SAFE SIGNAL

A REAL-TIME POST-TRAUMATIC STRESS SYNDROME DETECTION DEVICE

DESIGN DOCUMENT

TEAM NUMBER

sdmay25-13

CLIENT

America's VetDogs

MENTORS

BAE Systems

ADVISOR

Dr. Mohamed Selim

TEAM MEMBERS

Aidan Klimczak - Electrical Engineer
Justin Jaeckel - Computer Engineer
Justin Scherrman - Electrical Engineer
Katerina Zubic - Electrical Engineer
Neil Prange - Computer Engineer
Ty Decker - Cyber Engineer

TEAM EMAIL

sdmay24-13@iastate.edu

TEAM WEBSITE

https://sdmay25-13.sd.ece.iastate.edu

EXECUTIVE SUMMARY

Post-traumatic stress syndrome (PTSD) can be debilitating to a Veteran's quality of life. It can negatively affect their psychological health and bring on emotions of stress, alienation, and decreased life satisfaction.

The current market alternatives for monitoring mental health relating to PTSD are only reactive to the current symptoms of the episodes, are costly, and are intrusive. Due to the existing insufficient and expensive monitoring devices, Veterans continue to suffer from their PTSD symptoms.

Tackling this gap in inadequate products, we have been tasked to develop a post-traumatic stress syndrome detection device that proactively reads the biometric information of heart rate and blood pressure to mitigate the chances of a PTSD episode. If onset symptoms are detected, the Veterans' wearable will alert their service dog to provide necessary comfort before the symptoms become crippling.

The design constraints include that this detection device must be wearable for the Veteran and be capable of monitoring heart rate and blood pressure. Additionally, there needs to be another device on the service dog that is non-intrusive and discrete to receive some kind of distress signal to then provide assistance to their Veteran.

To create these devices for the Veteran and service dog, we have selected to use ESP32 WROVER microcontrollers that have Bluetooth compatibility. This is to establish wireless communication between the two parties so that they are effectively wearable and non-intrusive. Additionally, for the biometric data, we are using a photoplethysmogram (PPG) sensor to read heart rate and blood pressure. Finally, to alert the service dog, we have incorporated an eccentric rotating mass motor (ERM motor) that signals the Veteran is experiencing onset symptoms.

This semester we focused on implementing a breadboard design as our initial prototype. We have effectively established wireless communication between the two microcontrollers and created an interface that reads and deciphers raw data from the PPG sensor. This data gives us a heart rate that has been verified through a third-party device and is then displayed on a liquid crystal display (LCD). Additionally, we have created a pseudo interruption using a push button to mimic the detection of onset symptoms that then turn on the ERM motor.

Our design currently meets a few of the requirements and is addressing the user's needs. By establishing wireless communication this enables the capability of creating a wearable device that is non-intrusive as they do not need to be directly wired to their service dog. Additionally, by reading heart rate, we are moving towards detecting onset PTSD symptoms.

The next steps for our design include reading blood pressure values and then developing an algorithm with both biometrics to detect extreme values that mimic a PTSD episode. To then send a distress signal to turn on the motor. We will also Scale down our design to become wearable and secure our wireless communication following HIPPA laws and regulations.

LEARNING SUMMARY

DEVELOPMENT STANDARDS & PRACTICES USED

- Bluebeam
- Gitlab
- Integration / Unit Testing
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SUMMARY OF REQUIREMENTS

- The device must be wearable and comfortable for the user.
- The device must record the user's heart rate and blood pressure accurately.
- The device must be able to indicate a PTSD attack to the service animal.
- The device must keep the user's medical data secure per HIPPA.
- The device must be non-disruptive to the user's environment.
- The device must not harm the user or service animal in any way.

APPLICABLE COURSES FROM THE IOWA STATE UNIVERSITY CURRICULUM

- **CPRE 281**: Digital Logic
- **CPRE 288:** Embedded Systems I: Introduction
- **EE 201**: Electric Circuits
- **EE 230**: Electronic Circuits and Systems
- **EE 321**: Communication Systems I
- **EE 185**: Introduction to Electrical Engineering and Problem Solving I
- **EE 285:** Problem Solving Methods and Tools for Electrical Engineering
- **COMS 228:** Data Structures and Algorithms
- **CPRE 381**: Computer Organization and Assembly Level Programming
- **CPRE 308:** Operating Systems, Principles and Practices

NEW SKILLS/KNOWLEDGE ACQUIRED THAT WAS NOT TAUGHT

- Integrating Bluetooth communication
- Interfacing with sensors via I2C
- Power analysis of modules
- Understanding Ethics in Engineering

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1. INTRODUCTION

1.1. Problem Statement

PTSD episodes can be a hindrance and debilitating to veterans' quality of life. Thus, we have been tasked to develop a PTSD detection device that proactively detects onset PTSD episodes and alerts their service dog to provide comfort before the symptoms become incapacitating.

Current mental health care market alternatives are reactive to symptoms versus aiming to hinder the development of a PTSD attack. Additionally, their market products are costly and cumbersome as they currently entail brain electrodes to monitor activity. Due to the inadequate and expensive monitoring capabilities, Veterans continue to suffer from PTSD episodes which negatively harm their quality of life.

This is why we aim to solve these issues; to create a foresighted product to bring comfort to our nation's warfighters. To implement this solution, we will create a wrist-wearable device that monitors the Veteran's physiological data. This information will include heart rate monitoring via an electrocardiogram as well as blood pressure measuring by a photoplethysmogram. If symptoms arise, a signal via Bluetooth will be sent from the wearable to a receiver on the service dog that will exhibit a vibration to call for comfort.

1.2. Intended Users

Two groups of people will use our product. One group includes those who suffer from PTSD attacks and have service dogs to comfort them. The other group that will work with our product is the professional dog trainers who train service dogs to comfort veterans suffering from PTSD.

Our first user is a veteran with PTSD. This user feels PTSD symptoms, which can occur sporadically and are challenging to manage without help. This user needs comfort from their service dog whenever these PTSD episodes arise. They want to be able to participate in activities of daily life without having to worry about PTSD episodes going out of control.

Another user of this product is people with PTSD. The needs of this user are largely similar to a veteran with PTSD, but the environments or situations in which they may have symptoms can vary greatly from the typical veteran. Examples may include but are not limited to first responders and victims of abuse or other traumatic experiences.

Our last users are service dog trainers. These individuals specialize in training dogs to be able to react to an owner’s PTSD attack and provide comfort to alleviate symptoms. This user is currently faced with the challenge of having to train dogs to detect PTSD episodes purely from owner behavior, without any quantitative or technical measures to diagnose episodes. Therefore, they need some device that can detect with high certainty that a PTSD episode is about to occur and can inform the dog in such a way that the trainer can then teach the dog what to do when it perceives this PTSD alert. This would provide the trainers the benefit of not having to teach the dog how to read physical signs of a PTSD attack, as they could simply teach the dog to respond to a haptic vibration.

2. REQUIREMENTS, CONSTRAINTS, AND STANDARDS

2.1 Requirements and Constraints

Functional Requirements

The device must be able to effectively detect the biological markers of a PTSD episode without producing false positive or false negative readings. The device must reliably communicate via Bluetooth with another device secured to the dog without losing signal due to range. The dog device must be able to reliably control a haptic vibration device to alert the dog to a PTSD attack.

Resource Requirements

The device will require the use of two main microcontrollers: One that interfaces with the veteran, and one that interfaces with the dog. The human-wearable microcontroller must have sufficient processing power to handle process management and semi-complex data analysis algorithms. The dog microcontroller should be sufficient to handle low power draw to enable a vibration device. All devices must have efficient power dissipation to ensure a sufficiently long battery life. More specifically, both batteries for the microcontrollers should last at least a day **(Constraint).**

Physical Requirements

There must be two devices; a wearable device for the veteran and a device that fits in a dog vest. The wearable must be comfortable for the veteran and be nondisruptive to daily activities. The device for the dog must fit inside a dog vest comfortably and humanely relay a signal to the dog.

User-Interface Requirements

For UI we are attempting to make it as simple as possible for our user. Our design is as simple as a button to turn the device on and off. The device also will have multiple LEDs to tell the user if there are problems with the device. One LED will be used for power, another LED will give a visual representation if the Bluetooth has been successfully connected.

Economic / market requirements

We have been given a budget of $5000 for our design. **(Constraint).** The final product should be inexpensive and competitive to current mental health monitoring substitutes. Our goal is to produce and distribute our designed device for sub 200 USD. Having a more affordable product will increase accessibility contributing to an improvement in quality of life. Additionally, will increase the use of PTSD detection devices.

2.2 Engineering Standards

Importance of engineering standards

Engineering standards are set criteria and guidelines ranging in varying industries to ensure the safety of use, production, and quality control.

These standards are crucial for product production as they hold every business, enterprise, and inventor to given principles. Setting safety criteria helps protect consumers from accidents. Encouraging quality assurance promotes consistency and reliability. Giving production protocols increases efficiency as well as assembly safety. In all, these standards are vital for creating a safe, useful, friendly, and viable product.

Current Applied Standards

- IEEE 802.15.1: WPAN / Bluetooth
- ISO/IEEE 11073: Medical / Health Device Communication Standards
- IEEE 360-2022: IEEE Standard for Wearable Consumer Electronic Devices
- IEEE 11073-10407-2020: Health informatics--Personal health device communication Part 10407: Device specialization--Blood pressure monitor

External IEEE Standards

Consumer Electronics

- IEEE 360-2022: IEEE Standard for Wearable Consumer Electronic Devices--Overview and Architecture
    - This standard is intended to address concerns and help industry confidence when it comes to the reliability and quality of wearable electronics. As well as standardizing the safety and security of these wearable devices.
- IEEE 11073-00103-2012: Health informatics - Personal health device communication Part 00103: Overview
    - This standard defines set practices for data communication and standards for mobile health devices and separate computing engines. It is intended to ensure that personal health devices follow secure communication practices and are horizontally integrated.
- IEEE 11073-10407-2020: Health informatics--Personal health device communication Part 10407: Device specialization--Blood pressure monitor
    - This standard is part of a set of standards for personal health device communication specializing in blood pressure monitoring and promotes plug-and-play for the user.

Project Relevance to IEEE Standards

After reviewing the three chosen published standards, we believe that all three have relevance to our project. This is because our product is a wearable electronic device that would directly apply to the IEEE standard for a wearable consumer electronic device. This standard is relevant because we need to design a product that is reliable, safe, and secure. We also feel that the standards for health informatics and device communication apply to our product specifically because of the communication of medical data from the sensor to the microcontroller.

Design Changes Based on IEEE Standards

We plan to implement communication between the human-wearable device and the dog device that adheres to the personal health device communication standards. This includes implementing previously defined Bluetooth protocols to make the communication compatible with other devices. We also plan to adhere to the standard for wearable consumer electronic devices so that the veteran-worn device implements all necessary personal wearable device protocols.

3. PROJECT PLAN

3.1 Project Management/Tracking Procedure

To increase proficiency we chose to adopt a management style of Hybrid. We chose to use a hybrid project management style during our project. We chose this management style because it is adaptive and accommodates unforeseen challenges. This allows forthe opportunity to reflect on previous steps in our project. Using the hybrid management style, we will be able to improve our work based on updated criteria and constraints from our client. The hybrid management style is a combination of waterfall and agile project management that we use to fully meet deadlines.

To maintain organization and track progress, our team will use a work progress chart made in Google Sheets to keep track of our work throughout the course. We will be using GitHub to maintain our work progress for software development.

3.2 Task Decomposition

To keep our team on track, we decomposed our tasks into major and sub-tasks. This is to ensure we are staying on track and accomplishing all necessary milestones to meet our client's needs with precision and efficiency.

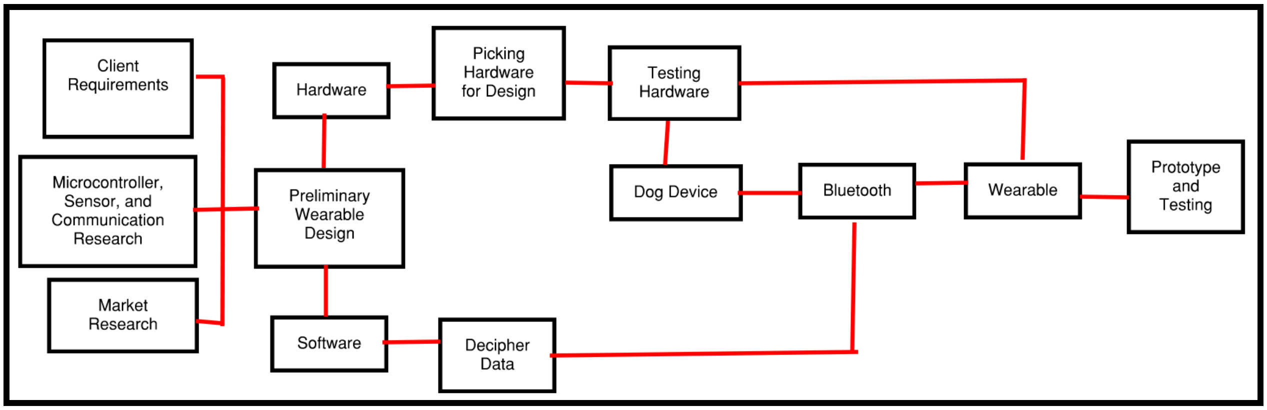

Figure 3.1: Task Decomposition Flowchart

Below is a breakdown of our major tasks.

Hardware

- Purchasing any hardware: photoplethysmogram sensor, microcontroller, haptic vibration sensor, and LEDs.

Software

- Interfacing with hardware.
  - Initializing registers and reading data.

Decipher Data

- Comparing and contrasting read data to a control group to diagnose if a PTSD episode is imminent.

Dog Device

- Includes a microcontroller and the haptic vibration sensor.

Prototype and Testing

- Developing a functional breadboard prototype to test and verify it functions as wanted.

3.3 Project Proposed Milestones, Metrics, and Evaluation Criteria

Illustrating milestones are to help keep our team in the scope of our project as well as decompose what tasks are necessary for a functional project.

Research requirements - 10/15/2024

- What data needs to be collected from the user?
- Form factor requirements for wearable devices.
- How the human-worn device needs to interact with the dog-worn device.
- Functional requirements.
  - How fast does the device need to respond to episodes?
  - How should the dog be alerted reliably and humanely?
  - What sensor data is needed to detect an episode?

Research and order hardware components - 10/31/2o24

- Evaluate the utility of ESP32.
- Look into photoplethysmogram (PPG) Sensor.
- Haptic vibration device.
- Electrocardiogram (EKG) sensor.
- System batteries.

Begin implementing core programming functionality - 12/17/2024

- Interface microcontroller with PPG sensor.
- Write algorithms to analyze PPG data.
- Interface bluetooth connectivity between microcontrollers.
- Output estimation of PTSD attack with > 50% accuracy.
- Enable haptic dog vest vibration within 1 second of PTSD attack detection.

Evaluate and refine accuracy - 02/28/2025

- Add new inputs to device to better refine results.
- Perform testing to ensure reliability of data communication.
- Increase performance by improving key metrics such as:
    - Battery life - Battery must be able to operate with device on for > 16 hour.s
    - Response time - Dog must be alerted within 15 seconds of PTSD attack beginning.
    - Accuracy of PTSD event detection - Detect and positively diagnose PTSD attack with accuracy > 90%.

Add additional functionality and create final device layout - 03/31/2025

- Push button to control operation of device.
- Easy to use on-off switch for dog device and human device
- LED indicator to give device state data to user.

Create PCB with final device peripherals, finalize device firmware - 05/13/2025

- Device can take in sensor data and diagnose PTSD episodes with high (> 90%) accuracy.
- Device does not produce false positives more than 5% of the time.
- Device is small enough (< 3x3 inches) such that it is comfortable to wear.

3.4 Project Timeline/Schedule

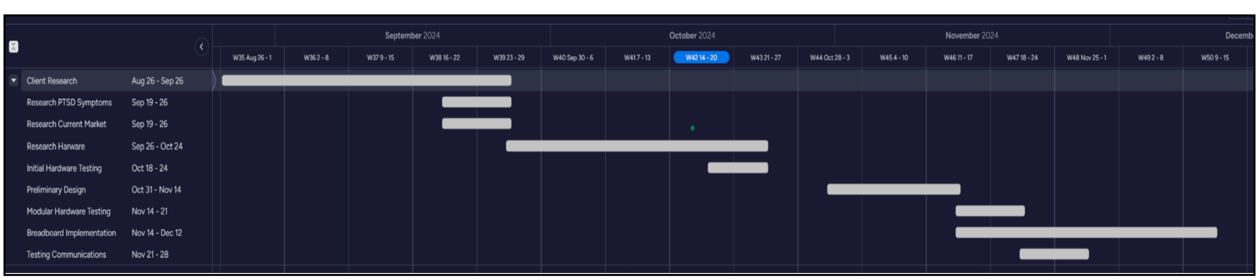

Figure 3.2: Group Gantt Chart For Fall Semester

The Gantt chart above details the projected timeline of our project throughout the fall semester. The first phase of the project is exclusively devoted to client research to clarify exactly what project constraints will be required. This step lets us know what hardware research we need to do in later phases. The next phase would be to research PTSD conditions as well as the current market for devices similar to the one we are creating. Researching PTSD conditions allows us to know what we should be checking for in our clients. Looking into the market for PTSD devices allows us to see examples of ways to improve our design or compare what should be expected from our product. The third phase is researching hardware. The basic hardware research we did was on microcontrollers, Bluetooth, and sensor research. A subcategory of hardware research is initial hardware testing of hardware we have ordered and received. Preliminary design is the fourth phase where we take the components and design a basic prototype for testing. The small subcategory of modular hardware testing pertains to getting our devices to work together. The fifth phase of the project is breadboard implementation where we take the preliminary design and create a working prototype for testing. A subcategory of the implementation phase is testing communications, as our product needs two devices to communicate properly with each other.

3.5 Risks And Risk Management/Mitigation

Risk 1: Veteran or dog device battery running out of charge - 0.9

- Mitigation: Give users an indication of battery status with an LED. Design hardware to be power efficient and easy to charge.

Risk 2: Sensors being too sensitive to motion for accurate data interpretation - 0.4

- Mitigation: Detect motion with a sensor or software data analysis in order to discard invalid data.

Risk 2: Loss of connection between devices - 0.2

- Mitigation: Notify users of any connection interruption with an LED. Train users on best practices with the device to avoid situations where the connection is more likely to struggle.

Risk 4: Dog does not tolerate device vibration: 0.1

- Mitigation: Have different levels of vibration intensity to acquaint the dog with the vibration sensation.

3.6 Personnel Effort Requirements

Task	Estimated Hours Spent
Client Research	20
PTSD Symptom Research	20

Current Market Research	10
Hardware Research	40
Initial Hardware Testing	20
Preliminary Design	20
Modular Hardware Testing	20
Breadboard implementation	60
Testing Communication	20

Figure 3.3: Allocated Project Hours Table

3.7 Other Resource Requirements

Illuminating other resources aside from financial needs, we will need to acquire several other resources to be successful.

Biometric Control Data:

- Receiving data from American VetDogs to accurately detect PTSD attacks.

Computers/Laptops

- This is to interface with our specified microcontrollers IDE's.

Digital Multimeter

- To ensure the electrical integrity of our parts are functioning properly, we need to measure that the values read what we expect.

Contact With Iowa State Veterans

- Once a working prototype exists, we will need to test our device on a test group.

4. DESIGN

4.1 Design Context

4.1.1 Broader Context

The larger context in which our design problem is situated is within communities of people who are suffering from PTSD attacks. The communities include veterans and first responders. Our project addresses the issue of the societal need for veterans who suffer from PTSD to be able to live their everyday lives without needing to worry about suffering a PTSD attack. Our design will act proactively to detect PTSD attacks and alert the service dog to help prevent PTSD attacks.

4.1.2 Prior Work/Solutions

In today's current market, there is no technology available that answers the problem of detecting a PTSD attack before it happens. Efforts to create this product have been proposed by BAE to previous senior design groups.

The previous senior design group from 2023-2024 was assigned this project also proposed by BAE. An advantage of the previous senior design group is that the device is user-friendly for people wanting to track their heart rate and episodes through the app. A disadvantage of the previous senior design group's product is that the prototype seems not to be wearable so the user can’t exactly use the device. This prototype just seems to be functional.

S. D. May. "Project Website for SDMay24-15." Iowa State University Department of Electrical and Computer Engineering. [Online]. Available: https://sdmay24-15.sd.ece.iastate.edu/.

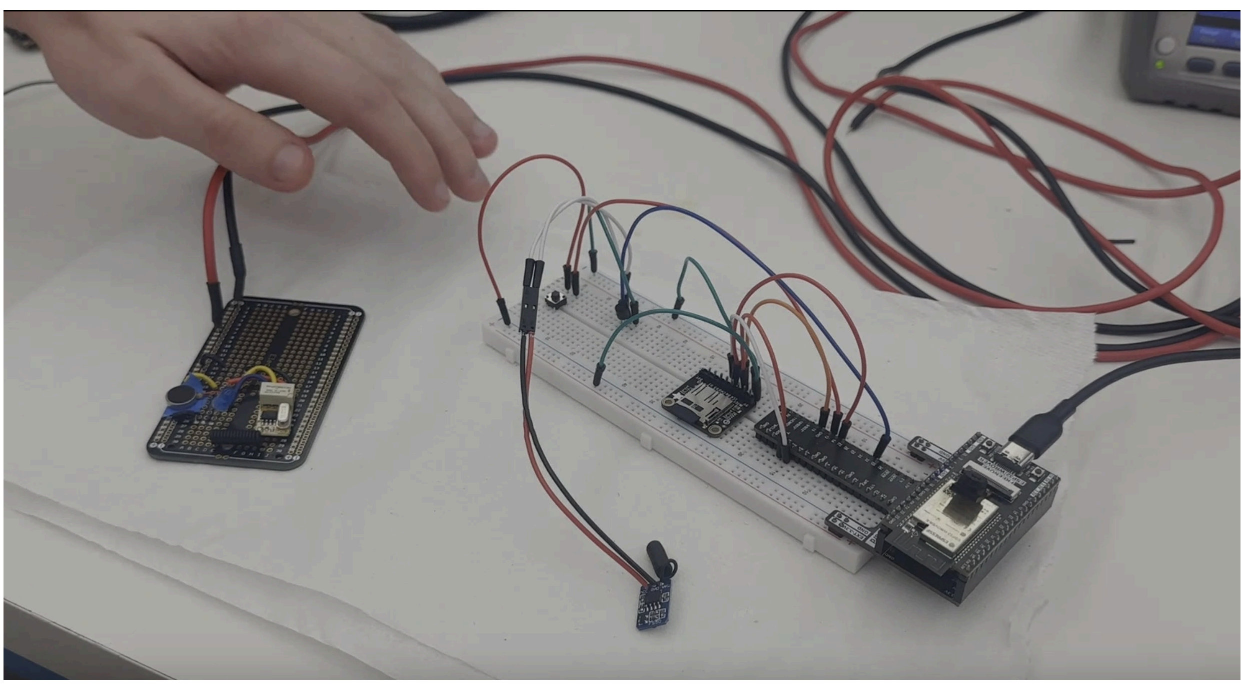

Figure 4.1: Previous Senior Design Team Implementation

4.1.3 Technical Complexity

Given the constraints of our problem and the inherent complexity in detecting PTSD symptoms reliably and accurately, our device must utilize an array of different hardware components and engineering methodologies to accomplish our goals. All of our design choices have been based on careful deliberation on the needs for our users, as well as modern research on the best strategies for performing engineering tasks related to our project.

The first of these choices was brought about in an attempt to answer the question of how to actually detect PTSD symptoms from the veteran. We looked into many different strategies from sweat detection to electro-cardiogram monitoring, but ultimately decided that the use of a photoplethysmogram (PPG) sensor would best fit our needs. This device uses simple light capture to detect pulses of light from a patient's skin corresponding to heartbeats, a vital biometric for PTSD detection.

Going from raw LED pulses to an accurate and reliable heartbeat was a challenging task, and required a deep understanding of PPG capturing nuances as well as the most accurate beat detection schemes available. Our team did numerous experiments of different ways to configure our PPG sensor, including changing the sampling frequency and bandwidth of light the sensor captured. Ultimately, we came up with a configuration that yielded the most clear and consistent data without using excessive power.

Next was the challenge of analyzing this raw data in order to determine the user's heart rate. Luckily, several studies have been published examining different algorithms for this exact use case. We found via research that MSPTD was the consensus best performing algorithm for this, and our own experimental data against an electrocardiogram supported this finding. We implemented this algorithm while also making several significant optimizations to allow it to run effectively on our resource-constrained microcontroller, which has been able to detect heart rate in real time with state-of-the-art accuracy.

TODO: Expand on technical complexity by explaining the bluetooth functionality and vibration motor?

4.2 Design Exploration

4.2.1 Design Decisions

Some key design choices for our current prototype are listed below.

ESP32 WROVER E

This is a microcontroller with integrated 2.4 GHz Wi-Fi and Bluetooth capabilities. It is being used for the user wearable subsystem. It will serve as the central control for our project, collecting and processing data from our selected sensors. The decision on this specific microcontroller was based on its Bluetooth capabilities. This wireless communication is vital for our project to function as proposed because there needs to be a method of dialogue between microcontrollers to exchange the information that the user is in distress and thus needs comfort from their canine. Without this wireless capability, the canine microcontroller would need to be connected through wire to the user wearable. This creates inconvenience and becomes an obstruction to lifestyle.

DC ERM Motor Vibration

This is the vibration device that will signal to the canine that their owner is in distress. Many different design options came up for this decision. Between DC and AC power, as well as the mechanical design choices. This is a human and discrete method of signaling to the canine that their owner needs comfort.

MAX86150 - Integrated Photoplethysmogram and Electrocardiogram

This is dual-integrated with a PPG and EKG sensor. The PPG detects blood pulses, and the EKG detects electrical pulses corresponding to heart beats . This sensor has lots of built in configurability including pulse frequency scaling, LED bandwidth adjustment, LED pulse strength, and continuous sampling.

4.2.2 Ideation

For at least one design decision, describe how you ideated or identified potential options (e.g., lotus blossom technique). Describe at least five options that you considered.

One of the design decisions that we had to make was what kind of motor we would use to create the vibration inside of a dog vest. We had a choice between working with AC or DC motors as well as working with types of motors, including eccentric rotating mass (ERM) vibration motors, Linear resonant actuators (LRAs) or Solenoid actuators.

ERM vibration motors work by rotating an off-center mass attached to the motor shaft. When the motor spins it causes the whole device to vibrate.

LRA vibration motors work by using a magnetic mass and a voice cell. The AC signal drives the coil, and the mass oscillates back and forth, creating vibration. These devices are energy efficient.

Solenoid actuators work by using electromagnetic forces to create linear motion, which causes vibrations in the device.

4.2.3 Decision-Making and Trade-Off

We chose to use a DC motor because we have a power source that is DC power. We chose to use an ERM motor as opposed to an LRA or solenoid actuator because of its discrete size and low decibel output. We needed to make sure that the vibration device operated in a humane manner when attached to the dog vest. The ERM motor was the best choice for this because its DB output was about 50 DB.

4.3 Proposed Design

4.3.1 Overview

Our design begins with a device worn on the wrist of the veteran, which is capable of detecting PTSD episodes. When the device detects the episodes, it signals a device worn by a service dog to alert the dog of the episode. The wrist-worn device consists of a battery, a microcontroller, and a PPG sensor. The microcontroller is an ESP32 which can take and process data from the PPG sensor. The PPG sensor is a photoplethysmogram which is able to read data from the veteran and send this data to the ESP32, which processes the data in order to determine heart rate and PTSD episodes. The ESP32 microcontroller also has built in bluetooth capability in order to send signals to the dog-worn device. The dog-worn device consists of another ESP32, a haptic motor, and another battery.

4.3.2 Detailed Design and Visual(s)

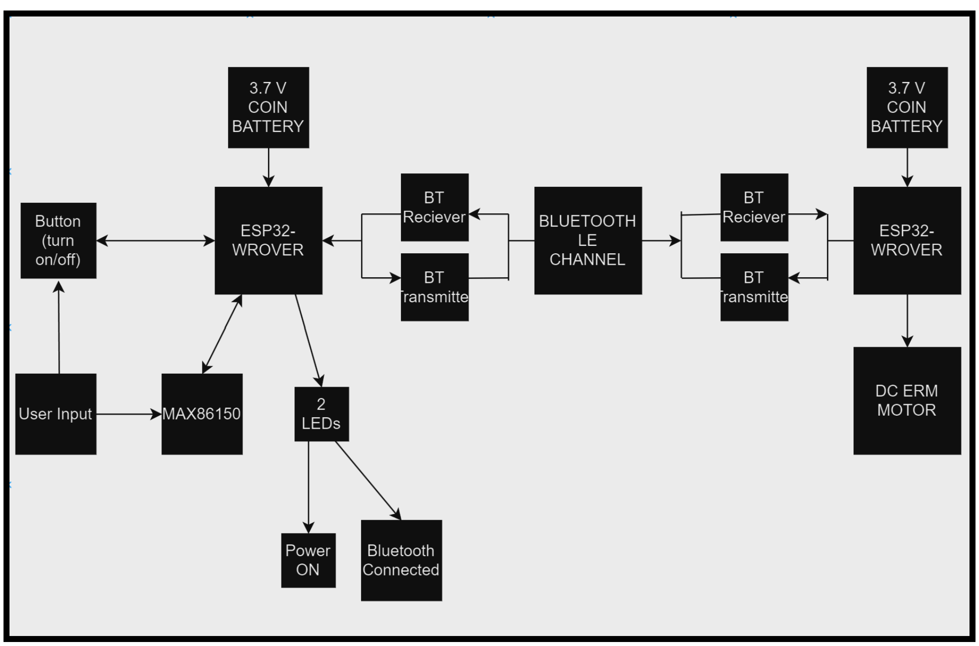

Figure 4.2: Prototype Design Flowchart

The wrist-worn ESP32 connects to the onboard MAX86150 PPG sensor through standard I2C. The microcontroller latches raw IR data data from the PPG according to the ESP32 MCLK output. The raw data is passed through the MSPTD beat detection algorithm to extract useful heart rate data. The heart rate data goes through additional analysis to determine if a signal needs to be transmitted to the dog. This device can be powered on and off by the user to avoid false positives in PTSD detection. The wearable is powered by a 3.7V 500mAh rechargeable battery. Using Bluetooth Low Energy, the ESP32 on the wearable device communicates with the ESP32 in the unit that sits within the dog vest. This unit is powered by the same kind of 3.7V battery. When the ESP32 receives the correct signal from the ESP32 on the wearable, the device in the dog vest vibrates to give the dog the signal that is needed for the dog to go to its owner.

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.

Our design is meant to be as simplistic as possible to remove any point of failure with our product. We implemented a pancake vibration device that will trigger the dog's response to the PTSD attack. We also implemented a blood pressure sensor in the PPG sensor. This sensor will provide the microcontroller with accurate data so that an algorithm can detect the presence of a PTSD attack. The user will have a button to turn off the device so they can do activities that may cause a false presence of PTSD. An example of this is physical activity as simple as going for a run and exercising. The user will also get to interact with LEDs on the device that detail battery power, on or off, and Bluetooth connection. These choices are meant to make interaction with our device simple and easy. The design for the dog satisfies all requirements for a discrete device that triggers a react out of the dog. We chose a small pancake vibration device to be as quiet as the device can be triggering that response from the dog.

4.3.4 Areas of Concern and Development

Our design satisfies VetDog's requirements and meets user needs by detecting biometrics and communicating with a vibration device. This is the basic functionality and core of the design, which should satisfy requirements. We have also done a good job at building a system that is cheaper for the user than similar wearable devices, which was a base need of our user. Apart from this core, we have not reached the point in development for a few user needs and requirements such as wearability and practicality.

Our primary concerns are making sure that the design is wearable and conducive to a normal lifestyle. Although we have a good technological base for our design, the end goal is to have a device that allows veterans to live their lives as normally as possible, and the size of our device does not allow for that at the moment. Along with size, it is simply not a wearable device at the moment.

Despite not meeting these requirements at the moment, we have clear plans for meeting them in the future. Once we have proven the core functionality of our technology, our efforts will be pointed towards scaling down the size design as much as possible. This will allow us to have freedom in the design of the actual wearable, as we see bulkiness as a limiting factor when it comes to comfortability and practicality, which are paramount in an everyday device like this. We will also have to shift our focus from technical design to user empathy as we find a balance between functionality and user comfort.

4.4 Technology Considerations

For our project, we are utilizing microcontrollers. These are advantageous because they can be used to read raw data and create algorithms to process them. However, with our design solution, we need to create a device that is wearable and due to the microcontroller bulkiness, this makes this goal challenging. As a solution, we hope to contact BAE Systems to create a PCB design using the ESP32 CPU to make a smaller version of our current microcontroller and create a wearable solution.For the vibration device, we chose a DC ERM haptic motor. This is a non-invasive and discrete solution, however, there are some concerns with power consumption. Another design option was the linear resonant actuator, as this is the most power-efficient, however, it creates a higher dBA output which is concerning dealing with an animal with sensitive hearing.

MAX86150 - this is our photoplethysmogram and electro-cardiogram sensors. There are some concerns in regard to the accuracy of the PPG sensor. This is because current market solutions have yet to be perfected in creating a wrist-wearable device that accurately reads blood pressure. Nonetheless, this is the best current solution we can offer the project given the market solutions.

4.5 Design Analysis

So far, we have spent our time developing functionality of individual components and modules within our design. We have configured bluetooth to send signals from the human-worn microcontroller, as well as gotten the microcontroller to interface with the mounted PPG sensor. We have also gotten the evaluation kit for the PPG to output data to a laptop, and gotten it to accurately detect heart rate from this data. We have not gotten the proposed design from 4.3 to work yet as we have not yet put all the modules together. Based on this, our plans for future design and implementation involve putting all modules together, and working out any bugs that come up. Looking farther in the future, we will need to scale down our design considerably in order for it to fit on the veterans wrist. An additional design consideration would be adding accelerometer functionality in order to differentiate a PTSD attack from exercise when the device is actually worn by a veteran.

5. TESTING

For our prototype this semester we prioritized getting basic functionality to work so we could be better prepared to integrate much more complex requirements into the design. The main components we focused on where communication and sensor data processing. Communication was deemed a large part of our design where we would settle on using the on board bluetooth LE transmitters and receivers. We chose this to use pseudo interrupt to turn on the vibration device that will communicate to the service animal to comfort the veteran experiencing a PTSD attack. The ability to read the user’s heart rate and bloodpressure was huge priority as recieving data from the PPG sensor was a huge goal we set for this semester that would allow us to complete our design.

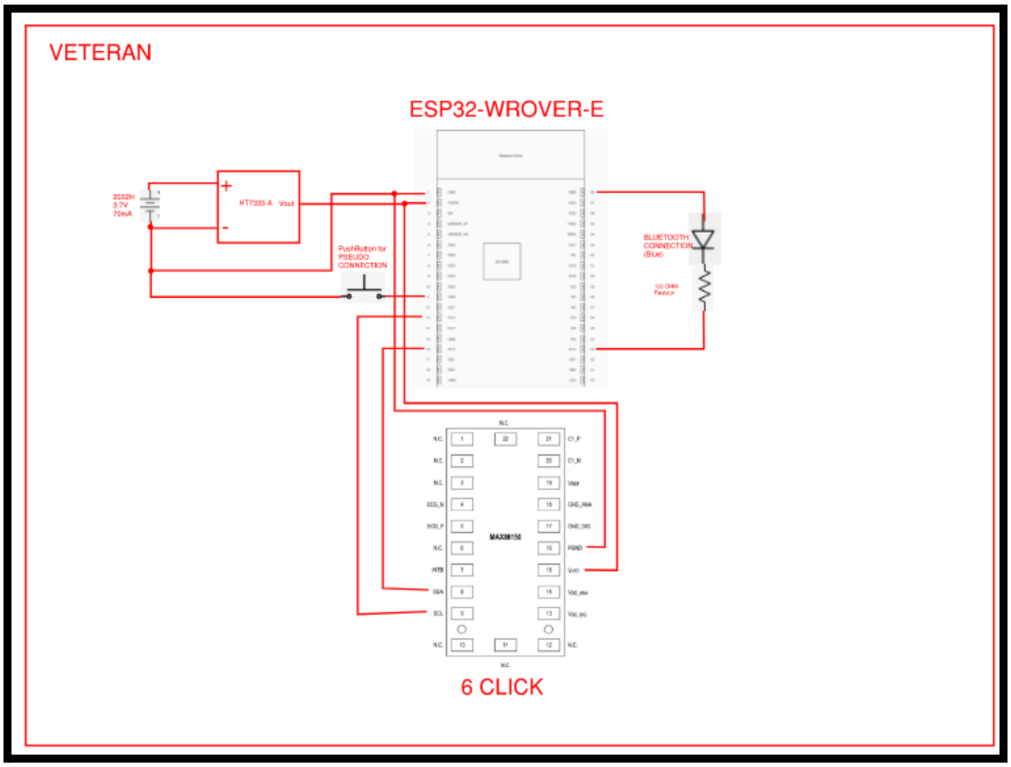

Figure 5.1: Veteran Testing Prototype Schematic

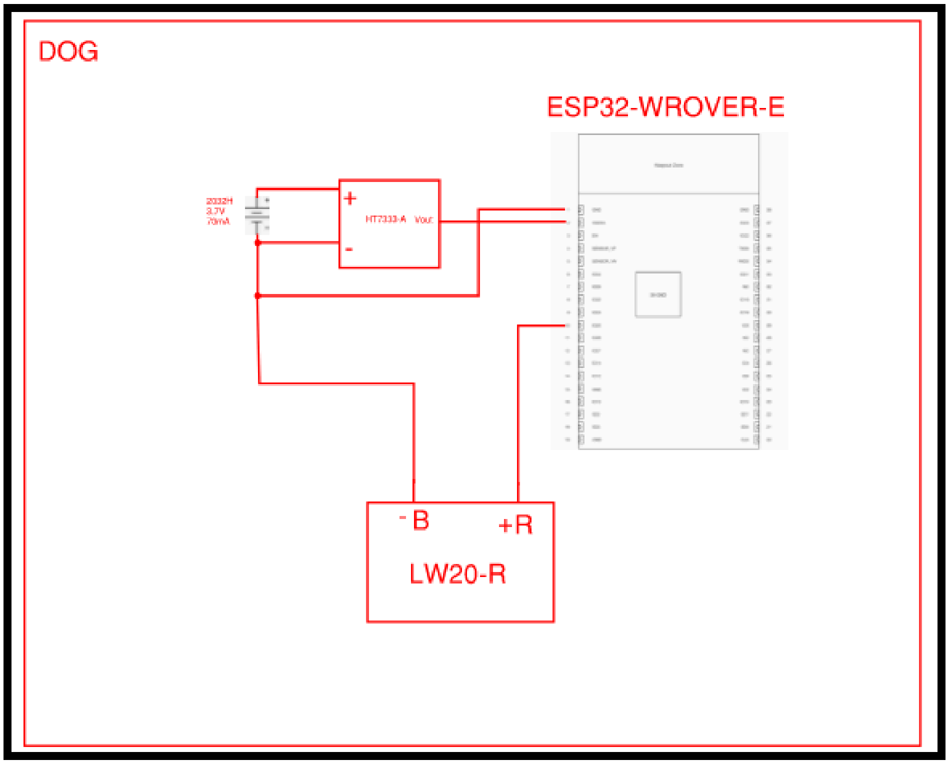

Figure 5.2: Service Animal Testing Prototype Schematic

5.1 Unit Testing

ESP32 WROVER E Development Kit

- Does the board carry out the functions properly?
- Does the device have enough memory to carry out our functions?
- Does the board output an acceptable voltage for the equipment? Tested via multimeter.

MAX 86150

- Does the sensor output accurate heart rate and Blood pressure data? Tested with another wearable application.
- Is the sensor able to send data properly to the microcontroller? Tested on serial monitor display.

Bluetooth LE

- What is the range of the Bluetooth in feet? Tested by distance test between devices.
- Does the Bluetooth connection continue through walls? Tested by putting a wall between the client and server devices.
- Does the LED for Bluetooth turn on properly for an active secure connection of the microcontrollers? Visual test for LED turning on.

Power Cosumption

- The length of time it takes to deplete the batteries. Tested from taking current from multimeter and calculating the amount of time it would take to deplete the battery.

5.2 Interface Testing

MAX86150 PPG Sensor to ESP32 Microcontroller

- Utilizes I2C to communicate between the modules
- Wire library in Arduino supports simple and reliable interface to I2C peripherals
- Data acquisition was tested through examining consistency in RAW ppg data to microcontroller
- Interface utilizes acknowledge (ACK) and not-acknowledge (NACK) bits to ensure each byte was received correctly

Bluetooth to interface between ESP32

- Uses Bluetooth low energy library in arduino
- Testing connection with phone as well as other microcontroller
- Successfully sending messages (characters) over Bluetooth

5.3 Integration Testing

MAX 86150 PPG sensor to ESP32 WROVER E microcontroller

- Does the sensor send accurate data to the microcontroller. Tested by using wristwatch with it's own sensor to test accuracy.
- Does the microcontroller display the data properly on a serial monitor or LCD display. Simple visual test with debugging if it does not work properly.

ESP32 Wrover E Bluetooth communication with each other

- What can cause the Bluetooth connection to disconnect:
- Do the microcontrollers communicate properly over long distances. Can be tested by walking far distances between microcontrollers.
- How many walls can the connection be active for. Testing connection between walls in case our service animal is in another room without the veteran.

5.4 System Testing

- Our microcontroller processes the data from the PPG sensor accurately in real time for heart rate. The microcontroller displays that heart rate data properly onto the LCD display.
- Our microcontrollers connect via bluetooth LE without the being plugged directly into a laptop. The microcontroller sends the command for the vibration device to turn on over the established Bluetooth connection.

5.5 Regression Testing

New editions should nat harm the capabilities of our current prototype's design and functionality. The key features we can't disrupt is the readability of the PPG sensor to the microcontroller as well as the Bluetooth features of the device. We will be integrating both the bluetooth design and sensor design to where they will be operating in conjunction with each other. This may present a possible memory size issue with the microcontroller.

We may be switching out from the development kit for a smaller implementation to better implement the wearable requirement for our product. This may require an external bluetooth transmitter/reciever as the current microcontroller has a built-in Bluetooth transmitter.

We may integrate an accelerometer to test motion of the user and the device. There will be no concerns regarding this implementation do to the amount of usable ports on researched prospects for new microcontrollers.

Pertaining to the battery of the microcontroller we will have major improvements. We may increase the size of the battery to allow the device to last longer. Another capability we plan to introduce is rechargeable batteries will require their own module for a charge cable. This will operate in conjunction with a low battery LED so the user will know when they need to charge the device.

5.6 Acceptance Testing

To ensure that our design will meet both functional and non-functional requirements we will conduct testing on our initial prototype. The prototype will be tested for functionality of its heart rate senor and bluetooth communication.

We will send a prototype to American VetGods for hands-on testing with veterans and service dogs. Their team will provide us with data they collected and from veterans as well as the service dog trainers. We will take this data and complete any necessary improvements. This provess ensures that the end users needs will be met as well as involve the client in our testing.

5.7 Security Testing

We plan on using a suite of tools to test the wireless security of our device. We believe the bluetooth connection is the most likely attack vector, considering the physical situation of the device being worn on the user's wrist and inside a dog vest. For this reason, we will focus our security testing on the Bluetooth LE protocol.

We have identified the following tools as potentially useful for Bluetooth LE penetration testing:

- BlueZ - Official Bluetooth protocol stack
- Hcitool - Information gathering
- Wireshark - Information gathering
- BlueMaho - Exploitation tool with commonly known Bluetooth exploits
- Spooftooph - Bluetooth spoofing

We will need an NRF dongle

With these tools, we will continuously confirm or deny the viability of common exploits on our design and identify shortcomings in our device's security posture as we develop. We will evaluate success based on the design conforming to NIST SP 800-121, Guide to Bluetooth Security.

5.8 Results

Bluetooth Testing

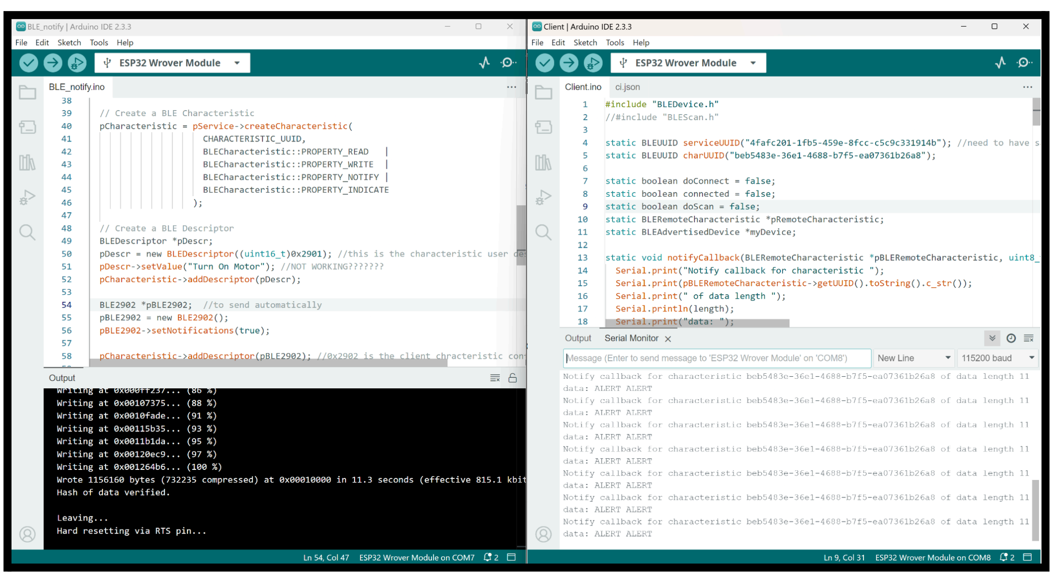

Figure 5.3: Code example of successful Bluetooth connection and wireless communication

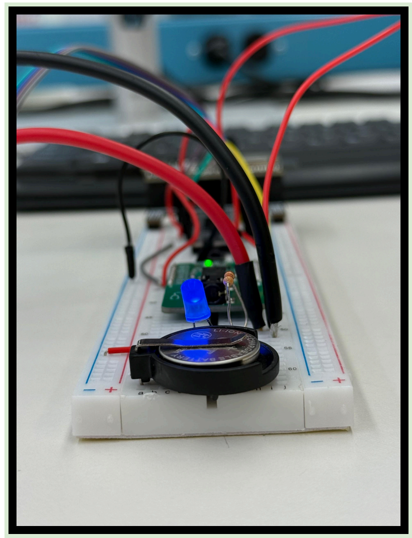

Figure 5.4: Photo of blue LED indicating a bluetooth connection

Loading Testing For Power Consumption

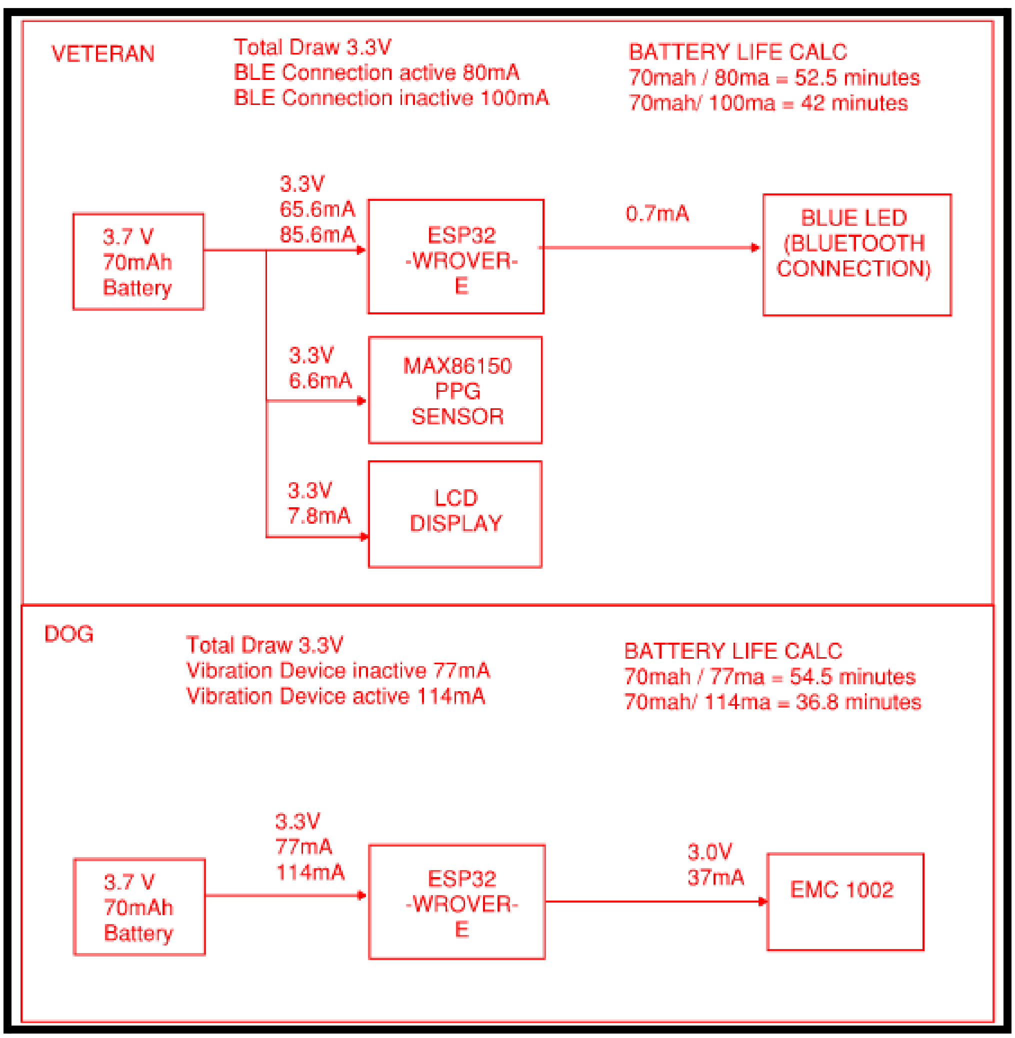

Figure 5.5: Battery Life Calc based on load put on battery

From testing and calculation the battery on the handler side will last roughly 52.5 minutes. On the service dog device it will last 54.5 minutes when there is no PTSD attack. These numbers are well short of what we should expect from these devices, and will be a problem for our users if the device dies in under an hour. The major problem seems to stem from the amount of power consumed by the microcontroller. We should expect for in the future to increase the size of the battery, optimize the software uploaded to the MCs, and decrease the size of the MCs themselves to conserve more power.

Heart Rate Detection Testing

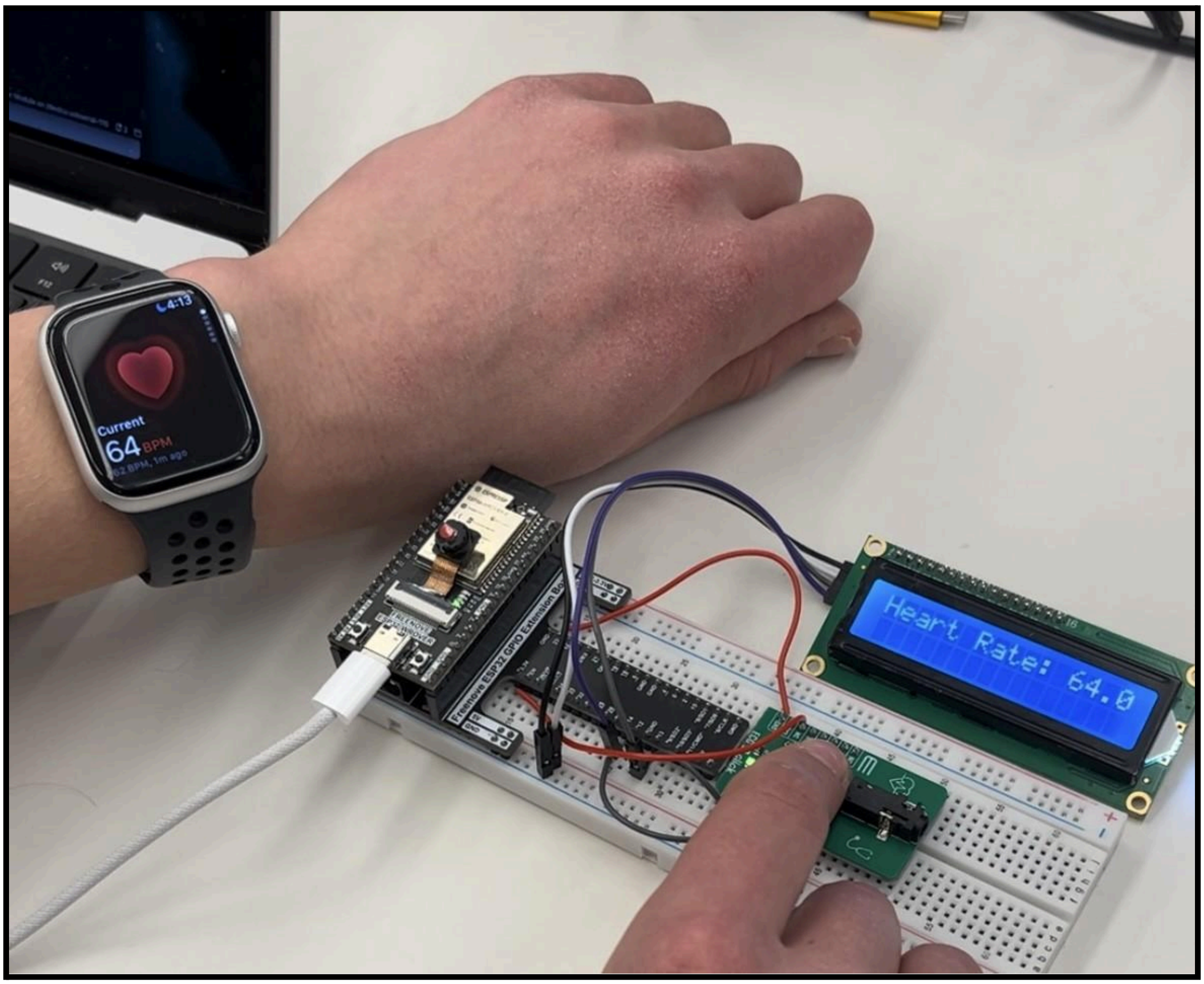

Figure 5.6: Heart Rate Data Acquisition

6. IMPLEMENTATION

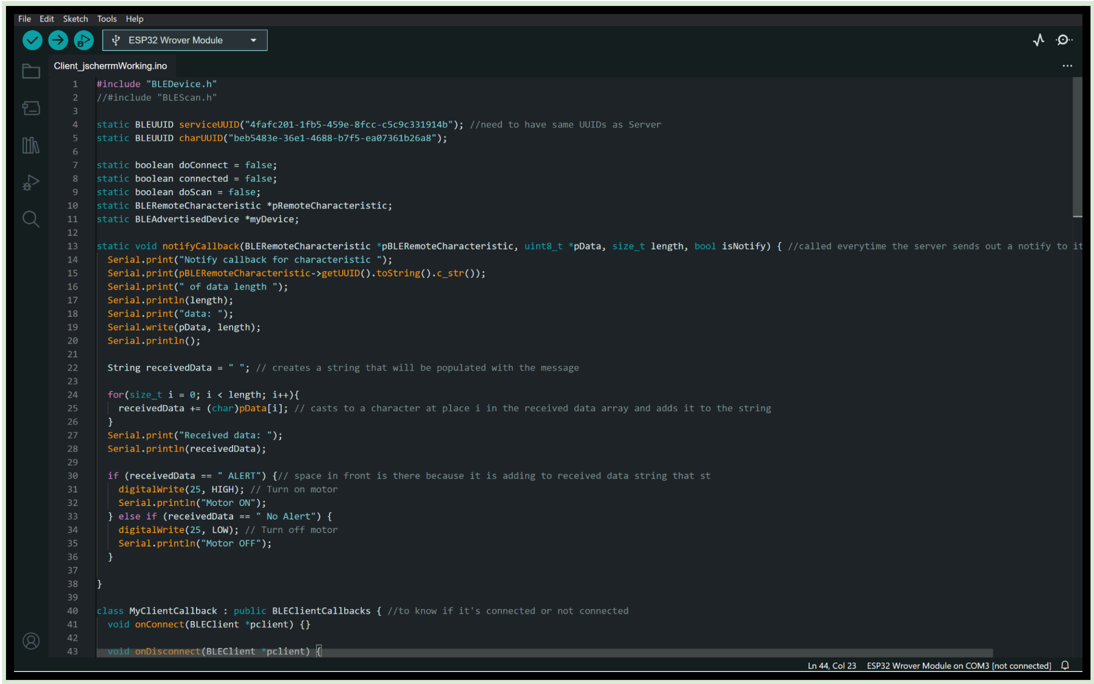

Figure 6.1: Screenshot of client side code

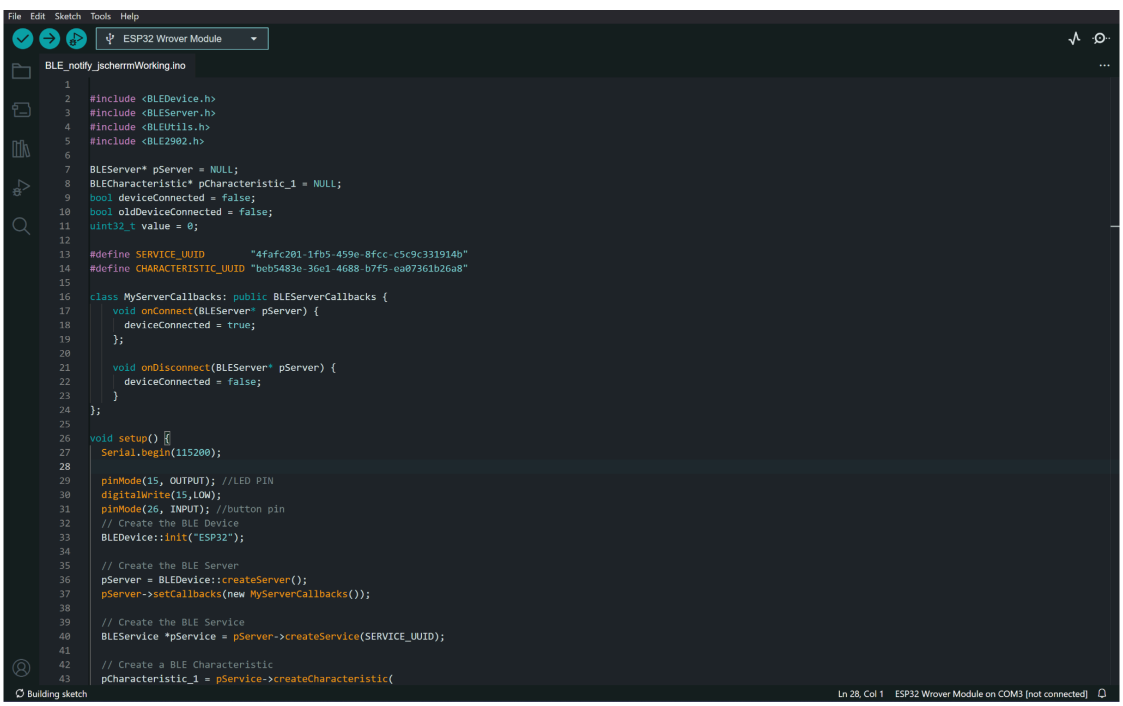

Figure 6.2: Screenshot of server-side code

Figure 6.3: Screenshot of beat detection main program

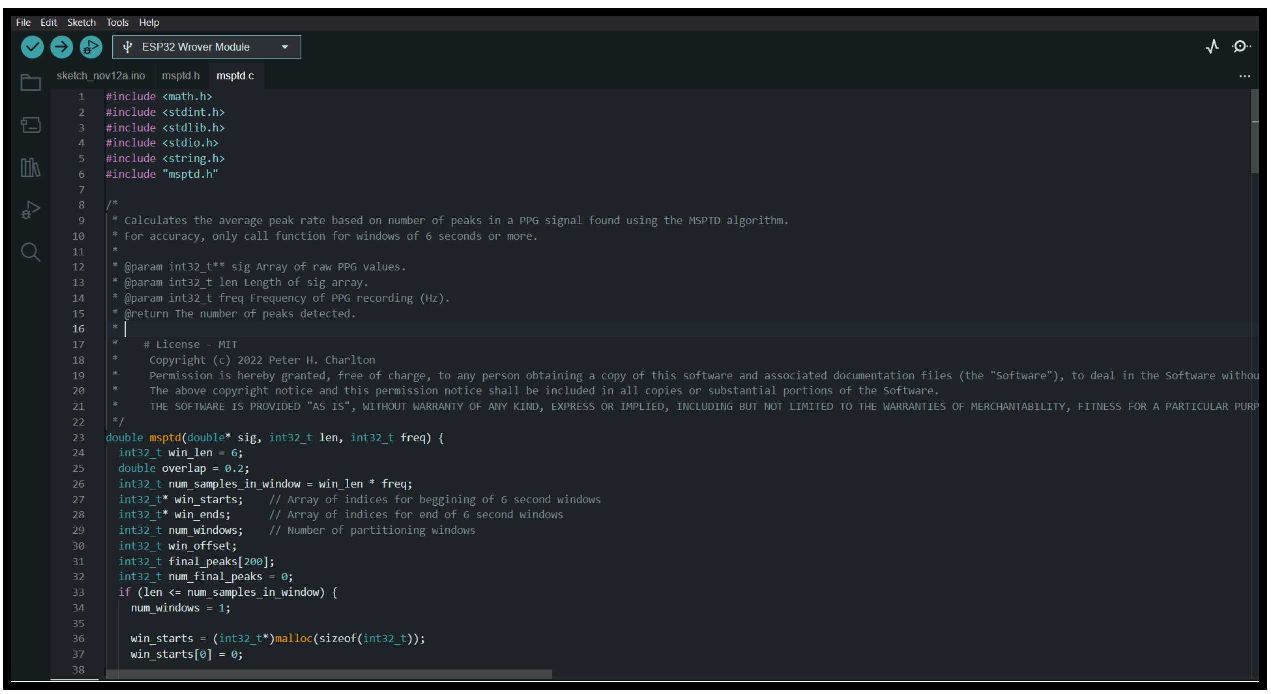

Figure 6.4: Screenshot of MSPTD heart beat detection implementation

Our preliminary implementation solution involves two breadboards, each equipped with an ESP32 WROVER E microcontroller. Each board represents one half of our design; the wearable device and the device for the dog vest. The two boards communicate using onboard bluetooth modules to trigger the vibration device when needed. Each board is also equipped with a 3.7v rechargeable battery that powers each system.

The board representing the wearable device is equipped with a MAX86150 PPG sensor on a Mikroe ECG Click 6 board. This interfaces with the ESP32 using the i2c protocol to collect raw data for processing. The data is then processed on device to calculate a real time heart rate that is outputted to a liquid crystal display again using the i2c protocol. As research into PTSD indicators continues, the signal used to alert the dog can be simulated with an added button programmed to send the signal to the device in the dog vest. A successful bluetooth connection is indicated with a blue LED. When the board representing the dog vest receives the alert signal, a current is sent to a DC ERM Motor which vibrates; alerting the service dog that its owner is in need.

7 ETHICS AND PROFESSIONAL RESPONSIBILITY

7.1 Areas of Professional Responsibility/Codes of Ethics

Area Of Responsibility	Definition in our own words	Relavent item from Code of Ethics	Description of how our team has adheared to the code
Work Competence	Deleiver accurate work in a professional way	ACM 2.1	Our team has strived to achieve high quality in both our design process and professional work
Financial Responsibilty	Deliver a product that is within the allotted budget	ACM 1.1	Our team is knowledgeable and respectful of the monetary design constraints given to us by our client.
Communication Honesty	Present work in an honeset and transparent way	ACM 1.3	Our team has been honest and trustworthy throughout our design process

Health, Saftey, Well Being	Reduce the risks to the saftey and heath of individuals using the product	ACM 1.7	Our team has been diligent to designing our product in a way that does not compromise users health data.
Property	Honor and safeguard the property, ideas, and information of clients and others	ACM 1.6	Our team prevents the leakage of our users data to people that would seak to harm them
Sustainability	Preserve the environment and conserve natural resources on both local and global scales	ACM 1.2	Our team will not harm the environment that the device will be interacting with.
Social Responsibility	Create Product and Services that positively impact society and strengthen communities	ACM 3.1	Our team upholds the code as our product aims to positively impact the people we are developing our device for.

Figure 7.1: Table of seven areas of professional responsibiltiy

One area that our team is doing well is communication honesty. We have been doing a good job with priorotizing communication in our assignments and delegating work throughout the project. This good communication helps us develop trust and reduces misunderstandings. However one area where we can seek improvement is in sustainability. Moving forward we should keep track of our materials and work to incorporate more sustainable materials. This will ensure that our design aligns with the best practices that support sustainability.

7.2 Four Principles

	Beneficence	Nonmaleficence	Respect of Autonomy	Justice
Public health, safety, and welfare	Helps the quality of life of the handler. Can also mitigate public disturbances to do outbursts	The product is non-disruptive to the user's environment	The product is non-disruptive to the user's environment. And customizable	Promotes general well-being for a selective group
Global, Cultural, and social	Can improve the social life of the handler.	Does not harm any group or animal	Does not disturb cultural or religious practices	Create different wrist sizes wearables
Environmental	The product can be recyclable and made with renewable resources	Possible pollution from the development of products and materials	Create an eco-friendly option. Creating alternatives and choices	Will not disrupt the environment
Economic	Is an affordable solution	More affordable cost compared to current market alternatives	can create different variations for different costs	Will not break the beak in cost

Figure 7.2: Four Principles Table

Public Health, Safety, and Welfare are important principles for our project. Our project directly affects the welfare of veterans as this device is made to alleviate possible PTSD episodes. A group indirectly affected is bystanders around the veteran, since episodes can be abrupt, disruptive, or worrying to those unfamiliar with the disorder. We ensure these principles by giving veterans a device they can reliably trust to alleviate their symptoms. Extensive reliability testing and a design that keeps uptime and reliability in mind is key to our success in achieving these principles.

Respect for autonomy is a principle that is somewhat difficult to completely achieve given the nature of the project. Because the design requires that veterans are helped by a service dog that is in turn helped by the device itself, there is an implicit loss of autonomy when a veteran decides to use the device. However, we plan to alleviate this loss of autonomy by giving the user choices and control over the device. Also, despite the inherent loss of autonomy, this project should restore autonomy in other parts of the user's life by allowing them to do activities that PTSD has prohibited in the past.

7.3 Virtues

Three virtues that are especially important to our team are compassion, justice, and diligence.

As a team, compassion has to be a base for all of the work that is done on design and implementation. With a medical device such as this, there is always a human using and relying on our design for their well-being and safety. Specific to our project, a dog is also an integral user. To keep compassion at the forefront of our design, we have done extensive research on our users to anticipate their needs and potential problems with the device.

Justice is also an important virtue for this project. A goal of the project is to allow veterans with PTSD to be able to live lives equal to those who do not suffer from it. Achieving this goal to the best of our ability ensures justice by promoting equality and fairness despite differences in medical status.

Finally, diligence is important because it helps ensure tasks are completed thoroughly, on time, and to an acceptable standard. This helps to focus on the challenge at hand and pay necessary attention to detail. Doing so reduces the likelihood of big mistakes.We have shown this by constant communication of when assignments should be completed by and what is expected as to information that should be included. As well as we have many folders and sub folders helping aid in organization so files are easily accessible.

Katerina Zubic

Virtue Demonstrated: Friendliness

- **Why is it important to you?**
  - Friendliness is important to me because it helps promote communication, collaboration, and trust. This makes it easier for our team to feel comfortable to share ideas. Additionally, it helps create a friendly environment that can boost productivity and the comfortability to support each other. In all, it is a vital virtue for a successful team.
- **How have you demonstrated it?**
  - I have shown my support and encouragement to my teammates by encouraging them to share ideas and keeping a positive attitude towards their thoughts. Even when challenges arose, I approached it with a constructive attitude. Additionally, if a team member did something well, I shared joy in their success.

Virtue Not Demonstrated: Clear and Thorough Documentation

- **Why is it important to you?**

- This virtue is incredibly important and useful because it helps to ensure that all details, processes, and decisions are well recorded and easy to find. It helps to maintain consistency and allow for all team members to stay informed and on track. Additionally it makes it easy to compile final documents if organization is thorough.

- **What might you do to demonstrate that virtue?**
  - I have done some to demonstrate this virtue, but I believe it still needs work. For example, better organizing all the schematics and prototype photos into one folder. As well as if we update the schematic, ensure proper labels are given to the different iterations. Finally, organizing our code and making sure all revisions are properly pushed to gitlab would help.

Justin Jaeckel

Virtue Demonstrated: Patience

- **Why is it important to you?**
  - Patience is very important as an engineer as most problems we face aren't easy and don't have simple solutions. Patience is also important when projects require many different parts and the team has to rely on each other to get the work done.
- **How have you demonstrated it?**
  - This semester, I was working with embedded systems for the first time in awhile and taking deep dives into datasheets for the first time since CPRE 288. I thought I understood the material better than I actually did, so it took a long time for me to catch myself up to where I needed to be.

Virtue Not Demonstrated: Discipline

- **Why is it important to you?**
  - Discipline is an extremely important part of engineering and it is essential for teams to work together and accomplish their goals. Discipline is needed to make sure tasks are completed quickly and efficiently. Discipline also leads to a better quality product, which is what we're trying to produce.
- **What might you do to demonstrate that virtue?**
  - This semester, I have felt that my work has been inconsistent and I could do better. I have spent a lot of time on this project just catching myself up to where I felt I should have been already and the amount of accomplishment hasn't been as much as I would have liked. I have had to rely on my team to help me with tasks I felt I should have been able to complete myself and want to do more next semester.

Ty Decker

Virtue Demonstrated: Humility

- **Why is it important to you?**
  - Humility is important as a base for good teamwork and cooperation with others. Being humble allows a group member to have realistic expectations for themselves and their teammates and keeps emotions in an appropriate and professional place when decisions are made.
- **How have you demonstrated it?**
  - As a Cyber Security Engineering student, large parts of the project have felt quite foreign to me. I like to be helpful and have input in design, but for many parts of the project I have had to realize that other group members are much more experienced. This has kept me humble and thankful for each opportunity I really do have to make a difference, especially as the design becomes sophisticated enough to become more security-involved.

Virtue Not Demonstrated: Discipline

- **Why is it important to you?**
  - Discipline is needed for any task to be completed, especially in the setting of CPRE 4910. Classes and meetings require discipline to be physically and mentally present for, and class assignments and design implementation require the same. Without discipline, nothing gets done.
- **What might you do to demonstrate that virtue?**
  - I have demonstrated this virtue by attending all group meetings and fulfilling the work that is required of me, however I was not always disciplined in fulfilling personal goals for project research, design, etc. I simply wish I did more work than I did this semester, and that requires discipline.

Neil Prange

Virtue Demonstrated: Discipline

- **Why is it important to you?**
  - Discipline is important in any engineering project because most technical challenges faced by engineers will take extraordinary amounts of time doing tasks an individual might not want to do. Being able to push through the most difficult and challenging tasks is necessary in order to produce useful results. An engineer who is able to use discipline is well-suited to tackle the most challenging but exciting problems.
- **How have you demonstrated it?**
  - I have demonstrated discipline by pushing through some of the more technical tasks I have been working on, despite some major setbacks that were very

discouraging. When writing the code to detect heart beats from PPG data, various issues arrose from compatibility with our microcontroller to runtime requirements and resource availability. Despite these challenges, I was able to keep pushing and eventually produce code that could effectively detect heart beats.

Virtue Not Demonstrated: Team Orientation

- **Why is it important to you?**
    - When working with a team on an engineering project, the ability of each individual to put aside their own goal in favor of team goals is critical for success. When members are able to all strive towards a common goal by helping each other out whenever and however necessary, the team is far more effective than the individuals who compose of it.
- **What might you do to demonstrate that virtue?**
    - Going forward, I should improve on helping out more with team assignments and group tasks rather than focusing solely on my individual tasks. When I don't do my part on these group tasks, other members are forced to take time off of their own tasks to pick up my slack. If I took more initiative on tackling these team assignments and organizational tasks, the team as a whole would be better off.

Justin Scherrman

Virtue Demonstrated: Integrity

- **Why is it important to you?**
    - Integrity is crucial when working with a group because it helps with trust and accountability. Integrity ensures honesty in the group which in turn helps with collaboration. It allows for me to take responsibility for my actions during the design process.
- **How have you demonstrated it?**
    - Throughout the project thus far I have demonstrated integrity by making sure that my contributions to the design were accurate. This meant revisiting my work and redoing it in order to make sure I am contributing the best possible design. I also made sure to communicate openly with the team.

Virtue Not Demonstrated: Perseverance

- **Why is it important to you?**
    - Perseverance is important to me because it allows me to push through challenges and possible setbacks during our project. For a team perseverance makes sure that we remain focused on completing our goals regardless of difficulties.
- **What might you do to demonstrate that virtue?**
    - At times I have demonstrated perseverance but there have been moments where I could have pushed harder to work on our project. I plan on demonstrating

perseverance by staying focused on problems during team meetings and in class. Another way I plan on maintaining perseverance is by keeping a positive attitude when progress seems slow.

Aidan Klimczak

Virtue Demonstrated: Patience

- **Why is it important to you?**
  - Patience is important especially in a group environment because not all things can be completed in a short amount of time. Having patience builds trust in a team setting allowing me to focus on the tasks that I need to complete instead of tasks I should not be worried about.
- **How have you demonstrated it?**
  - The functionality of our device requires many moving parts to work properly. Although I am not working on some of those parts I had patience that we could get our prototype functionality working. Also demonstrating patience when waiting for an ordered part to arrive so I can test it.

Virtue Not Demonstrated: Discipline

- **Why is it important to you?**
  - This virtue is important to me because group settings require discipline and focus. Without discipline little to nothing would get done in a group setting. This virtue handles distractions which can prevent you from doing things you shouldn't be doing when you are asked to do a task.
- **What might you do to demonstrate that virtue?**
  - I have demonstrated this virtue regularly throughout this semester although at some points I could have been more disciplined and worked harder on the project. I have been to all team meetings and done almost everything I had goals of completing by the end of the semester.

8. CLOSING MATERIAL

8.1 Conclusion

Semester Goal

This semester we have successfully integrated with the photoplethysmogram, receiving and decoding the raw data to reveal a real-time heart rate. This was done through I2C serial communication and processed via our ESP32 WROVER E microcontroller. Another accomplishment was developing a Bluetooth channel where we could have both of our WROVER microcontrollers talk over wireless communication. These microcontrollers have been assigned roles of server and client. The server, like the name, creates a server, and the client looks for this server by checking and verifying its universal unique identifier. Using this wireless communication we developed a pseudo interrupt that acts in such a way that if the external push-button is pressed, the server sends a message to the client, notifying there is an alert. This alert is then read by the client and sends voltage to the external eccentric rotating mass motor which vibrates accordingly. The importance of this pseudo interrupt is to demonstrate proof of concept that if onset post-traumatic stress syndrome symptoms are detected (button is pressed) it sends a distress signal to the client side and turns on the motor to notify the service dog their veteran requires comfort.

This semester we focused on creating a breadboard design. This means we put our efforts towards creating a system that is functional, but not necessarily ready to be wearable. Focusing on creating this more modulus design is in hopes of ensuring all of the basic hardware and software components work, mitigating risks of failure in the future. Our plan of action consisted of focussing on the integration of the photoplethysmogram and establishing wireless communication to turn on the motor.

The plan of action we followed was splitting these sectors between team members. This is so we don't have everyone working on the same problem which can create conflict. We had the computer engineers focus on the sensor integration because this deals with more embedded systems expertise. On the other hand, the communication and motor were dealt with by the electrical engineers of the team because of their knowledge of circuits and signal processing. The other team members worked on schematics and researched security concerns and protocols. Every member had a role to play for everything to come together.

The one goal that we had originally set out to achieve that was not accomplished was reading the photoplethysmogram for blood pressure values. We were able to get the heart rate, but the blood pressure proved to be a lot more complicated and possessed more unreliable readings. What constrained us from achieving this goal was the misunderstanding of the complexity of the blood pressure reading technology as well as the lack of time.

Going into the next semester we have plans to tackle the blood pressure monitoring. We'll have plenty of time to do more research into how the blood pressure values are found through the device and understand the scope of that section of the device. Additionally, because some of our team members have functional familiarity with the sensor as they were able to retrieve heart rate, this should prove advantageous in deciphering the new set of data values.

The goals for next semester include interfacing with the blood pressure values, scaling down our breadboard design to become wearable, developing ways to have both apparatus' (microcontrollers) be wearable (on the wrist and the dog vest), as well as integrating security protocols to ensure the health data being read is safely protected.

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8.3 Appendices

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9. TEAM

Complete each section as completely and concisely as possible. We strongly recommend using tables or bulleted lists when applicable.

9.1 Team Members

- Katerina Zubic
- Justin Jaeckel
- Neil Prange
- Aidan Klimczak
- Ty Decker
- Justin Scherrman

9.2 Required Skill Sets For Your Project

(if feasible – tie them to the requirements)

Coding/Programming

Our device requires programming for a lot of the device functionality. The biggest portion of programming is incorporated in the algorithm that deciphers and pulls raw data from the photoplethysmogram. Additionally, we used coding to create wireless communication over Bluetooth between the microcontrollers. This is to enable the possibility of sending a distress signal to the service dog to signal for comfort.

Communication

Our device requires an understanding of wireless communication in order for two microcontrollers to communicate with each other. This means being comfortable with Bluetooth protocols and understanding the uses of universal user identifications. This is so the service animal will be connected to the veteran at all times.

Electrical Design

Our device requires an understanding of electrical design to create a working interface with the vibration device. This is so we can ensure the motor can receive the proper voltage and current ratings to develop a safe and effecient product.

Security

Our device requires the understanding of Cyber Security protocols to prevent data breaches in our device as we are dealing with medical information. This specifically pertains to HIIPA laws. We plan on incorporating this in the next iteration of our project.

9.3 Skill Sets Covered By The Team

Soft skills of communication and teamwork: All Team Members

Sensor Integration Via Programming: Neil Prange and Justin Jaeckel

Bluetooth Communication Programming: Katerina Zubic and Justin Scherrman

Schematic and Power Design: Aidan Klimczak

Security: Ty Decker

9.4 Project Management Style Adopted By The Team

Our team chose a hybrid management style. We chose a hybrid management style because it is adaptive, allowing us to accommodate unforeseen challenges. This style provides an opportunity to reflect on previous steps and make necessary changes and improvements for the future. This management style ensures that all previous steps are completed, hindering possible problems while maintaining an easy-to-follow structure.

9.5 Initial Project Management Roles

Project Organizer: Katerina Zubic

- Hold team members accountable to the signed team contract. Ensures the team meets set deadlines and orchestrates external communication to our client.

Software Interface Design: Justin Jaeckel and Neil Prange

- Integrated sensors with microcontrollers to pull raw heart rate data from the photoplethysmogram and display it on the LCD.

Sensor Algorithm Design: Neil Prange

- Developed and integrated photoplethysmography to decipher raw data.

Technical Schematic and Power Design: Aidan Klimczak

- Developing schematics for our microcontrollers and providing a power analysis on the entire integrated system.

Security Analyst: Ty Decker

- Determining security risks and ways to mitigate Bluetooth liabilities.

Communication (Bluetooth) Design: Katerina Zubic and Justin Scherrman

- Creating a script to establish Bluetooth communication between the two microcontrollers. Additionally, developing a pseudo interrupt to mimic alert signal.

Stenographer: Ty Decker

- Writes the meeting minutes for the team. This includes the meetings with our faculty advisor, BAE Systems, and America's VetDogs.

9.6 Team Contract

Team Name: sdmay25-13

Team Members:

1) Aidan Klimczak
2) Ty Decker
3) Justin Scherrman
4) Katerina Zubic
5) Justin Jaeckel
6) Neil Prange

Team Procedures

Day, time, and location (face-to-face or virtual) for regular team meetings:

Our team meetings are set to occur every Wednesday at 2:15 in the Student Innovation Center. To maintain a private and productive work environment, we will reserve a room in ICTR. Booking a room is simple through an online portal, and we can reserve it months in advance, ensuring we always have a space to collaborate.

Additionally, we have established a standard with our faculty advisor to meet biweekly via Zoom.

Preferred method of communication updates, reminders, issues, and scheduling (e.g., e-mail, phone, app, face-to-face):
We have decided to communicate through a Snapchat group chat. All team members are comfortable with the app, and it works across different operating systems. Snapchat's direct messaging also ensures that all members will be updated quickly. For contacting our faculty advisor, we will use email as needed for any inquiries; otherwise, we have our biweekly zoom calls as the primary mode of communication. Finally, we will use email to communicate with our client/BAE mentors.

Decision-making policy (e.g., consensus, majority vote):
We will make decisions based on a consensus. This is because we want all group members to have the opportunity to express their opinions and develop the best decision that incorporates everyone's ideas and thoughts. The goal is to find and create a solution acceptable to everyone. Coming to a consensus can also open the doors to having a deeper conversation about the said problem statement or argument.

Procedures for record keeping (i.e., who will keep meeting minutes, how will minutes be shared/archived):
We have created and shared a Google Drive folder containing all written documents for easy accessibility.

The entire group will work together to keep meeting minutes. This ensures that everyone is contributing to the discussion at hand. We have a master document that will be updated during our weekly meetings and will be properly labeled with the appropriate dates.

Regarding recording minutes spent working on the project, we have a master Google sheet that holds all the hours, including a small description of what it was for every week. This is expected that every individual updates on their own.

Expected individual attendance, punctuality, and participation at all team meetings:
All team members are expected to attend and participate in all scheduled meetings unless they have a valid excuse or extenuating circumstances, granted that it was communicated to the group prior to said meeting.

It is also expected that all team members contribute something to the discussion during the team meetings.

Punctuality is important for creative and productive work environments. It is encouraged that all members be present for the meetings on time, and if they can't, they should at least communicate how late they may be.

Expected level of responsibility for fulfilling team assignments, timelines, and deadlines:
It is encouraged that all team assignments are completed by a soft due date of the morning of the official due date. This enables any final tweaks to be made by the end of the day so that the finished product is satisfactory.

All submitted assignments shall be reviewed by all team members and be held to a high standard and accountability.

Expected level of communication with other team members:
Response to messages are expected within a 24-hour period from the team members. Additionally, if a team member is working on a specific aspect of the project, send an informal message to update the team on your work. This ensures all team members are constantly updated on the project's progress.

Expected level of commitment to team decisions and tasks:
We expect integrity. If a member says they will work on a portion of the project, it is expected they stay true to their word. If problems arise that hinder the ability to achieve certain personal deadlines, communicate them. This is so we know what's going on and can possibly contribute to resolving the problem.

Leadership

Leadership roles for each team member (e.g., team organization, client interaction, individual component design, testing, etc.):

It is said that each team member will be responsible for their own individual component designs and testing. This is not to say that we cannot contribute to each other's design ideas and thoughts.

Katerina Zubic - Team organizer; responsible for keeping the group on track for deadlines.

Justin Scherrman - Meeting coordinator; reserving the weekly meeting room.

Anointed that anyone can respond to faculty/advisor emails, but communication of action is required. Additionally, everyone plays the role of the stenographer for weekly meetings.

Other roles will be assigned once the project's scope has been ironed out.

Strategies for supporting and guiding the work of all team members:
Plan to start weekly reports together to ensure every team member is on the same page.

Stay verbally encouraging. Sometimes, we face adversities, but we are a team and are here to support and help one another. As well as give credit when credit is due.

Strategies for recognizing the contributions of all team members:
Each team member will log and discuss their contributions in the weekly report and during weekly meetings with members and faculty.

Collaboration and Inclusion

Describe the skills, expertise, and unique perspectives each team member brings to the team.

Aidan Klimczak- Expertise in design, basic knowledge of embedded systems and coding

Justin Scherrman- Experience with electrical systems design, Desire to learn hardware aspects of our system. Basic understanding of code.

Justin Jaeckel- Experience with embedded systems, software development, as well as other computer engineering disciplines

Ty Decker- Experience with software development and computer engineering concepts. Small amount of medical experience.

Neil Prange- Experience with embedded systems design, microcontroller programming, communication protocols.

*Katerina Zubi*c- Experience with electrical system design, schematics, CAD, communications, and control systems.

Strategies for encouraging and supporting contributions and ideas from all team members:

Verbally recognizing all contributions in team meetings. As well as ensuring that everyone's thoughts and ideas are heard. If you disagree from the get-go, don’t tune them out, listen to what everyone has to say. This is also why our method of coming to a consensus is highly stressed.

Procedures for identifying and resolving collaboration or inclusion issues (e.g., how will a team member inform the team that the team environment obstructs their opportunity or ability to contribute?)

It is encouraged to bring up the conflict when it first occurs. This hinders the ability to have the problem snow-ball and become a bigger issue. If extenuating circumstances persist (on a case-to-case basis), contact with the faculty member will be required.

Goal-Setting, Planning, and Execution

Team goals for this semester:

We plan to complete research into any necessary components (sensors, microcontroller, etc) for the product. As well as generate a flow chart showing how we would like everything to communicate.

Additionally, we hope to have preliminary prototype testing by December of at least all the individual components to ensure compatibility.

Strategies for planning and assigning individual and team work:

Assigning individual tasks is to be announced once the scope of the project is better understood as well as understanding everyone's strengths and weaknesses.

Hope to assign individual components to different group members.

Strategies for keeping on task:

During weekly meetings we'll start by stating the goals and deadlines for the next week. This will ensure all members are updated with the current expectations and there are no surprises.

Ensuring that all members are updating the master note sheet as well as filling out their time tables.

Hold one another accountable; integrity.

Consequences for Not Adhering to Team Contract

How will you handle infractions of any of the obligations of this team contract?

Discuss the issue with the group internally first to reach an agreement or create a course of action to solve the problem.

Will also communicate the issue, if necessary, in our weekly report if the circumstance permits.

What will your team do if the infractions continue?

If necessary, communication with the faculty or TA will be required.

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a) *I participated in formulating the standards, roles, and procedures as stated in this contract.*
b) *I understand that I am obligated to abide by these terms and conditions.*
c) *I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.*
1) __________Aidan Klimczak__________________________ DATE _________9/17/24__
2) __________Neil Prange______________________________ DATE _________9/17/24__
3) __________Ty Decker_______________________________ DATE _________9/17/24__
4) ___________Katerina Zubic__________________________ DATE _________9/17/24___
5) ___________Justin Jaeckel___________________________ DATE _________9/17/24___
6) ___________Justin Scherrman________________________ DATE _________9/17/24___