AIMM

Mechanical and Aerospace Engineering

Students: Nathaniel Acres, Garrett Adams, Shelby Altman, Mason Bledsoe, Mason Custer, Mitchell Dickman, Roger Ellyson, Cole Goodman, Coltin Haylett, Brogan Jones, Kyle Kirtley, Asher Markitan, Alexander Menelli, Daniel Siebeneck, Trenton Vanderkuyl

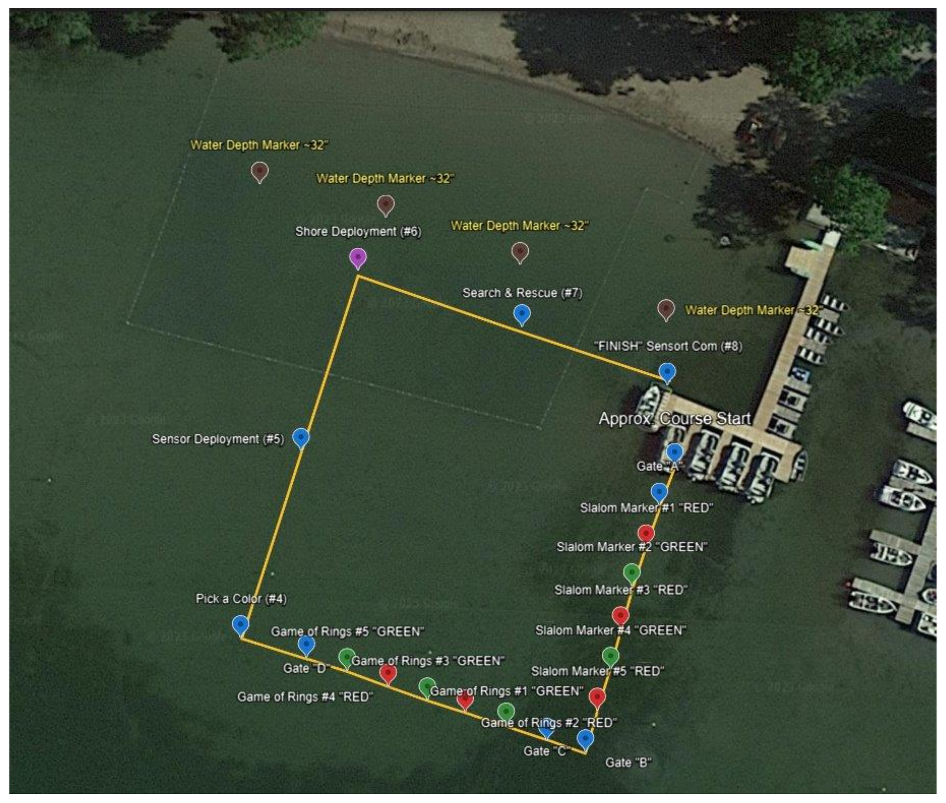
Advisors: Dr. Andrea Mitofsky, Dr. Rizacan Sarikaya, Dr. Kendall Teichert

Abstract

The Mechanical Engineering Department representing Trine University for the Artificial Intelligence Maritime Maneuver (AIMM) Indiana Collegiate Challenge (ICC) designed and developed a device to collect rings off buoys along a course and retrieve an object from the water safely. The team brainstormed and developed concepts for different subsystems for the device. Once the best system was chosen for the device, the team went through multiple iterations from gathering information from finite elemental analysis, real life material testing, prototyping, and computational fluid dynamics. Based on the testing and calculations the device chosen to complete the tasks mentioned earlier was a crane. Once the final iteration was designed, the team manufactured the crane and mounted it to the low-profile vehicle (LPV). Once the team had the crane securely mounted, the team worked with the Electrical and A.I. departments to clarify whether the crane was communicating with the rest of the systems on the boat. Once the mechanical team goes through multiple tests with the full team, including dynamic testing whilst mounted to the boat, the team will go to Pokagon State Park in Angola Indiana for the AIMM ICC.

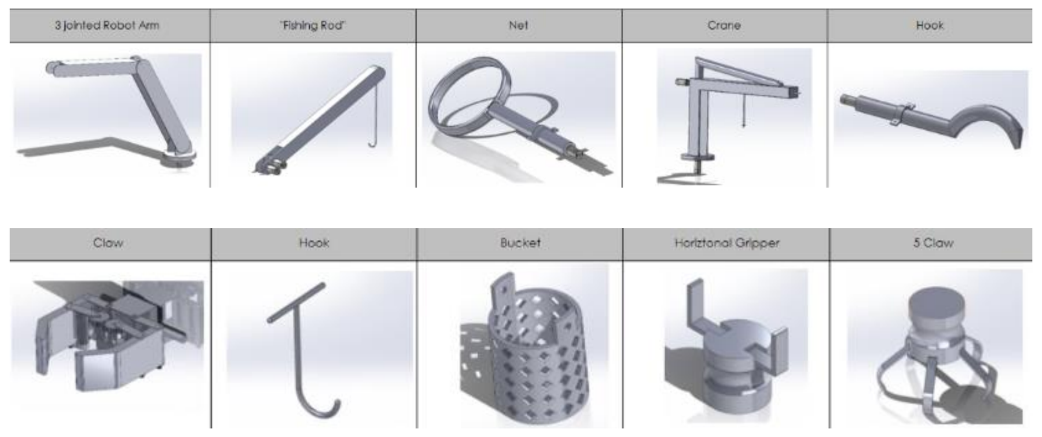
Customer Needs and Requirements

- Collect five rings off buoys along a slalom course
- Five rings with a 5-3/4'' outer diameter and 3/8'' cross-section
- Pick up baby-like mannequin and return it to the dock
- Mannequin dimensions are 26'' x 9'' x 8'' and weighs 6-12 lbs



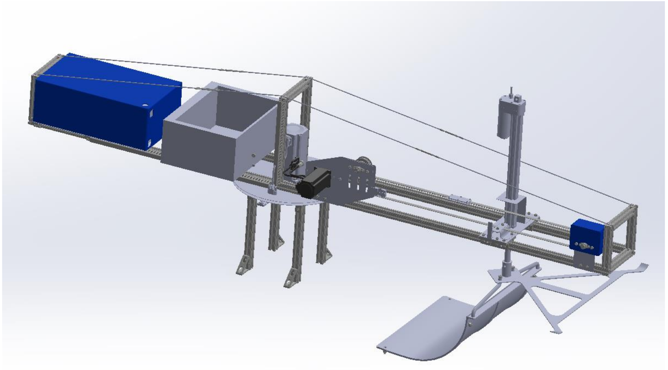
Concept Selection

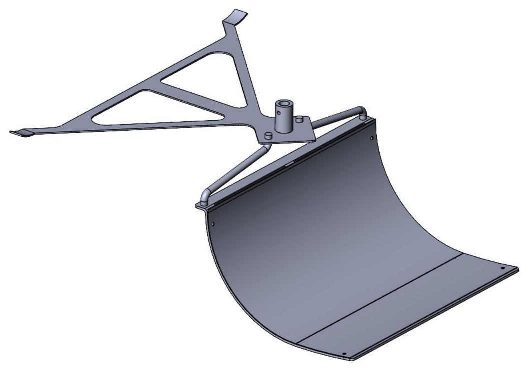
Using the customer needs and requirements, the team chose to look at different geometries of arms (robot arm, fishing rod, net, crane, and hook) and tools (claw, hook, bucket, horizontal gripper, and 5 finger claw) that could complete the required tasks. After considering the following criteria for the arm: cost, maneuverability, manufacturing time, size, object release capability, and weight, the team decided a crane was the best design. After considering the following criteria for the tool: cost, grip, manufacturing time, weight, and how it would be integrated to the arm, a combination of the hook and bucket was used.



Design Solution

After multiple iterations, the team chose a 4ft arm on one half of the crane which holds the tool, and a 3ft arm for the counter-balance side which holds the electrical components. This was designed based on the width of the boat and the estimated weight of the components on either side of the crane. The linear actuator has a stroke length of 14 inches, while the legs mounting the crane body to the LPV are 12 inches. The tool with the net adds another 12 inches of reach into the water. The net part of the tool curves upward so the mannequin would not fall out of the tools grasp. The two prongs of the tool was designed to hook onto the rings while passing each buoy. The prongs are curved upward to ensure the rings will not fall off whilst the LPV is in operation.



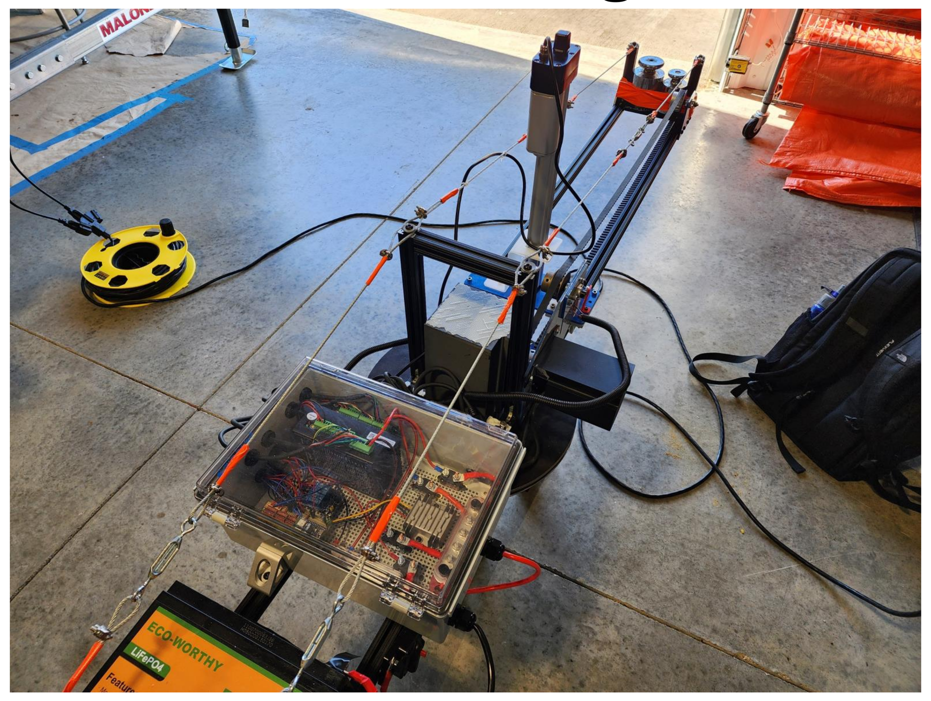


Manufacturing

Geometry

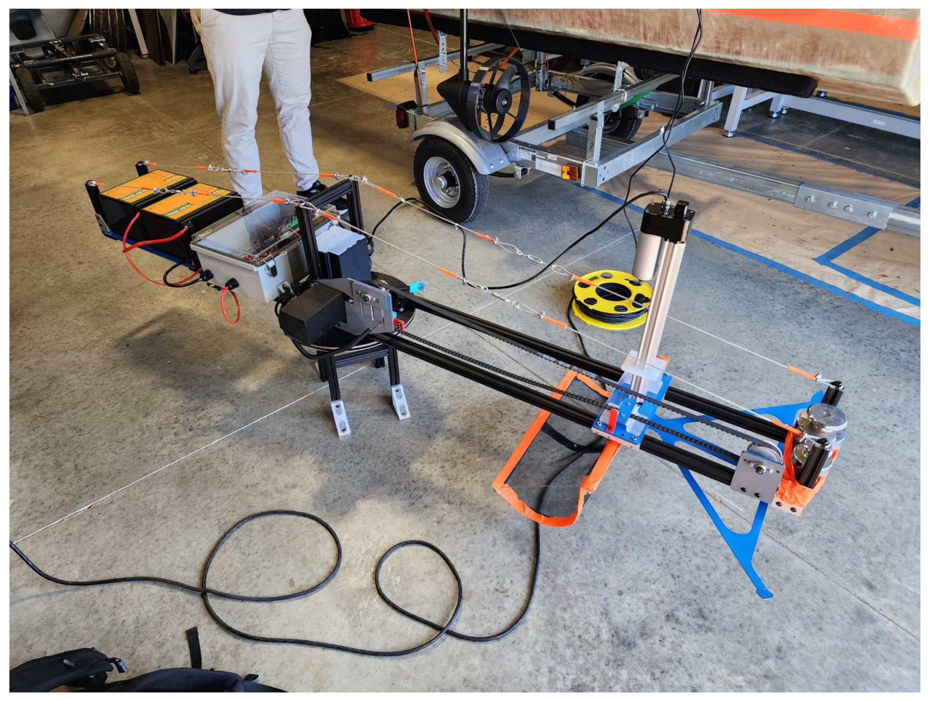
The team manufactured the geometry of the crane using 80/20 extruded aluminum. The 1st iteration was manufactured with wood to check mounting points. The final iteration was manufactured with steel.

Electrical Integration



The team included a waterproof box with all electrical circuits installed inside. Both stepper motors are mounted and the linear actuator with the belt and pulleys installed. Two batteries in series are installed next to the electrical box.

Full Assembly



Fully iterated with all electrical components and geometry. The tool with pongs angled out for ring and mannequin rescue. All degrees of freedom can be controlled manually with a controller.

Testing and Validation

Test 1: Full Geometry

- Once the geometry was manufactured and assembled, the team added weight to the end simulating the mannequin. This test was validating FEA simulations.

Test 2: Electrical Integration

- After the geometry was validated, the ME department worked with the EE department to install and integrate all electrical components, including motors and batteries.

Test 3: Water Testing

- Once the electrical components were integrated to the geometry, the team tested the crane at Fox Lake simulating competition conditions.

Acknowledgments

As the Trine team worked on the project, there were a few organizations and people that helped to reach a fully developed design. A special thanks goes out to the Trine faculty and staff that advised the team during the design and manufacturing phase. Another thanks goes out to the Crane advisors that gave the team the project to work on and helped with many decisions, competition or creative-wise, giving the team many opportunities to ask questions for clarity. One last thanks goes out to the Steuben County YMCA, particularly the aquatics director Steve Lake. Steve allowed the team to run crucial tests in the YMCA pool, when weather prevented the team to test in local bodies of water.