Definition of **Sea Challenge** Guidelines

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B	Updated Drop point description	J. Searle	02/04/2015	
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D	Update new logo	P. Ward	11/01/2016	
E	Updated mission description and Section 2.2 notes	S. Zingaro	06/19/2017	
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G	Updated measurements units, cover, section 2.1 and Figure 1.	S. Zingaro	06/27/2019	
H	Updated mission	S. Zingaro	09/09/2020	

1 Introduction

1.1 Purpose

The purpose of this document is to define the Sea Challenge of the Sea, Air and Land Challenge.

1.2 Scenario

A new ocean passage is needed quickly for reconnaissance submarines near the equator. A time saving shortcut has been located, but the concern of having a manned vessel damaged in the tight passage is high. Therefore, an unmanned submersible is being sent out to map the deep and difficult underwater passage for the larger manned vessels. It will also take samples of the ocean floor for further understanding of the area including possible shifts in the terrain.

Unmanned submersibles may be referred to as a remotely operated vehicle or ROV, or an unmanned underwater vehicle or UUV. The latter can be autonomous or not. Bathymetry is underwater topography or the study of the depths and shapes of underwater terrain for the safety of sub-surface navigation. The submersible's mission will be to visually confirm the terrain and any solid outcroppings that might cause difficult maneuvering for larger vessels. It will also take the ocean floor samples and return them to the surface ship.

1.3 Definitions

Tele-Operated (or remote controlled) – References a type of robot that has an operator making decisions about the operation of the robot. Sensory data from the robot or other device (video, telemetry, etc.) is delivered in near real time to the robot operator, and the operator makes decisions about what the robot is supposed to do (e.g. turn left/right, speed up/down, deposit a payload etc.). This is the type of operation used by hobbyists and may also be called operator in the loop. This can either be accomplished by wired or wireless communications, though some applications favor one or the other methods.

Autonomous - The robot has a sensor package that collects data, and based on computer processing, makes decisions without an operator on how it is to operate and what it is to do. The general rules of an autonomous robot are:

- Gain information about the environment (Rule #1)
- Work for an extended period without human intervention (Rule #2)
- Move either all or part of itself throughout its operating environment without human assistance (Rule #3)
- Avoid situations that are harmful to people, property, or itself unless those are part of its design specifications (Rule #4)[i]

2 Challenge

To design and build an underwater vehicle that is tele-operated (or autonomous) and can perform the following tasks to complete the sea challenge use a vision system or sensors to maneuver around the obstacles on the "ocean floor", and pick up the samples boxes (objects). These boxes will then be carried back to the surface and deposited on a holding box near the surface ship. The submersible system should be able to perform the following tasks to complete the Sea Challenge, noting that efficiency and accuracy are important aspects of this challenge.

(The object number/color to pick up and deposit will be given before each run.)

- Start near the surface ship (designated starting area)
- Find and navigate to defined object on the bottom of tank or pool
- Pick up the object from bottom of tank or pool
- Carry the object from the pickup point
- Find and navigate to the drop off point
- Deposit the object at/in drop off point
- Surface after each object delivery
- Continue for each of the objects

**Bonus: After last object is delivered and if time remains, teams can run an autonomous lawn mower pattern in the pool, with the height of the run defined by team.

In this challenge, there will not be any direct viewing of the tank/pool by the team. This will mimic true deep water operations, where the submersible is controlled using situational awareness provided by cameras and other sensors. You should test your robot under less than ideal conditions and verify that it works properly. On Challenge Day, each team will have two runs in the course with a break in between to make adjustments and recharge if needed. There will be a maximum run time of 10 minutes for each of the two runs.

2.1 Requirements and Scoring

To receive maximum score on the sea course the vehicle must complete the following:

- Must be able to change buoyancy (Float or sink on command)
- Must be able to pick up and carry a negatively buoyant object (defined in 2.2, below)
- Must be able to cross the tank or pool
- Must be able to identify objects
- Must be able to identify the delivery point
- Must be able to put object into the delivery point
- Must surface after each object delivery
- Must move through the course without being touched by the team and without the pilot's direct line of sight (hint: use sensors or cameras to navigate remotely)
- At any time during a run, if the robot becomes disabled and must be touched in order to continue, a one minute penalty will be assessed to the final time. Each time a team member touches the robot, an additional penalty will be added. The timing clock will not stop during this time.
- The team that completes the task in the least amount of time will awarded the most points.

- Total cost of the robot system must not exceed $500
- Prior to running the course, team is to introduce themselves and robot design concept in a short “elevator speech” (not timed)

Note: Users may manually move any umbilical cords for their robot system without penalty.

2.2 Object Definition

The objects will have the following characteristics:

- Each object will have a unique high visibility color
- Each object will have a unique number identifier
- Each object will be 65 mm x 65 mm x 65 mm (2.5” cubed) and negatively buoyant (approximately 1.2 g/ml)
- Each object will be approximately 325 g $\pm$ 25 g (0.68 lbs. $\pm$ 0.05 lbs.)
- Each object will be solid (no external holes)

Notes: Teams can add unique marking to the object if desired BUT must be approved by challenge coordinator.

For teams desiring an additional challenge, an off-sized (smaller) or off-weight (heavier or buoyant) object may be added. This will not negatively affect the team’s score.

2.3 Drop Point Definition

The Drop Point will have the following characteristics:

- The drop point will be 305 mm x 305 mm (12” x 12”)
- The drop point will be a 4 sided box with a lip on the open side.
- The drop point will NOT have a top.
- The drop point height may vary run to run
- The drop point will NOT be above the water line

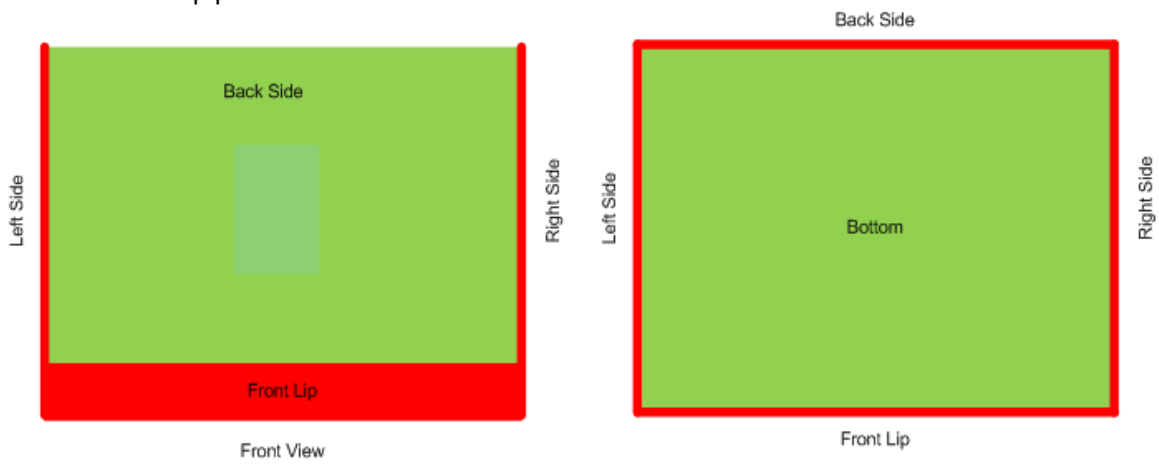

Figure 1. Top and Front Views of Drop Box

Note: Teams can add unique marking to the drop point if desired BUT must be approved by challenge coordinator.

2.4 Obstacle Definition

The course may have terrain elements and physical obstructions that the submersible must maneuver around or avoid. The obstacles will have the following characteristics:

- The minimum clearance between obstacles will be 300 mm (12”)
- The maximum footprint of the obstacle will be 300 mm x 300 mm (1 foot squared)
- The maximum height of the obstacles will be 300 mm (12”)

2.5 Key Design Points

The following bullets are some key design points that will be instrumental to the success of your vehicle.

- Vehicle must be water proof
- Determine method to power the submersible vehicle
- Convey information from vehicle to user and user to vehicle
- Able to change buoyancy (float/sink)
- Have three axes of control (roll, pitch, yaw)
- Able to move to move forward/backward
- Able to identify an object
- Able to identify a drop off point
- Able to grab object
- Able to place object in delivery box

2.6 Course layout

- The course will be 3 m x 3 m (10’ x 10’) tank with a maximum depth of 1 m (3’)
- Obstacles may be added to the water tank
- Water will be as filled from source (may/may not be clear)
- There may be up to six objects

Figure 1 is a possible course layout derived from the above given description. This is a template for the sea course and not meant to be an implementation diagram.

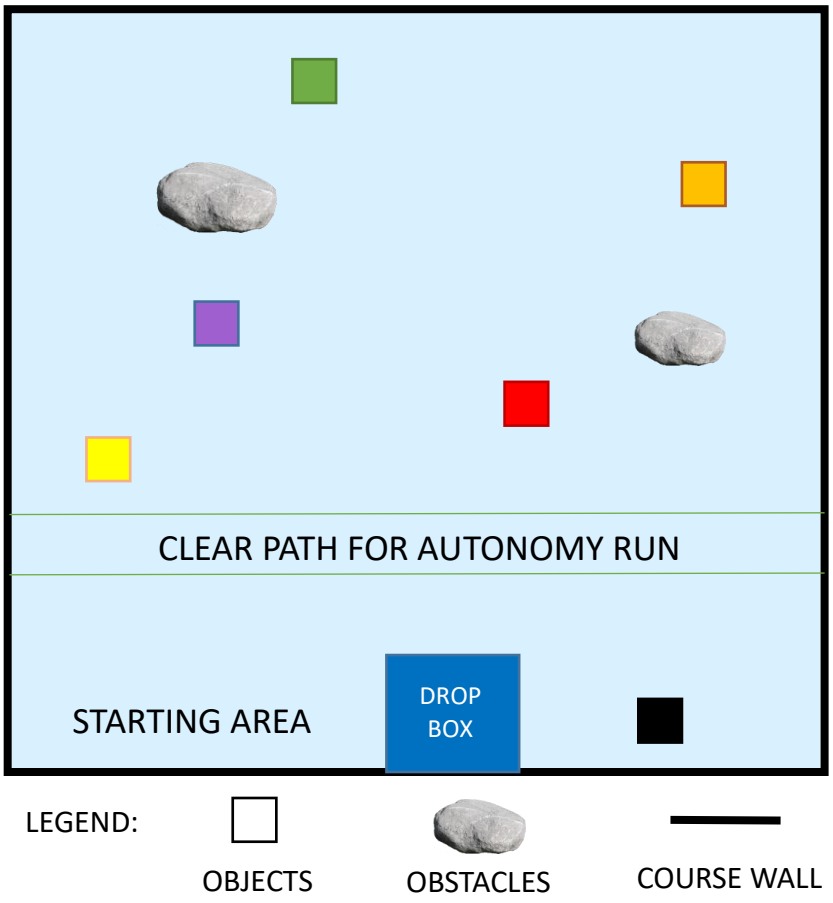

Figure 1 Course Layout – Top View

[i] http://en.wikipedia.org/wiki/Autonomous_robot

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