CPE 191/EEE193B Deployable Prototype

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Team 7

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TABLE OF CONTENTS

Page

TABLE OF FIGURES

Page

TABLE OF TABLES

Page

Elevator Pitch – Our project is a medical device that can collect basic vital signs and create and store medical profiles to timely notify those with health risks.

EXECUTIVE SUMMARY

Our vital monitoring medical device has been a project that has seen many different adjustments, debugging and integration into a working prototype that collects a user's vital information such as blood pressure, heart rate, blood oxygen levels and body temperature. The project has seen some adjustment in the societal issue being addressed and is thus accounted for when tackling the design and continued progress of this project. This document will cover the process as a whole from the development of the idea for such a monitoring and trending device all the way to the working prototype and associated collected data. We'll discuss some topics already discussed such as the marketability of the prototype and where the design philosophy arises from. There will be references towards the end of the document that are of use such as the user manual and how the hardware and software aspects are separated but also integrated.

Abstract— **Medical attention and monitoring is an issue amongst those who do not actively seek medical advice or go in for routine check-ups. Medical procrastination is common amongst many of those who have higher stress levels both physically and emotionally. The individual's perception of themselves also has a key role in whether they get check-ups infrequently or at all. Medical care avoidance is fundamental as cognitive reasoning to make decisions. A proposed solution is for home monitoring. A user would be able to monitor their own vital signs and review their medical history based on what the device has gathered thus far. Trending will be standardized to allow the user consistency with results so if there is a discrepancy, it is due to misuse or would be considered accurate. If there is a negative or positive trend beyond a certain threshold pertaining to the user's vital data, notifications will be presented for the user to decide if action is needed. Such notification will vary by urgency as the device will only provide suggestions as far as to possibly seek a medical professional. The desire is to assist the community of those who do not favor regular medical check-ups. Monitoring vitals on the user's own schedule and comfort will ease stress on medical procrastination. The current global market for vital signs monitoring devices is currently valued at USD 4.7 billion and expected to grow by 8.7% by a compound annual growth rate. Vital sign monitoring devices have been evolving in a short period of time from single measuring devices to multiple measuring sensors in one device. Due to this increase in integration, there has been a continuous increasing demand for home health care services, hospitals and other healthcare settings. However, since there has been an increasing market growth and increase in demand, there has also been an increase in competition from other manufacturing companies and businesses.**

Index Terms— **Market, Medical Devices, Trade, Global Industries, Domestic, International, Competition**

I. INTRODUCTION

The market for medical devices and even consumer level solutions for in-home use is a competitive and financially dominant market. Medical industries invest large amounts for internal or external entities to produce a reliable device that can output information about a patient's or user's vital information. Companies have a multitude of medical products ranging from industry level monitors for hospitals all the way to smaller vital devices for personal use. Much of the medical industrie's physical infrastructure is held upon these devices working properly in order to have quick responses and retrieve vital info to make informed decisions. Medical monitoring devices are responsible for making sure patient's and user's stay continuously informed with their vitals and be able to notice any alteration in a timely manner. With this in mind, it is apparent why the medical device industry is vastly growing market as health becomes a greater issue.

II. SOCIETAL PROBLEM

For all of humanity, it is essential to maintain a healthy life and live life in a content manner. However, a recurring problem is that people tend to fail in taking care of their health in a timely manner. According to a study provided in [1], up to 68.9% of the people studied, never visited a general practitioner for a free medical check-up. Postponing medical assistance and avoiding health problems can be derived from a variety of factors that cause people to delay attending their health problems. Many factors as to why an individual does not seek out medical care are involved in the process of constant delay. The most significant processes that contribute to these constant delays are; mental health, personality traits, and task characteristics.

States in mental health tend to be one of the contributors at large when procrastination on a doctor's visit or dentist appointment become issues. Mental health is greatly affected by stress levels and studies have begun to display stress and mental health in new light in even the most minute situations. Stead et al. [2] has reviewed a study amongst University students as to how their physical health and treatment delay was affected during a time period of high stress. The results of the study concluded that "stress was found to fully mediate the procrastination-illness relationship". Students were found to procrastinate on seeking treatment and showed fewer symptoms of good health. According to Silkane [1] there is a strong relationship between procrastination, higher stress levels and worse health. Individuals tend to have a form of tunnel vision when presented with tasks that are time and effort demanding. That drive to accomplish those tasks can have a negative aspect that can manifest into neglection of one's own personal health.

Many individuals have an issue that deserves medical attention but usually continue their daily lives without seeking advisement. Mental health has contributed to a trait that deteriorates as one gets more involved in the stressors of life. A study conducted by Stead and other contributors [2] amongst University students have brought numerical data to represent how many of those students in a controlled group got treatment from those who would likely need it. The study was conducted amongst 200 students as a "total of 48 individuals were flagged as likely to be currently experiencing clinically significant distress". Screening was conducted amongst all the students to assess mental health behavior (MHB) on a 5-point scale. Out of the 48 students who were in distress, less than half scored a zero on their MHB assessment and led the conductors to conclude that they never sought out for assistance. Help-seeking does not occur very often amongst the students that may have needed it due to what can be viewed as procrastination or neglect. This form of procrastination is not for all general situations as this form of neglect is associated with stress in the study.

Medical procrastination is often associated with stress and mental health issues. The study conducted by Stead et al. [2] hypothesized such a claim. Results of the study have shown the relationship between procrastination, higher stress and poorer mental health. From [2, Fig. 1] the column of CF-1 is considered to be in the high moderate levels. Overall procrastination (weather medical or academic) trended amongst more than half of the students. Mental health behavior being as low as 16% can be seen at the bottom of CF-1 displaying very low scores in positive mental health. There is the relationship visually between high overall stress and poor mental health in association. On the contrary, those of higher age and female were the individuals that had sought out more external assistance. Those in the third column are interpreted to have a better grasp on their awareness of their state of mind. Those students may have a more open mindset with their own help-seeking behaviors and seek help when a need is perceived. Looking for mental or psychological help can come with negative connotations as this group out of the course will usually disregard the stigmas. There is no coincidence that these individuals have lower levels of procrastination.

Canonical loadings for procrastination/stress and mental health variables.

	Canonical function (CF)		
	CF-I	CF-II	CF-
Canonical loadings (n = 200)			
General procrastination (GP)	**.60**	.10	−.5
Academic procrastination (quantity; PASS-1)	.48	.10	−.5
Academic procrastination (problem; PASS-2)	**.56**	−.22	−.5
Daily stressors (cumulative severity; DHS-R)	**.89**	.04	.2
Age	−.02	**.61**	−.0
Gender (male – 1, female – 2)	.10	**.64**	−.1
Social desirability (MC-20)	−.30	.04	−.4
Cognitive functioning (CF-6 from MHI-38)	**−.98**	−.18	.1
Mental Health Index (MHI-32)	**−.85**	.18	−.5
Mental health behaviour (MHB)	.16	**.76**	.6

Fig. 1 Student procrastination and health [2]

The issue of help-seeking may be as fundamental as cognitive functioning. An interpretation of this is “appropriate decision-making under stress may be affected by cognitive load as a stressor itself” [2]. Students that are under more pressure when it comes to academics or life at home have more clouded judgement when important decisions for the individuals own sake arise. Improper cognitive functioning can limit one’s own nature to search for guidance to benefit their wellbeing.

There are proportional correlations between procrastination, stress and mental health. As students are screened and results are found that 22% of them label their procrastination high, the relationship with stress and mental health trends low overall [2, Fig. 2]. Better overall mental health may be a result of lower stress levels and lower scores on procrastination. The students studied represent a group that may be under more or less stress than in a general population. From the common trend of stress levels, students may be in higher levels overall and thus contributing to lower levels in mental health.

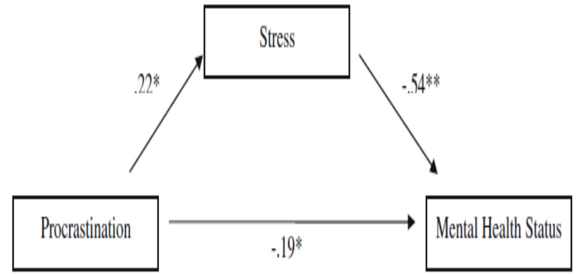

Fig. 2 Percentage and factors amongst students [2]

In a variety of studies procrastination is usually defined as a personality trait that has been created by repeated procrastination behavior. According to [1] both low conscientiousness levels and high neuroticism levels can relate to procrastination. For example, people with high conscientiousness levels usually tend to be self-disciplined and can fulfill tasks within the deadlines and overcome resistance with tough tasks. On the contrary, people with low conscientiousness levels have a more difficult time fulfilling the requirements to complete a task in a timely manner and proceed with more difficult tasks. Additionally, people with high neuroticism levels are relatable to impulsivity which conflicts with fulfilling tasks due to succumbing to various temptations and enticements. The higher the neuroticism levels the harder it is for each individual to postpone immediate satisfaction and refuse short term benefits for the sake of long-term benefits. Due to these two personality traits, people tend to procrastinate in their health. Not being self-disciplined enough or having self-control with their impulsive desires, usually affects people’s willingness to get necessary checkups from a practitioner.

Another factor that contributes deeply with why people tend to procrastinate a lot is due to task characteristics. People usually prolong avoiding certain tasks that require boring, frustrating, or unpleasant requirements to fulfill. People often avoid seeking medical care even when they suspect it may be necessary; nearly one-third of respondents in a recent national United States survey reported avoiding the doctor. Even individuals with major health problems or who are experiencing symptoms avoid seeking medical care. For example, in one study, 17% of patients diagnosed with rectal tumors reported that they waited a year or more to seek medical consultation after noticing symptoms, with some waiting up to five years according to [3]. It is essential for people to seek medical care and refusing to do so, may result in late detection of a disease, reduced survival, and potentially preventable human suffering.

Understanding why people avoid seeking medical care is key to reducing medical care avoidance or procrastination to seek help. Avoidance of medical care has been defined as “keeping away from something that is thought to cause mental or physical distress.” There are several reasons for medical care avoidance that occur as a result of barriers. These barriers can be defined as factors that limit access to obtaining quality healthcare. Some of these barriers include financial concerns considering health insurance and high cost. Also, time constraints could play a factor because people value their time very highly. It seems that people would rather be doing something else than checking up on their health. Another reason for avoidance of medical care can be focused on specific factors such as psychological characteristics of human beings. For example, there could be a fear of a diagnosis. Nobody wants to know truly if they are sick or unhealthy. It would be devastating psychologically and could change how one lives their life.

According to [3] five of the six studies reviewed assessed avoidance of specific procedures. The exception was a focus group study among a sample of Hispanics that explored reasons for avoiding medical visits in response to warning signs of heart disease, cancer, and diabetes. This qualitative study identified factors such as low trust in doctors, low perceived severity of symptoms, emotional factors (e.g., denial, avoiding worry, embarrassment), practical barriers, and prior negative experiences as contributing to avoidance. There is a significance and prevalence of medical care avoidance in the United States. The question is why people avoid medical visits that could save lives or reduce suffering. Getting checked regularly can result in early detection of disease or timely treatment to prevent possible diseases. The purpose of the study [3] was to identify the reasons people avoid seeking medical care and to classify these reasons into conceptually distinct categories reflecting underlying factors contributing to avoidance. The authors of [3] developed a model of medical care avoidance that can inform efforts to promote care seeking, help providers reduce avoidance in their patient populations, and promote theoretical advancement in this area of research.

The data collected were obtained from the National Cancer Institute’s 2008 Health Information National Trends Survey (HINTS). This survey collects data from a nationally representative sample of adults aged 18 and over to assess trends and patterns pertaining to health. The survey [3] was completed by 7,674 participants. Participants were asked several questions such as: whether they “avoid visiting their doctor even when they suspect they should” (58.8% participants); reasons for avoiding the doctor (i.e., feeling uncomfortable when their body is being examined, fear of having a serious illness, and because it makes them think of dying); or “any other reasons why you avoid seeing your doctor”. Among the participants who indicated avoiding medical care, characteristics of those who provided qualitative responses (n=1,369). Of the 1,369 participants who provided interpretable responses, fewer than half (43.5%, n=595) endorsed at least one researcher-identified reason for avoiding medical care. Approximately one-fourth reported avoiding medical care because of feeling uncomfortable (26.8%, n=369) or fearing a serious illness (26.4%, n=363), with substantially fewer reporting avoiding medical care because it made them think of dying (8.2%, n=113) according to [3].

From the analysis [3], the article generated four distinct categories of reasons for avoiding medical care. In the first category, "low perceived need to seek medical care," responses indicated a determination that seeking medical care was unnecessary. In the second category, "traditional barriers to medical care," responses indicated that seeking medical care was not an option because of a lack of resources. In the third category, "unfavorable evaluations of seeking medical care", people evaluated some aspect of the care-seeking process as negative. A fourth category, labeled "personality traits", was also identified as a reason for avoidance. Below is a figure [3, Fig. 3] with each category and relevant subcategories relative to the analysis described in detail below.

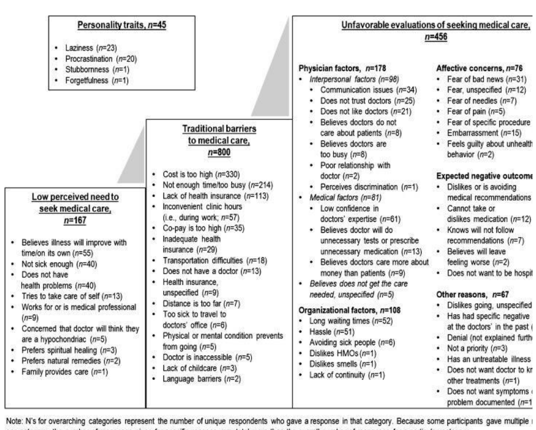

Fig. 3 Participant-generated reasons [2]

The results of the following categories is as follows: low perceived need to seek medical care (n=167); traditional barriers to medical care which is the largest category (n=800, 58.4%); unfavorable evaluations of seeking medical care (n=456, 33.3%); self-ascribed personality traits (n=45). Some examples of low perceived need to seek medical care are medical problems would either "improve over time" or "improve on their own", contingent on the problem is not being very serious and participants stating not being sick enough. The major category of traditional barrier to medical care includes responses indicating circumstances or obstacles limiting access to medical care such as having too little time or being too busy to seek medical care and significant financial reasons including concerns about overall cost and health insurance.

Unfavorable evaluations of seeking medical care is broken up into several subdivisions such as physician factors, organizational factors, affective concerns, and expected negative outcomes. Physician factors is the most frequently reported reasons for unfavorable evaluations where factors related to physicians such as interpersonal concerns and concerns about the quality of medical care. This includes perceptions that doctors do not follow-up, communication being difficult, and disliking how doctors communicate. In addition, concerning the quality of medical care was that participants had low confidence in doctor's expertise. Organizational factors for unfavorable evaluations concerned aspects of the medical system, such as long waiting times, and "hassle". Affective concerns included participants that anticipated fear, embarrassment, or guilt kept them from seeking medical care. Expected negative outcomes pertained to beliefs that the outcome of seeking medical care would be negative, including dislike of a provider's medical recommendations or the perception that recommendations would not be useful. Some other reasons reported was simply that people just generally not liking or wanting to go to the doctor.

Lastly, self-ascribed personality traits, reasons for avoiding medical care concerned personality traits. Specifically, participants responded that they were "lazy" or that they "procrastinate" with little elaboration according to [3]. Below is a conceptual model of medical care avoidance that emerged from the various categories generated from the study of [3, Fig. 4].

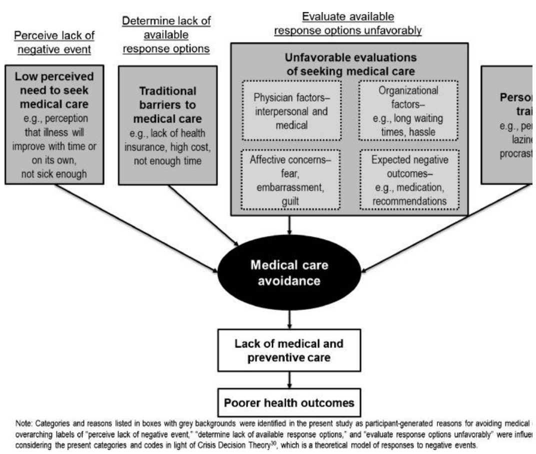

Fig. 4 Conceptual Model [3]

Reasons for avoiding medical care were highly varied. Understanding why people do not make it through to seek medical help is critical to extending the reach and effectiveness of patient care. This study [3] and data point to new directions of research and strategies to reduce avoidance and increase health awareness.

In order to help solve this medical avoidance problem, we have designed a device that will constantly update each person with information on their vitals. Our design addresses the problem of patient awareness of conditions by keeping the individual updated on their conditions. The best way to increase awareness is to create a device that can monitor their overall health. This device would have various sensors to gather real-time analysis of vital signs such as blood pressure, oxygen levels, heart rate, and temperature. The data collected will be stored into our system, we will be able to detect trends overtime to determine a patient's health condition whether it is healthy or unhealthy. With this information, we can make it possible for medical representatives to examine these trends to help them initiate a treatment for patients before it is too late.

A monitoring device will be utilized as the main form of the data collection. The device used will wrap around the patient's arm and placed over the blood pressure cuff. What will be embedded within the device will be a microcontroller, power supply, a Bluetooth module, and the sensors for the heart rate, oxygen levels and temperature. Sensors included in the design will be electrodes, oxygen/pulse, temperature and light sensors for gathering human vitals. For our design we will be using various electronic components to gather the vital readings and transfer the readings wirelessly to the monitoring device. Our device will be user friendly with easy follow along steps for usage and collecting data.

III. DESIGN IDEA

"Comprehensively review the Design Idea Contract covering both Fall and Spring Semesters with attention to the prototype feature set."

A. Assistive Data Trending Medical Cuff

Design idea is an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. Our design is to create a positive overall wellness when it comes to seeking medical care. As stated in our societal problem there is an increasing number of medical care avoidance and medical care procrastination. Our objective to our design idea is to create a medical device that will collect vitals through various sensors with the integration of a blood pressure monitor. We plan to develop a prototype that you could easily use at the comfort of your home. This will help in decreasing medical care avoidance and procrastination by allowing the user to get their vitals screened as they would at a hospital during normal checkup. We stated many reasons and factors why people choose to avoid seeking medical care. Our device aims to aid in this problem making it accessible to consumers who are too busy to seek medical care or can't afford the cost of medical care. What makes our device unique is our system will be able store your measurements of vitals and compile these measurements to produce a baseline of your vitals to create a history of the measurements. Based on your vitals at any given period of time, if there are any abnormal measurements of your blood pressure, oxygen levels, heart rate and body temperature, our system will alert you to seek medical attention. The information you get from your vitals provide critical information about your state of health. Vitals can identify the existence of an acute medical problem, are a means of rapidly quantifying the magnitude of an illness and how well the body is coping with the resultant physiologic stress and are a marker of chronic disease states. Now, let's begin to dive further into the technical aspects of our design system.

B. Design System

Our design addresses the problem of patient awareness of conditions by keeping the individual updated on their conditions. The best way to increase awareness is to create a device that can monitor their overall health. Our device has various sensors to gather real-time analysis of vital signs such as blood pressure, oxygen levels, heart rate, and temperature. The data collected will be stored into our system, we will be able to detect trends over time to determine a patient's health condition whether it is healthy or unhealthy. With this information, we can make it possible for medical representatives to examine these trends to help them initiate a treatment for patients before it's too late.

A monitoring device will be utilized as the main form of the data collection. The device used that will wrap around the patient's arm will be the blood pressure cuff. What will be embedded within the cuff will be a microcontroller. Sensors included in the design will be electrodes, oxygen/pulse, temperature and light sensors for gathering human vitals. For our design we will be using various technologies to collect the vital signs.

One technology we will be using is a blood pressure meter, which is a device used to measure blood pressure. The meter is used when an inflatable cuff for restricting blood flow and a pump to inflate the cuff. Digital blood pressure meters typically measure two types of pressures called systolic and diastolic. Systolic pressure is related to the phase of the heartbeat when the heart muscle contracts and pumps blood from the chambers into the arteries. Whereas diastolic is related to the phase of the heartbeat when the heart muscle relaxes and allows the chambers to fill with blood. Using a method called oscillometric detection and a piezoelectric pressure sensor. This method analyzes pulse waves collected from the cuff during constricted blood flow and a piezoelectric pressure is a device to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge.

The second technology will be using an optical heart rate sensor, which is a photodiode designed to measure pulse waves, which are changes in the volume of a blood vessel that occurs when the heart pumps blood. Pulse waves are detected by measuring the change in volume using an optical sensor and an LED.

To measure blood oxygen levels, will be using a technology called pulse oximetry. Pulse oximetry utilizes light-based sensors clipped onto a finger to collect blood oxygen levels. This technology has been available for many years, but the real challenges are to handle ambient light, patent motion, and blood-pulsation effects in order to gather more precise data. Currently professionals use a method of Sp02, which is peripheral capillary oxygen saturation can be packaged as a single-function device for personal devices for personal monitoring as part of a health/wellness wearable or used in a medical/hospital setting in a complex integrated monitoring system. This system consists of using a pair of LEDs, one for IR and one for red visible light, and a single photodetector. Simply, the attenuation between the two wavelengths is the key marker of SpO2 levels. The optical signals arriving at the photosensor are converted to current and then processed by a sophisticated algorithm to provide SpO2 reading in real time. To conclude photon-based sensing to determine Sp02 is an easy set up and offers real-time results and tracking.

Another technology we will be using is a body temperature sensor, which will provide valuable patient information to nurses. This sensor will enable simple body temperature measurements that represent how much thermal energy is in a substance or a measure of how hot something is. For nurses, body temperature provides valuable information since humans are warm-blooded creatures who have the ability to maintain homeostasis, or thermal equilibrium, regardless of their environment. Different temperatures can signify different things such as: a high body temperature, or a fever, indicate an immune response to a foreign intruder in the body such as bacteria; low body temperature can indicate intense environmental effects like extreme cold, shock, or alcohol poisoning. Body temperature is a measure of internal thermal energy, the most accurate measurements involve putting the sensor into the esophagus or urinary tract, places where it’s uncomfortable. The sensor that we will be using will measure temperature outside of the body like the armpit, ear, and forehead. The problem we will run into is the accuracy of temperature at these various sites. Differing from one degree more or less can have an impact of diagnosing a certain symptom.

C. Feature Set

Our system is split into two major features. We define these two major features as hardware and software. There are several sub features in our design that will be integrated to complete our system. Simply we will have a microcontroller to control the SpO2/ heart rate and temperature sensor that will transmit the measurement data via Bluetooth to a microprocessor that has a graphical user interface (GUI) implemented into it, which will be an LCD monitor. A blood pressure monitor from Omron will be integrated into our system using Google Fit’s Application programming interface (API). The cuff device will wrap around a person's arm and collect the patient's blood pressure information. The oximeter sensor will collect both the blood oxygen levels while also collecting the heart rate of the user. Lastly, the temperature sensor will simply analyze the user's temperature. The user will be able to see the vital sign measurements on the LCD screen along with trending graphs to display the history of measurements taken from the user.

D. Hardware

Blood pressure sensor- is a device used to measure blood pressure. The sensor is used when an inflatable cuff restricts blood flow with the pressure from the inflatable cuff. Digital blood pressure meters typically measure two types of pressures called systolic and diastolic. Using the method of oscillometric detection, the blood pressure sensor analyzes pulse waves collected from the cuff during constricted blood flow by using a piezoelectric pressure sensor. This is a device that measures changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge.

Oxygen level sensor- to measure blood oxygen levels, we will be using a technology called pulse oximetry. Pulse oximetry utilizes light-based sensors clipped onto a finger to collect blood oxygen levels.

Heart rate sensor- is a photodiode designed to measure pulse waves, which are changes in the volume of a blood vessel that occurs when the heart pumps blood. Pulse waves are detected by measuring the change in volume using an optical sensor and an LED.

Temperature Sensor- this sensor will enable simple body temperature measurements that represent how much thermal energy is in a substance or a measure of how hot something is.

LCD screen- the purpose for our LCD screen will display the various vital sign measurements such as blood pressure, oxygen levels, and temperature.

Bluetooth/Wi-Fi module- will be designed to connect our microcontroller to our laptop or computer for our GUI. This will allow us to transmit the data of the vital signs from the user to our system.

E. Software

All coding will be done in Python unless otherwise specified. There are two software requirements: the GUI, and the algorithm for health monitoring predictions.

The GUI will be coded using the Python package Tkinter, which is Python's built-in GUI package. There will be an interface which can take user input for age, height, and weight, and an internal clock to store the date and time that measurements are taken.

F. Design Specifications

Blood Pressure Monitor - Cuff should have an adjustable circumference between 9-17 inches. The cuff will weigh a maximum of 1.4 lbs. The pressure should be able to withhold between 0- 200mmhg or more, with an accuracy of a 5mmhg deviation. The pulse should be able to read between 60-120 beats per minute (or more) with a standard deviation of 7%.

Pulse Oximeter Sensor - this sensor should be able to operate in a temperature range of -20 to 70 degrees Celsius. The peripheral capillary oxygen saturation (Sp02) sensor will have an accuracy deviation of 5 for 70%-90% readings.

Heart Rate Sensor - this sensor will be able to read around 40-180 beats per minute with an accuracy deviation of 3BPM.

Temperature Sensor - The temperature sensor will be able to read between 10 to 45 degree Celsius and have an overall accuracy standard deviation of 0.7.

IV. FUNDING

The components were purchased by our team. The materials list shown in Table I [1], lists our expenses as a team. The total dollar amount spent on our project is $214.23. We split this equally amongst the four team members - $53.56 each. This was well below our expected budget of $150 per person at the beginning of the semester.

V. PROJECT MILESTONES

1) Established accurate measurement for temperature.
2) Established accurate measurement for SpO2.
3) Integrated heart rate/SpO2 and temperature sensor into one program.
4) Figured out how to establish healthy baselines for users' vital signs.
5) Implemented Bluetooth communication between microcontroller and microprocessor.
6) Integration of blood pressure monitor using Google Fit's application programming interface.
7) Graphical User Interface accepting incoming data from blood pressure monitor, heart rate/SpO2 and temperature seEstablished accurate measurement for heart rate.
8) nsor.
9) Parent program outputting vital sign measurement with trending graphs onto the LCD monitor.
10) Implemented portable power supply to drive our microcontroller, sensors and Bluetooth module.
11) 3-D Print enclosure to house our electronics that will be attached to the cuff of blood pressure monitor.

VI. WORK BREAKDOWN STRUCTURE

Our work breakdown structure is designed to be modular so that we can work on our individual parts without depending on each other's time and varying schedules as much as possible. It is designed to make sure each person gets their individual part working properly before we link our systems together. The benefit of having a modular project is that there is a lot of flexibility for team members to work on their portion without having to depend too much on each other's parts.

Focusing on hardware and its components are Daniel, Jose, and Jessie. Yamini will take lead on the software components. Daniel will also assist with GUI development while Yamini takes on the database component individually. Team leaders will be in the following order: Yamini will be first, Jose will be second, Jessie will be third, and Daniel will be last. This designation was random as everyone needs to take over team leader at some point in the project.

In order to create our system, we broke down our medical device into two main features: Hardware and Software. Our hardware feature includes various subtasks such as: SPO2 & Heart Rate Sensor, Blood Pressure Sensor, and Temperature Sensor. The sensors play a key part in our system because they're going to measure the vital signs. It is important that we get solid and accurate measurements for our vital signs in order to achieve success for the next part of our system which is the data trending aspect.

Our software feature includes various subtasks such as: Interfacing Microcontroller/Microprocessors, Data Trending, and Graphical User Interface (GUI) through a terminal. Ensuring accurate data is being measured by our sensors, our next step is to transfer that data collected by the microcontroller to the microprocessor via serial communication (wired), in which the vital sign data will be recorded and presented in a graph, displaying the trends in your blood pressure, heart rate, oxygen levels (SPO2), and temperature.

VII. RISK ASSESSMENT

Critical paths within our risk assessment include a division in both hardware and software. Software is divided in its own section as so are sensors, communication modules and our integration. Other sections included are unknown risks that may occur.

RISK ASSESSMENT: Medical Cuff

RISK RATING KEY	LOW	MEDIUM	HIGH	EXTREM
	0 ACCEPTABLE	1 ALARP (as low as reasonably practicable)	2 GENERALLY UNACCEPTABLE	3 INTOLERA
	OK TO PROCEED	TAKE MITIGATION EFFORTS	SEEK SUPPORT	PLACE EV ON HO

	SEVERITY			
	ACCEPTABLE LITTLE TO NO EFFECT ON EVENT	TOLERABLE EFFECTS ARE FELT, BUT NOT CRITICAL TO OUTCOME	UNDESIRABLE SERIOUS IMPACT TO THE COURSE OF ACTION AND OUTCOME	INTOLER COULD RES DISAST
LIKELIHOOD				
IMPROBABLE RISK IS UNLIKELY TO OCCUR	LOW (Weather and natural disasters – 1 –	MEDIUM (Sensor breaking) – 4 –	MEDIUM (Function calling from code to GUI) – 6 –	HIG (Da transm from se – 10
POSSIBLE RISK WILL LIKELY OCCUR	LOW (Student error and routines) – 2 –	MEDIUM (Enclosing hardware) – 5 –	HIGH (GUI usability, bluetooth module communication, bluetooth and GUI) – 8 –	EXTRE (Data tr through wirel commun and c gathe – 11
PROBABLE RISK WILL OCCUR	MEDIUM – 3 –	HIGH – 7 –	HIGH (Communicatio n between C program and python, serial communication) – 9 –	EXTRE – 12 –

Risk Assessment for software components:

There are three main software components in this project that have their own individual risks associated with them and could also hinder the whole project.

1. The first component is data processing and trending. This runs on a python script with several specifications for input values to correctly process and trend the data. In the case that the data is not inputted properly, or there isn't enough storage to put the data, there will be problems with the user not being able to get their values back. In addition, this serves as the backbone of the entire project, so the code and all the values inputted need to be robust to encourage optimal data processing.

2. The second main component is the GUI that will be running on Raspberry pi assisted by a 7-inch LCD screen. Both hardware components need to be working in conjunction with the data processing program. Not only does the GUI needs to be functional, it needs to be aesthetically pleasing and robust to continually run whenever booted up.

3. The third main component is the microcontroller that will transmit the received data from the sensors to the Raspberry pi. This microcontroller must have enough SRAM and flash memory to be able to run the programs necessary without any errors. The programs in the microcontroller must be able to get return values from loop functions in order to transmit the data to the GUI. Also, it is necessary that the microcontroller can wirelessly communicate with the raspberry pi to be able to transmit the data while the microcontroller is connected to the cuff with the necessary sensors.

Risk Assessment for Sp02/HR and temperature sensors:

For these sensors there is a significant amount of errors that could occur due to hardware and software issues.

1. The first portion is the hardware design of the circuit break board and the connection to the microcontroller. Depending on the way the break boards are built we need to assure that there is a maximum of 4.7kohms as a pull up resistor connected to both the SDA and SCL I2C interfacing connections. Also, since we're working with straight wired connection from a printed circuit board(pcb) to microcontroller, we must maintain the circuit boards dry without spilling water on them and causing a short circuit. Lastly, the circuit boards must be able to read and transmit accurate data to the microcontroller without inconsistent data.

2. The second portion for these circuit boards is the software side of the connection. Since each of these boards have their own libraries, we must maintain each board working accurately within the same program without losing accurate measurements from the circuit.

Risk assessment for Bluetooth module:

1. An issue for the Bluetooth module is being able to collect the correct data from the blood pressure monitor. The data will first be collected to the monitor itself and needs to relay that information to the Raspberry Pi. Interfacing to the hardware to transmit that data wirelessly will pose issues.

2. Since the Bluetooth module is doing the collection in python, the code needs to be able to communicate to the other microcontroller running in C code. Much of that will be done with serial communication but will also need to be collected alongside the Bluetooth interfacing possibly causing crosstalk issues.

3. The portion with the GUI may cause interfacing issues with function calling both the data collected in Bluetooth and serial communication.

Risk assessment for Integration:

Much of the project is dependent on every part working together both in software and hardware.

1. Testing each sensor implemented displays its own faults when it comes to interfacing with software and code. Also, within gathering external data from the subject. Each sensor must loop through iterations to show consistent data. When all sensors must collect at the same time, there are possibilities for overlapping issues within the code and loop functions. Collection from one sensor may hinder or skew values for another making for an avalanche effect of unreadable data.

2. Since every sensor is being tested individually, translating each piece of C code into one master file can propose communication issues. Whether each sensor will have its own loop or separate functions requires a call to main as the data will need to auto populate our data fields. The risk here is the code not having a consistent structure and readability for every call.

3. The GUI will have to display every collection in a readable manner. Interaction with our interface needs to be easy to use. Problems foreseen are plotting the data accurately for trending. The trending is based on daily averages of many values as the wrong value can be sent to the interface that doesn't give the full representation of the data. Interaction with the GUI needs to trigger functions in our code. If the right pointers are not set to the correct function or that function has non-desirable format issues the graphic may crash or not respond.

4. One of the final pieces is an enclosure that can fit all our components

together. Our blood pressure cuff has hardware that is vital for taking the blood pressure readings. Relocating this in its own enclosure on the cuff or another location can cause physical restraints. Every piece of hardware needs to fit in a design that can enclose every part in protection. Relocating the hardware can cause issues as well due to damaging parts such as an irreplaceable ribbon cable tied to the blood pressure monitor's display.

Risk assessment for the weather and natural disasters:

Harsh weather changes can become a high-risk factor when completing a project design. Weather changes can come upon naturally from too much rain or not enough rain causing natural disasters to occur like fires or floods. For an example, if a drastic fire occurs nearby campus the smoke set out from the fire can contain carbon monoxide, carbon dioxide and particulate matter that can be too hazardous for humans to breath. Thus, the school campus will be closed until the air clears up which causes a time delay to retrieve the project and continue working on it. Another example can be if the American river overfloods from an abundance of rainwater which then can affect the engineering building (Riverside), and again delay the continuation of the project.

Risk assessment for the students and daily routines:

Being a Sacramento state student and working in a group project can be a difficult task due to different schedules and communication issues. Certain tragedies like a broken-down car or even a car accident can hinder a group member from being able to meet up with the rest of the group and successfully complete their portion of the project. Also, a broken cell phone can cause communication issues with the rest of the group. Lastly a damaged laptop or pc can cause the group to lose a portion of their necessary programs for the project. Inevitably causing the group to work double time to recreate the programs and complete the project within the required timespan.

Mitigation strategies for our software components can include more assistance from everyone in the group. It is very easy for one person to get stuck within coding issues if there is no one else to recognize where an error may be occurring. Multiple minds looking at the same code may find ways to make it more efficient in more ways than what was not thought of before. Much of mitigation strategies within all our categories will include constant communication with group members. Portions of the project can be overwhelming and as one group member steps forward and discusses the issue we can decide to allow more people to work together on the portion or ultimately decide it won't be worth the effort based on current circumstances. This will be the case for the unknown risks as constant communication will allow other group members to act accordingly.

VIII. DESIGN PHILOSOPHY

The Societal Problem that we wanted to address was the increasing number of people avoiding medical care due to low perceived need to seek medical care, traditional barriers to medical care, unfavorable evaluations of seeking medical care and personality traits. Our design philosophy for our project was that we wanted to tackle certain aspects that people could benefit from seeking medical care. The normal routine in getting checked up at the doctors is getting your vitals screened. This is one of the major factors that we wanted to help contribute to society in giving them an easier alternative to screening their vitals without physically going to the hospital. So, our team decided to make an at home medical device that can gather your vitals. In addition, our system will not only measure and collect your vitals but will be able to track and trend your vitals over a period of time. This will be beneficial to the user because they can see the history of their vital screening giving them a good indication of their state of health. The information you get from your vitals provide critical information about your state of health. Vitals can identify the existence of an acute medical problem, are a means of rapidly quantifying the magnitude of an illness and how well the body is coping with the resultant physiologic stress and are a marker of chronic disease states. This is why we wanted to implement a notification system within our device that will be able to notify you when your vitals are beginning to trend in the "unhealthy" direction.

Our at home medical device will build on the foundation of a blood pressure monitor and a microcontroller to control various sensors to gather real-time analysis of vital signs such as blood pressure, oxygen levels, heart rate, and temperature. The data collected will be transmitted wirelessly to our microprocessor to be stored into our system, we will be able to detect trends over time to determine a patient's health condition whether it is healthy or unhealthy by the status of their vital signs. Essentially, we wanted to integrate a blood pressure monitor, heart rate/SpO2 sensor and temperature sensor into one compact and portable design. The user interface will be a LCD monitor in which the user can observe their vital sign measurements and a trending graph of their vitals as well.

IX. DEPLOYABLE PROTOTYPE STATUS

Our project design was achieved as measured by the full implementation of our feature set. To reiterate, our design was to create a medical device that will collect vitals through various sensors: blood pressure, SpO2 (Oxygen level), heart rate and temperature. Our medical device will have an internal storage/memory to store the measurements of the vitals. Our system will compile this data and produce a baseline of your vitals to create a history of the measurements. Based on your vitals at any given period of time, if there are any abnormal measurements of your blood pressure, oxygen levels, heart rate, and body temperature, our medical device will alert you and in extreme measures will notify you to seek medical attention. We strive to create a system that can track these trends over time. We split our system into two major features: hardware and software which both contained sub features that would be integrated and become our medical device. The hardware features consisted of a blood pressure monitor, heart rate/SpO2 sensor and a temperature sensor. As a team we were able to implement these components to retrieve the vital signs measurements. The blood pressure monitor is integrated into our system using the help of Google Fit API. Whereas the heart rate/SpO2 and temperature sensor is integrated into our system using a microcontroller. From here, the data will be transmitted wirelessly using a Bluetooth module to our microprocessor. The data will now be processed with our parent program and you'll be able to observe your vital sign measurements and trending graph on our user interface which will be an LCD monitor. Overall, our project design has been achieved as measured by the full implementation of our two major feature sets of both hardware and software to complete our deployable prototype medical device.

Our measurable metrics are the following:

Blood Pressure Monitor: Cuff should have an adjustable circumference between 9-17 inches. The cuff will weigh a maximum of 1.4 lbs. The pressure should be able to withhold between 0- 200mmhg or more, with an accuracy of a 5mmhg deviation. The pulse should be able to read between 60-120 beats per minute (or more) with a standard deviation of 7%.

Pulse Oximeter Sensor (SpO2): this sensor should be able to operate in a temperature range of -20 to 70 degrees Celsius. The peripheral capillary oxygen saturation (Sp02) sensor will have an accuracy deviation of 5 for 70%-90% readings.

Heart Rate Sensor: this sensor will be able to read around 40-180 beats per minute with an accuracy deviation of 3BPM.

Temperature Sensor: The temperature sensor will be able to read between 10 to 45-degree Celsius and have an overall accuracy standard deviation of 0.7.

There were many factors to consider that could have altered our results. To ensure the best possible results we considered to take measurements accordingly. Generally, we wanted to make sure to take each measurement roughly at the same time every day. In addition, we wanted to make sure to take each measurement under the presumption that no exercising was involved prior to taking a measurement or basically activity levels were normal before taking a measurement. Also, we wanted to make sure that any foods or drinks that could alter measurements of blood pressure or heart rate weren't consumed before taking a measurement. This would include the consumption of caffeine which could increase your blood pressure and heart rate resulting in inaccurate measurements. There are other technical factors in our system that you must be aware of such as the proper procedure to operate each of the hardware elements. For example, when using the blood pressure monitor there several procedures like correct posture and positioning in order to get accurate measurements. Technical aspects of operating specific hardware in our system will be discussed in our user manual of our medical device.

Below are the results of the measurements in blood pressure, heart rate, SpO2 and body temperature in a 20-day period.

Table 2. Blood Pressure

Day	Systolic/Diastolic [mmHg]
	Omron
1	119/76
2	114/70
3	110/74
4	117/74
5	114/72
6	112/79
7	112/77
8	117/74
9	111/77
10	114/75
11	117/74

12	117/71
13	112/79
14	119/73
15	114/73
16	11274
17	113/76
18	118/77
19	113/72
20	119/77

Table 3. Heart Rate

ay	Beats Per Minute [bpm]			
	O mron	Clinica l Guard CMS 50 DL	M AX 30100	anual reading
	70	68	68	8
	64	66	63	4
	61	64	68	4
	75	77	74	2
	68	72	70	8
	70	72	71	8
	66	64	68	4
	70	70	72	8
	68	65	68	8
0	73	76	75	2
1	67	69	70	8
2	72	69	70	2
3	65	64	66	8
4	73	76	69	2
5	74	72	74	2

6	69	68	65	8
7	69	68	65	4
8	68	66	64	8
9	60	61	63	0
0	63	65	66	8

Table 4. SpO2

ay	Oxygen Saturation [%]	
	Clinical Guard CMS 50 DL	MAX30 100
	96	97
	95	97
	96	96
	96	93
	98	95
	95	92
	96	98
	95	95
	98	97

0	98	96
1	97	95
2	96	95
3	98	98
4	95	94
5	98	97
6	96	97
7	98	97
8	96	96
9	92	94
0	97	97

Table 5. Temperature

	Body Temperature [Celsius]

ay	Parame d	MLX90614
	36.9	36.7
	35.7	35.7
	37	36.7
	37	37
	36.9	36.2
	35.5	35.8
	36.4	36.1
	36.1	36.6
	36.5	36.7
0	36.5	36.1
1	36.5	37.1
2	36.3	36.7
3	36.7	36.6
4	36.7	36.8
5	36.7	36.1
6	36.4	36.6
7	37.1	37.3
8	35.4	35.2
9	37.2	36.9
0	36	36.1

After testing out all of our sensors within a 20-day period, we were able to compare our sensor readings with other readings. Although we were unable to use calibrated devices for the SpO2 and heart rate sensor, we were able to compare with other equipment to test for accuracy. Also, for the Heart rate we were also able to test manually by counting the beats per minute within 15 seconds and then multiply by four to get the test subject beats per minute. Furthermore, we were unable to get another blood pressure monitor to compare readings. Therefore, we decided to test the readings of the Omron cuff at the same time right after waking up to note the accuracy of the blood pressure monitor. Lastly, as for the temperature sensor, we compared the results from our MLX90614 with the calibrated paramedic temp sensors to compare for accurate data readings.

In summary, after filtering out the unreadable readings from our MAX 30100 and MLX90614 readings with coding, and comparing with other methods of getting results, we were able to note that our devices were functioning properly. Our sensors were within our measurable metrics and were fairly consistent with the other methods of getting measurements. As for the blood pressure monitor, it was tested to be within all its measurable metrics aside from the

5mmhg deviation since we did not have a way to test the pressure's accuracy.

X. MARKETABILITY FORECAST

The global market for vital signs monitoring systems is a competitive and financially dominant market. This global market is currently valued at 4.7 billion US dollars and expected to grow at a compound annual growth rate of 8.7%. Due to the constant growth of innovating products and increasing demand of home healthcare systems, and other factors, the market has been able to flourish and increase year by year. Within this market, there is a variety of end users who contribute to the share of the demand. From the largest end users; Hospitals, Physician Offices, and home Healthcare, to the lower users; Ambulatory centers, Emergency Care Centers and other Healthcare settings. From all those categories, the main targeted audience for our medical device is Home Healthcare. This is due to our focus being daily vital readings of users and trend the readings to notify the users of any alterations in their vitals. Within this document we will further explain the global market of medical devices, the targeted audience for our specific medical device and the competitors within the market.

The market for medical devices and even consumer level solutions for in-home use is a competitive and financially dominant market. Medical industries invest large amounts for internal or external entities to produce a reliable device that can output information about a patient's or user's vital information. Companies have a multitude of medical products ranging from industry level monitors for hospitals all the way to smaller vital devices for personal use. Much of the medical industries' physical infrastructure is held upon these devices working properly in order to have quick responses and retrieve vital info to make informed decisions. Medical monitoring devices are responsible for making sure patient's and user's stay continuously informed with their vitals and be able to notice any alteration in a timely manner. With this in mind, it is apparent why the medical device industry is vastly growing market as health becomes a greater issue. For some countries it is a faster growing issue that sees an effect on both their domestic and international markets. Some of the biggest competitors see a positive increase in their production due to increasing demand for the products as well as support from other countries allowing for a growth in the global market for this industry. Focusing not just internationally, but domestically there is great masses of competition between companies as the United States is the leader in the global market for medical devices. This allows for a great amount of comparison between our prototype and those currently on the US market. Even though the built prototype is not intended to be marketed as it is further than the extent of the project, there are plenty of comparable feature sets of the marketed products when viewed from the prototypes window. Much of the marketed products do have many advantages over the prototype as there are also differentiating strengths, weaknesses, opportunities and threats.

For our medical device, we plan on reaching the global vital signs monitoring devices market. This market is crucial for our senior design project due to our device falling directly under the market category. This market can be considered as a wide-open market due to large spread in offer prices in investment products. For example, There has been a widen market boundary to home healthcare's for blood pressure monitors due to user-friendly mercury free BP monitors available at low cost. Also, since most medical devices have been evolving in a short duration from individual devices to multiple sensors in one device, there has been an increase in home healthcare services. Furthermore, increase in awareness contributes to an increase in demand for personalized and accurate vital sign monitoring devices. Thus, continuing in having an increase of volume for products in the marketplace. According to [1], The current size of the global market for vital signs monitoring devices was at USD 4.7 billion and is expected to grow at a compound annual growth rate (CAGR) of 8.7% over a forecast period. Figure 1 introduces an example of the Japan vital signs monitoring devices market size by product from 2015 to an expected 2026 with the CAGR. From the figure chart you are able to notice the increase of market size for 3 of the major sensors we are currently using in our senior design project, the Blood pressure monitor, Temperature and Pulse Oximeter.

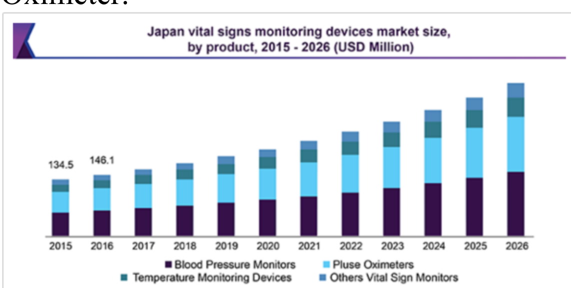

Fig 6. Japan's market growth in medical devices [5]

The vital sign monitoring market is highly competitive and consists of several major players. Companies like A&D Medical, Hill-Rom holding Inc., Nihon Kohen Corporation, Coinlike Philips NV, and Medtronic PLC, hold a substantial market share in the market [3].

China is another large competitor in the medical industry market. This is due to a large percentage of their production being imported from the United States. America's expansion into the Chinese market is not the sole reason for an increase in production. From Boyer et al. referencing the World Health Organization [2], "more than 80% of deaths in China are attributable to chronic disease, with an annual estimated 400,000 premature deaths linked to air pollution". Much of the normal quality of life situations lead to health risks for many of the Chinese people. This is one big reason for the connection between the Chinese domestic market of medical devices. China is also seeing their elderly population getting larger. The statistics was that the age group of Chinese people 65 years or older would grow from 8.9% in 2010 to 17% in 2020 [2]. China's healthcare expenses are also seeing a steady growth from what was $256 billion in 2009 to $600 billion in 2015 [2]. This in turn brings up the higher demand for medical devices since there is also a constant demand for rapid healthcare reform. China's medical device market is now expected to rise 15% annually. A big portion of their market does come from imports. Since tariffs have seen such a drop in recent years, taxes from continuous exchanges between countries are depreciated so more trade across seas may occur between competing markets. The U.S. International Trade Commission conducted an analysis of medical device opportunities and blocks in China and found a steady increase in imports from the U.S. to China from 2008 to 2013 [3, Fig. 2]. The imported devices have ranged from everything such as monitoring devices such as diagnostic and imaging devices all the way to cardiovascular and orthopedics. The graph is a positive display of a healthy market between China and the U.S. as the trade market only continues to rise. This grows annually by about 15% [2]. As the Chinese market sees a constant growth Japan is also importing about 35% of their medical devices [4].

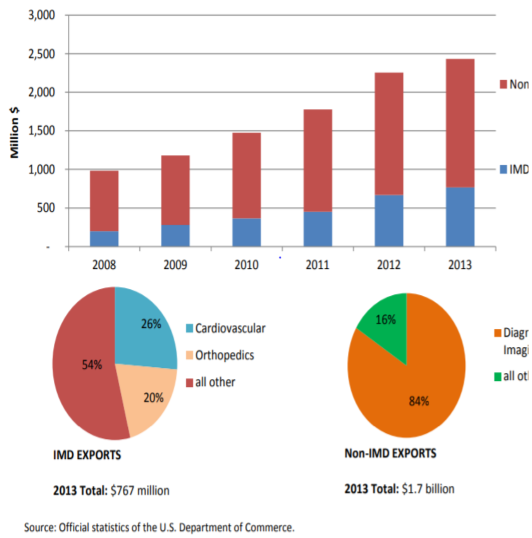

Fig 7: Some marketing statistics and trends related to our applicable market. [6]

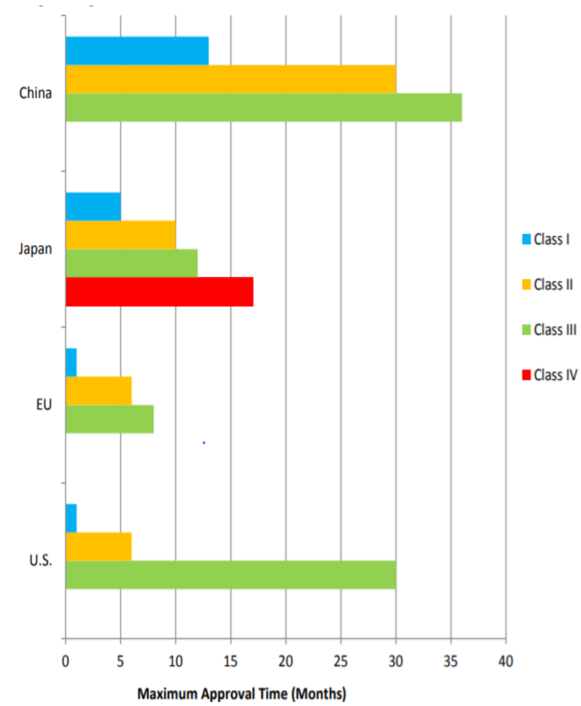

Fig 8. Monthly process for Medical Device Approval [7]

From all the countries discussed, the leading nations in the global medical industry would be the United States, Japan and China respectively. A common process for all these nations is the need to have to propose, obtain approval and reimbursement from their government or regulated entity. For the United States, the common organization would be the Food & Drug Association (FDA). Sealey and colleagues state that the process for the Japanese market takes “approximately 2.2 years… the requirements are much more stringent compared to the US or EU” [4]. This is a rough estimate as the process is also seen to take much more time. The extra time is mainly due to the reimbursement process to make the money back for the device given to the government for medical use. From [3, Fig. 3] below it is seen how long the process can typically take while each descending class represents proposal, approval and reimbursement respectively. Note that from figure 2, China is seeing the longest time to get reimbursed with a monthly period of about 35 months from approval.

Some of the key players in the vital signs monitoring devices industry include Medtronic, Omron Healthcare, and Phillips Medical. When researching the market for vital sign monitoring, we began to realize how big of a market there is. There are a lot of companies investing in monitoring people’s health. This means that this specific market is very highly competitive. One of the ways for our team to compete with these big players of the industry is to produce a product that has enough performance and accuracy compared to our competition but be more affordable. There devices that range from the low $200 to almost $3,000. The more expensive models are priced so high because of the delivery of the product’s performance. We estimated our product to be around the lower end of the spectrum, which is around $200, but we imagine if we really put our product to the test of the market that we can definitely outsource cheaper components if we were to buy it in bulk. To reiterate, the only way we would survive in a market like this is to create a product just as good at a lower cost. There are several ways that our competitors reach the market. After researching, we categorize the key elements in making a medical device to be the very best and efficient. The first element is portability. Portability is important because if this is going to be a household product that it must be compact enough to store and be able to use whenever is needed. The next element is the products' "user friendly" experience. Trying to create a product that any person can use is another difficult task. The user should be able to go through the interface of your device without any problems. The third element is performance. Performance is key because the main objective of our device is to measure vital signs. These particular measurements are very sensitive, and you must take precautions on how to go about using taking measurements such as blood pressure, blood oxygen, heart rate and body temperature. The product should ensure that it has enough performance to its designated duty. Lastly, since technology is advancing it should contain wireless communication. The power to transmit the vital sign data is really helpful and can be interfaced to an app onto any device. This gives the user the ability to access their information virtually from anywhere they can get their hands on a phone, tablet, computer, etc. The core competencies a product must have to compete is speed, reliability, performance, and validation. This core competencies will allow a product to succeed in any market. Developing such a product to satisfy all the requirements will be the test of our ability as engineers.

Medical advice, examinations and treatment are a vital part of maintaining a positive well-being in the current era. Most of the treatment now happens in medical facilities that are controlled environments for people to go to. Common check-ups are a way for a medical professional to give updates on their patient's current state of health based on their previous medical history. Where a patient is projected to be in the future will be based on trends found in the patient's medical records so the professional judgement may be accurate and precise. This information is vital for patient's and those who need more information on their health. Trends in health will let an individual know if they are following a positive trend into better wellbeing or into deteriorating health. Much of the current medical system has consistency with those routine check-ups tailored to an individual's personal health and conditions they may have.

Many do not take advantage of the current medical system due to many reasons. One could be due to the cost of going in for check-ups if insurance is not involved as the opportunity provides for a financial burden. For the others focused on here, it is the medical procrastination to seek help for even a large recurring problem. This form of procrastination is related to stressors from a person's life. Stress provides a narrow view for someone to get greatly invested in. Such a perception may cause one to not even consider their own mental or physiological health as an issue or consider the idea in the first place. A medical condition can prove itself to be neglectable by an individual. Thinking that it may be an issue that will pass over time. To make matters worse, there is a belief that the issue is something that can be lived with. Emotional and physical perception by an individual or others may also play a factor. A condition can put more stress on someone by anticipating bad news from a medical professional. Physically, a condition can present to be unappealing to view and thus brings up insecurities for many. To assist in better treatment for such individuals, home monitoring for personal is a minor assist.

People have been monitoring their own blood pressure, checking their oxygen levels as well as their heart rate all from their own home without any external assistance. The solution to be presented will be just as such. One will be able to monitor all 3 of the previously mentioned vitals as well as body temperature and monitor their history in terms of their trends within their health. Trending of their data over time with a standardized plot will display negative and positive trends. Notifications will be utilized to update the user if they are beyond or below certain thresholds within their vitals. Depending on the threshold, some notifications will be a light reminder as others will be more urgent to advise the user that medical attention may be necessary. Home monitoring will be useful for the user to track their own health on their own schedule with consistency, so their own procrastination becomes a lesser issue.

XI. CONCLUSION

Medical advisement, examinations and treatment are a vital part of maintaining a positive well-being in the current era. Most of the treatment now happens in medical facilities that are controlled environments for people to go to. Common check-ups are a way for a medical professional to give updates on their patient's current state of health based on their previous medical history. Where a patient is projected to be in the future will be based on trends found in the patient's medical records so the professional judgement may be accurate and precise. This information is vital for patient's and those who need more information on their health. Trends in health will let an individual know if they are following a positive trend into better wellbeing or into deteriorating health. Much of the current medical system has consistency with those routine check-ups tailored to an individual's personal health and conditions they may have.

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[8] Team 7, Senior Design 2019-2020

GLOSSARY

[1] Auto-populate: automatically populating (filling in) in a field.
[2] Automation: Performing a process or procedure with minimum human assistance.
[3] Competition: rivalry between companies selling similar products and services.
[4] Conscientiousness: One of the big five high-order personality traits. People with high conscientiousness have the quality of wishing to do their work well and thoroughly.
[5] Database: An electronic system that allows data to be accessed and updated.
[6] Diagnosis: the identification of an illness or other problem by examination of the symptoms.
[7] Diagnosis: The identification of an illness by examination of symptoms.
[8] Domestic: production of goods within a country's residence.
[9] EMR: Electronic Medical Record
[10] Global Industries: industries that effectively operate in all, or most of the markets across the world.
[11] Health awareness: Developing an understanding of one's mental health needs.
[12] Healthcare barriers: An obstacle that prevents access to healthcare such as high cost, insurance, mobility etc.
[13] Help-seeking: When having a problem that needs medical attention or advising.
[14] I/O: Input and Output

[15] Low perceived need: indicated the belief that seeking medical care was unnecessary.
[16] Market: structure that allows buyers and sellers to exchange any type of goods.
[17] MD: Medical Doctor
[18] Medical care avoidance: Keeping away from medical care that is thought to cause mental or physical distress.
[19] Medical Devices: device intended for medical monitoring or action.
[20] Medical procrastination: The action of delaying or postponing medical health care.
[21] Navigate: A planned and direct course.
[22] Neuroticism: One of the big five high-order personality traits. People with high neuroticism are more likely to experience feelings such as anxiety, worry, frustration, and depression.
[23] Patient delay: The delay between the first symptoms of an illness or problem to the first consultation of a doctor.
[24] Personality traits: reasons for avoiding medical care concerned personality traits, e.g., procrastination, laziness.
[25] Practitioners: A person who is actively engaged in medicine.
[26] Procrastination: Action of delaying or postponing something.
[27] RAM: random-access memory
[28] ROM: read-only memory
[29] SpO2: peripheral capillary oxygen saturation
[30] Stress: Feeling of emotional or physical tension.
[31] Trade: the action of buying and selling goods and services.
[32] Traditional barriers: responses indicating circumstances or obstacles limiting access to medical care.
[33] Unfavorable evaluations: responses that demonstrated unfavorable evaluations of the process or outcomes of seeking medical care.
[34] User interface (UI): human and computer interactions

APPENDIX A. USER MANUAL

This section of the report will outline how to operate AMDTC as per the deployable prototype standards. Note that this report will specifically outline how the prototype works in fully integrable conditions. Given the situation of COVID-19, it was nearly impossible to fully integrate the hardware components. When booted up on the Raspberry Pi-0, the User will be taken to a welcome screen where they will have the following options: View personal health profile (“Your Profile”), view personal health readings (“Your Readings), and take a new measurement (“Take Measurements”). These components are outlined in Figure A-1. In the upper right-hand corner, there will be a “Help” function that takes the user to a screen where they will have detailed directions for use (Figure A-2).

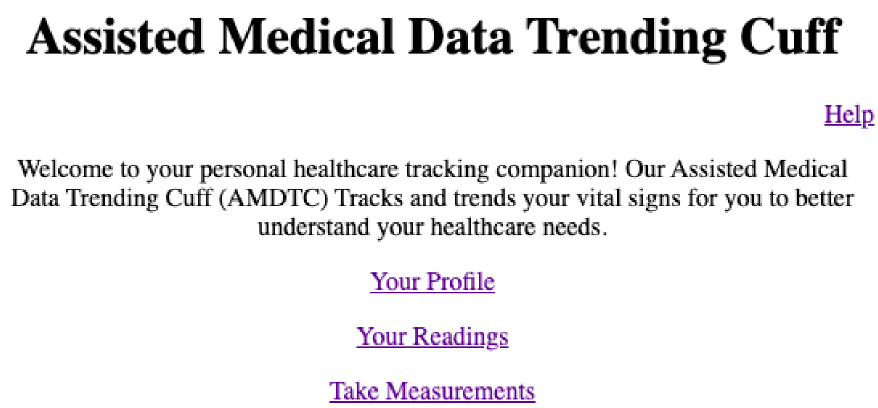

Figure A-1: Welcome screen for AMDTC [8]

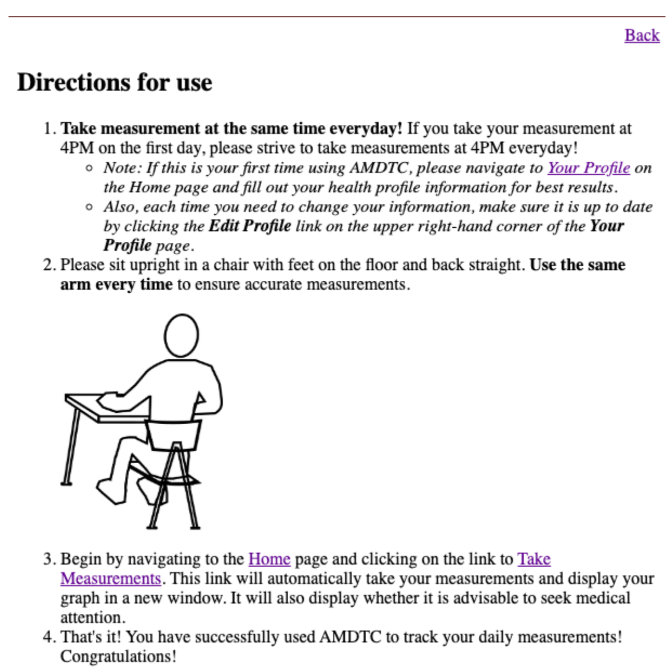

Figure A-2: Help Section [8]

The “Help” Section explains the basic use operations. It advises the user to take measurements at the same time every day for consistency. The team had taken into account that blood pressure, heartrate, and temperature screenings will vary with different conditions, and therefore made this suggestion for the user in order to maintain as much consistency as possible. Furthermore, there are instructions for the user in case it is their first time utilizing the screen, or if there are any changes in height or weight. This takes them to their profile in addition, where they can view their information easily. This interface is outlined in Figure A-3.

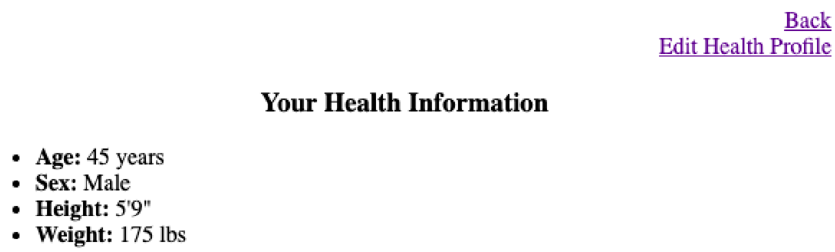

Figure A-3: Health information profile interface. [8]

In addition, there is a function for the users to update their health profile. This is included in Figure A-4. Within certain thresholds, there are different requirements for our sensor data. This is outlined in the backend of the code; therefore the user never interacts with it, but the coded portion updates the requisites as the user changes health data.

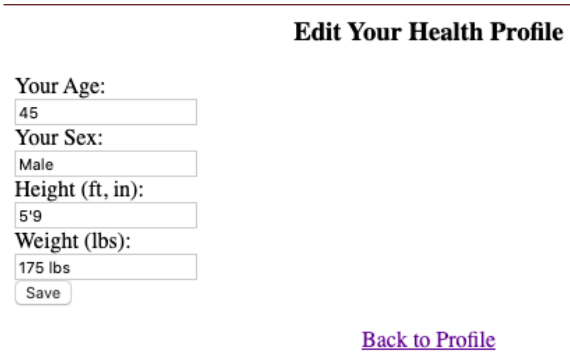

Figure A-4: Edit health profile interface. [8]

Next, to take measurements, we have an interface with invokes the Python script through a JavaScript handler and enables the sensors to work to take measurements. The measurements, which are quantified through our external programs, are then appended to a .CSV file, which automatically tallies and outputs trending graphs. This is shown in Figure A-5.

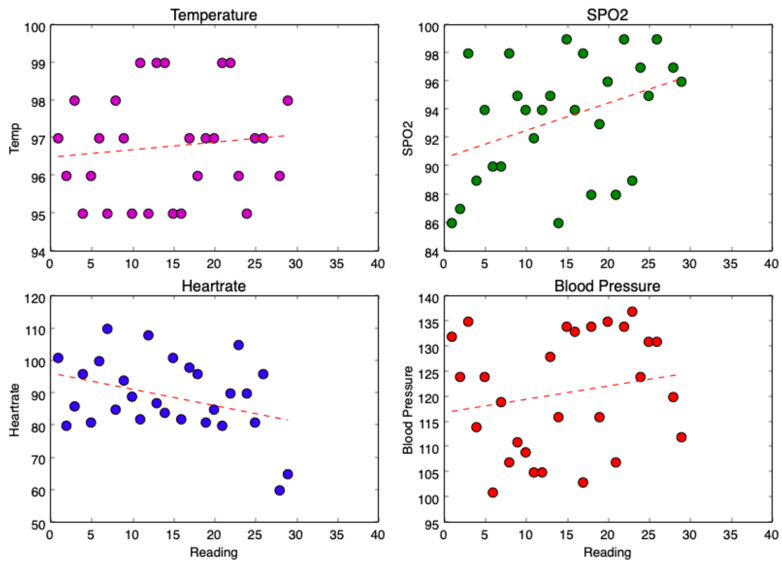

Figure A-5: output of the graphs as appended by CSV. [8]

After this, the program autosaves the information and the user can safely exit the interface. The readings result displays a message as according to the system handler based on these thresholds as can be observed in Figure A-6.

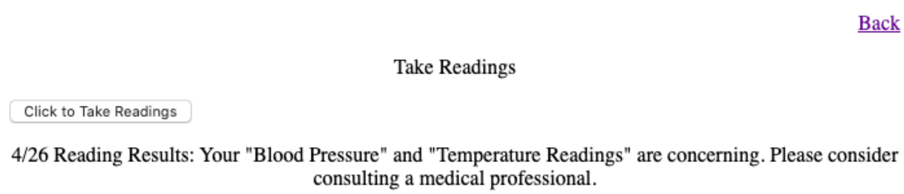

Figure A-6: Reading results display message. [8]

The temperature sensor (MLX90614) is an infrared thermometer for non contact temperature measurements. The normal temperature range on the forehead is approximately between 35.4°C and 37.4°C. This thermometer reads the heat waves coming off the temporal artery. This blood vessel runs across the forehead just below the skin. Place the sensor head at the center of the forehead. Slowly slide the termometer across the forehead toward the top of the ear while keeping the sensor head in contact with the skin. Stop when you reach the hairline. The temperature reading takes approximately one minute. You can read your temperature on the display screen.

The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor solution. This sensor can measure both heart rate and SpO2. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart rate signals. Place the index finger onto the sensor and use the available strap to help provide an even amount of pressure throughout the reading process. Repeat the procedure to measure both heart rate and SpO2. Both the heart rate and SpO2 readings take approximately one minute in total. You can read your heart rate and SpO2 on the display screen.

The Omron 10 Series utilizes a pulse meter and the oscillometric method to determine heart rate from the main artery in the user's arm. To use the blood pressure system as it is integrated with the project has some prerequisites. One prerequisite is having a Google account and the Google FIT app as it is needed to update the blood pressure values to the integrated code. Once that is done, the user may place the blood pressure cuff about an inch above their elbow with the inflation tube towards the inside of their arm. They may press 'start' on the monitor and wait about 1 minute for the cuff to inflate and deflate to gather their blood pressure. Once done the user will run through the GUI made and select blood pressure. Once there a link is provided to access their google account and run through two permission prompts to access their blood pressure reading. This will allow for a link to copy back into the GUI and receive their blood pressure reading alongside their other vital data.

Team 7 would additionally like to cite a disclaimer that although we strived to achieve accuracy and consistency in our values and have worked hard to discourage misinformation, we are engineers, not medical professionals. Although our measurements come from reputable sources, we do not claim to be qualified to be insisting on taking action based on our calculations or measurements. It is for this reason that we use the appropriate verbiage in our interface, including, but not limited to "consider", "suggestion", and "informal". These practices are meant simply to be suggestions for user, as preventative care for larger problems, and not diagnoses or prescriptions. At-home care can never replace professional medical advice, as it is meant to be a bridge to the means, not the solution. Therefore, we advise users to please consult with medical professionals on any discrepancies before taking drastic actions.

APPENDIX B. HARDWARE

Hardware Block Diagram

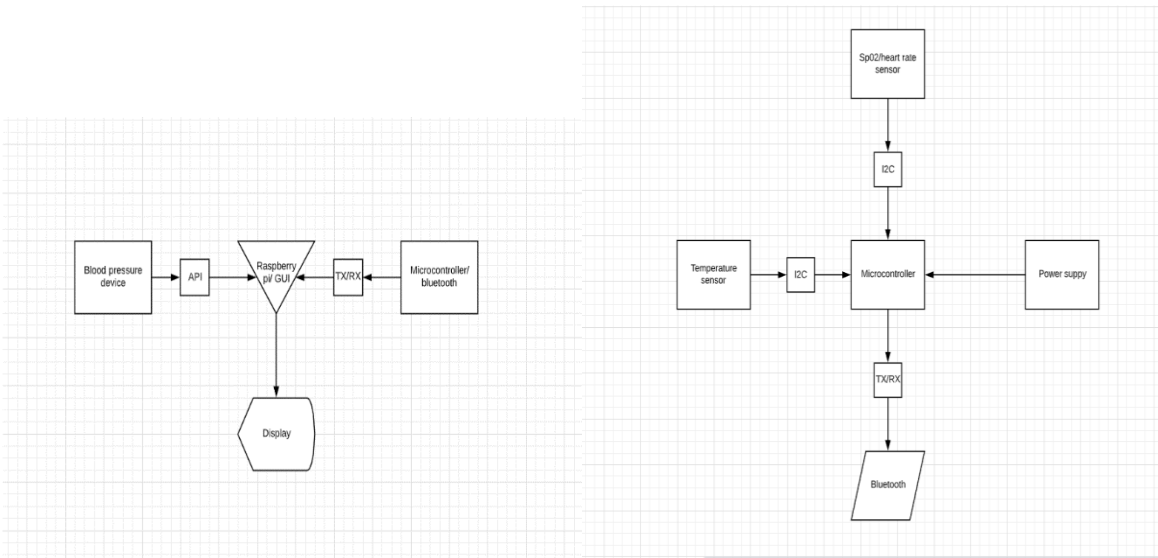

Figure B-1 Hardware block diagram [8]

Schematic at Component Level

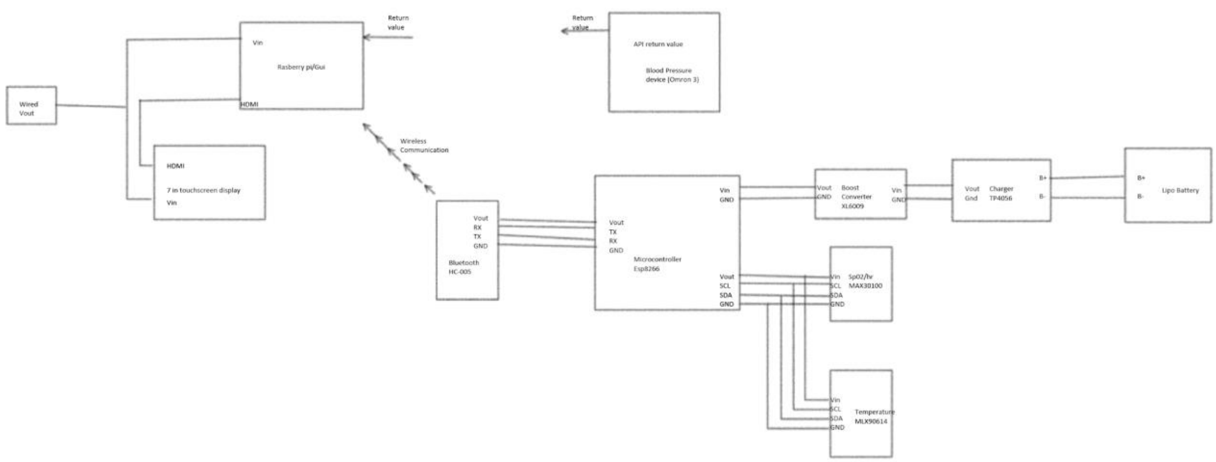

Figure B-2 Schematic at component level [8]

Test Plan

Device	Method
Blood Pressure	Using the blood pressure (OMRON BP761) provided, we plan to take consistent measurements from a particular time in the day considering various variables that could affect our accuracy. These variables must be controlled or consistent (i.e., consumption of caffeine, exercise/activity, posture when taking blood pressure, etc.). Using these precautions will provide more accurate results.
Heart Rate	Similarly, using the same method as the blood pressure, we plan to take consistent measurements from a particular time in the day considering various variables that could affect our accuracy. These variables must be controlled or consistent (i.e., consumption of caffeine, exercise/activity, posture when taking heart rate, etc.) Taking these precautions, we will test the results comparing OMRON's reading to our heart rate sensor (MAX30100) for accuracy. Also, we will compare the results with manually tested values.
SpO2	Using a fingertip pulse oximeter blood oxygen saturation monitor (Zacurate 500BL) provided, we plan to take consistent measurements from a particular time in the day considering various variables that could affect our accuracy. These variables must be controlled or consistent (i.e., consumption of caffeine, exercise/activity, etc). Taking these precautions, we will test the results comparing Zacurate's reading to our spO2 sensor (MAX30100) for accuracy.
Temperature	Using a digital body thermometer (Paramed) provided, we plan to test the calibration of Paramed's digital body thermometer by measuring the melting point of water (32°F). After calibration, we will take the axillary measurement under the arm for both instruments: Paramed's digital body thermometer and our temperature sensor (MAX30205). We will compare the results from both instruments for accuracy.

Table B-1 Test Plan

Test Results

Day	Systolic/ Diastolic [mmHg]
	Omron
1	119/76
2	114/70
3	110/74
4	117/74
5	114/72
6	112/79
7	112/77
8	117/74
9	111/77
10	114/75
11	117/74
12	117/71
13	112/79
14	119/73
15	114/73
16	11274
17	113/76
18	118/77
19	113/72
20	119/77

Table B-2 Test results for blood pressure device

Day	Beats Per Minute [bpm]			
	Omron	Clinical Guard CMS 50 DL	MAX 30100	Manual reading
1	70	68	68	68
2	64	66	63	64
3	61	64	68	64
4	75	77	74	72
5	68	72	70	68
6	70	72	71	68
7	66	64	68	64
8	70	70	72	68
9	68	65	68	68
10	73	76	75	72
11	67	69	70	68
12	72	69	70	72
13	65	64	66	68
14	73	76	69	72
15	74	72	74	72
16	69	68	65	68
17	69	68	65	64
18	68	66	64	68
19	60	61	63	60
20	63	65	66	68

Table B-3 Test results for heart rate sensor

Day	Oxygen Saturation [%]	
	Clinical Guard CMS 50 DL	MAX30100
1	96	97
2	95	97
3	96	96
4	96	93
5	98	95
6	95	92
7	96	98
8	95	95
9	98	97
10	98	96
11	97	95
12	96	95
13	98	98
14	95	94
15	98	97
16	96	97
17	98	97
18	96	96
19	92	94
20	97	97

Table B-4 Test result for blood oxygen sensor

Day	Body Temperature [Celsius]	
	Paramed	MLX90614
1	36.9	36.7
2	35.7	35.7
3	37	36.7
4	37	37
5	36.9	36.2
6	35.5	35.8
7	36.4	36.1
8	36.1	36.6
9	36.5	36.7
10	36.5	36.1
11	36.5	37.1
12	36.3	36.7
13	36.7	36.6
14	36.7	36.8
15	36.7	36.1
16	36.4	36.6
17	37.1	37.3
18	35.4	35.2
19	37.2	36.9
20	36	36.1

Table B-5 Test result for temperature sensor

APPENDIX C. SOFTWARE

This section of the report will continue software documentation. Beginning with a high-level overview of the algorithm needed for the appropriate data storage and processing, block-level diagrams and annotated flowchart, and finally concluding with pseudocode to further elaborate processes. The essential user interface was implemented by using HTML. HTML was chosen in order to use the least amount of data possible and also create a robust and easily accessible user experience. The data processing and fetching algorithms were implemented using Python, as there was extensive documentation for the team's purposes in this particular language as opposed to others.

Next is a high-level overview, further illustrated in the block diagram in Figure C-1. There is a user interface, specifically in the software portion, which houses the Python program used for storing and processing the data. The Python program is responsible for a few different functions. First, main.py communicates with the hardware sensors, which read and aggregate the raw data, sending back one singular value either calculated by averaging hundreds of measurements, or choosing a "best fit" value of sorts. This is for the case of the SPO2, heart rate, and temperature sensors. (The API for Blood Pressure and data retrieval for related entities will be elaborate further in the coming section.) The sensors work in series, gathering measurements one by one. After calling these functions and receiving the values, the main program then appends each to a .CSV file, "sample.csv". Here, the aggregated values are appended in a row at the bottom. The program then takes these values and pushes them to the graph. In a secondary process, the program also runs through several conditional statements in order to print a message to the screen as to whether vital signs are high, low, or normal, and determines, using this algorithm, what the verdict will be. Additionally, the program does an updating "y = m(x) + b" calculation along with said conditional statements to generate a trendline of health data. This is also printed on the graphs. Another major component of the main program is said "defaults" of health data based on age. These are, again, dealt with using conditional logic, and the program utilizes variables in the subsequent conditional statements to implement these values, so that data is personalized. Finally, the user interface contains a few high-level features including

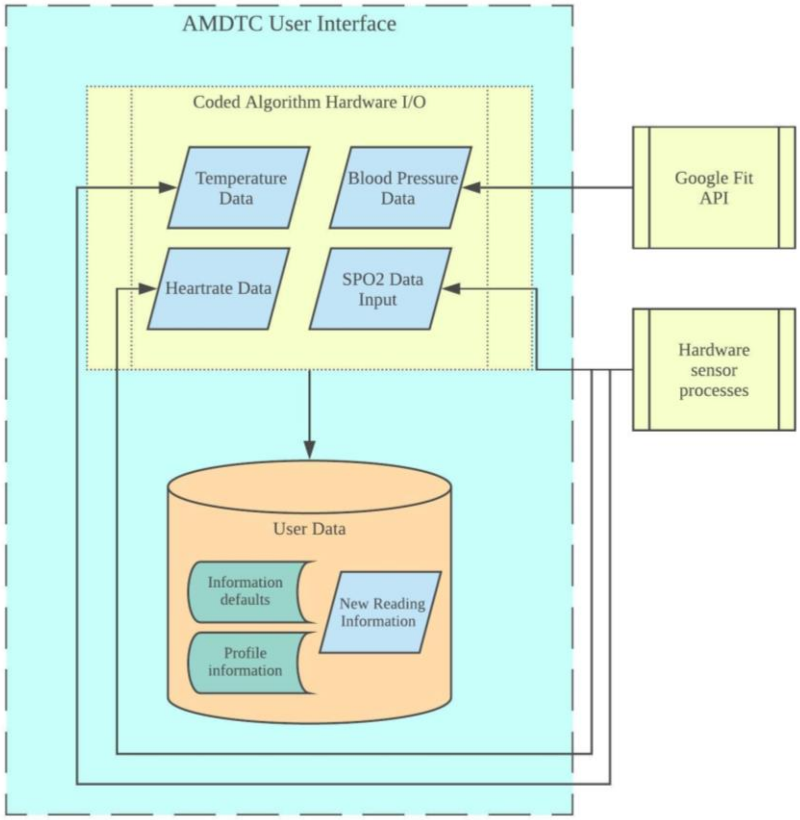

Figure C-1: High-level block diagram of software components. [8]

The data processing and user experience has been outlined in Figure C-2 below. Essentially, the data depends on user inputs and conditional logic. Simple pseudocode for these conditional logic operators is as follows:

Def user_profile(age, height, weight, gender):

Age = User input (some int)

Height = user input (some float)

…

If age >= 45:

Blood_pressure = some_int

#continue for other values

Def health_values(blood_pressure, heart_rate, oxygen, temperature):

Blood_pressure = GoogleFitAPI.get() #retrieves value from Omron cuff

Heart_rate = hardware_retrieval_program.get_heart_rate() #retrieves value from sensor retrieval program.

#continue for all values

#update standard deviation

From 'sample.csv' retrieve column = "blood pressure"
Std_dev_bp = Pandas.std(blood_pressure)

#next, we check using conditional statements
If blood_pressure >= std_dev_bp + bp_average:
  Print(Issue warning statement specific for blood pressure)
*If blood_pressure >= 2*std_dev_bp + bp_average:*
  Print(Issue statement to get checked specific for blood pressure)
#issue these checks for all sensor values in the program.

Since data averaging and standard deviations are essential to this form of processing, utilizing packages such as matplotlib, pyplot, NumPy, and Pandas was essential. There already exist libraries for generating trendlines and standard deviation calculations. Graphing was a relatively simple task. Using matplotlib, scatter charts were created to output the data. These graphs are a representation of the trends over time.

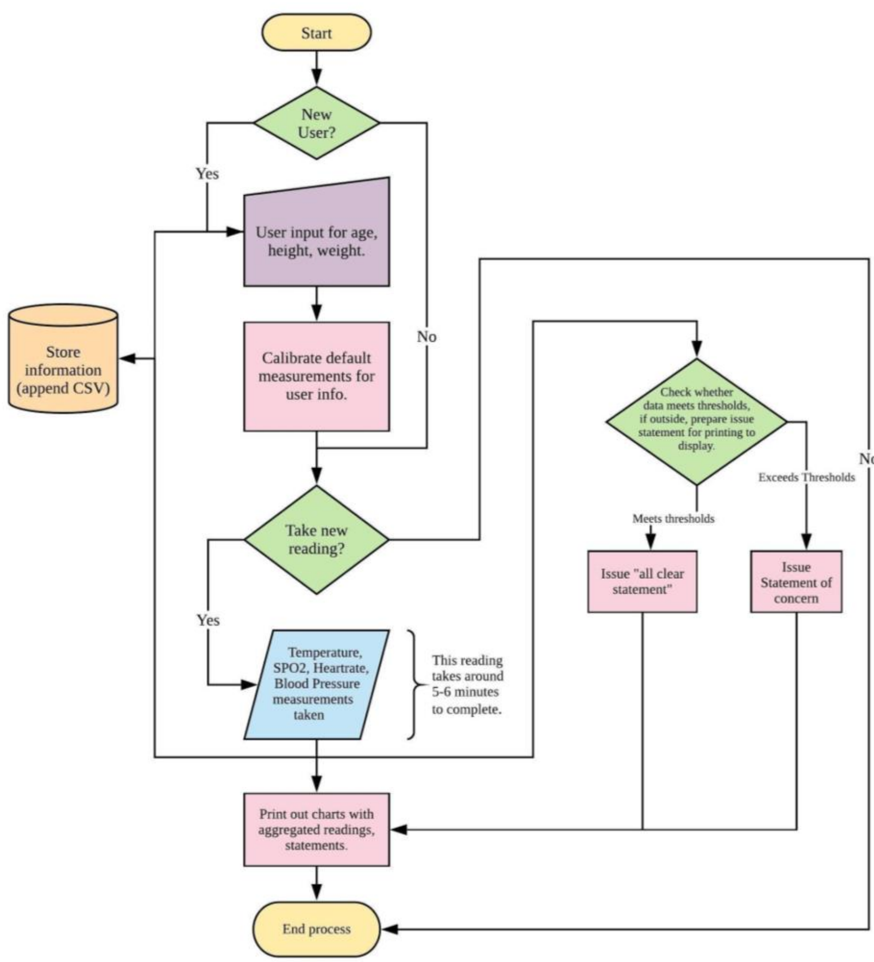

Figure C-2: Process flowchart.[8]

The process for obtaining and retrieving clear values from the temperature sensor, heart rate sensor and SPO2 sensor is outlined as follows. Using I-squared-C protocol, we connected the sensors to a microcontroller. The sensors will be ready to use when given the designated input by the user (i.e. the temperature “button” is pressed will execute the program). Once the program is executed you will be able to gather your measurements for heart rate, SPO2, and temperature. Each measurement will be transmitted wirelessly using a Bluetooth module to our microprocessor. We implemented various strategies in our program in order to increase the accuracy of our measurements such as averaging and taking the median of our data values to conclude with one accurate measurement for each heart rate, SPO2 and temperature. Below is the following pseudocode for the heart rate, SPO2 and temperature sensor:

```
if input = s;
        while x<150
            Sp02 = readings from i2c(MAX30100)
            increment  by one
        if the readings are within the range of standard reading levels:
            get the median of the result
            serial.print median
if input = h;
        while x<150
            heart_rate = readings from i2c(MAX30100)
            increment  by one
        if the readings are within the range of standard reading levels:
            get the median of the result
            serial.print median
if input = t;
        while x < 1000
            temperature = readings from i2c(MLX90614)
            increment by one
        if  the readings are within the range of standard reading levels:
            get  the average of the results
            serial.print average
```

The final component was obtaining values from the blood-pressure sensor. As stated before, the team has opted to use a pre-built blood pressure measurement cuff as opposed to building from scratch. Therefore, the process to obtain values from this hardware is as follows. First, the Omron blood pressure monitor must first collect a reading of blood pressure that takes approximately a minute. Since the monitor has bluetooth, this is the direct form of wireless communication that updates to a user’s Google FIT account that automatically updates with the recent value. This can be seen in figure C-3 taken as a screenshot.

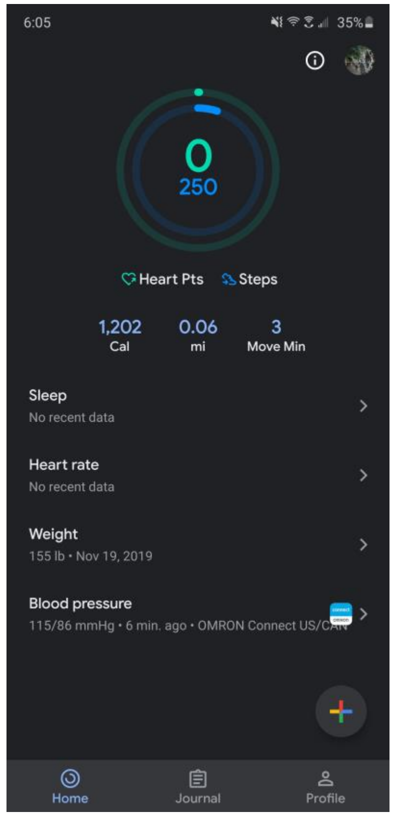

Figure C-3: Google Fit app with updated blood pressure [8]

Verifying that the blood pressure reading updated in the app makes certain that the most recent value will be called from the local python program. The following step would be to run the local python program that takes all the credentials necessary to access such personal data. How an API from google operates is well illustrated by figure C-4.

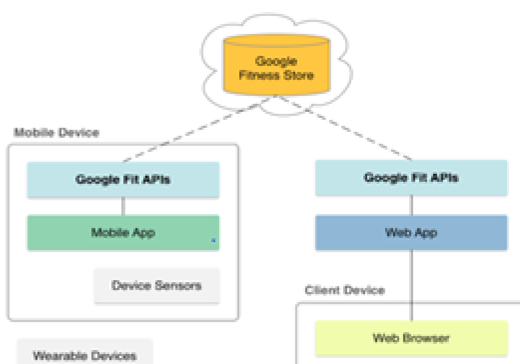

Figure C-4: FIT API process [8]

After the verification process for the user, the code goes through a JSON file where the values of blood pressure are stored in an array and pulls the value in the last position of the list. This JSON file is data stored and updated by google as the area of the file we are interested in is shown in figure C-5.

```
"dataQualityStandard": [],
"application": {
  "packageName": "com.omronhealthcare.omronconnect"
},
"dataStreamId": "raw:com.google.blood_pressure:com.omronhealthcare.omronconnect:com.alivecor.mobileecg",
"type": "raw"
```


Figure C-5: Portion of JSON file containing updated Omron values [8]

APPENDIX D. MECHANICAL ASPECTS

There are not many moving aspects of our physical project besides the blood pressure monitor. A diagram of how the cuff inflates according to the oscillometric method is shown in figure D-1.

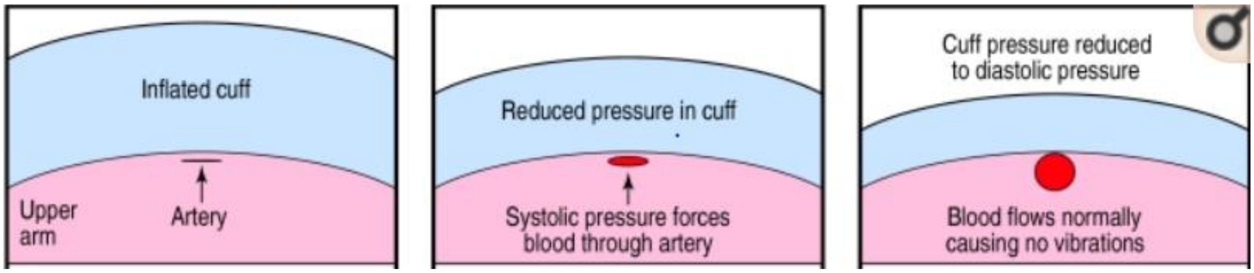

Figure D-1: States of blood pressure cuff [4].

Other such mechanical aspects would likely be our physically 3D printed enclosures housing three out of the four sensors along with the microcontroller and power supplies. One separate enclosure is built for the temperature sensor since that is made to be placed on the forehead.

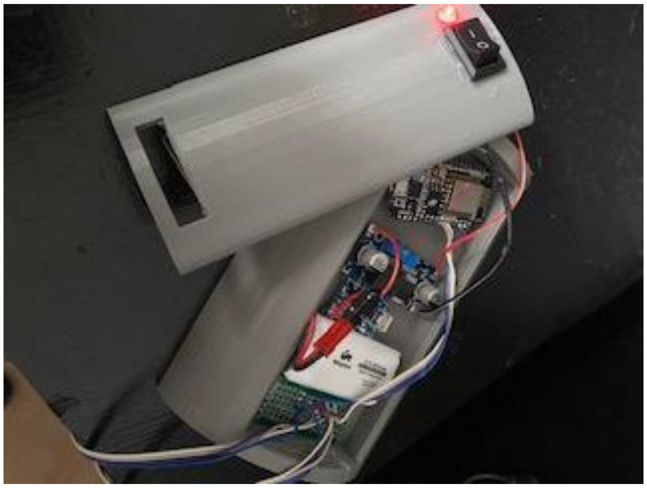

Figure D-2: Physical enclosures for hardware [8]

APPENDIX E. VENDOR CONTACTS

Vendor contacts not applicable.

APPENDIX F. RESUMES

DANIEL BRACAMONTES

OBJECTIVE | Motivated to obtain my bachelor's degree and attend Graduate school in Electrical & Electronic Engineering with a specialization in Control Systems. Seeking to pursue careers in automated systems and industrial machinery.

SKILLS & ABILITIES |

- Programming experience (Java, Python & C)
- Soldering on printed circuit boards (PCBs)
- Microcontroller & Single board computer experience (Arduino & Raspberry Pi)
- Computer hardware installation
- Field Programmable Gate Arrays (FPGA)
- Sales in electronics for consumer and business purposes

EXPERIENCE | **MAGNOLIA HOME THEATER SALES ASSOCIATE** BEST BUY
05/2018 TO PRESENT

- Sales in audio & video with a great focus in AV receivers (amplifiers), two-piece projection and custom installs.
- Performer in ability to translate customer problems and wants into solutions with product.
- Enthusiastic about taking classroom and project knowledge to a consumer standpoint in electronics.

DIRECTOR OF ENGINEERING & COMPUTER SCIENCE ASSOCIATED STUDENTS INC.
08/2017 TO 05/2018

- Student representation of students at large in CSU, Sacramento and specifically those who belong to the Engineering & Computer Science College.
- Committee chair of Green Team (sustainability committee).
- Constant meetings with College Dean to represent students.

EDUCATION | **CALIFORNIA STATE UNIVERSITY, SACRAMENTO**, SACRAMENTO, CA
BACHELOR'S DEGREE (IN PROGRESS)

- Project experience in small scale automated agriculture and sensor-based control systems.
- Tau Beta Pi Engineering Honor's Society (Member since Fall 2018)
- GPA: 3.2

Jessie Degala

Objective: Obtain Electrical & Electronic Engineering internship or entry level position.

Education: Bachelor of Science, Electrical & Electronic Engineering, California State University Sacramento
Graduation Spring 2020

Related Courses

Product Design Project I & II*	Power Electronics*	Applied Electromagnetics
Advanced Logic Design*	Electromechanical Conversion	Probability+Random Signal
Electronics I & II	Intro to Feedback Systems	Modern Communication Systems
Intro to Machine Vision*	Signals & Systems	Intro to Circuit Analysis
PCB Design*	Network Analysis	Computational Methods
Cmos and Vlsi	Intro to Microprocessors	Intro to Logic Design

** In progress as of Spring 2020*

Project Experience:

Automatic Plant Irrigation System
Using a microcontroller and microprocessor my team created a system that will irrigate water to the plants based on temperature and soil moisture thresholds.

DC Motor with Self-Adjusting Speed Control
Cruise control system designed to maintain a designated speed with a distance infrared sensor.

Assistive Medical Data Trending Cuff *in progress
Medical device that can collect basic vital signs and create and store medical profiles to timely notify those with health risks.

Skills and Abilities:

Software: Pspice, Cadence, Matlab, Simulink, Advance Design System, and Multisim.
Hardware: Microcontrollers/Microprocessors including Raspberry Pi, Parallax Propeller, and Arduino.
Lab Equipment: Oscilloscope, Function Generator, Digital Multimeter, and Power Supply.
Programming Language: C, C++, and Python
Hardware Description Language: VHDL and Verilog

Work Experience:

Shift Manager | **McDonald's** | 2012- Current

Adhered to company standards and compliance requirements for operations and cleanliness of all areas. Trained and mentored new employees to maximize team performance. Modernized and improved operational procedures to increase efficiency and profitability while tightly controlling costs such as labor and preventing waste. Evaluated employee performance on weekly basis and conveyed constructive feedback to improve skills.

Activities and Accomplishments:

Dean's Honor Roll Spring 2019
Dean’s Honor Roll Fall 2019

Working 20 hours per week, while carrying 16 units per semester and maintaining a major 3.3 GPA

Jose Luis Gonzalez

(209) 513-4914 josegonzalez3@csus.edu

Objective: A entry level/internship in Electrical and Electronic Engineering, with a focus in Analog/Digital

Education:

In progress: Bachelor of Science, Electrical and Electronics Engineering, CSU Sacramento, Senior year expected graduation date spring: 2020, Major GPA 3.455.

Related Courses:

Product Design Project II *	Intro To Microprocessors	Signals & Systems
Electronics II	Product Design Project I	Modem Communication System
Electronics I	Network Analysis	Logic Design
Cmos And Vlsi (Discussion)	Intro to Machine Vision *	Circuit Analysis
Advanced Logic Design *	Intro To Feedback Systems	Computational Methods & Applications

** In progress as of Spring 2020*

Project Experience:

Automatic Plant Irrigation System - Intro to Microprocessors

Used a microprocessor as the master and a microcontroller as a slave via serial communication, my team and I designed an irrigation plant system. This system was able to diagnose the temperature and humidity using sensors and upon certain temperature or inputs, turned the water on or off.

DC Motor with Self Adjusting Speed control - Feedback Systems

Created a version of an automobile cruise control with a DC motor using a feedback loop and a infrared distance sensor.

Alarm Clock

Built an Alarm clock using a microcontroller, LCD screen and other components.

Assisitive Medical Data Trending Cuff (AMDTC)

Currently in progress
This project is a medical device that can collect basic vital signs and create and store medical profiles to timely notify those with health risks.

Skills and Abilities:

Hardware:
Arduino micro-controller, Raspberry Pi, NodeMcu, Soldering, Parallax Propeller, Oscilloscope, Function Generator, Digital, Multimeter, Power supply.
Programming:
C, Python, Verilog
Software:
Pspice, multisim, linux, Vivado, Agilent Advance Design System, Cadence, ModelSim, Matlab, Simulink.
Bilingual:
Speak fluent English and Spanish.

Related Experience:

Team Leader **Capstone** **11/14 - 12/17**

Work with a software to input truck drivers Load info and create Receipts. Gave prices to lump(breakdown pallets) depending on the truck load size. Communicated and solved problems with truck companies, and head managers of the warehouse(Unified Grocers). Was in charge with everything running smoothly throughout the day and gave the workloads to other employees to.

Activities and Accomplishments:

Dean's Honor roll Fall 2018, Spring 2019, & Fall 2019
Repair electronics such as phones, game systems, televisions etc.
Disassemble a dirt-bike apart and put it all back together.
Maintaining a healthy lifestyle.

Yamini Sameera Dasu

Professional Goal: I am seeking a major-related internship to solidify my knowledge of programming and/or hardware concepts I learned in school, specifically their practical applications. I aspire to offer the hiring entity varied technical skills and personal attributes while gaining hands-on experience and new skills.

Education:

California State University, Sacramento (CSUS) — Expected Graduation: May 2020
Bachelor of Science in Computer Engineering, Minor in Applied Mathematics

Work Experience:

OneIT Global Services, Business Intelligence (BI) Modem Engineering Team — **May 2019 - August 2019**
Qualcomm
Programmer/Systems Analyst Intern

- As part of the Enterprise Business Intelligence Team, worked with QCT Modem Engineering team to develop logic that will determine 4G LTE chipset builds that will yield optimum modem performance.
- Benefits to QCT include less time spent by Engineering to sift through large amounts of data to find optimized performance, faster transition of chips into production, and assurance that the best performing chips are implemented.
- Logic not only applied to 4G LTE chipsets, but can also be carried over to 5G in the future.

Web Applications and System Support (WASS), Information Technology Division (ITD) — **January 2019 - May 2019**
CA Department of Developmental Services (DDS)
Web Development Student Assistant

- Using HTML, CSS and JavaScript to update the content of the existing DDS Website to meet the American Disability Act (ADA) Web Accessibility Standards
- Front end content migration, styling, and accessibility scanning for all webpages
- Working with a team of five other employees and student assistants to launch the new website in May 2019

Natural Science and Mathematics Department, CSUS, Sacramento — **Aug 2017 – Present**
Peer Assisted Learning (PAL) Supervisory Facilitator: January 2019 – Present

- Assuming responsibility for and overseeing 64 student facilitators within the PAL program
- Conducting observations and debriefs for facilitators within the program through the semester
- Recognizing when an issue needs to be addressed by faculty advisors and informing them as needed to come up with a solution for the problem
- Mentoring facilitators within the program who may be facing challenges

Peer Assisted Learning (PAL) Facilitator: August 2017 – August 2018

- Facilitating students' learning in multivariable calculus with a regular class section of 10 students, and weekly office hours
- PAL students are proven to have a 15% grade bump in the course they are supplementing with our classes
- Served as a Lead Facilitator, overseeing two other Facilitators from August to December 2018.

Technical Projects:

IEEE VAST 2018 Challenge – Visual Analytics and Electronic Imaging — **May 2018 – Sep 2018**

- The goal of this project was to find a way for machine learning to be more understandable for the average user
- Researched and documented various methods for visualization of bird calls, wrote and ran Python and R scripts to create data visualizations such as heat density maps to detect trends and patterns in data.
- Published our research: *"Incorporating the Everyday User with Machine Learning using Visual Analytics Case Study: Kasios Bird Call Data Set"* as the second author

Simple Microprocessor Design — **Nov 2018 – Dec 2018**
Created a simple microprocessor containing several data structures in hardware design, such as D-flip flop, finite state machine, arithmetic logic unit, and multiplexer

- Practiced structural hierarchical design to implement the datapath circuit, coded using VHDL, and programmed and tested on FPGA
- This was an individual project involving extensive testing and debugging of both hardware and software components to demonstrate the logic of the processor

Coursework:

- Microcomputers and Assembly Language
- Introduction to Logic Design
- Introduction to System Programming
- Introduction to Circuit Analysis
- Advanced Logic Design
- Computer Interfacing
- Data Structures and Algorithm Development
- Network Analysis
- Electronic Signals and Systems