Prototype 2 - Deliverable G

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Introduction

This deliverable contains within it the prototyping test plan for prototype II, as well as investigating the results that we have found so far. Additionally, we will analyze the feedback that we received from our customer based on our last prototype so we can further polish the final product.

Prototype test plan

Our goal with prototype II was to try and further polish our design to a point where the functional aspects of it were nearly ready for design day. Our two main focuses for this deliverable were to make the wiring of the device work and also to for us to create the final design for the encasement of the device on solid works.

The first part of the prototype was a physical model, we planned it to be a comprehensive prototype that will focus on the critical functionality of our product, we are doing this to measure the performance of the plan we devised in the last prototype. Our goal is to have the Arduino reading the blood oxygen saturation level and sending the measurements to the app we built. We plan to complete this by doing the following steps, building a function in the Arduino script that will take in real values from the sensor, build another function that takes the values that are read from the blood oxygen sensor and send them to the BlueTooth module. The BlueTooth module will be used to transfer these measurements to the app we built, which will be displayed to the user. This will be a high fidelity prototype, so if we can get this process working we will have completed a good portion of our prototyping goals and be very close to having the finished product.

The second part of prototype II was to design the case for the product. This part of the prototype was done so that we could get to testing how comfortable the device was to wear. As well as test that the device did not move around on the user's wrist too much when they were wearing the device, as the customer said this was one of the main challenges that were faced when designing an opioid detection device that was in the rough shape of a watch, and so as a result of the customer saying this we wanted to expedite the process of getting a physical model of the prototype to test this aspect of the device.

What is going on and how is it being done?

The two different parts of this prototype (physical model and case), were both tested with different parameters. For the physical model, we built code so the Arduino would function as we needed it to. Once we got the correct program we tested to see if it was functioning properly by touching the blood oxygen sensor to check if the device was reading values correctly, we verified that the values being outputted were correct by touching the device with our fingers multiple times and checking that the margin of error between each touch was within an acceptable range, which was roughly 2.5%, and that the values did not go below 95% or above 100%, as these values would be outside the normal range for a human who is healthy. This part of our prototype test plan was successful as we achieved our main goal.

The way that we tested that the solid works model of the case design was acceptable was by making a sketch of how big the device would be using a piece of paper, and finding out the dimensions of the sketch, then we took the dimensions and inputted them into our model on Solidworks, and as such the model on Solidworks should be big enough to incase all the components necessary for this device.

When is it happening?

For this deliverable the first test will be to make sure that the physical prototype of the device works, this will be done within one day, where multiple members of our group will get together and touch the blood oxygen sensor to test that the readings are accurate. The second prototype, which is the casing of the device does not require anytime to test at the moment and it is still just a Solidworks sketch. However, when the group ends up 3D printing the device, we will have one group member wear the device for a day to test its comfort, and then we will also put it through a series of more stressful test such as sleeping in it, jumping with it on, and falling down onto a padded surface to ensure that the device does not break connection with the skin throughout these tests, so it can still make accurate readings. These tests have been chosen to try and simulate both a working environment and also what someone who is overdosing might do when they are unconscious, so with all this testing, this will take approximately 3-4 days in total. Prototype III will be worked on between now and design day, we are hoping to have the final product done by the 20th of March, as we don't want to wait until the last minute in case there are any underlying issues with the device that are not initially apparent, so this should take around 12 days.

Customer feedback

We showed the customer an overview of what the device will look like, as well as its more technical aspects, the following is her feedback, as well as what measures we will use to try and best ensure that it is addressed.

1. The customer was concerned that the device would move around too much, and as a result not make accurate readings of the user's blood oxygen levels.
    a. In order to try and address this concern, we will add a strap to the device with many size settings, as well as testing how good the device stays in one spot by performing a series of thorough tests. Another way that we will try to reduce the

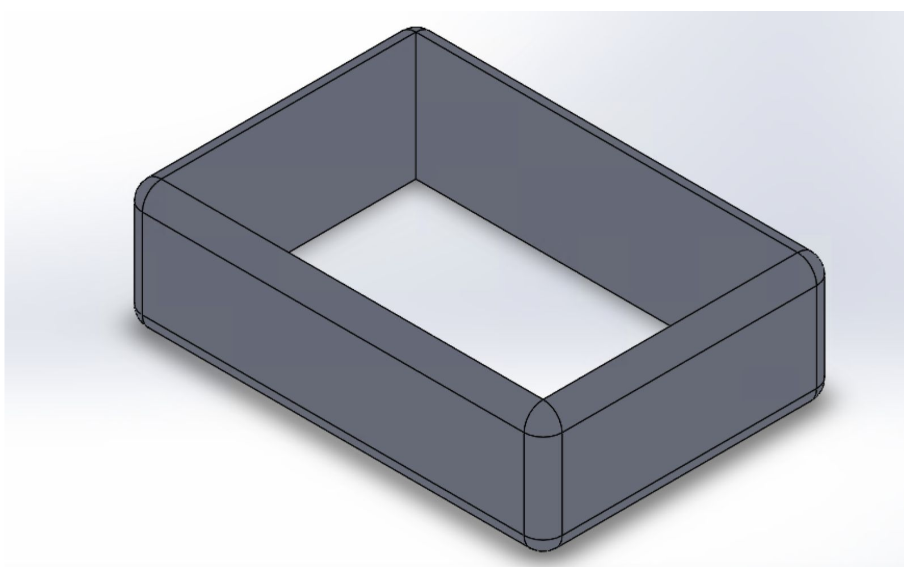
movement of the device would be to make the device out of a material that has more friction.

2. The customer was concerned that if the device was in the shape of a box that it could get caught on stuff.
    a. In order to address this concern, we have gone with a shape that has rounded corners that should hopefully not get caught on things as easily.
3. The customer was concerned about the overall battery life of the device, as she would like it to last for a full day of use.
    a. We have already done the calculations and our device should last a full day, however, we do have plans to add an on-off switch to the device in the future, to further increase how long it can last on one charge.

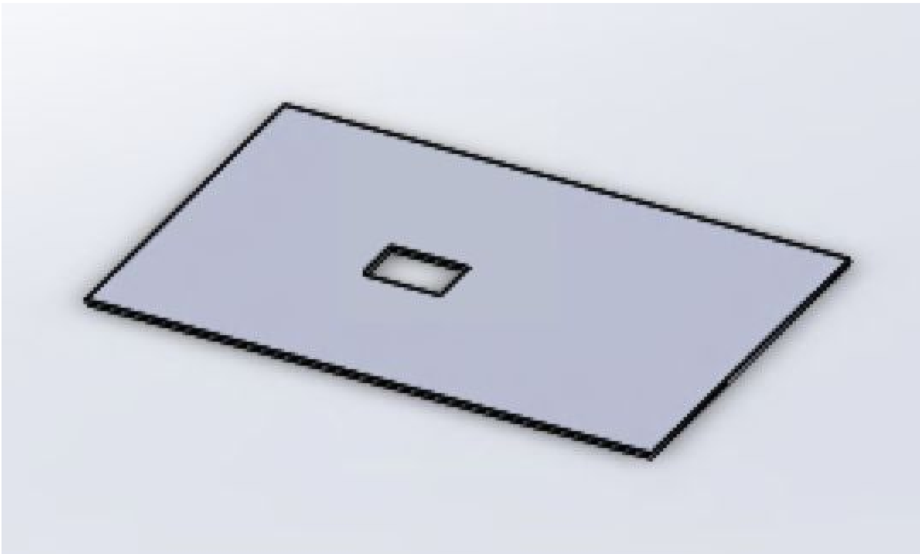
Device Design

We decided to print the design in three parts.

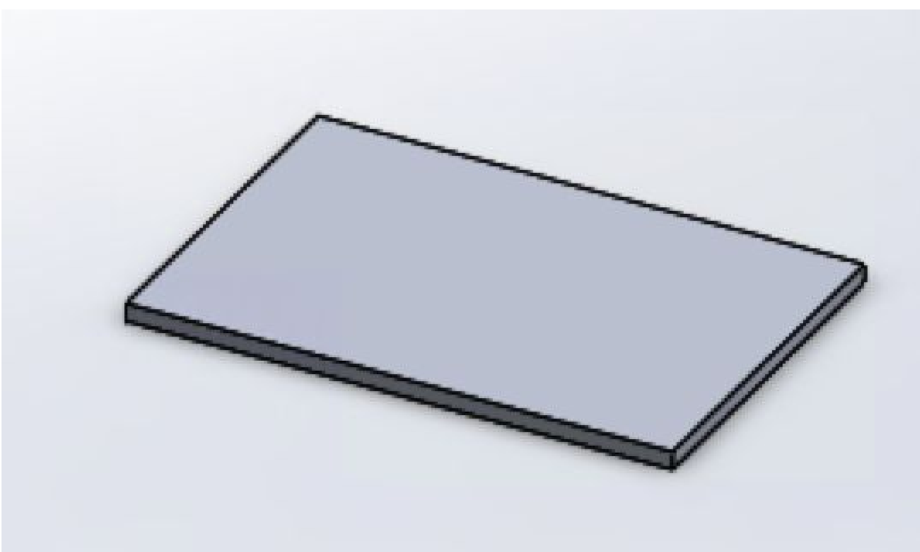
The first part is the sides, we made the sides slightly thicker than the rest of the parts so that we could have bigger curves. This would make it look less boxy and make it more aesthetically pleasing, as well as decrease the odds that the device will get caught on things, which was a concern of our customer.



The second part is the bottom of the device. The bottom has to be quite thin in order to allow the blood oxygen sensor to make contact with the skin. The bottom also needs a cutout for the sensor to allow it to make contact with the skin.



The third part of the device is the top. We decided not to make the top as thin as the bottom to increase durability. We still think it should be fairly thin in order to minimize the size of the device.



Further device refinement plan

- Make the app as simplistic as possible, while still having enough features as to not annoy potential future customers
    - Planned app features include adding emergency contacts, displaying blood oxygen levels and breathes per minute, adding a customizable phrase to send to emergency contacts when the device detects an overdose and having an option to cancel sending an alert in the case of a false reading from the device.
- Reduce movement of the device as much as possible when it is fastened on the user's wrist
    - Add a strap with multiple size settings in order to ensure the user has a wide variety of options so they can choose the one that best suits them
- Add an on-off switch to the device to save power
- Move the device away from a breadboard and onto a soldering board
- Install the battery pack to the device so that it will work away from a computer

Prototype results

We learned alot from our comprehensive prototype because this is the critical system of our device. We had to change the code multiple times to get the arduino and sensor functioning the way we needed it to. We also needed to keep critiquing our circuit. The main thing we realized is that our sensor needed to be adjusted so that it would work properly, the adjustment was we needed to connect two resistors with each other by a wire. Once we did this our sensor was working properly and displaying the proper results. This is a very big step towards the end of our project so we are glad to have completed this.

There were a couple of things we did not finish for the critical system analysis. The main feature we did not include is building the app that will display the sensor results. We just had our sensor measurements show up on the serial monitor so we knew it was working properly before worrying about sending the results to our app. The app has been started but will need more work to be completed. We will have the app completed by the end of this weekend. Once we have the app completed we just need to assemble the device on a pcb board and solder the components together. Therefore, based on the results from this prototype our group has made good progress and should have a completed product by the time our third prototype needs to be submitted.

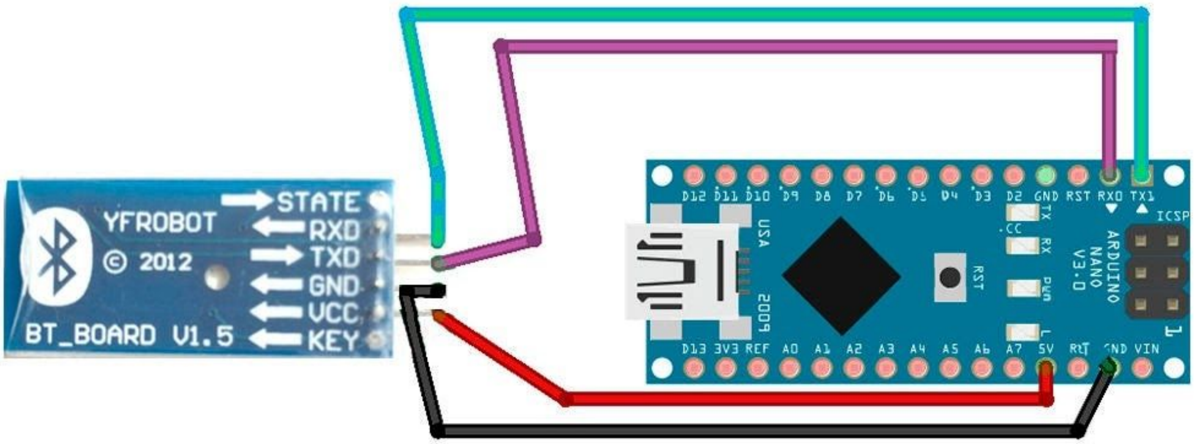
Conclusion

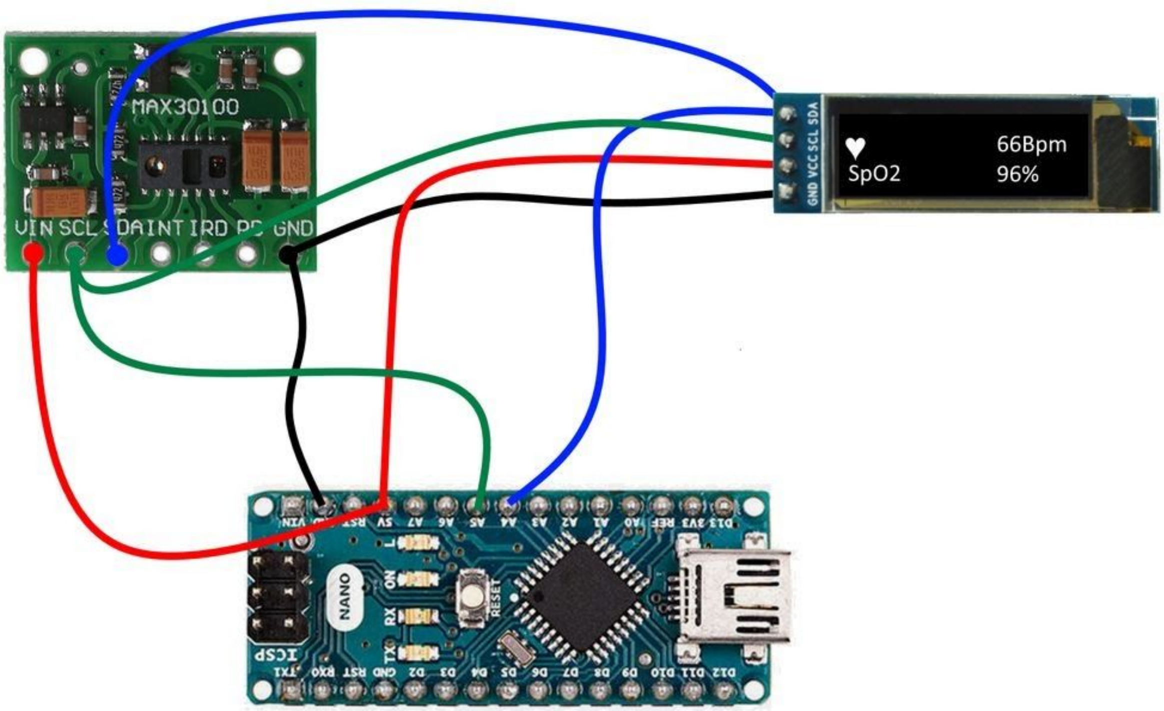
This report consists of the tests and results that were found in prototype II, customer feedback and what we are doing to address it, and what we plan on doing in the future to improve the overall quality of the device.

Appendix

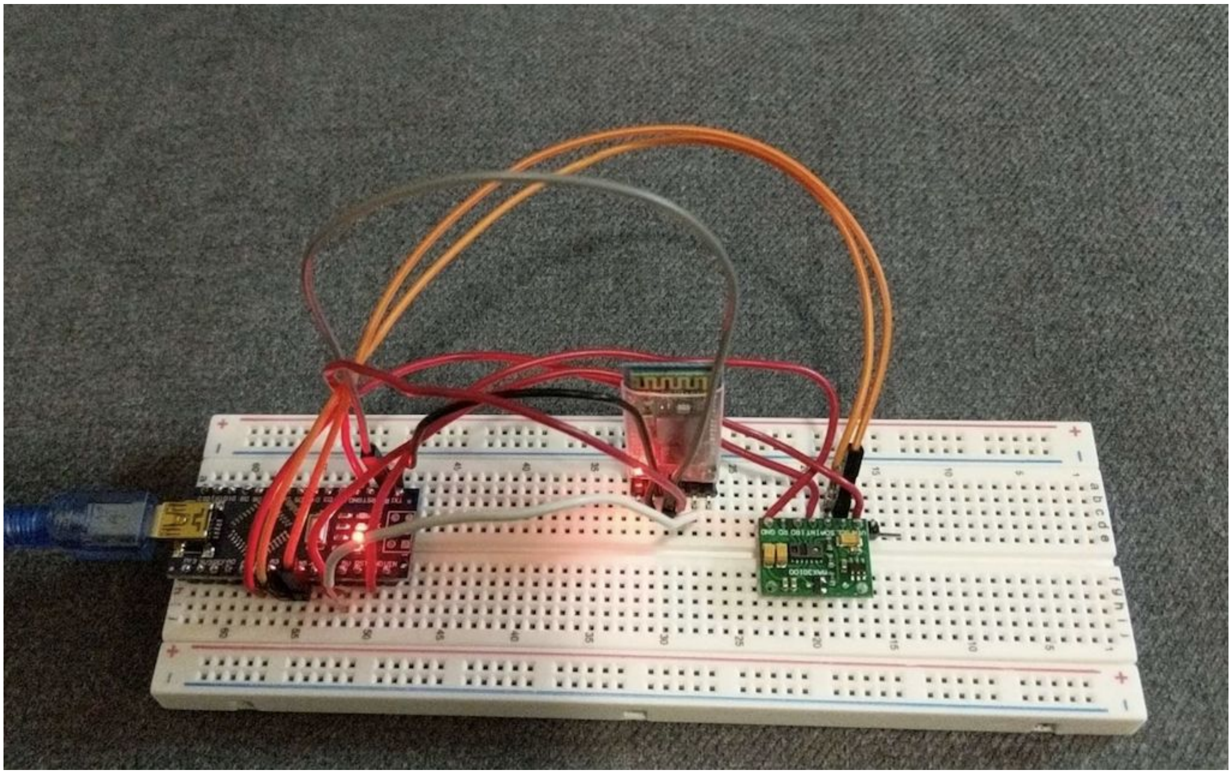
Wiring schematics:

Conceptual design





Actual design



Functioning arduino sketch

```
#include <Wire.h>
#include "MAX30100_PulseOximeter.h"

#define REPORTING_PERIOD_MS     1000

// PulseOximeter is the higher level interface to the sensor
// it offers:
//  * beat detection reporting
//  * heart rate calculation
//  * SpO2 (oxidation level) calculation
PulseOximeter pox;

uint32_t tsLastReport = 0;
```

```
// Callback (registered below) fired when a pulse is detected
void onBeatDetected()
{
   Serial.println("Beat!");
}

void setup()
{
   Serial.begin(115200);

   Serial.print("Initializing pulse oximeter..");

   // Initialize the PulseOximeter instance
   // Failures are generally due to an improper I2C wiring, missing power supply
   // or wrong target chip
   if (!pox.begin()) {
      Serial.println("FAILED");
      for(;;);
   } else {
      Serial.println("SUCCESS");
   }

   // The default current for the IR LED is 50mA and it could be changed
   //   by uncommenting the following line. Check MAX30100_Registers.h for all the
   //   available options.
   // pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);

   // Register a callback for the beat detection
   pox.setOnBeatDetectedCallback(onBeatDetected);
}

void loop()
{
```

```
  // Make sure to call update as fast as possible
  pox.update();

  // Asynchronously dump heart rate and oxidation levels to the serial
  // For both, a value of 0 means "invalid"
  if (millis() - tsLastReport > REPORTING_PERIOD_MS) {
    Serial.print("Heart rate:");
    Serial.print(pox.getHeartRate());
    Serial.print("bpm / SpO2:");
    Serial.print(pox.getSpO2());
    Serial.println("%");

    tsLastReport = millis();
  }
}
```

Sensor Readings