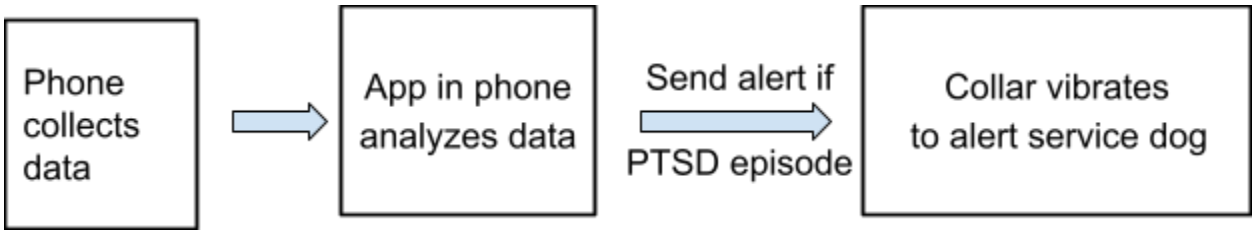
4.3 Proposed Design

4.3.1 Overview

Provide a high-level description of your current design. This description should be understandable to non-engineers (i.e., the general public). Describe key components or sub-systems and how they contribute to the overall design. You may wish to include a basic block diagram, infographic, or other visual to help communicate the overall design.

Our system involves 3 main components; a fitness watch, mobile application, and a custom produced vibrating dog collar. Our goal is to create a system that detects PTSD episodes from a human user and alert their service dog through a vibrating collar. The fitness watch's role in this system is to gather the vitals that will be necessary to conclude the user is having a PTSD attack. The mobile application will be installed on the fitness watch and will be responsible for handling the information gathered by the watch and determining if the vitals are showing a clear sign of PTSD. The mobile app will also be connected to the dog collar via Bluetooth and send a message to the dog collar to inform the collar to vibrate in order to alert the dog of an attack.



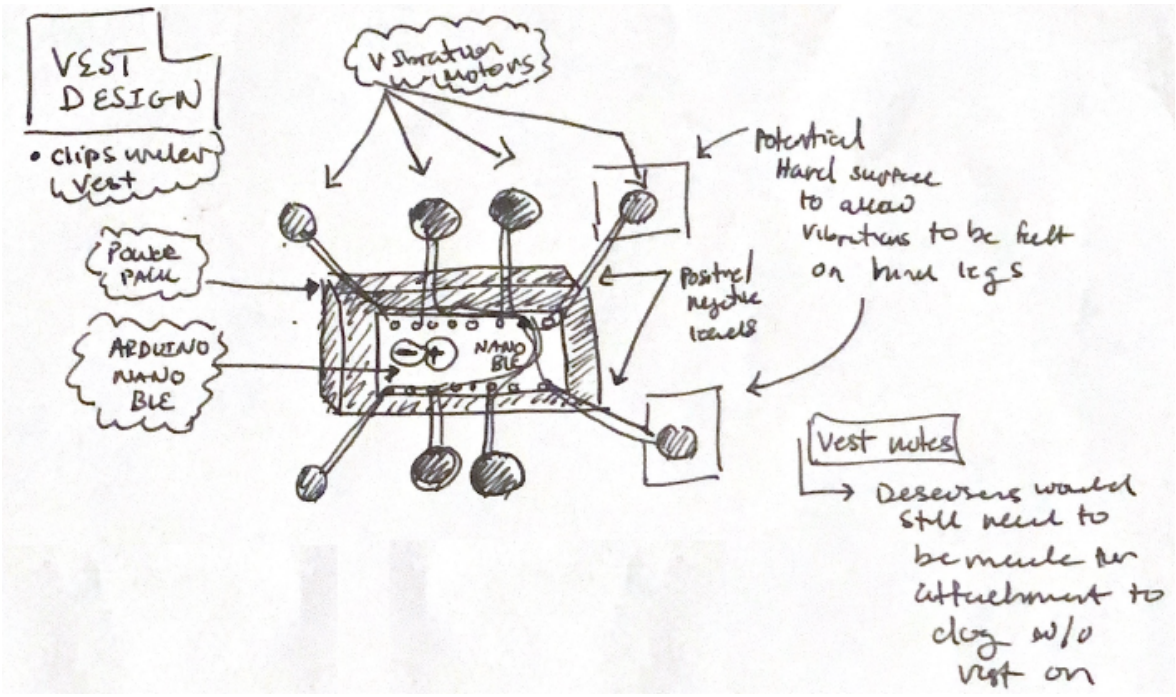
4.3.2 Detailed Design and Visual(s)

Provide a detailed, technical description of your design, aided by visualizations. This description should be understandable to peer engineers. In other words, it should be clearly written and sufficiently detail such that another senior design team can look through it and implement it.

The description should include a high-level overview written for peer engineers. This should list all sub-systems or components, their role in the whole system, and how they will be integrated or interconnected. A visual should accompany this description. Typically, a detailed block diagram will suffice, but other visual forms can be acceptable.

The description should also include more specific descriptions of sub-systems and components (e.g., their internal operations). Once again, a good rule of thumb is: could another engineer with similar expertise build the component/sub-system based on your description? Use visualizations to support your descriptions. Different visual types may be relevant to different types of projects, components, or subsystems. You may include, but are not limited to: block diagrams, circuit diagrams, sketches/pictures of physical components and their operation, wireframes, etc.

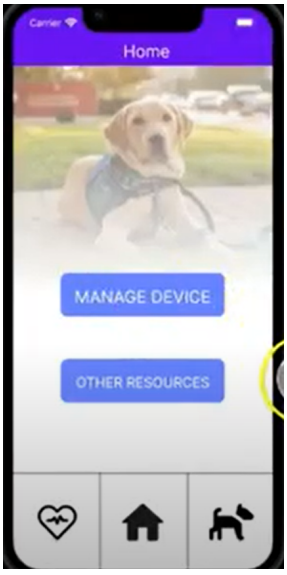
The dog device consists of an arduino, a custom pcb. and a vibration motor. We will design the pcb in a way that allows the arduino controller to be slid into place, connecting all the proper GPIO pins, and allowing for mounting screws to slide through holes in the board to secure the controller. From here, we have a 3D printed rectangular housing that will have slots to slide the board in and secure it inside. It will also have a mounting area to securely attach the vibration motor to the housing to reduce vibration noise. There will be space to slide in and secure a battery before closing the housing after everything has been secured with a binding agent to further reduce vibration noise. The arduino will have C code running onboard that will be transmitting and receiving data over the bluetooth connection to the apple watch application that is written in flutter.

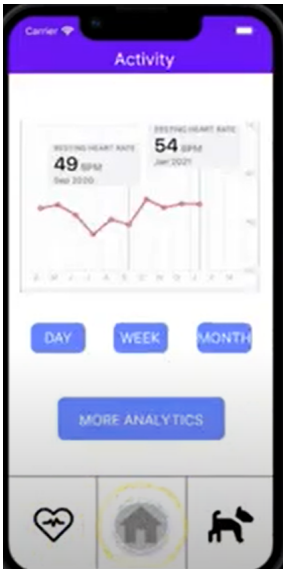


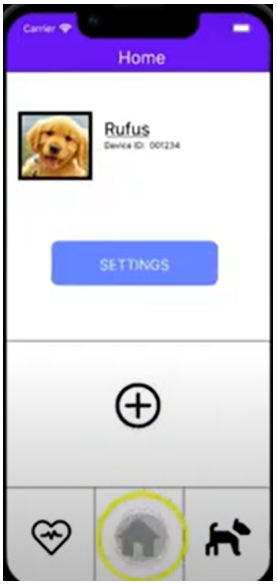
(Dog Device Model Without Enclosure On)

For our Flutter app…

Our software app follows an MVC design. We will implement a service to receive data from the user's fitness watch either via fitbitter or Apple watch's flutter package. We will update the backend components of this which will call listeners to update the views (main screen, Home Screen, activity screen, dog screen, etc). The service will also allow us to send a notification to the user upon the detection of a PTSD attack as well as a signal to the Dog's collar via Bluetooth module.







4.3.3 Functionality

Describe how your design is intended to operate in its user and/or real-world context. What would a user do? How would the device/system/etc. respond? This description can be supplemented by a visual, such as a timeline, storyboard, or sketch.

In the real world, this device will be used on the service dog and the veteran worn smart watch. These platforms will be linked over bluetooth, and will be installed on the wrist and under the service dog vest. During operation, the watch will monitor the user's heart rate for irregular heart rates. When it detects an irregular heart rate, it will cross reference the heart rate information with the other gyroscopic, altitude, and gps sensor data to determine if the user is having a PTSD attack, or if they are performing a physically demanding task triggering a false positive. When a positive PTSD attack is determined, the device will send a message over bluetooth to the dog worn device to alert the dog of the attack in progress. The dog will require some training to recognize what the vibration sensation indicates, but once trained it will know this means it needs to focus on the user to bring them out of that attack.

4.3.4 Areas of Concern and Development

How well does/will the current design satisfy requirements and meet user needs?

Based on your current design, what are your primary concerns for delivering a product/system that addresses requirements and meets user and client needs?

What are your immediate plans for developing the solution to address those concerns? What questions do you have for clients, TAs, and faculty advisers?

Currently our design will satisfy the requirements and meet user needs as best as we are able to on the budget we are provided. The task of determining a psychological condition based solely off of physiological symptoms is incredibly difficult, and is limited extremely by the design requirements of not having anything but a smartwatch sized device. We cannot add any sensors onto this apple watch sensing device, which leaves us the activity detection and heartbeat monitoring alone to detect. We believe that this can provide a function and usable prototype, but further funding and technical resource knowledge from apple level user device design and manufacturing is required to make a device that will function faster than a $75,000 trained animal. We believe that this prototype will aid in adding more detected PTSD attacks by reminding the dog to look at the user when an attack is detected. If for any reason the dog was distracted or preoccupied, this device will detect attacks that the dog isn't aware of and refocus the dog on its job to stop the attack faster than if the device wasn't present.

4.4 Technology Considerations

Describe the distinct technologies you are using in your design. Highlight the strengths, weakness, and trade-offs made in technology available. Discuss possible solutions and design alternatives.

Flutter Framework:

We are choosing to use a flutter framework to build our mobile app for a variety of reasons. The first being, flutter allows easy cross-platform development, regardless of the operating system we are developing on, this means we can develop for web, iOS, and android all within our Windows machines. Secondly, flutter provides a host of libraries that will make development significantly easier, including libraries to integrate with Bluetooth modules, arduinos, Apple watches, fitbits, and more. Finally, their is experience in developing with flutter in our team, making it an easy choice. Only weakness we anticipate is there are still some limitations to iOS development specifically, but flutter will meet around 90% of our needs.

Fitness Smart Watch

We are choosing a fitness smart watch such as the Fitbit or Apple Watch given that making a device such as the ones provided would be costly in both time and resources. Competing with devices that have already been out and honed in monitoring biometrics of humans would be incredibly difficult and is the reason we chose an already existing device to begin with. The strengths as mentioned before is the fact that this device already has algorithms and measurement systems built into them and all we have to do is interpret them. A weakness of this device is the fact that they are quite costly when purchased brand new. For our prototype, we will be buying a preowned device in order to cut costs.

Arduino

We are choosing the Arduino Nano 33 BLE as our microcontroller that goes on to the dog. The strengths of such a device is good processing power, small power use, bluetooth connection, and small form factor that are all desirable traits for our dog device. A weakness of this device is that interfacing with the pins requires lots of wiring which will require cable management and ways to minimize said cable mess. There have been other alternatives such as the Raspberry Pi but this device we are all familiar with and has similar features therefore we choose the Arduino Nano 33 BLE.

PCB Breakout Box

This piece of technology is a PCB board customly designed by our team in order to declutter the cables on top of the Arduino. The strength of doing so is the fact that it minimizes space our device takes up by routing wires and components via a small/thin PCB. The weaknesses of this is the fact that we will have to create a custom board which requires a learning curve of PCB design which not many of us are experienced with.

4.5 Design Analysis

Discuss what you have done so far, i.e., what have you built, implemented, or tested? Did your proposed design from 4.3 work? Why or why not? Based on what has worked or not worked (e.g., what you have or haven't been able to build, what functioned as expected or not), what plans do you have for future design and implementation work? For example, are there implications for the overall feasibility of your design or have you just experienced build issues?

So far we have been able to design, code, and deliver a flutter coded application for prototyping communications between hardware and software. This has been the only thing thus far that we have been able to test because we have been chasing down how to get approval to order parts for most of the semester. We have successfully gotten approval, and have successfully ordered the parts necessary for the first prototype of our system. So far our proposed design from 4.3 for the flutter application has worked. Based on my previous experience in embedded systems and hardware design, I am confident that the parts we ordered with the dog device will produce a functional prototype. So far the overall feasibility of our design is intact, remaining solid. We will need to set out on building our hardware prototype next in our future design and implementation work. Once these two systems are functioning independently, we will need to design and implement a bluetooth communication API for our device.