Lionfish – Phase V Major Qualifying Project

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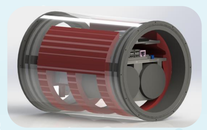
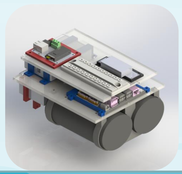
Abstract

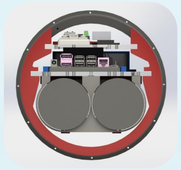
Lionfish, a species of venomous fish indigenous to the Indo-Pacific Ocean, are an invasive species along the southeast coast of the United States and the Gulf of Mexico. Due to the absence of any natural predators, their exponential rate of reproduction, and their ability to survive in a wide range of habitats, their population has been growing rapidly in the Atlantic Ocean. As a result, they are destroying the coral reefs and fish that live in and around the reefs, thus damaging the local ecosystem. The Lionfish MQP aims to mitigate the spread of the lionfish population by creating a remotely operated vehicle (ROV) to harvest lionfish. This year's team plans on expanding and improving the work done by the previous iterations of this project. The team's focus is to design and implement new spearing design, employ machine learning and computer vision to detect lionfish, and implement autonomous underwater navigation.

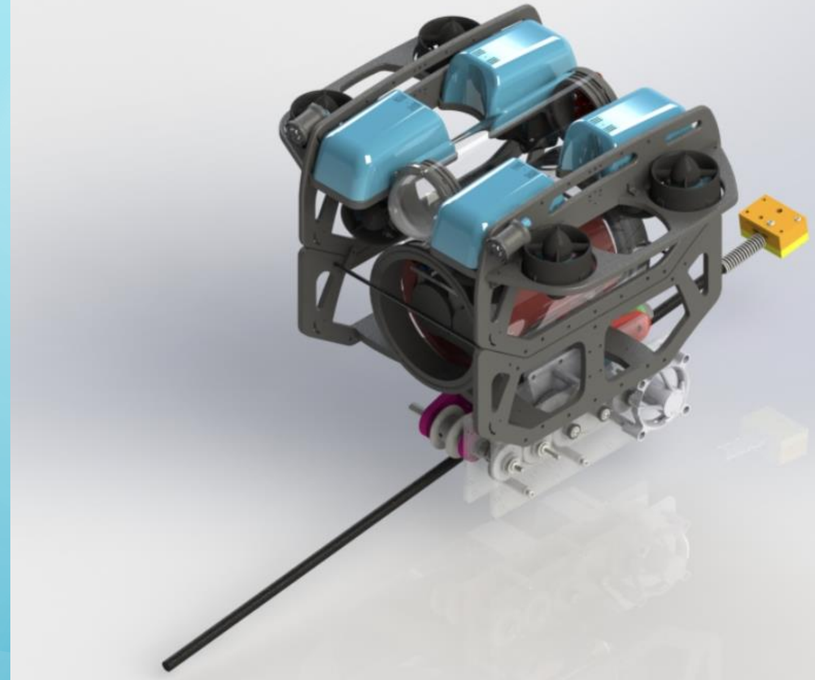
Electronics Redesign

- Original internal chamber design was very difficult to work with and suffered from poor construction
- The redesign emphasizes serviceability
- Two shelves of electronics can be slid out of either end once the outer steel bulkhead plate is removed
- Batteries can also be removed for recharging without removing the shelf they hang from



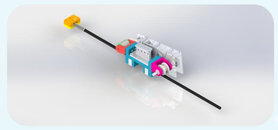






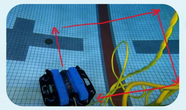
Spear Mechanism

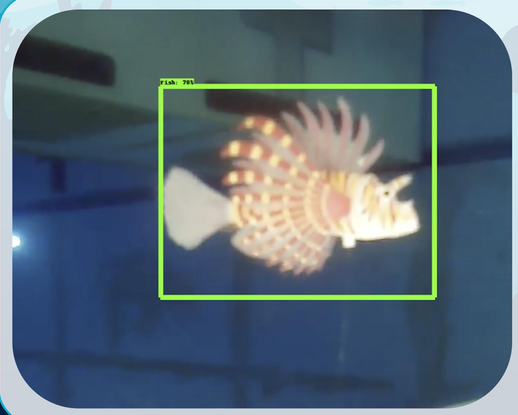
The spear mechanism we designed is very loosely based on the same principles as crossbows, pole spears, and Hawaiian slings, drawing inspiration from the original spear mechanism design of Phase I. Much like Phase I's design, a spring-loaded shaft is driven backwards using a BlueRobotics motor and a custom gearbox. However, instead of being driven forward with the gearbox, this design utilizes a 2-stage shifting gearbox to allow the spear shaft to be locked in place or shot forward with the full force of the constant force spring. In addition, instead of having detachable spearheads, this design uses one reusable spearhead and will be fully integrated with a containment mechanism in the future.

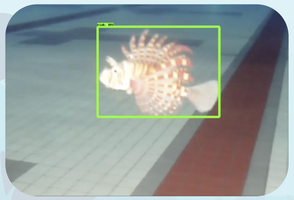


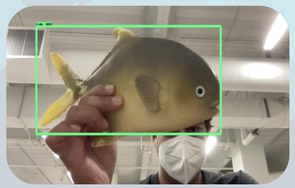
Movement Control & Navigation

- Autonomous navigation can use two movement command and control structures.
- RC control is based on RC channel commands imitating manual control using joysticks.
- The vector control is based on drone code so compatibility issues have plagued the progress in this mode of control.
- The current mode used during autonomous navigation is RC channel.
- The navigation is simple: the robot will search in a square pattern at subsequently deeper depths.









Computer Vision and Object Detection

- Employed the top module camera for object detection
- Trained machine learning model using TensorFlow to detect Lionfish
- Construct a bounding box around the identified object with a confidence output

Results:

- Attained a confidence level of 97%
- Program dynamically tracked the object in real-time with no significant drop in frame rates