Initial Project and Group Identification Document: Divide and Conquer

Project N.I.H.M.S. (Non-Invasive Health Monitoring System)

University of Central Florida
College of Electrical and Computer Engineering
College of Optics and Photonics

Group E

Nicole Fossenier — ***Photonic Engineering***

George Michael Ruiz — ***Electrical Engineering***

Schnieder Maxime — ***Computer Engineering***

Gabriela Pinedo — ***Computer Engineering***

Client/Advisor

Dr. Lei Wei

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Project Narrative

Technology has always played an important role in the administration and progression of medical care, now more than ever in the wake of the COVID-19 pandemic. In order to properly get diagnosed and treated, the patient would need to enter a clinic or hospital and risk exposure to the virus. However, with the advent of telemedicine doctors are better prepared to take care of patients from the comfort of their own home. The main issue that comes about with this method of clinical care is that many people lack access to proper diagnostic equipment, such as a means to measure blood pressure or heart rate. Without the appropriate tools for a patient to check their own vitals, the effectiveness of an off-site doctor decreases. Another obstacle to overcome in telemedicine care is that many people do not know how to effectively take their own vitals with the equipment available to them. Diagnostic tools that are easy to use and understand are then important to aid a doctor in making a proper diagnosis of the patient.

There are also times when having a method of continuously measuring vitals are important, such as determining trends in a patient to help prevent future medical emergencies from occurring. Many diagnostic tools, especially those available commercially, only measure an instance at a time. While this has its own applications, this method does not provide much information about the patient beyond the time the measurements are taken. By having continuous measurements taken, a better profile of the patient will be available to the doctor.

Our proposal is for a piece of non-invasive wearable tech that will continuously measure vitals of the user and transmit them to an app. This will allow both the user and any healthcare professionals to see the data and any trends therein. The device aims to focus on ergonomics and accuracy for the user, to ensure a positive experience while under use. Blood pressure, heart rate, blood oxygen, and skin temperature will be recorded by the device, with an alert system built in to let the user know if an irregularity in vital signs is detected. It should be lightweight and easy to use, so that the user can utilize the device without much instruction or hassle.

This device aims to be used mainly for medical use, but the applications for self care are also understood, as many people would be interested in monitoring their own vitals on a day to day basis. Users could then be better informed of their own health, with the possibility of altering life habits based on pressing needs, such as making changes to accommodate for high blood pressure or better sleep habits based on lower blood oxygen levels at night. The included ability of recording vitals on a day to day basis would also allow the user to create an E-Diary to record what activities were done during an episode of irregular vital measurements.

There are various types of wearable health monitoring equipment out in the market, but most of them are not as all encompassing as our proposed device will be. With regards to blood pressure, the two gold standards are non-continuous measurement with a blood pressure cuff, or the continuous measurement of arterial catheterization, a process that is quite invasive. Both have their reasons for use, but our device will be using a third option, continuous non-invasive arterial pressure (CNAP). This will allow

the benefit of continuous measurement without sacrificing the comfort of a non-invasive approach.

With new methods of diagnosing illnesses and taking care of patients, a better way to facilitate accurately reading vitals is necessary, and so our goal is to make it easier for users to get proper readings and relay the data to relevant healthcare professionals. By encompassing varying methods of measuring vitals into a simple to use device, our hope is that we can do our part to help everyone take better care of themselves, and to help prevent future emergencies from occurring through trends found in continuous measurements.

Specifications and Requirements

Table 1: Requirements and Specifications Table

#	Requirement	Specifications	Description	Priority
1	**Wi-Fi Connectivity**	150 ft indoors	This will allow standard area of motion around a router without impeding the user	Medium
2	**Data Transfer**	At least 2Mb/s	A higher rate of transfer will allow for a more continuous view of vitals on the app	High
3	**Weight**	Less than 1 pound.	Allow users to easily wear the fingerless gloves without additional weight	High
4	**Battery Life**	Up to 8 hours battery life	As the solar cells are exposed to light, the charge power is stored the battery	High
5	**Application Storage**	1 years worth	A year's worth of data will provide a complete profile of the user.	High
6	**Wearability**	Fit a hand of 7.6 inches	Allows the average user to comfortably use our product.	High
7	**Product Storage**	2 weeks worth	Data stored on the device will be reset after reaching the storage capacity of 2 weeks in order to keep the device fast	High
8	**User Friendliness**	Less than 2 minutes	Teach users to use the product in less than the time mentioned.	High
9	**Application speed**	Under 45 seconds	Instantaneous feedback from watch to phone application	High
10	**Emergency Detection**	Within 60 seconds	Calls proper authorities if the product detects major irregularity in data	Medium

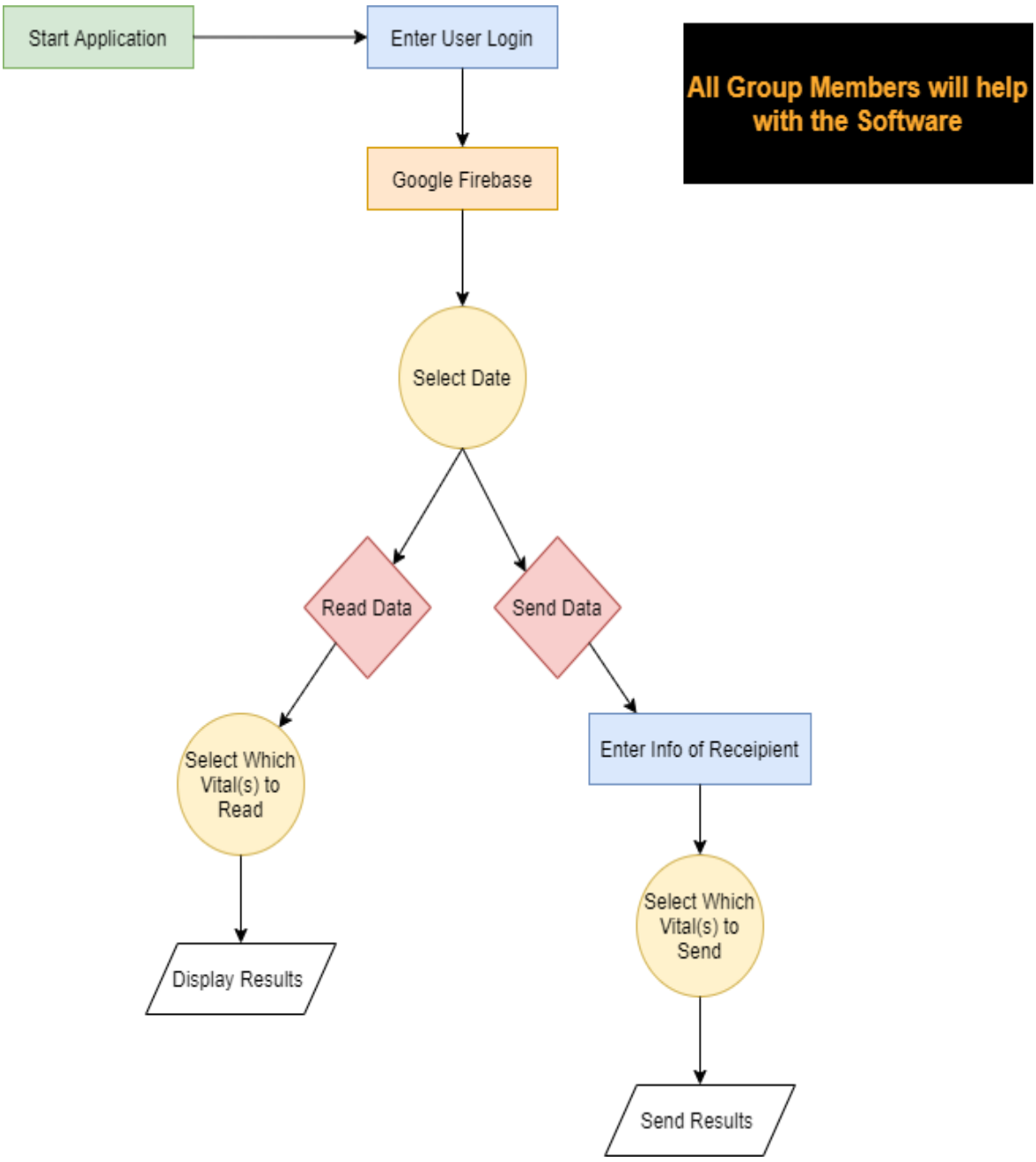


Chart 1: Software Flowchart

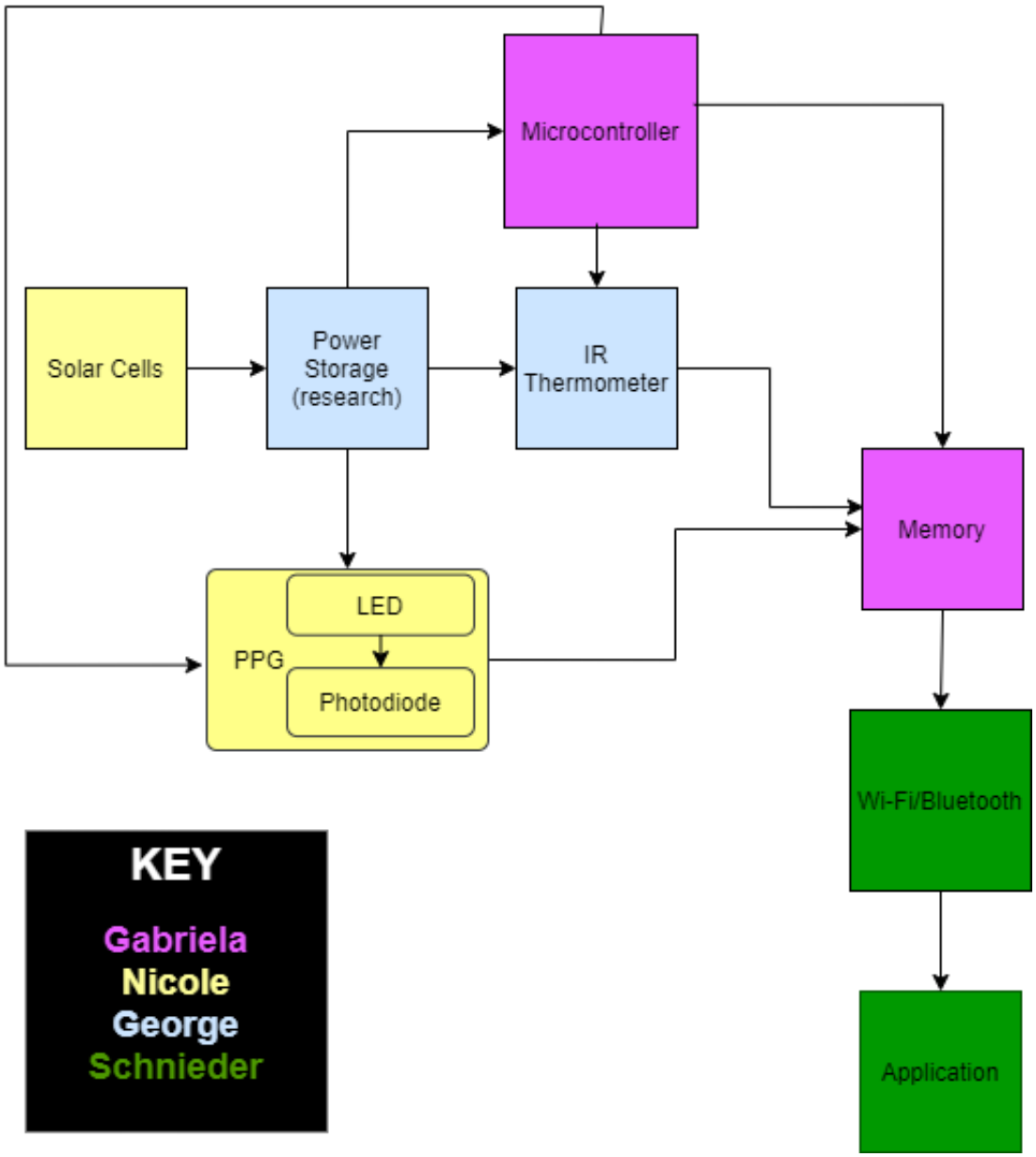
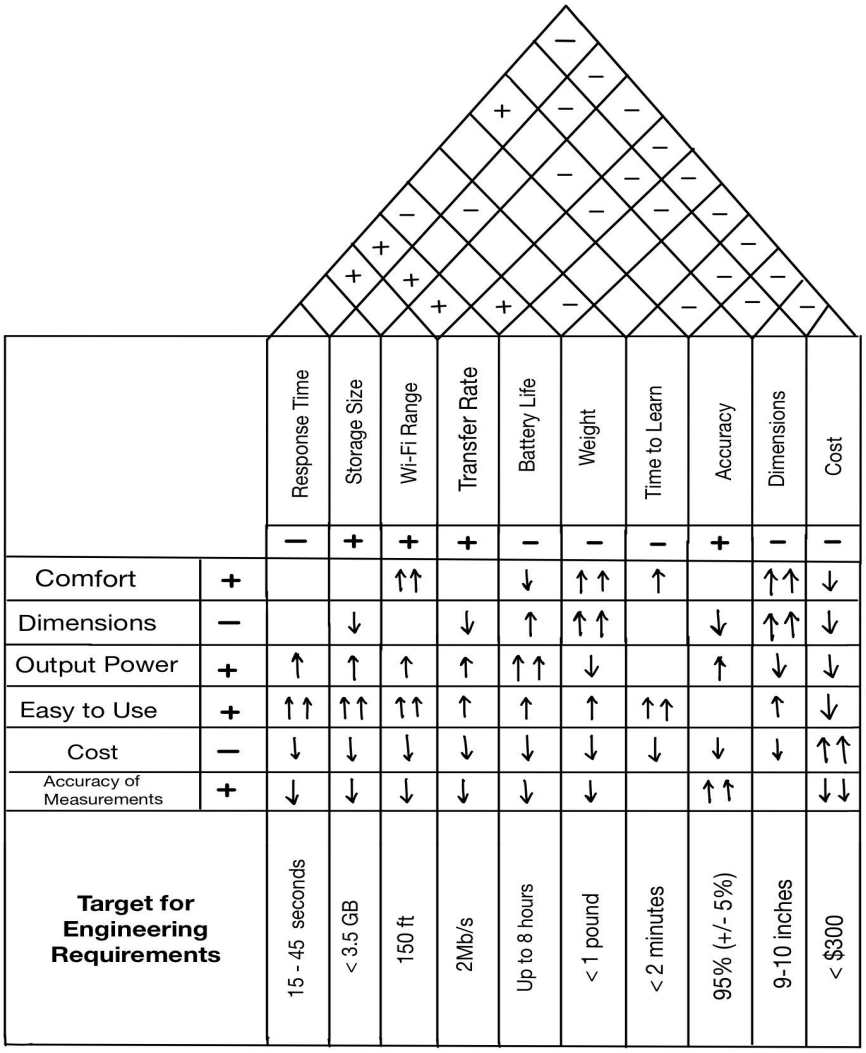


Chart 2: Hardware Flowchart

House of Quality

Table 2: House of Quality



		Response Time	Storage Size	Wi-Fi Range	Transfer Rate	Battery Life	Weight	Time to Learn	Accuracy	Dimensions	Cost
		−	+	+	+	−	−	−	+	−	−
Comfort	+			↑↑		↓	↑↑	↑		↑↑	↓
Dimensions	−		↓		↓	↑	↑↑		↓	↑↑	↓
Output Power	+	↑	↑	↑	↑	↑↑	↓		↑	↓	↓
Easy to Use	+	↑↑	↑↑	↑↑	↑	↑	↑	↑↑		↑	↓
Cost	−	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑↑
Accuracy of Measurements	+	↓	↓	↓	↓	↓	↓		↑↑		↓↓
Target for Engineering Requirements		15 - 45 seconds	< 3.5 GB	150 ft	2Mb/s	Up to 8 hours	< 1 pound	< 2 minutes	95% (+/- 5%)	9-10 inches	< $300

Table 3: House of Quality Legend

↑	Positive Correlation
↑↑	Strong Positive Correlation
↓	Negative Correlation
↓↓	Strong Negative Correlation
+	Increasing Requirement
-	Decreasing Requirement

Table 4: Engineering Trade-off Matrix

	Response time	Storage Size	Wifi Range	Transfer Rate	Battery Life	Weight	Time to Learn	Accuracy	Dimensions	Cost
Response time			+	+	-			-		-
Storage Size				+		-			-	-
Wifi Range				+				-		-
Transfer Rate					+			-	-	-
Battery Life						-			-	-
Weight								-	-	-
Time to Learn										-
Accuracy									-	-
Dimensions										-
Cost										

Table 5: Engineering Marketing Trade-off Matrix

		Response Time	Storage Size	Wi-Fi Range	Transfer Rate	Battery Life	Weight	Time to Learn	Accuracy	Dimensions	Cost
		−	+	+	+	−	−	−	+	−	−
Comfort	+			↑↑		↓	↑↑	↑		↑↑	↓
Dimensions	−		↓		↓	↑	↑↑		↓	↑↑	↓
Output Power	+	↑	↑	↑	↑	↑↑	↓		↑	↓	↓
Easy to Use	+	↑↑	↑↑	↑↑	↑	↑	↑	↑↑		↑	↓
Cost	−	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑↑
Accuracy of Measurements	+	↓	↓	↓	↓	↓	↓		↑↑		↓↓
Target for Engineering Requirements		15 - 45 seconds	< 3.5 GB	150 ft	2Mb/s	Up to 8 hours	< 1 pound	< 2 minutes	95% (+/- 5%)	9-10 inches	< $300

Budget

Table 6: Budget Table

Item	Estimated Cost
IR Thermometer	$40
Solar Cell Cloth	$30
PCB	$50
Wi-Fi / Bluetooth Device	$20-$40
Microcontroller	$25
Fingerless Glove	$20
Photodiode	$50
LED	$15
Solar Cell Charger	$10
Battery	$15

Total project: ~ $295

Project Milestones

Table 7: Project Milestones Table

Date	Milestone to be completed
January 22, 2021	Solidify project goals and objectives
January 22, 2021	Start Research on Project
January 22, 2021	Begin Work on first Divide and Conquer Document
January 29, 2021	Finish first Divide and Conquer Document
January 30, 2021	Begin Work on updated Divide and Conquer Document
February 12, 2021	Finish updated Divide and Conquer Document
April 2, 2021	Finish 60 page project documentation
April 16, 2021	Finish 100 page project documentation
April 27,2021	Final Documentation Due (End of Senior Design 1)
April 28, 2021	Order Parts for Design of Project
May 9, 2021	Test all Parts are functional - reorder if necessary
August 23, 2021	Begin work on Software
August 23,2021	Begin work on Hardware
September 10, 2021	Test every part of project separately
September 30 , 2021	Test parts when connected together
September 30 - Dec 1, 2021	Test and Debug and work on any other unresolved issues
December 1, 2021	Finalize Project
December 1, 2021	Final Test
December 6, 2021	Presentation of Project
December 11, 2021	Last day of School