

UNDERWATER EXOSKELETON FOR DIVER ASSISTANCE

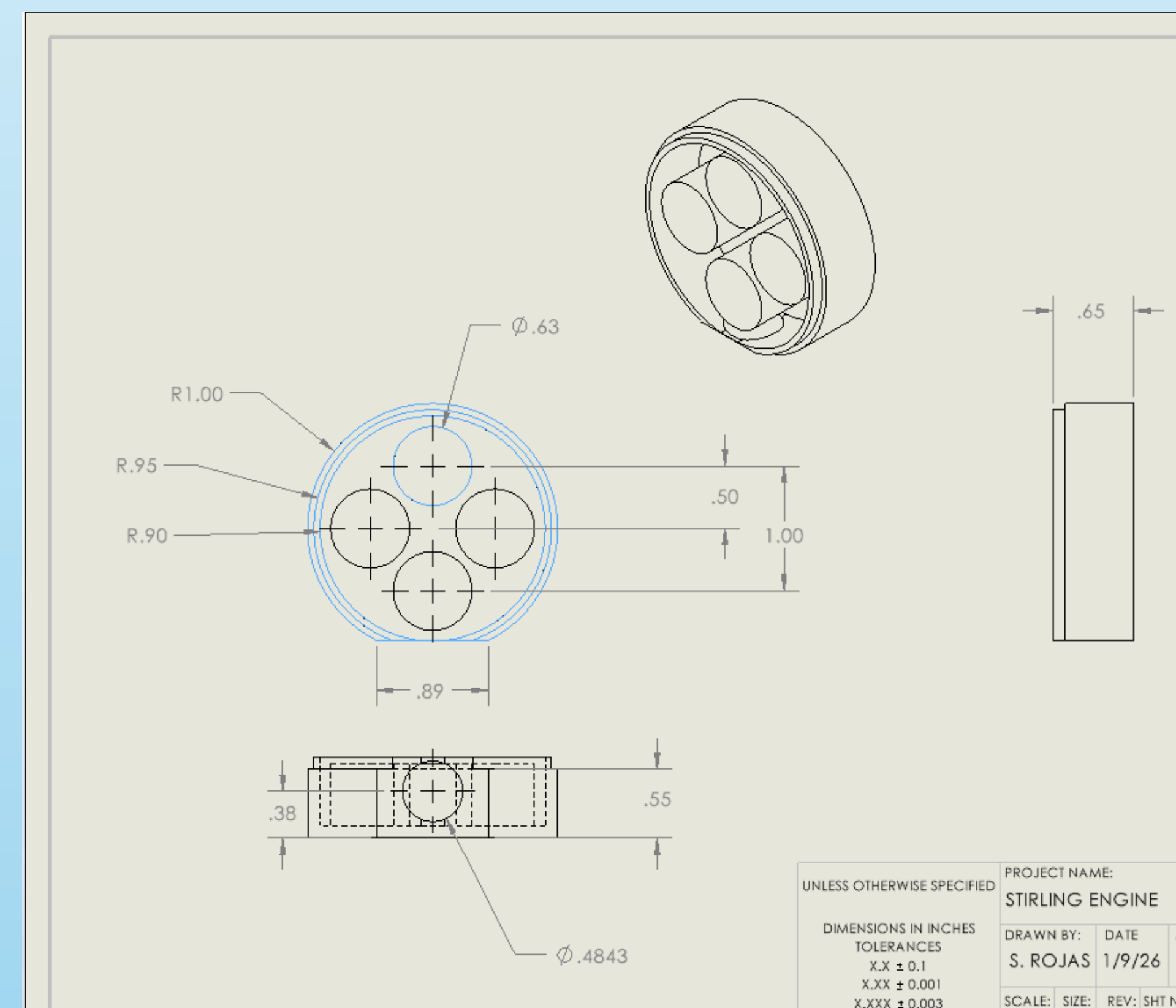
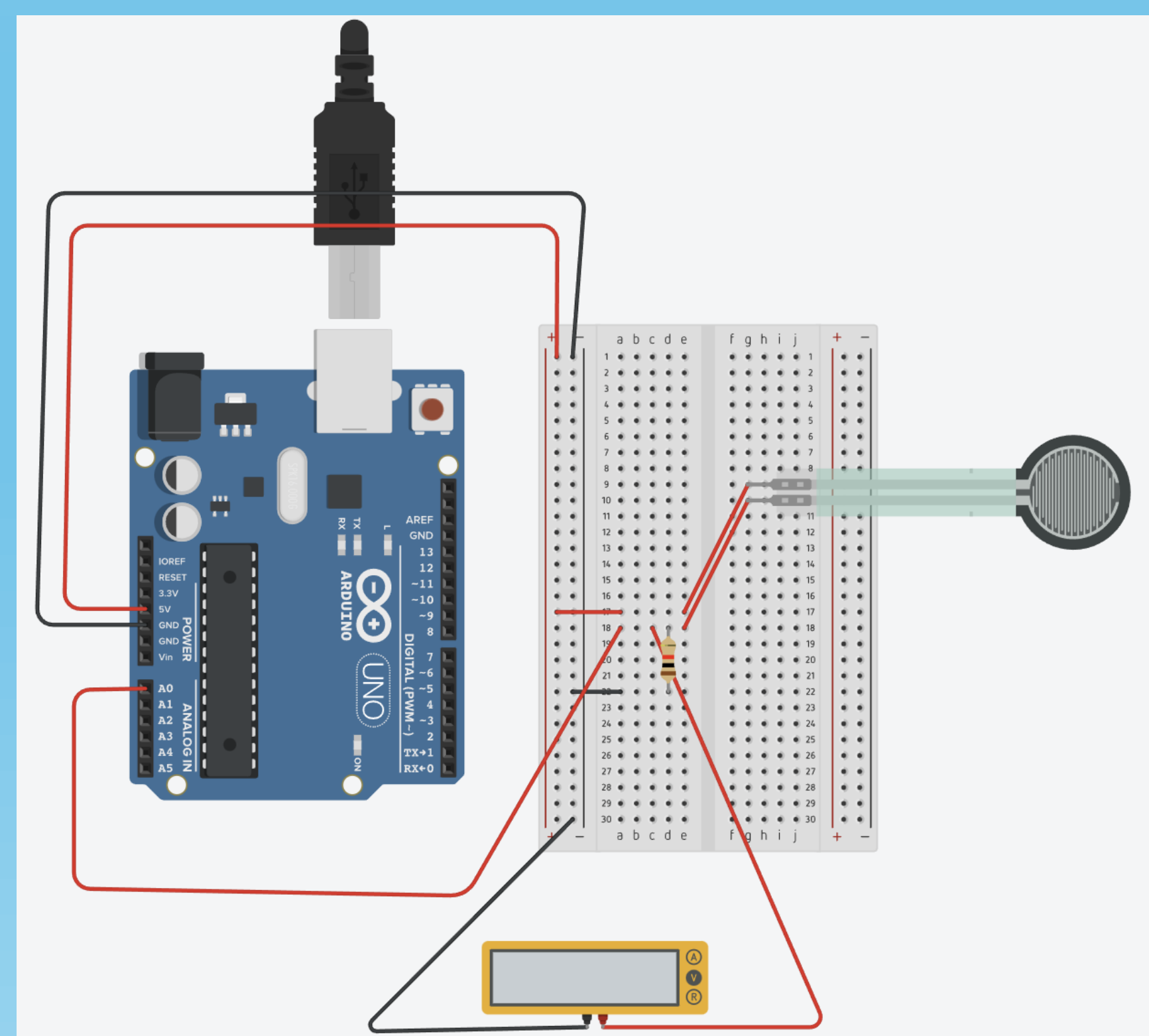
Marco Smith, Santiago Rojas and Dr. Higgins

ABSTRACT

In defining the basis of the research for this project, we sought to answer the question of, "How can we aid the general exploration and mobility of human pursuit in underwater environments, specifically with complex tasks through stabilization within rough currents. This research topic was specifically chosen due to a lack of attention and negligence within the industry regarding specific applications of underwater activity-like underwater welding. The research project revolved around the main components of research, brainstorming, concept development, and redesign. The Research phase consisted of a wide search for past underwater exoskeletons to find inspiration and attributable features. The following brainstorming involved dividing the tasks between the senior design team and the UROP team, funneling the new purpose to design a watch interface to control the output of the exoskeleton. To achieve this new directive, I started learning the basics of circuits and designed rudimentary systems for analyzing the effects of water pressure on touch sensors. Furthermore, breadboarding with Arduino was used to prototype the sensors that will go along with the wrist-attached interface with depth pressure tests reaching down to 100M.

INTRODUCTION

Within underwater travel, there are already some established inventions that aid underwater travel. Special underwater jetpacks and Diver propulsion vehicles are used to increase independent human travel speed and general directional movement. Furthermore, there already has been intensive research on being able to stabilize ocean currents when in water through HAUVs or Hovering Over-Actuated Autonomous Underwater Vehicles that utilize Sliding mode control. However, many of these commercial devices that aid in increasing underwater travel fail to aid in complex tasks or small adjustments that professions like underwater welding rely on and many of the HAUV type devices struggle to apply to human exoskeletons without altering the necessary components. The purpose of this research project is to then create an underwater exoskeleton that is capable of being both wearable and able to stabilize divers to allow for more complex tasks.



RESULTS

We had evaluated the performance and capabilities of the underwater exoskeleton but at this time of the research have a specific attention toward the wrist-interface's capabilities within water. Within measuring the force per area that the FSR touch sensors can withhold under different depths being 10kg, it was established that the maximum water pressure that could be applied to the FSR while having a perceivable change in force was found at <100 meters through the calculation:

$$\begin{aligned} \rho \cdot g \cdot h &= (997)(9.81)(100) = 978057 \text{ Pa} \\ 978057 / 10,000 &= 97.801 \text{ N/cm}^2 \\ 97.801 / 9.81 &\sim 10\text{kg} \end{aligned}$$

Meaning the maximum depth the buttons for the wrist-interface was reliable for had to be significantly higher than 100m to be accurate.

```

1  const int sensorPin = a; // Replace 'a' with the actual pin number
2  void setup()
3  {
4      pinMode(sensorPin, INPUT);
5      Serial.begin(9600);
6  }
7
8
9  void loop()
10 {
11     int sensorvalue = analogRead(sensorPin);
12     float voltage = sensorvalue * b / 1024 ; // replace 'b' with right voltage
13     float pressure = voltage * c; // replace c with conversion
14     Serial.print("Pressure is: ");
15     Serial.println(pressure);
16     delay(100); // moment between readings
17 }
18

```

METHODS

The subject of this research study is the underwater exoskeleton along with the wrist interface and its performance under increasingly realistic tests to assure its validity in real life scenarios. The aspect of this research that will be measured is the satisfactory and unsatisfactory performance of this device within an underwater environment. The research will further measure the accuracy of the wrist interface in communicating actions toward the exoskeleton. The study is conducted through practical test such as measuring performance and input at different depths going to 100M in a pool. The analysis that was conducted include the influence the water pressure has on the touch sensors and adjusting for said values along with the amount of force each touch sensor produces on the exoskeleton.

CONCLUSION

This project not only showed an in-depth application of the accommodations for external factors on hardware, but an additional step toward the innovation of more capable and complex merging of robotics and human skill that is culminated within the UI of the exoskeleton.

As for the future of this project, the research will stretch on within its development of the exoskeleton wrist-interface along with testing its practicality within real-world applications via

RESOURCES

- Scaradozzi, David ; Sorbi, Laura ; Zingaretti, Silvia ; Biagiola, Matteo ; Omerdic, Edin 22nd Mediterranean Conference on Control and Automation : 16-19 June 2014, 2014, p.664-669
- G. Canales-Gómez, G. León-González, N. Jorge-Muñoz, J. H. Arroyo-Núñez, E. D. Antonio-Yañez, and R. S. Núñez-Cruz, "Communication system based on magnetic coils for underwater vehicles," *Sensors*, vol. 22, no. 21, p. 8183, 2022, doi: 10.3390/s22218183.