Definition of **Land Challenge** Guidelines

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1 Introduction

1.1 Purpose

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

1.2 Scenario

A tornado has touched down in the city's central park and has uprooted trees and scattered debris. Among the high-rise buildings surrounding the park, is a hospital, and many individuals trapped within this building require critical supplies to stay alive. Most of buildings, including the hospital, and the roads to the buildings are deemed unsafe because of structural damage and uprooted trees. Your robot and team must deliver supplies to the trapped people and remove debris and obstacles that are preventing rescue personnel from safely entering the area.

Ground robots are becoming increasingly more sophisticated and utilized in different types of applications including emergency situations. This application of the technology provides a critical link to injured or stranded people and keeps first responders out of harm's way until a safe passage can be established.

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 wireless or wired communications, although most applications dictate wireless communication.

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

The object of the Land Challenge is to design and build a tele-operated (or autonomous) land based vehicle that can pick up and move various objects to their associated drop locations. In addition, debris will need to be cleared from the "roadway". Each team will have two runs in the course with a break in between to make adjustments and recharge. There will be a maximum run time of 10 minutes for each of the two runs, so efficiency and accuracy are important aspects of this challenge.

In this challenge, there will not be any direct viewing of the course by the robot driver(s). This will mimic true operations, where the rover is controlled using situational awareness provided by cameras and (optional) sensors. The course will also be changed between runs, so that knowledge of one course is not an advantage.

2.1 Dimensions and Accuracy

All dimensions and characteristics given in this document are approximations. Robots should be designed with an error +/- 10% on any given dimension. Colors may not be uniform. Walls are not guaranteed to be exactly perpendicular to the floor nor square to one another.

A successful robot will be able to handle small misalignments, inaccuracies, discolorations, and other course imperfections. You must test your robot under less than ideal conditions and verify that it works properly.

2.2 Definition of Objects and Debris

The objects in this challenge simulate supply packages needed by people trapped in dangerous environments. It is not acceptable to damage the objects during delivery. The objects will have the following characteristics:

- Each object will have a unique, high visibility color
- Each object will have a unique numerical identifier
- Each object will be at least 25 mm x 25 mm x 25 mm (1" cubed) and at most 65 mm x 65 mm x 65 mm (2.5" cubed)
- Each object will weigh between 115 g and 455 g (0.25 lbs. to 1.0 lb.)
- The roadway debris shape will be variable but no smaller than 25 mm (1") diameter and no larger than 65 mm (2.5") diameter. Length will be 305 mm (1 foot) or less.
- The debris will weigh between 115 g and 455 g (0.25 lbs. to 1.0 lb.)

2.3 Drop Point Definition

The objects previously described must be delivered to the appropriate drop point. The supplies needed at one drop point may be different that the supplies needed at another drop point. The drop points will have the following identification:

- Each drop point will have a unique high visibility color that matches the object
- Each drop point will have a unique numerical identifier that matches the object
- Each drop point will be 200 mm x 200 mm x 200 mm (8" cubed)
- Each drop point will be a 4 sided box with a lip on the open side

- Each drop point will have an open top
- Each drop point will vary in height along the course
- Each drop point opening will be no higher than the walls of the course

Figure 1 Drop Point

2.4 Obstacles

The course may have terrain elements and physical obstructions that the vehicle must overcome or avoid. These are not on the roadway and do not need to be cleared. The obstacles will have the following characteristics:

- The minimum clearance between obstacles will be 300 mm (12”)
- The maximum height of the obstacles will be 300 mm (12”)

2.5 Course Layout

The overall size and shape of the course is shown in Figure 2. The location of objects, drop points, the roadway and obstacles will vary. There may be up to six objects and drop boxes.

- The land course will be a 3 m x 3 m (10’x10’) box with starting area
- The land course will have 0.6 m (2’) high walls
- The starting area will be 0.6 m x 0.6 m (2’x2’)
- The roadway will have minimal height (less than 6 mm or ¼”)
- The color of the walls will not be the same as any object or drop point
- The bottom of the course will be the ground on which the course is set up (cement, asphalt, wood floor, carpet, vinyl tile, etc.)

Note: Figure 2 is an example layout. This is a template for the land course and not meant to be an implementation diagram.

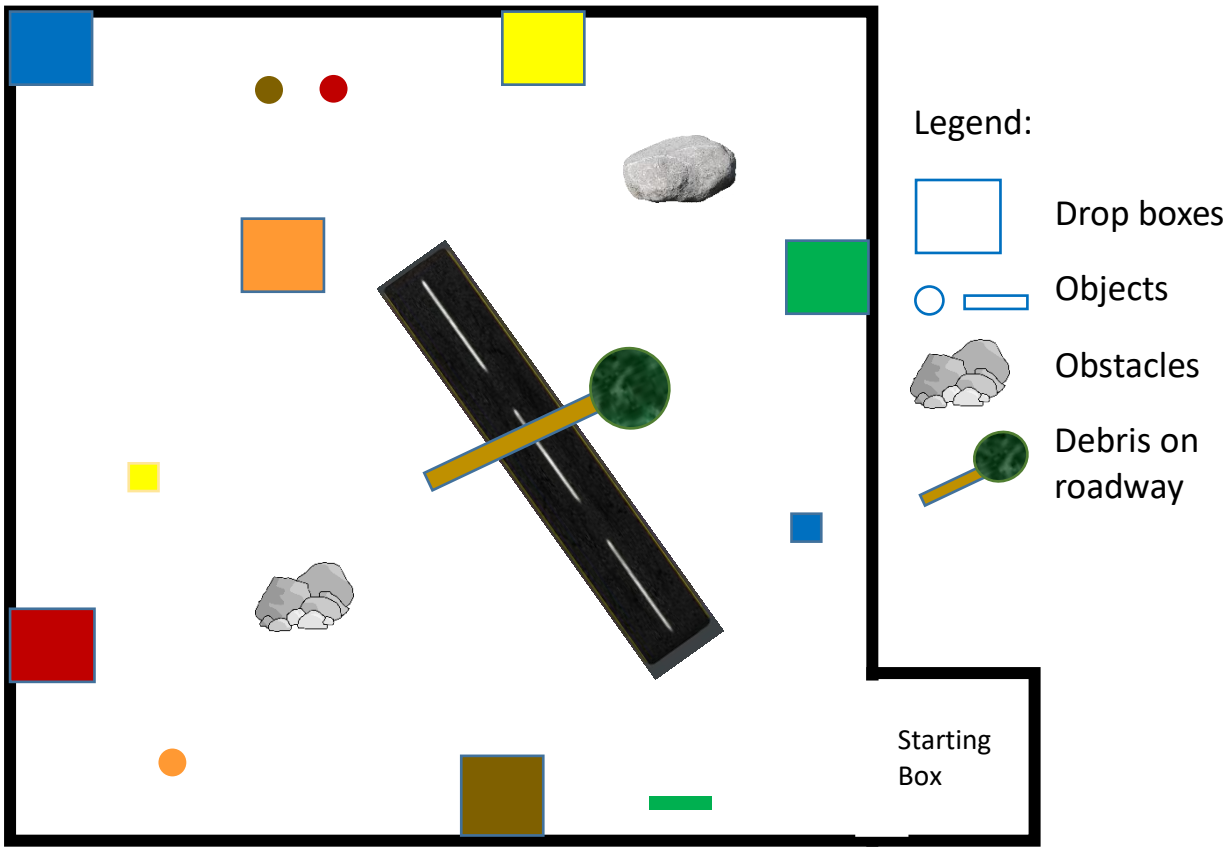

Figure 2 Course Layout

2.6 Requirements and Scoring

To receive maximum score on the land course, the robot and team must complete the following:

- Team to introduce themselves and robot design concept in a short "elevator speech"
- Robotic system must fit within the starting box and be no taller than the wall at the beginning of the run. (They may unfold, as needed, after the clock has started.)
- Traverse the course without being touched by the team and without direct line of sight (hint: use sensors or cameras to navigate remotely)
- Locate obstacle on roadway
- Completely remove obstacle from roadway
- Locate and retrieve 2 objects
- Carry the object while traversing the course
- Locate and navigate to the corresponding drop point
- Deposit the object in the drop point
- Complete the tasks without recharging or replacing batteries
- Complete the tasks in under 10 minutes
- The total cost of the robot must not exceed $500

Once the team places the robot inside the course, a timer will start. The team will have 10 minutes to complete the challenge. If the challenge is not completed, points will be awarded for removal of the road debris and points for each object/drop point combination given the following:

- Find Object
- Pick up Object
- Carry Object
- Locate Drop Point
- Deposit Object

If at any time during a run, your robot becomes disabled and must be touched in order to continue, a one minute penalty will be added to your 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 goal is to complete all of the tasks in the least amount of time. Each team will have two separate runs. The course layout and obstacles may change from Run 1 to Run 2 to provide a greater challenge.

2.7 Key Design Points

The following are some key design points to consider when designing the robot. They are not required, but are suggested for maximum probability of success.

- Ability to fit within the starting box
- Ability to move forward and backward, turn left and right
- Able to grasp and release object
- Ability to raise and lower object
- Ability to place object in delivery box
- Ability to identify objects and drop off boxes
- Ability to push an object along the floor
- Ability to visualize the area of operations in the course
- Ability to transmit visual information to team and command controls to robot

3 Open Class

In addition to the previously described challenge, there will be an Open Class demonstration. Any team can enter, but it is not required or counted towards the main challenge scoring. The purpose of the Open Class is to allow teams to demonstrate some functionality that goes above and beyond the prescribed challenge. Some examples include (but are not limited to) autonomy, extra small or large object retrieval, or low visibility navigation. The Open Class may watched and voted upon by the other teams present for Challenge Day. The Open Class teams may also be awarded bonus points or put the team in competition for the Innovation Award. Any team wishing to participate in the Open Class should notify the host at least three weeks ahead of Challenge Day.

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

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