Adaptive RC Sailer Enhancement Project

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Background

Nearly 60% of spinal cord injuries in the U.S. result in diminished use or complete loss of control of voluntary limb movement. When all four limbs experience paralysis, it is known as *quadriplegia* [1]. As a result of these injuries, the individual may voluntarily move from their neck up. Currently, mainstream RC sailing methods lack the functionality to allow quadriplegic individuals to participate. This project seeks to aid those affected by these devastating injuries by making the recreational activity of RC sailing accessible at a low-cost.

Problem Statement

Within the RC sailing community, quadriplegics lack representation in terms of a compatible controller. To best suit most quadriplegic individuals, the controller for the RC sailboat will utilize voice controls that coincide with discrete position commands to adjust the sails and rudder of the boat.

Requirements

- ☑ Inexpensive (Overall Cost less than $75)
- ☑ Standalone system
- ☑ Improved on previous years' work.
- ☑ Adhered to IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0Hz-300GHz

Methodology

The objective of this project was to implement discrete rudder and sail positions. To accomplish this, we developed a device that interprets voice commands, associates them with pulse width values, then converts them into a pulse position modulation signal transmitted to the sailboat via a connected FlySky transmitter..

The device is composed of an Arduino UNO, Elechouse Voice Recognition Module V3, S-Video port, indicator LEDs, and a voltage divider. The code takes indexed voice commands received from the voice module and groups them into either a sail, left rudder, or right rudder group. These are associated with PWM values, converted to PPM, then sent to the transmitter to be sent to the sailboat.

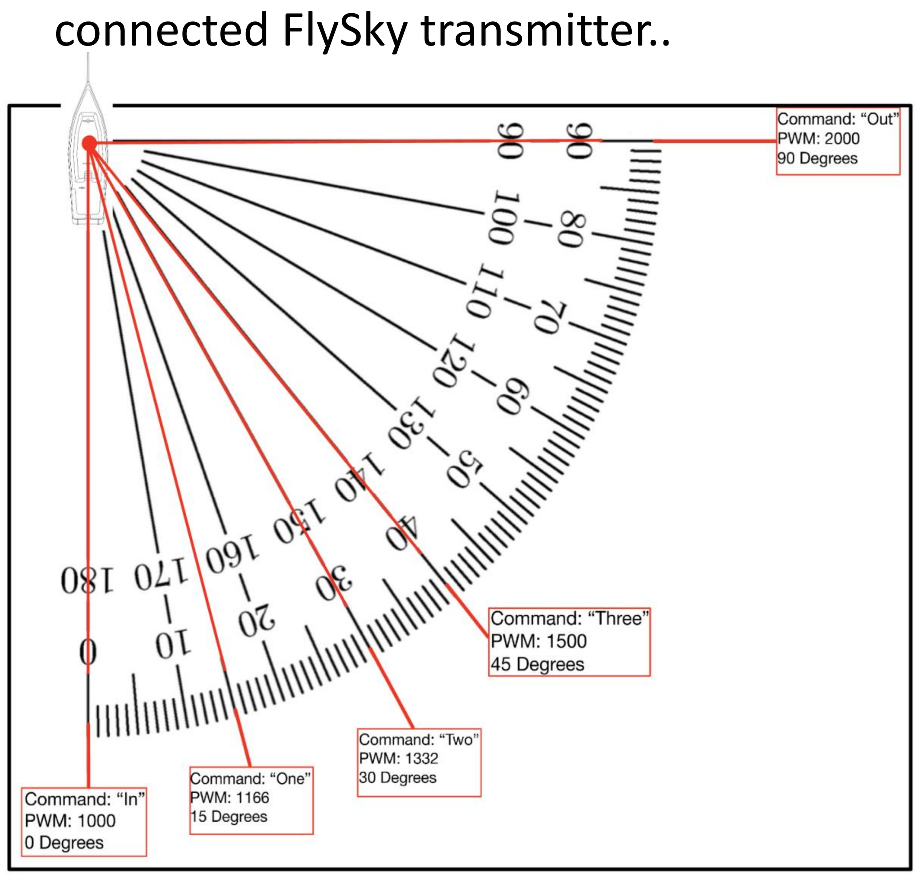


Figure 1: Sail Command Diagram

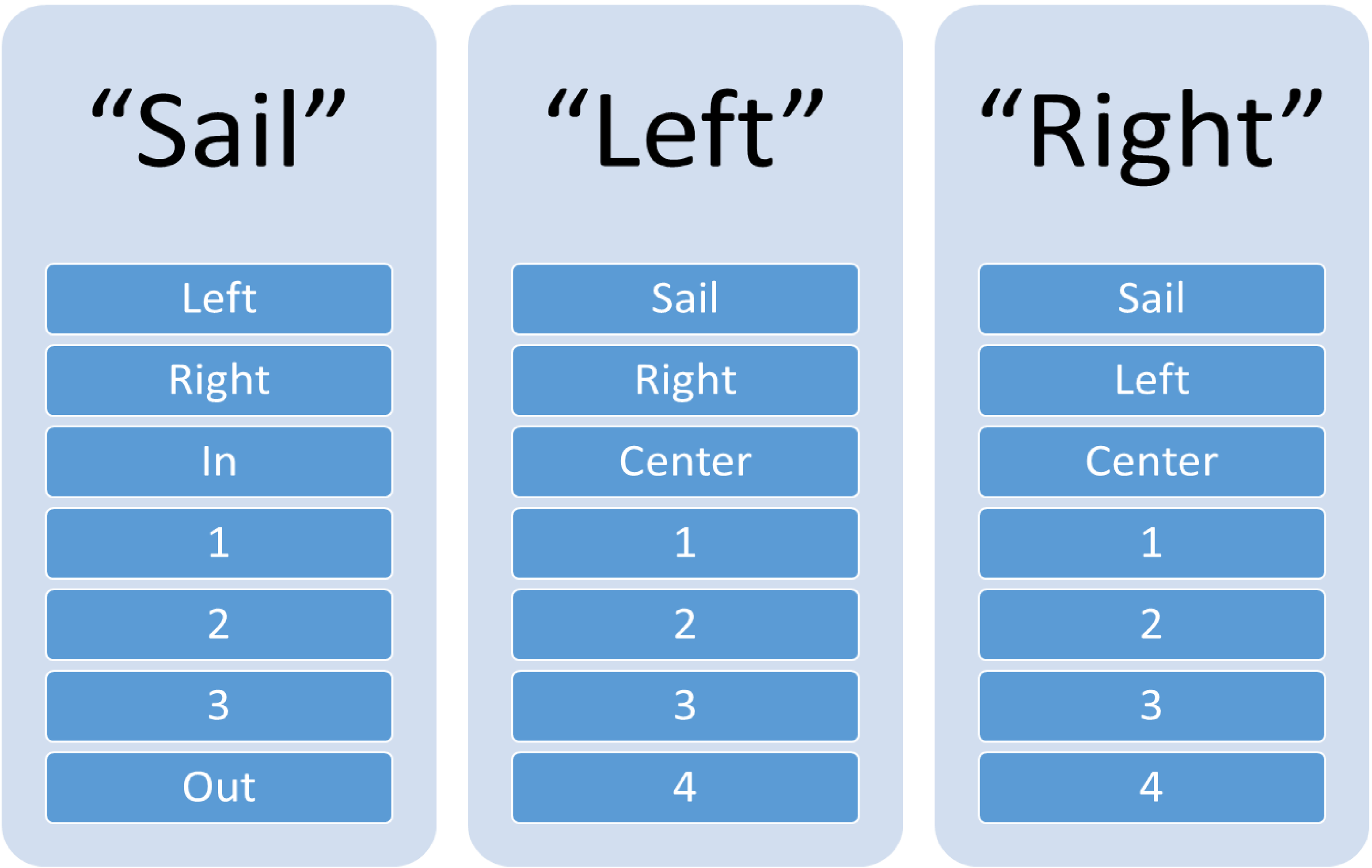


Figure 2: List and Groupings of Commands

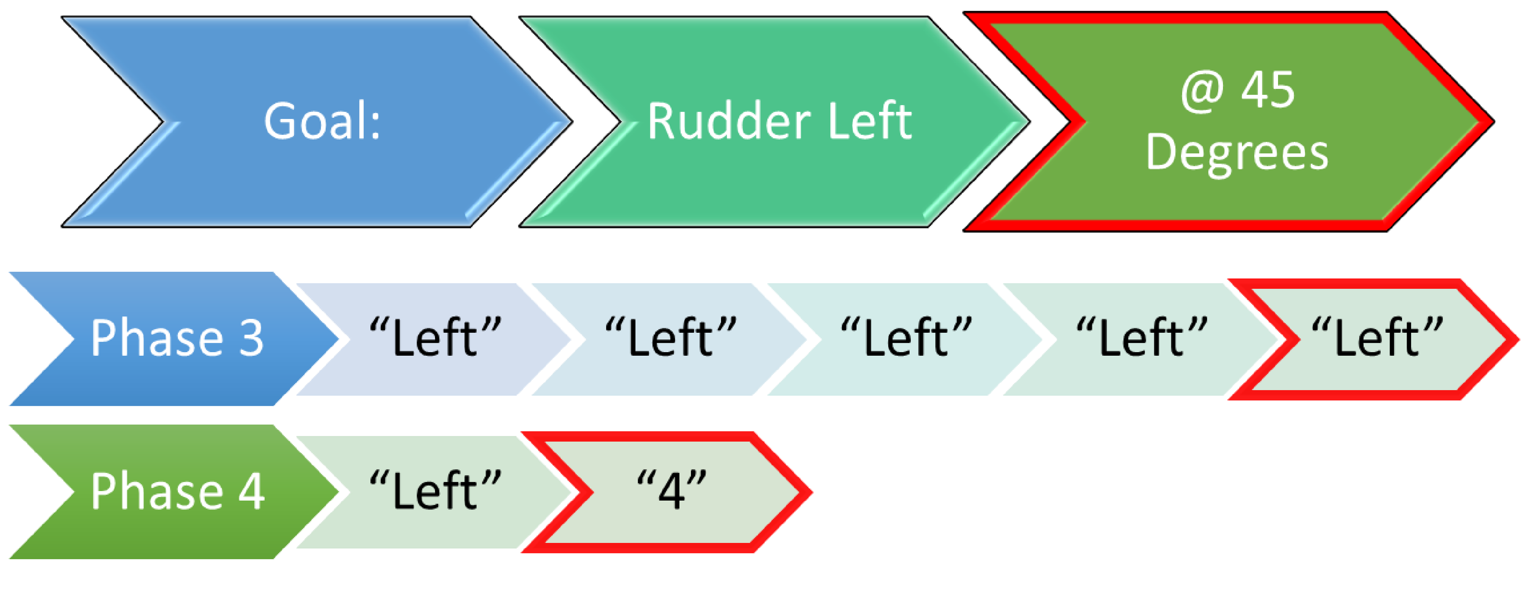


Figure 3: Comparison of Phase 3 to Phase 4

Results

The results from Phase 4 are a functionally improved design and code for the stand-alone device. These improvements have kept the price of device overall to stay within the $75 threshold. The improved code significantly reduces the number of commands required from the user to accomplish a task, as shown in Figure 3. The improved design is more compact than previous Phase's. The cost to replicate this device with the prices of the components shown in Figure 4.

"Miscellaneous components" include the resistors, LEDs, connector pins, and the MDC-4-01.

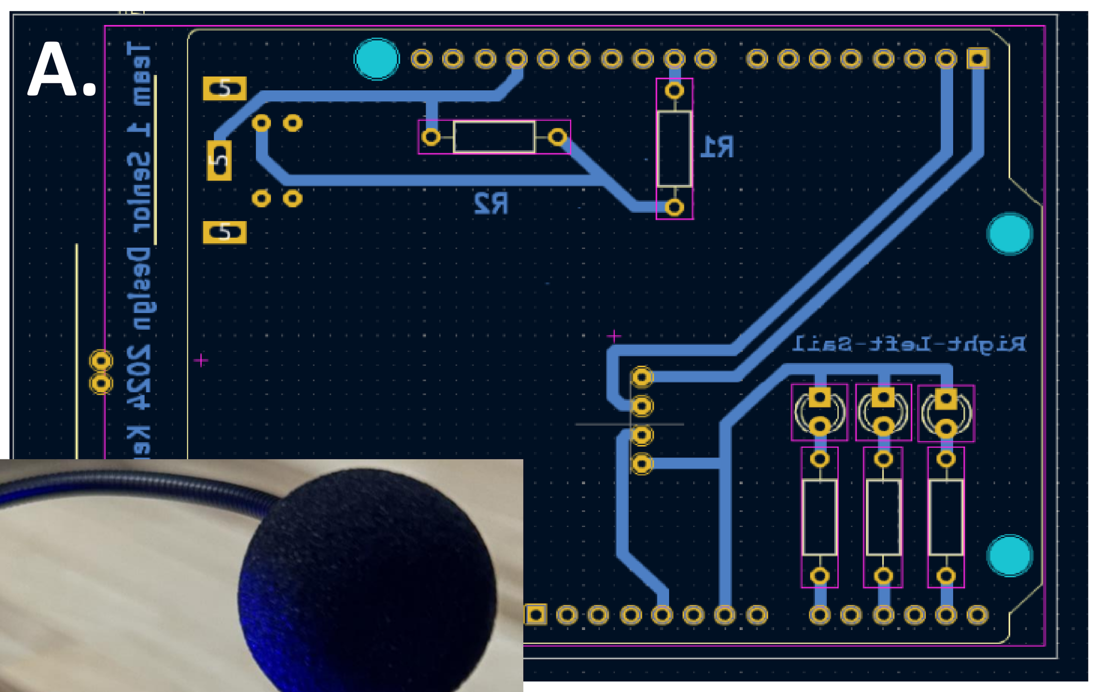
The custom PCB board was produced in-house, but ideally a third-party manufacturer could produce one for ~$5.

Part/Device	Cost
Arduino UNO REV3	$27.60
Elechouse Voice Recognition Module V3	$29.99
Miscellaneous Electrical Components	$5.00
Custom PCB	~$5.00
Total	$67.59

Figure 4: Final Costs

Final Prototype

Figure 5A. shows the final layout of the Printable Circuit Board (PCB) used in Phase 4 with labeled pin holes for ease of construction.



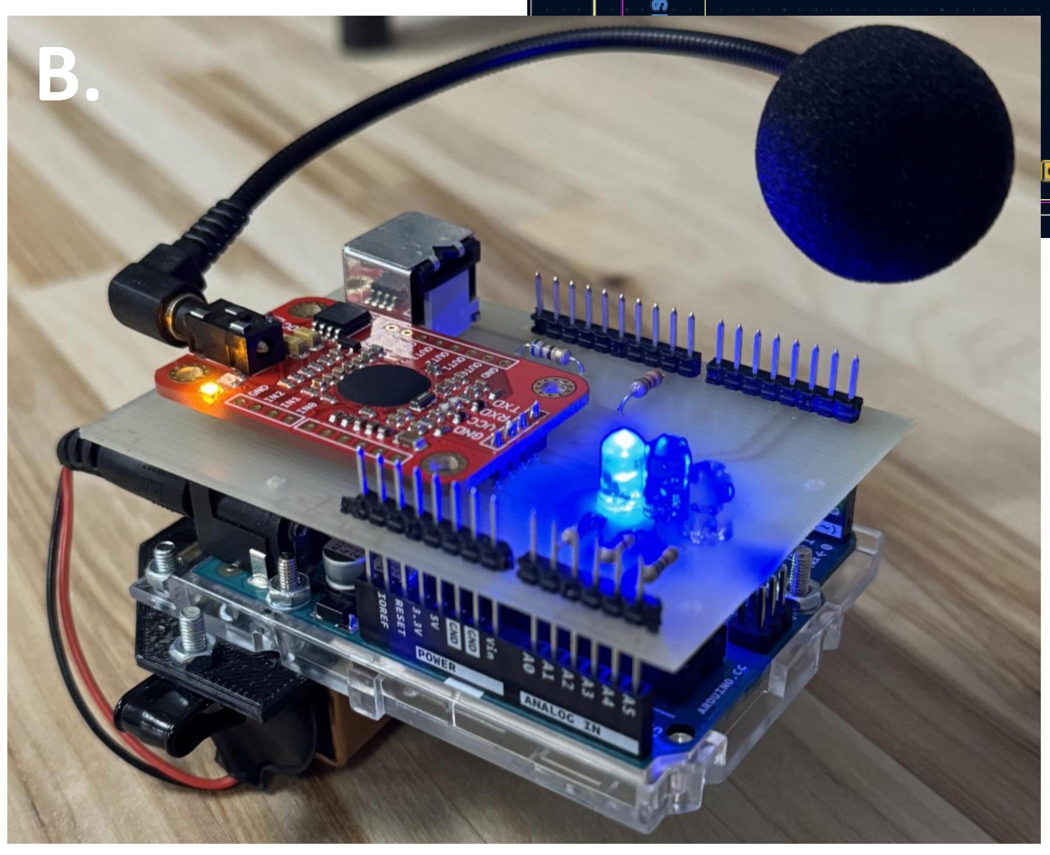


Figure 5B shows the completed stand-alone device when the PCB is plugged into the Arduino UNO with the microphone and powered via 9-volt battery.

Discussion

While the current design is an improvement over previous Phases, further improvements can be made to the device. One of these improvements includes the development of an encasing for the device to further the functionality in a practical setting. Another future improvement is to make the voice recognition module compatible with other microcontrollers, such as the Arduino Nano RP2040 CONNECT or Raspberry Pi Pico. An alternative to this effort would be to implement the Arduino Speech Recognition Engine instead of the dedicated voice module. Finally, future efforts should improve upon command recognition under ambient noise.

Conclusion

In conclusion, what will be provided to the client is a working prototype that improved upon the work of the from previous Phases. Phase 4 saw the implantation of two working methods of turning voice commands into discrete rudder and sail positions. This is an improvement upon Phase 3 which used compounding vocal ques to achieves the same results. Deliverables for this project include an assembled device prototype, a written user manual, an instructional voice module training and coding video, copies of the Gerber files for the PCB board, all code files, and a copy of the final report.

Acknowledgments

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References

[1] Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines. (2004). https://www.govinfo.gov/content/pkg/FR-2004-07-23/pdf/04-16025.pdf

[3] "IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz," in IEEE Std C95.1-2019 (Revision of IEEE Std C95.1-2005/ Incorporates IEEE Std C95.1-2019/Cor 1-2019), vol., no., pp.1- 312, 4 Oct. 2019, doi: 10.1109/IEEESTD.2019.8859679.