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.

Hardware

From a high level, the hardware consists of a temperature sensing device, external battery power supply, hardware responsible for communicating data, and various alert systems. The user will be able to strap the hardware to any area of their body and place the temperature sensing device in whatever area they desire to have temperature measurements for. When their body reaches or approaches dangerous temperature levels, visual and auditory alerts will be displayed to the user to allow them to make corrective adjustments.

Software

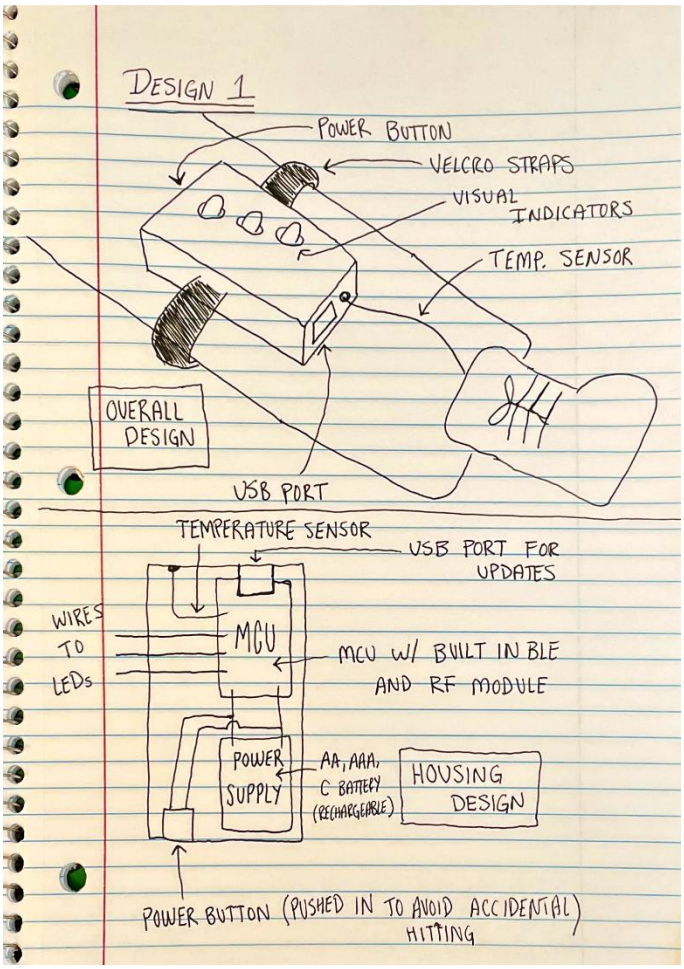
The worn device will communicate with the users Android phone to an application they have downloaded. This application will show the sensors' current temperature, customize the temperature ranges at when to be alerted at, and alert the user through on-screen notifications and sound alerts when the range is exceeded. The application will be used by both the veteran and the instructor, allowing both parties to know when a specific device has detected abnormal temperatures.

4.3.2 Detailed Design and Visual(s)

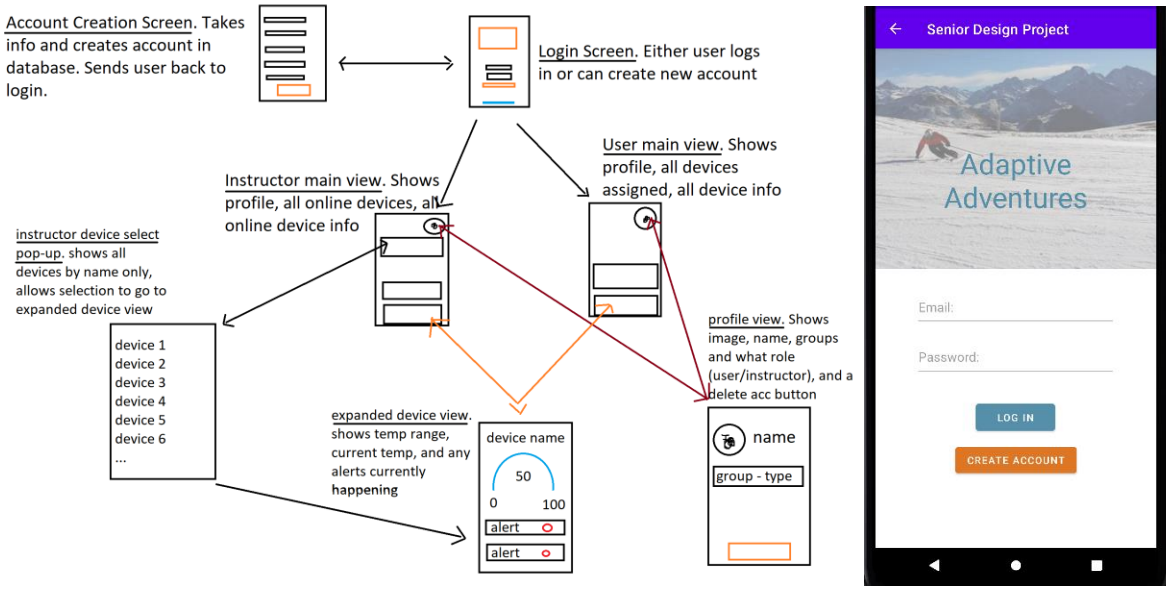
Provide a detailed, technical description of your design, aided by visualizations. This description should be understandable to peer engineers. In other words, it should be clearly written and sufficiently detail such that another senior design team can look through it and implement it.

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.



Above is an overview of the hardware design for our project. It includes an example case where the individual would utilize the device to obtain a real-time temperature measurement of their feet. The hardware responsible for this functionality includes a temperature sensing device (thermistor), a microcontroller to process and communicate the data to the user and supervising individual, a power supply to power the alert systems, temperature sensing device, and microcontroller, a power button to initialize the device, LEDs to provide a visual alert for battery life, loss of connection, and dangerous temperature levels, and a installed horn to provide an auditory alert of dangerous temperature levels. The microcontroller will have Bluetooth and radio frequency communication functionality that will allow local data transmission to the application on the user's cellphone and global transmission to the gateway or local hub that will be utilized by the supervising individual. All hardware components will be connected by jumper wires to the power supply and microcontroller. The housing enclosure for the hardware will be at minimum IP64 rated in order to provide resistance against water, dust, and other contaminants. The power supply will consist of 4-5 AA lithium-ion batteries in order to provide reliable quality under extreme temperatures. Overall, this system will be able to be strapped to any area of an individual to provide real-time temperature measurements of any desired areas.



Above is the flow of the application itself. We will have two different accounts that can use the application. The instructor will have a view where they can see multiple devices at the same time so that they can keep track of multiple athletes at one time. We then have an athlete view where they can choose the temperature to alert the system of being an unsafe temperature. We will then have a place to store data. We are using android studio for the front end development and we plan to use a cloud platform for the back end. We have decided to create a half circle icon to show the temperature. Shown on the right picture, we will be using Adaptive adventures colors for the application's base colors. We will have popup and vibration alerts for out-of-range temperatures and low battery of the hardware. We will have a login screen for existing users and a create account screen for new users.

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.

This device is designed to obtain real-time temperature measurements of any area of an individual's body. The user will strap the housing enclosure in near proximity to the desired area, place the temperature sensor on the desired area, push the power button to initialize the hardware, connect to the device using the application, and begin obtaining real-time temperature measurements with ease. The device will handle obtaining the temperature measurement and communicating the results to the local application and global hub. This will allow the data to also be historized in order to make corrective adjustments in the future.

4.3.4 Areas of Concern and Development

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

The current design should satisfy all of the users needs and we are working on prototypes of both hardware and software and we are keeping the clients, TAs, and faculty advisers updated in case anything needs to be changed or modified.

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

1- The low temperatures that the device needs to work at may affect the accuracy of its reading and will give false alarms, therefore.
2- The cloud that will be used to store users' information can come at a price for some providers, and the free ones can have glitches or cause unexpected errors.
3- The range of the transmission between the sensor and the app has a maximum range that will cause the readings to get cut off or inaccurate.
4- The casing where the sensor will be put may cause discomfort to some users so we will be considering multiple options.

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

1- The cloud problem was discussed today with Dr. Gaffar and he suggested using one provider where it comes at a cheap price, but we will start looking at it asap.
2- The range of transmission problem was also discussed with Dr. Gaffar and he suggested using a relay system where each user's device can act like a repeater.
3- To avoid discomfort, we are designing aiming to make the attachment system for the housing and sensor as modular as possible. Having more options will fit a greater amount of users.

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.

Hardware

For the hardware responsible for temperature measurement and data communication, one of the big technological aspects of the design is the microcontroller. We have chosen to prototype using the Arduino Uno in order to test temperature measurements, power consumption, and alert system functionality. Utilizing the Arduino Uno will allow our team to easily transfer the programming to the final microcontroller which will hopefully be the Arduino nano 33 BLE. The Arduino Nano 33 BLE provides a compact design to provide comfortable use of the device and Bluetooth capabilities in order to locally communicate data to the user's phone application. Our team plans to install a radio frequency module in order to globally communicate the data to the supervising individual utilizing a gateway or local hub. We will also install alert systems using LEDs and a horn in order to provide auditory and visual alerts for battery life of the device, loss of connectivity between the device and phone application, and most importantly, approach/reaching of dangerous temperature levels for the individual. Our team has numerous microcontrollers, temperature sensing devices, power supplies, and alert devices that we plan to prototype in order to find the overall best solution to the needs of the user.

Phone Application

For the phone application, the software development team is focused on the Android system, using Java in Android Studio to develop the App. A focus on the Android system was decided as splitting development into two to account for iPhone and Android systems would increase workload without major payoff. Furthermore, the team has a considerable background with Java and Android development, allowing focus on implementation of key features rather than learning new software and systems.

A key feature within the application is the use of a cloud database, which holds login details, user information, and other features necessary for the functionality of the project. Firebase has been selected as the cloud database provider, as it is compatible with Android Studio and has the most documentation available to project development. Although alternatives exist with higher functionality, such as Microsoft Azul, Firebase is the most cost-effective solution our team has found.

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?

On the hardware side, our team has captured many of the design constraints and needs for the device. Our team is currently working with the client and users to confirm the constraints fully. We may have to make some compromises with the client on different features such as range of communication or modularity, but our aim is to meet all client specifications that are technically possible. Once completed, our team will purchase the hardware described above to prototype a design for the users. We will utilize the metrics and additional quantitative tests in order to confirm functionality of the device to a high degree, and pursue alternative components or re-design of certain components to ensure feasibility of the design.

On the software side, our team has decided on a basic design. We have discussed the two types of users, one for the athlete and one for the instructor. We determined that only the athlete can input the desired temperature to qualify as an unsafe temperature. We have discussed the cloud server and determined that we will be using android studios for the development. With android studios we have come up with a few basic designs and for temperature gauges and we are in the process of putting those examples together to make the final decision. We have created a basic flow chart of how the pages of the app will work together. When it comes to development, we have created basic login screens and create account screens. For the future, we will finish the interfaces and create the different profiles. We will also wait for the hardware to get semi functional to try and connect the data through Bluetooth. We have not yet had any issues that we do not think that we can solve. Our design is currently going smoothly