Autonomous Lionfish Hunting Robot

Members: Cray Johnson (RBE), Lokesh Gangaramaney (RBE), Matt Ferreira (RBE), Leonardo Go (ME)
Advisors: Craig B. Putnam, Bradley A. Miller, William R. Michalson

Abstract

Indigenous to the western Pacific, lionfish are an invasive species which have been wreaking havoc along the coasts of the western Atlantic. The rapid reproductive cycle of these fish combined with the fact that they have no natural predators in the Atlantic Ocean has made them a considerable threat to the local ecology. Current methods of combating the invasive lionfish have seen little to no results. This is the fourth year that students from WPI have collaborated to develop a robotic solution to help curb the exploding lionfish population. This year's focus was on developing a stereo vision system capable of detecting an object and determining its distance, an improved navigation system which incorporates PID control, as well as a revised design for the harvesters' container.

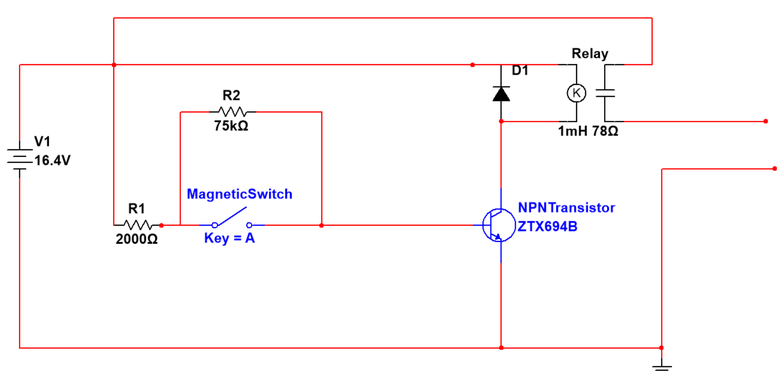
Objectives

Our objectives are:

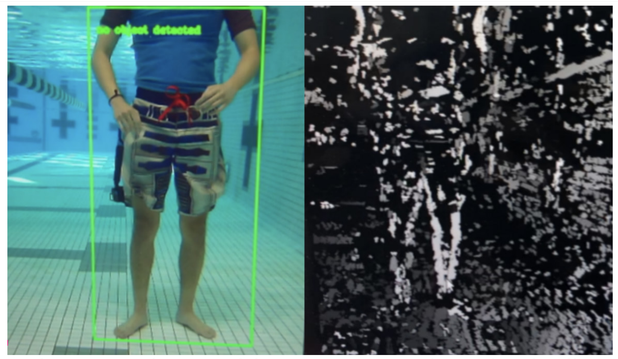
- Stereovision
  - Recognize and distinguish object
  - Determine how far the object is
- Navigation
  - Control robot through code to move forward, backward, up, down, and turn specific angles
  - Combine with stereovision to move to objects detected
- Harvesting mechanism
  - Create container for lionfish to go with the least amount of drag added to robot
- Electronics
  - Be able to turn on and off robot without needing to open pressure chamber

Electronics

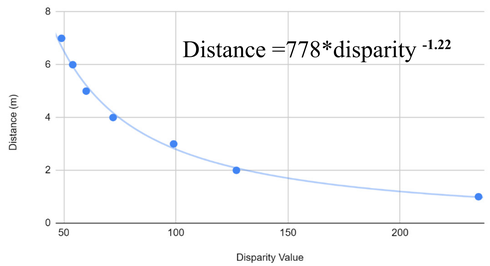
We wanted to be able to power the robot on and off easily without opeing up the pressure chamber and we decided to use a magnetic switch as that could reach through the acryllic of the chamber. Magnetic switches can't handle the 90A output of the batteries, so we used a relay and controlled it using the magnetic switch and a transistor to control the current going through the Relay's coil. Before building the circuit we first modeled the circuit in Multisim. The latching magnetic switch and relay that were used were unable to be simulated perfectly due to their complexity. After getting the simulation working we then built and tested it with lab power supplies and then implemented it onto the robot when it worked.



Stereovision



For the project we used stereo vision as a means to determine the distance from the robot to other objects. This process works by taking images from two different cameras located on the front of the robot and comparing them. Corresponding pixels are matched between the two images and the difference in the position of these pixels are calculated. This difference is known as the pixel's disparity. Objects that are closer will have higher disparity values than those that are farther away. The right side of the image above shows the disparity map for the image shown on the left side. Lighter areas denote higher disparity values, and so indicate closer objects.

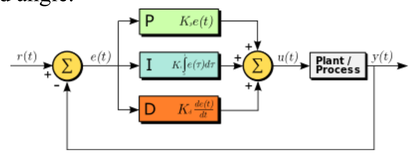


By empirically finding the disparity values of objects of at known distance, a mathematical relationship can be found between the disparity value and the distance.

The image above demonstrates our stereo vision working underwater. The program is using an object detection model to track the swimmer and form a boundary box. This boundary box is then used to determine which disparity values are relevant and those values are then used to calculate the swimmers distance. The system is fairly accurate, determining the swimmer is at 0.98 m when he is actually at 1 m and 3.85 m when at 4 m.

Navigation

To perform basic navigation capabilities such as driving straight, turning to a certain angle, diving and ascending a certain depth, the team utilized the built in libraries given by BlueRobotics. We utilized the pymavlink-library and made the necessary connections using TCP/UDP communication. To implement PiD Control, the team wrote a PID function that outputs different velocities based on how far it is from achieving the required angle.



CAD

The robot needed an onboard containment system to gather multiple lionfish in a single trip. Looking at previous designs, we realized that it was necessary to not only maximize the capacity but also design the container to not impede the robot's mobility. A new containment system was developed and designed in Solidworks, with the goal of minimizing the robot's frontal and side view profiles to reduce the amount of drag experienced in motion. Other features include a mechanism to receive captured lionfish from a retractable spear.