

Under Water Exoskeleton for Diver Assistance

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Abstract

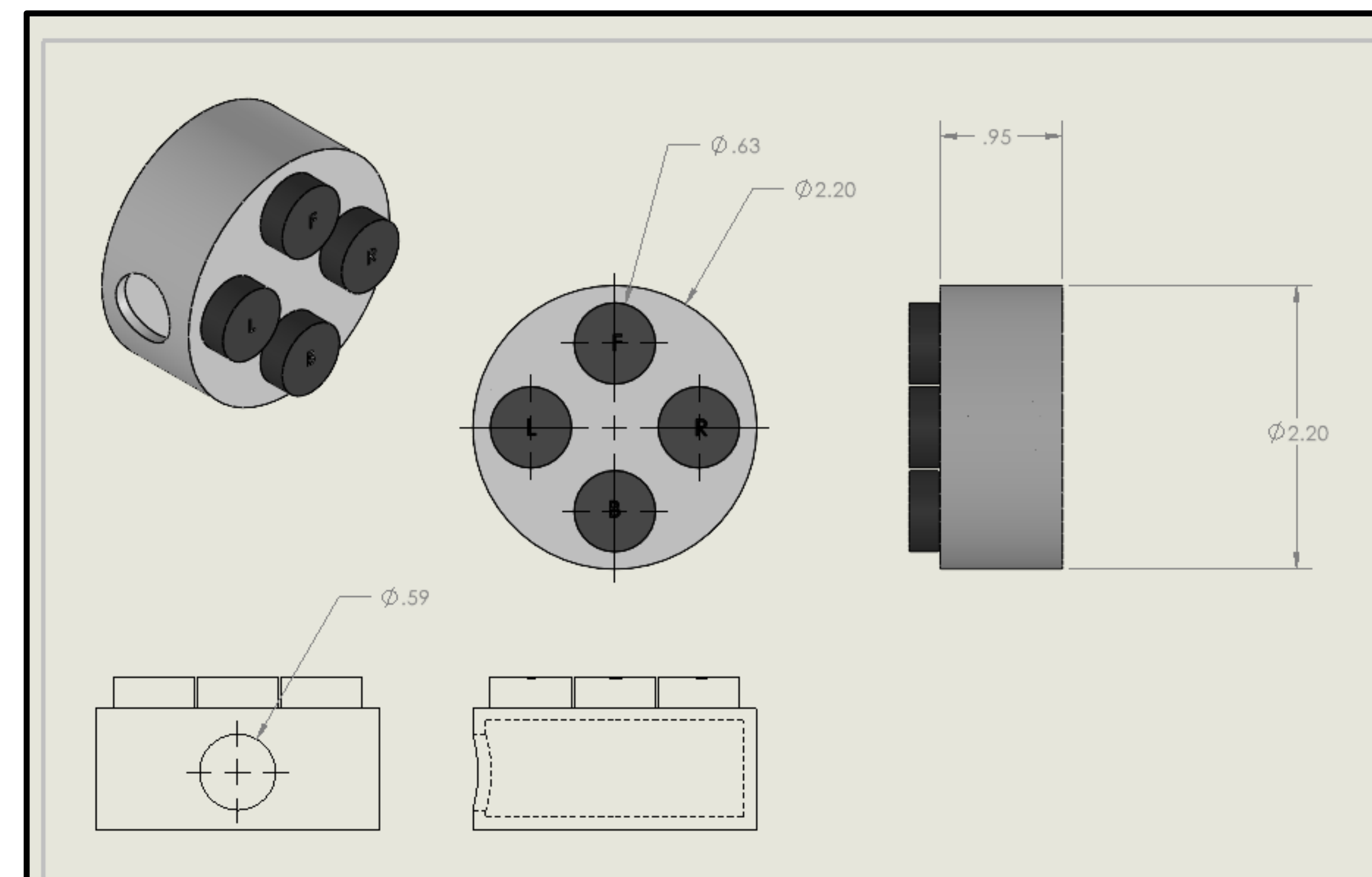
This research investigates the design and preliminary development of a waterproof, wrist-mounted human-input device for controlling an underwater diver-assist exoskeleton. Wearable electronic control systems must withstand pressure and liquid exposure while maintaining reliable performance, making waterproofing a critical design challenge¹. The project aims to improve diver mobility during underwater research and exploration, where currents and other environmental resistance can increase drag and fatigue, resulting in limited movement. An extensive literature review informed system requirements such as signals underwater³ and design decisions. Using computer-aided design (CAD), a digital prototype of the control interface was developed. Results indicate that compact, wearable electronic control systems for underwater exoskeletons are feasible, with future work focusing on physical prototyping, waterproof testing², and human-subject evaluation.

Introduction

- Underwater divers experience increased physical strain due to hydrodynamic drag, water currents, and restricted mobility, which can reduce endurance during prolonged dives.
- Current underwater assistance technologies mainly consist of propulsion systems to assist with forward movement – none currently address the problem of station keeping.
- Although wearable exoskeletons are well studied for terrestrial applications, compact wearable underwater systems remain limited due to challenges in waterproofing, signal transmission, and user comfort.
- This project investigates a small-scale, wearable underwater exoskeleton control interface using a waterproof force-sensitive resistor (FSR) input system.

Methods

- Conducted a literature review of prior research on wearable exoskeletons and underwater robotics.
- Designed a force-sensitive resistor (FSR) input system for user control.
- Added FSR with a microcontroller for signal processing.
- Encased electronics in a waterproof housing to prevent water intrusion.



SolidWorks design with dimensions in inches



3D printed prototype with additional pieces

Results

- Design is on-going to appropriately incorporate all components and then ensure waterproofing
- Once the design is more finalized, it will undergo underwater testing at various depths to make sure that input signals are robust ever at depth

Conclusions

- We will soon be testing a waterproof force-sensitive resistor input system can reliably transmit control signals in submerged conditions.
- Results demonstrate the feasibility of a compact, wearable control interface for underwater exoskeleton applications.

Future Research

- Fully integrate the user-input device herein with the station-keeping system developed by a different group.



Picture shows a FSR that will be used inside the design

References

- [1] H. Xia, M. A. Khan, Z. Li, and M. Zhou, "Wearable robots for human underwater movement ability enhancement: A survey," *IEEE/CAA Journal of Automatica Sinica*, vol. 9, no. 6, pp. 967–977, Jun. 2022.
- [2] A. Manzanilla, P. Castillo, and R. Lozano, "Nonlinear algorithm with adaptive properties to stabilize an underwater vehicle: Real-time experiments," *IFAC-PapersOnLine*, vol. 50, no. 1, pp. 6857–6862, 2017.
- [3] Y. Z. Li *et al.*, "Magnetic induction-based underwater wireless communication systems: A review," *Sensors*, vol. 19, no. 18, 2019. Available: <https://pmc.ncbi.nlm.nih.gov/articles/PMC9655287/>