RoboBoat Spring Project Plan

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The following chart shows a summary of the document. This document will explain the tasks and requirements of the RoboBoat group and individual team members. To start, the holiday break between semesters will involve each team member understanding the entire code. Based on the Spring Project Plan made in Microsoft Project.

Engineer	Main Tasks
Sebastian Alonso	Introductory course completion, implementing camera, communication with boat, seven segment display finding algorithm
James Aspinwall	Raise the flag algorithms (navigation & machine learning numbers)
Edwin Diaz	Add remote kill switch & expand color recognition
Adam Hurdis	Landing algorithm of drone to boat
Steven Pisarchuk	Lidar implementation – obstacle avoidance algorithms

The main tasks will now be explained, and the tasks needed to accomplish this. For more information, see attached Gannt chart and OPPM. This paper is supplement to the chart and OPPM.

Sebastian's tasks

Introductory course completion

The current state of the RoboBoat allows it to complete one of the three tasks set in the introductory course. But with the available code and algorithm it is possible to alter them to allow for the slalom maneuver and circumnavigation.

For the slalom maneuver it will mostly involve changing the output of the PWM values for the motors based on color recognition of the buoys to turn left on red and right on green. While in the circumnavigation it will only require to recognize the general shape of the buoys and turn 90 degrees after it passes them to find the next one.

Implementing Camera

Design camera mount with weight and size limitations appropriate for the drone and chosen camera dimensions. The mount should be lightweight, secure and not obstructive to the video feed or the drone's taking off and landing protocol. Determine best type of material or combination of materials for the task. Make sure it can be taken off and secured in a timely manner.

Communication with boat

Figure out how the camera feed can be used to upload to the image recognition software. GoPro has built in streaming capability through Wi-Fi which will facilitate the process. It would only be needed to place the video input and turn it into readable data for OpenCV to interpret.

Based on the readings from the camera and interpretation of the algorithm generated to read the data the boat should send commands to the drone to control it. The challenge at this level is the different programing languages being used on the systems. Some preliminary control has been created by the last team that worked on the project, but it needs to be refined.

Seven segment display finding algorithm.

After the drone can be controlled with the boat, we need to design a sequence to find the seven-segment display for the raise the flag challenge. To do this there are two possible ways we have thought of doing it, one involves the drone taking off and flying up in the air until it finds the dock and descend until it can read the display. The other option is to make the drone fly around the boat in increasingly wider ranges until it finds the dock and later homing in to the display.

James's tasks

Raise the flag algorithms (navigation & machine learning numbers)

Raise the flag challenge requires a lot of moving pieces between the drone, CPU on the boat, and motors in order to complete this task. After the boat can receive the video feed from the drone displaying what the seven-segment number on the dock, the computer must then read this number and be able to match it to the specific location on the dock. The first task would be to write an algorithm allowing the machine to learn what each of the nine numbers looks like to locate the proper position on the dock. After this number recognition algorithm is proven to work and the computer has memorized it, the task would be for the boat to recognize the location of the dock through the onboard camera and head toward the closest side. When the boat is within reading distance of the numbers, it must once again read the camera feed and determine whether that number is the same as what the drone has read in. If this number is the same, a separate algorithm must send the power to the motors propelling it forward until it is able to touch the button which in turn would raise the flag. However, if this number does not match that of the drone, a loop must be written to continue to the next docking point and position itself to read the next number until it has recognized a match. This would be the most difficult part as it requires a lot of machine reading and turning of the boat as the camera is fixed facing forward. Because of these many readings, the positioning of the boat is extremely important as to not get it lost in relation to the dock, so we must to use a SLAM technique to localize the boat to the environment.

Edwin's tasks

Add remote kill switch

For the competition it is mandatory to add a remote kill switch, other than the physical kill switch and computer subsystem, that when activated must instantaneously disconnect power from all motors and actuators. To do this, first we need to select a suitable radio transmitter and receiver, if the receiver needs any modification it will be performed. Second, a control circuit must be designed to monitor the output of the receiver. Finally, a latching switch will be added to the transmitter so that it stays on without us having to hold down the button.

Color Recognition:

Because the boat's camera must be able to recognize the color of an object in different light conditions, it is important that the boat can recognize a specific buoy color to better perform in each of the courses of the competition. Because sun light is highly directional, even orientation makes a difference. So, to do this threshold values are chosen such that if a color value falls within this range, the object is considered to be that color. This is complemented with color space conversion, which involves the translation of the representation of a color from one form to another. In this case, trying to make the image captured by the camera look as similar as possible to the original. The values obtained from this analysis (the hue/saturation/value, HSV) are done by first using the LIDAR to first identify the mean HSV values over the region of interest. Finally, the color estimation algorithm can be developed using the Bayes theorem which states that the probability of the color of the object can be inferred from data (HSV values) by using the probability of distribution of sensor readings over known states.

Adam's tasks

Landing algorithm of drone to boat

After the Drone has taken off from the boat and sent the correct number to the boat shown on the dock, an algorithm must be written for it to return and land safely back on the boat. The first step will be to place a QR code on the top of the boat so when the drone is finished reading the number on the dock, it will be able to recognize its landing place on the boat. This is the most difficult part of this task as the boat will be subject to a lot of unwanted movement from the waves and wind, which will increase the uncertainty of positioning when the drone is ready to backtrack and return to the boat. We decided that the best way to encounter these issues will be to use the lidar to determine the distance from the dock, and while the drone is in the air, the boat will continually be monitoring its distances from local points to minimize the error.

Steven's tasks

Lidar implementation – obstacle avoidance algorithms

This task requires a lot of learning. The first step will be implementing the lidar and connecting it into the boat. This step will require learning all about the lidar, including the output, how it is powered, and the best location to attach the lidar. The next step will be getting the lidar to read in the main computer system. This involves understanding how to read the output, the physical wiring, the code to read the lidar, and analyzing (and implementing, if necessary) any signal conditioning that must be used. The final step will be coding. This is the most time-consuming step and will require writing code to read the output of the lidar, analyzing the lidar output, and adjusting motor speeds to avoid the signal (objects) detected by the lidar. The stretch goal of this engineer is to write additional code to complete the Find the Path

challenge, where the autonomous boat must use the object avoidance lidar code, and color recognition code to complete the challenge.

The additional task for this engineer is continual testing of the object avoidance software and hardware. It will be difficult to test the Find the Path challenge.