The final project requires you to fuse together aspects of multiple projects that were completed throughout the semester. The idea being to demonstrate you can use multiple things we learned collectively. To this end, you are expected to create an “Autonomy.m” function that drives the boat through the course and completes as many RoboBoat-Style Challenges as possible. This project can be completed in pairs. The challenges are identified below:

## Course Layout

The simulation lake is a rectangle location from 0 to 40m Northing, and 0 to 80m Easting. The exact location the boat will start and location of the challenges will not be given ahead of time. However, the general course layout will follow the diagram shown below (Note: tasks might partly overlap other regions):

A screenshot of a computer

Description automatically generated

Figure : General Challenge areas and starting location



Figure : Sample Course

### Tasks

There are a set of 6 tasks you can complete to earn points toward your project grade. But you do not have to do them all (see scoring). The tasks are describe in detail below, with scoring in a later section.

### Navigation Channel

A diagram of a diagram of a bottle

Description automatically generated with medium confidence

Figure : Navigation Channel overview

The vehicle passes through two sets of gates designated by a pair of red and green Tall buoys. The entire vehicle must pass through both sets of gates without striking any of these buoys for points. When the simulation starts the ASV will be placed in front of the Navigation Channel where the boat’s camera can view the red, green, or red and green buoy from the first of the two gates. The 2nd gate will NOT align perfectly with the 1st gate.

### Obstacle Channel



Figure : Obstacle Channel Overview

The vehicle passes between multiple sets of gates designated by pairs of red and green small round buoys. The robot frame origin must pass through each pair of buoys for points, touching any buoy will result in loss of points, regardless of where the vehicle is on the course.

### Obstacle Field

A diagram of a game

Description automatically generated

Figure : Obstacle Field Overview

The ASV must find an opening in a field of obstacles to then circle the white Tall buoy in the center. The vehicle must then exit the field. Black obstacle buoys will be used on this challenge. There will be at least one opening in the field that gives at least 2m of clearance to enter the field and circle the buoy. The USV must circumnavigate the tall buoy a full 360 degrees or more before exiting, so you cannot circle black buoys while circling the white buoy.

### Docking

The vehicle executes a docking and undocking sequence by identifying the active docking bay (pre-determined at the start) and then entering and leaving the docking bay. Each docking bay is fitted with a circular sign of a unique color (red, green or blue). The vehicle must enter the docking bay of the active colored circle. The ASV is considered “docked” when the bow (front) of the vehicle crosses the red-white, white-white, or white-green pair of posts in front of the dock bay. The boat must then back away by having the bow (front) cross the same post pairs before the stern (back) of the boat crosses the posts.

A cartoon of a blue circle

Description automatically generated

Figure : Docking Overview

### Speed Gate

The vehicle must enter through the gate buoys, go around the mark buoy (clockwise or counter-clockwise), and exit through the same gate buoys as quickly as possible. This is a timed challenge. The time starts when the robot origin of the vehicle crosses the Gate buoys (entry) and stops when the stern (back) of the vehicle crosses the Gate buoys (exit). Crossing the gate in either direction will start the timer.

A diagram of a path

Description automatically generated

Figure : Speed Gate Overview

### Return To Home

After having earned points on mission tasks, the vehicle returns to the starting location in autonomous mode. The vehicle avoids all obstacles and mission task equipment (buoys, floating docks, etc.) during its mission for a point bonus. The vehicle should get within 2m of where it started to complete this task. These points will only be earned if receiving points on at least one other task and the vehicle has traversed 150m total.

# Scoring

Each task has points that can be earned. Some tasks allow you to earn partial points by completing part of the task. Additionally, striking objects (except the dock) will result in negative points. Scoring is outlined below:

Table : Task Scoring

|  |  |  |
| --- | --- | --- |
| **Task** | Points | Criteria |
| Navigation Channel | 200 points | The vehicle must pass through both pairs of gates without striking an object to earn these points. |
| Obstacle Channel | 450 points | The vehicle will earn 30 points for each pair of gates through which the robot passes. There will be 15 sets of gates. The points for each gate can only be earned once. |
| Obstacle Field | 600 points | These points will be awarded in full when the vehicle is deemed to have circumnavigated the tall buoy as outlined in the task description. |
| Docking | 525 points | The vehicle will earn 200 points for docking in any bay and an additional 325 points for docking in the correct bay |
| Speed Gate | 450 points | The vehicle earns 225 points for passing through the gate, circling the Mark buoy and then passing through the gate again. An additional 225 points can be earned if you are the team that completes this task the fastest without striking any of the three task buoys. |
| Return to Home | 300 points | 100 points are awarded for returning to home after the vehicle travels 150m and has scored points on at least one other task. You must return to within 2m of where you started. An additional 100 points are awarded if the vehicle has not struck an object. The last 100 points is awarded if the vehicle has earned at least 1 point on all tasks. |
| Collisions | -60 points | Each obstacle hit will result in the loss of 60 points from your total score. The only exception to this, is there are no points lost for striking the dock. |

# Rules

The vehicle has a total of 5 minutes of simulation time to earn these points. The simulation will stopped if time runs out, the instructor deems the vehicle is no longer making progress, the team requests a “stop”, the vehicle returns to home, or the vehicle collides with the shore. If the code crashes, that is the end of your attempt as well.

# Grading

Your grade for this assignment is based on the earned score and submission of all required documents. The grading breakdown based on score is shown below:

Table : Scoring Breakdown

|  |  |
| --- | --- |
| Score | Grade |
| 0-300 | F |
| 300-600 | C |
| 600-900 | B |
| 900-1200 | A |
| 1200+ | A+ |

You will be allowed two attempts (course set-up will change). The highest of the two scores will count. The professor may make grade considerations beyond this breakdown to increase the grade if the vehicle is “close” to completing tasks. Scores over 1200 total points can receive grades over 100%.

## Submission Requirements

You must submit your “Autonomy.m” and any supporting files into canvas by the assigned due date to receive both promised attempts. On the due date Dr. Coyle will run your code “live” during the exam period. After your first attempt at the course, you will be given up to 1 hour (as time allows) to make any changes you wish to make and then complete your 2nd attempt. After your last attempt, you must re-submit your code. Note: you may use the solutions to previous assignments as part of your solution to this project, but you must cite its usage if you use Dr. Coyle’s solutions.