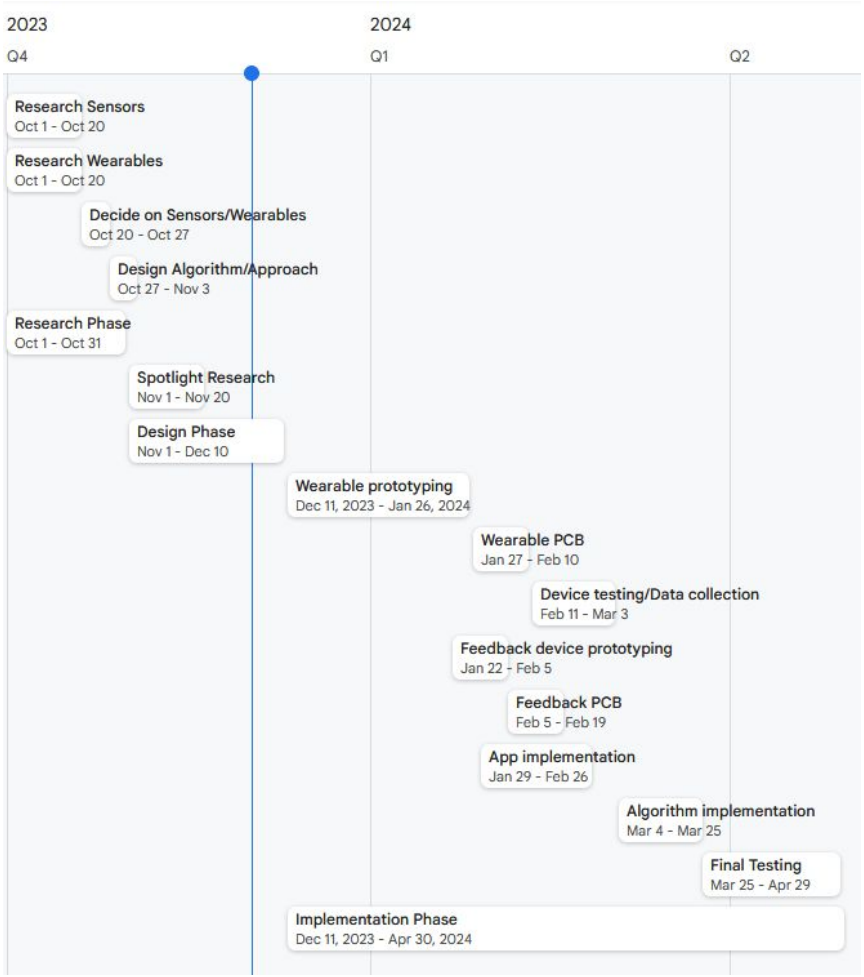
Risks:

- Invasiveness of physiological data collection
- Security for collecting physiological data.
- Data encryption in place and in transit
- Wearable device comfort
- Environmental impact of device

Mitigation Plan:

- Integration of non-invasive sensors for data collection
- Secured communication channel for data transfer
- Adjustable band for wearable device
- Use safe materials and processes for design

Timeline


2023
2024
Q4
Q1
Q2
Research Sensors
Oct 1 - Oct 20
Research Wearables
Oct 1 - Oct 20
Decide on Sensors/Wearables
Oct 20 - Oct 27
Design Algorithm/Approach
Oct 27 - Nov 3
Research Phase
Oct 1 - Oct 31
Spotlight Research
Nov 1 - Nov 20
Design Phase
Nov 1 - Dec 10
Wearable prototyping
Dec 11, 2023 - Jan 26, 2024
Wearable PCB
Jan 27 - Feb 10
Device testing/Data collection
Feb 11 - Mar 3
Feedback device prototyping
Jan 22 - Feb 5
Feedback PCB
Feb 5 - Feb 19
App implementation
Jan 29 - Feb 26
Algorithm implementation
Mar 4 - Mar 25
Final Testing
Mar 25 - Apr 29
Implementation Phase
Dec 11, 2023 - Apr 30, 2024

Test Plan

System / Acceptance

Requirement	Tests
Battery life /operating voltage (System)	• Use lab power supplies to test operation at different supply voltages. • Run device continuously to and test battery to determine expected battery life
Reliably detect episodes (Acceptance)	• Input simulated data and verify behavior • Have device worn by someone from VetDogs who has regular attacks and verify detection
Notifications can be dismissed/disabled by user (Acceptance)	• Simulate/trigger device and verify that it can be dismissed
Feedback device is not disruptive (Acceptance)	• Trigger the feedback device and ensure that it is not noticeable by humans

Interface / Integration

Tests	Tools
Sensors output signals modeling physiological data (1)	Voltmeters/oscilloscope
Wearable software reads sensor input data (1)	CEFIT, testing software
Wearable software correctly identifies upcoming PTSD episodes (2)	Run algorithm on test data
Sensor data is written to SD card (1)	Manual
Wearable device receives alerts of PTSD symptoms (3)	Manual/observable

Component / Unit

Component	Tests
MAX SPO2 cardiac output sensor	• Compare to off-the-shelf FDA approved pulse oximeter
Microcontroller	• Writing data to file • Check whether data is processed correctly
SD Card	• Data persists after microcontroller turns off or card is removed • Data/files are visible when attached to a computer
Touch Sensor	• On startup, output sensor is low • When sensor output is high, output remains high until pressed again

Demos

Conclusions & Questions

Appendix

PPG

Photoplethysmogram: plethysmogram used to detect blood volume changes

Measured using reflection/transmission of light through dermis and subcutaneous skin tissue

Provides indicators of cardiovascular output, heart rate, and blood pressure. These metrics have been proven correlated to stress, and environmental factors

EDA

Electrodermal activity: Variation of skin conductance in response to sweat secretion

Normally measured using electrodes

Indicator of intensity of emotional state, level of physical activity

SPO_2

Saturation of peripheral oxygen

Can be measured using the ratio of IR to red light reflected by skin

Provides an indication of user’s respiratory system output

Accelerometer

Device which measures linear acceleration

Useful as an indicator of the user's current state/environment. If a user is currently accelerating, or moving quickly, it is likely changes in their vitals are due to their environment and not PTSD.