Prototype I and Customer Feedback

Project Deliverable F

GNG1103
Team 13
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1.0 Introduction

In the previous deliverables, a problem statement was created which states the need for a non-intrusive, wearable device that monitors oxygen levels of an opioid user and detects overdoses. The device must be affordable, lightweight and compact; it must alert emergency responders of the location of the person affected. Each member then created three conceptual designs using the list of prioritized design criteria, and benchmarking. From the various designs, three fully-functional subsystems were put together. The three designs include a watch, a patch that can be placed on multiple locations of the body, and an earpiece. Through careful consideration of the pros and cons, the watch design was determined to be the most feasible.

The previous deliverable included an analysis, list of tasks, and a bill of materials. The analysis included a brief summary of the client meeting from which we gathered feedback and applied it to our existing concept. We decided to add an app that connects through Bluetooth to the watch so that all of the information that the sensors collect can be displayed in one place. Then a general plan and list of tasks were made for each of the three prototypes to ensure that we stayed on track. The bill of materials included all of the items that had to be purchased for this device. These items include the following: cardboard, MAXREFDES117, Arduino Nano 33 Ble, and Lipo Battery and Charger.

This deliverable is revolved around Prototype I. The Team first filled out the Prototyping Test Plan which outlines the objective of the prototype, test objectives (specific test objectives, what is being learned/communicated, possible results, select concepts, test success/failure), how the testing will be done (testing process, information measured, what's being observed/how is it recorded, materials needed/estimated costs, what work needs to be done), and lastly, how long would the testing take (estimated time/dependencies, gantt chart, when are the results required by). After completing the Prototyping Test Plan, we proceeded with making the physical prototype out of cheap material and 3D printed parts. A 3D model of the prototype created on SolidWorks along with pictures of the actual product is also found in this deliverable. We then presented the prototype to the client and gathered feedback which is all analysed. This prototype is primarily to see that the design works and all the components are able to fit inside.

2.0 Analysis

2.1 Prototype Test Plan

Why are we doing this test?

The objective of Prototype I is to test if the sensors work on the wrist. This will determine if we can go forward with our preferred design of the watch pulse oximeter. We will also try and make a physical copy of our top design (the watch) and we can get feedback on the customer on if it is discreet enough and whether she is on board with our product before going ahead and actually making it.

Test Objectives Description

*What are the **specific** test objectives?*

- Ensure that the sensor is able to accurately measure blood oxygen saturation.
- Ensure that the watch does not exceed a comfortable size (less than 45.7 * 25.4)
- Make sure that the system remains small and discreet to encourage users to wear the device

*What **exactly** is being learned or communicated with the prototype?*

- This initial prototype allows us as a group to understand how the different components of our design work together.
- It also ensures that all the parts, especially the oxygen saturation sensor, work appropriately for our purposes.

What are the possible types of results?

- The results we expect in this prototype are that the oxygen saturation sensor sends a positive result when tested on a group member and can send that information via Bluetooth either to the Arduino IDE or the app (if developed in time).
- Optimally, all the components will fit together in a small-sized container about the size of the target specifications of the watch.

How will these results be used to make decisions or select concepts?

- These results will confirm if the watch design is viable based on how discreet the system is and if all the components work well for our purposes.

What are the criteria for test success or failure?

- Test success can be confirmed if the prototype size is roughly around the target specifications (45.7 * 25.4). It does not need to be exact as minor changes can be made later.
- Success would also be that the sensors and Bluetooth all communicate effectively and accurately measure blood oxygen levels.
- Failure would be if the device is too large to remain discreet or if components do not work as intended.

What is going on and how is it being done?

This is a physical, comprehensive prototype. The prototype will be comprehensive because it is a very intricate product that requires a lot of parts working simultaneously. Each of these product attributes need to be tested to eliminate possible problems. The first thing we need to do is make sure our Arduino Nano and Sensor work with our chosen code and it actually displays the SO2. We are putting together a paper model of our watch so we can visually see how the watch will look when worn, and also if all the components will fit in our ideal watch size.

Describe the testing process in enough detail to allow someone else to build and test the prototype instead of you.

- The testing process of this first prototype involves the Bluetooth enabled Arduino and the blood oxygen saturation sensor. Using the Arduino IDE, develop a code to measure blood oxygen saturation levels and convey it back to the system via Bluetooth. This information will also be communicated with the app, once developed.
- Accurately measure the components and develop a casing that will remain discreet and look similar to a watch. Ensure that space is left for all connections (wiring) and an adequate battery - to be added in a future prototype - and remain at/around target specifications.

*What information is being **measured**?*

- We are measuring the size of our paper prototype. We are making sure that all the parts of the inner components fit inside the watch space.

What materials are required and what is the approximate estimated cost?

- As this is the first prototype, our physical device will be made out of cardboard/paper. This is just to show our client what the product will look like.
- We also are using the Arduino Nano and the Bluetooth (HC05), other than the initial cost for the parts we won't need to spend any money on the testing of this prototype.

What work (e.g. test software or construction or modeling work or research) needs to be done?

- The code required for the device to work effectively must be written so that our sensor can effectively communicate with the app, which must also be developed.
- A casing for the device must be created, possibly 3-D printed, but initial prototypes might be made with cardboard or paper.
- We must also research the average fluctuations of oxygen saturation and ensure that the code is written for the device to work only when oxygen saturation drops drastically, as in the case of an overdose.

When is it happening?

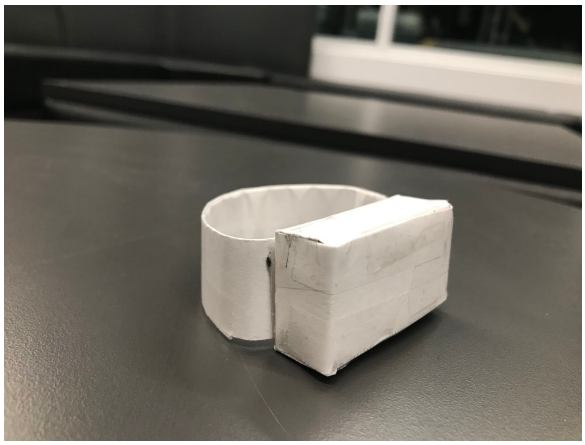
*How long will the test take and what are the **dependencies** (i.e. what needs to happen before the testing can occur)?*

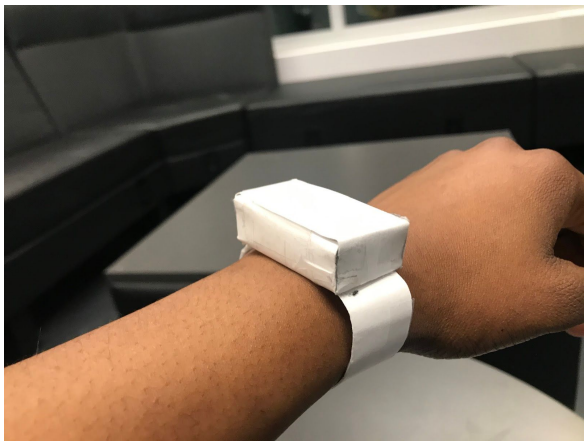
The test will take place Monday 24th February and should not take more than 1 hour. However, before we can test, we need to first 3D print out the product (watch casing), as well as receive the sensor and Arduino board ordered and write out the necessary coding for it to work.

When are the results required (i.e. what depends on the results of this test in the project plan)?

Without this test we will not be able to make a prototype for the customer to see. Therefore, we will be lacking customer feedback and we won't know if we are headed in the right direction in regards to customer satisfaction. The customer meeting is on the 2nd of March. So that is when the testing needs to be completed. Then we can move on to Prototype II.

2.2 Prototype I





The first prototype is a simple mock up designed to capture the look of our final product. The watch prototype is comfortable, sleek and light-weight to ensure user enjoyment. All the components can easily fit in the proposed watch dimensions.

We received our parts the day the first prototype was due however there was a mix up with the order and we did not receive the parts we wanted (MAXREFDES117, Arduino Nano 33 Ble). We received components (Arduino Nano, Bluetooth HC-05 and MAX30100) that are very similar to what we wanted to have and they serve the same purpose. We found a code for our arduino and have checked to see if it was compatible with our components and after a bit of editing and tweaking it works. The next stage of testing will be connecting our device to our app via bluetooth. We will also see if our sensor works on the wrist.

The app is being made using the App Inventor which is written in Java. As of right now, the app can display the user's information, emergency contacts, and location. The next step is to connect the sensors to the app via bluetooth; the app should be able to display the information while updating every 30 seconds automatically. The app should also be able to send the location of the user to the listed emergency contacts or the EMS. Currently, the app is unable to update frequently on its own without reconnecting through bluetooth and it also cannot run in the background. For prototype II, these errors need to be addressed and fixed.

3.0 Client/User Feedback

Our previous client meeting was 2 weeks ago and during the meeting we proposed 2 ideas. The first being a wearable pulse oximeter patch that would attach to the users chest, shoulder blade or shin inorder to monitor blood oxygen levels. The second being a wearable pulse oximeter watch that would monitor pulse via the users inner wrist veins. Our client seemed interested in both ideas while being most committed to the watch idea. She discussed the feasibility of a patch idea and stated that the user would have to reapply the patch daily and might not enjoy the patch. With this feedback we concluded the wrist watch was most feasible and most desirable.

I (Liam) discussed the project with my Uncle Mike who is a retired veterinarian. We discussed the viability of a wrist mounted design and the potential shortcomings associated with this method of measuring blood oxygen levels. A few potential shortcomings we discussed were the potential of the device to lose the pulse if the oximeter slides to the side of the inner wrist veins or if the oximeter is not secure. As a highly skilled veterinarian Mike has used many forms of pulse oximetry in his line of work and believes in the viability of a wrist mounted pulse oximeter. As a group we will create a second prototype to test the accuracy and precision of our wrist mounted pulse oximeter in order to create a sleek and functional product.

4.0 Conclusion

Our problem statement asks for a wearable and non-intrusive device that can detect opioid overdoses by monitoring blood oxygen levels of an opioid user. The device must be affordable, lightweight and compact. We focused on this part of our problem statement for this first prototype, creating a paper casing that can comfortably fit on the wrist but also contain all the components of our device. We were also able to build a code that would work for our purposes and effectively communicate the necessary information to our app. The development of the app has begun, but we will finalize it by the second prototype and ensure that the device seamlessly communicates with the app via bluetooth. So far, the app displays the user's information, emergency contacts, and location. For the second prototype, the app should be able to display the information gathered from the sensors and send the location to the listed emergency contacts once an overdose is detected. This first prototype was beneficial to ensure that all our components function well and fit in a discreet casing on the wrist, allowing us to continue with the current design.