An Edited Version of the Description of the Game for Winter 2020

The rules & tasks

Consider the scenario depicted in Figure 1, with two players labeled 1 and 3. The labels indicate the corners each machine started in, so Player 1 starts in Corner 1 (Green Zone) and Player 3 in Corner 3 (Red Zone). At the start of a round, both players are placed in their respective corners at a random orientation and started. Each player waits for a set of game parameters to be downloaded from the game server (more about this later). Once the parameters are received (which describe the layout of the playing field), each player must cross the river over to the central island by crossing the bridges (you cannot pretend that your robots can swim!). The key parameters here are RedTeam, GreenTeam, RedCorner and GreenCorner. Each player has an assigned team number, so it can determine whether it is in the red corner or green corner by matching against RedTeam or GreenTeam. Once the team color is identified, the starting corner can be located by the RedCorner and GreenCorner parameters respectively. From here a key landmark becomes available, i.e. the location of the bridge connecting the starting zone to the island. In the example shown in Figure 1, the red player would cross using the bridge located at TNR_LL (4,7) to TNR_UR (6,8). Once on the island, the player proceeds to a search zone (a rectangular area on the island) in which there is a stranded vehicle. As shown in Figure 1, the search zone for the red player is located at SZR_LL (6,5) to SZR_UR (9,8). The player must find the vehicle and then connect to it by a mechanism which will be defined later. Once connected, the player must tow the vehicle to the starting point by once more crossing the bridge. Similarly, the green player would cross using the bridge located at TNG_LL (10,3) to TNG_UR (11,5), and proceeds to its search zone located at SZG_LL (12,6) to SZG_UR (15,9). There are two complications that each player must cope with. First, there are obstacles located at random positions on the island. Second, both players **must** avoid hitting each other. The first player to contact the second is automatically disqualified.

Pay close attention to how the bridges are positioned relative to the Red and Green zones. Notice, in this example, that the bridge connecting the Red zone joins at the boundary whereas the bridge connecting the Green zone overlaps by one square. This will always be the case when the border separating two zones is one square wide.

Once each player reaches the island, it must navigate its way around any obstacles to reach the search zone and find the stranded vehicle. It should then connect itself to the vehicle. There are a number of design challenges implicit in this task. As part of the design of the player machine, it will be required to fit through the covered bridge. Since there is a time limit (which will be announced after the results of the Beta demo are in), machines must be nimble enough to move with a reasonable speed. In starting your design, you can assume that the nominal time limit is 5 minutes from receipt of parameters to completion of the task. If this time is changed, it will be adjusted upwards (more time).

Specific Details

The WiFi class which you will receive before the Beta demo, delivers the game parameters which are summarized in the following section. The procedure that each player must follow is summarized in the following steps and *must* be adhered to:

1. Each robot is placed in the corner specified by the marshal running the competition round. You will be instructed as to where to place and orient your machine.
2. Once placed and the start button pushed, you are no longer permitted to touch your machine. If there is any contact with the machine the team is disqualified for that round.
3. One started, the machine waits for the game server to deliver the parameters for the current run. This is done through a method call which will block until complete.
4. Each machine localizes to the grid. When the localization is completed, the machine must stop and issue **a sequence of 3 beeps**.
5. Each machine navigates to their corresponding bridge, transits, and then proceeds to their search area. Upon arriving, each machine will again stop and issue **a sequence of 3 beeps**.
6. Each machine searches for the stranded vehicle and connects to it.
7. Each robot returns to its starting corner, towing the rescued vehicle. The robot does not need to be returned to the starting orientation.
8. Upon returning to the starting corner, each robot halts and issues **a sequence of 5 beeps**.

Each team will have an opportunity to participate in 4 runs. A design will be deemed "successful" if it succeeds in recovering the vehicle once over the series of runs. The "competition" aspect relates to the number of points accumulated by each team for completing the different steps outlined above. On completion, each team is ranked in terms of the total number of points acquired. This is for bragging purposes only – your course grade is based on the quality of your design and not just the number of points accumulated.

Parameters

Game play is determined by a set of parameters, which are sent to the client (player) from a server. The following parameters are defined according to the details provided in Figure 1:

RedTeam (i=1,23) – Team starting out from red zone
GreenTeam (i=1,23) – Team starting out from green zone
RedCorner (i=0,3) – Starting corner for red team
GreenCorner (i=0,3) – Starting corner for green team
Red_LL (x,y) – lower left hand corner of Red Zone
Red_UR (x,y) – upper right hand corner of Red Zone
Green_LL (x,y) – lower left hand corner of Green Zone
Green_UR (x,y) – upper right hand corner of Green Zone
Island_LL (x,y) – lower left hand corner of the Island
Island_UR (x,y) – upper right hand corner of the Island
TNR_LL (x,y) – lower left hand corner of the red tunnel footprint
TNR_UR (x,y) – upper right hand corner of the red tunnel footprint
TNG_LL (x,y) – lower left hand corner of the green tunnel footprint
TNG_UR (x,y) – upper right hand corner of the green tunnel footprint
SZR_LL (x,y) – lower left hand corner of the red search zone
SZR_UR (x,y) – upper right hand corner of the red search zone
SZG_LL (x,y) – lower left hand corner of the green search zone

SZG_UR (x,y) – upper right hand corner of the green search zone

Note that the (x,y) coordinates listed correspond to the grid coordinates shown in the Figure 1. In the WiFi class, point parameters (x,y) are sent individually, e.g., TR (x,y) would be sent as TR_x and TR_y

Parameter Ranges

Red_UR_x – Red_LL_x:	Min=2, Max=10
Red_UR_y – Red_LL_y:	Min=2, Max=9
Green_UR_x – Green_LL_x:	Min=2, Max=10
Green_UR_y – Green_LL_y:	Min=2, Max=9
Island_UR_x – Island_LL_x:	Min=2, Max=10
Island_UR_y – Island_LL_y:	Min=2, Max=9

TNR_UR_x – TNR_LL_x:	Min=1, Max=2
TNR_UR_y – TNR_LL_y:	Min=1, Max=2
TNG_UR_x – TNG_LL_x:	Min=1, Max=2
TNG_UR_y – TNG_LL_y:	Min=1, Max=2

SZR_UR_x – SZR_LL_x:	Min=2, Max=8
SZR_UR_y – SZR_LL_y:	Min=2, Max=8
SZG_UR_x – SZG_LL_x:	Min=2, Max=8
SZG_UR_y – SZG_LL_y:	Min=2, Max=8

Game Play

Both players act almost independently, so the design can focus mainly on navigation, mobility, handling and searching for the stranded vehicle. Some collision avoidance will be necessary to cope with obstacles and the event that both players are in the same vicinity. Each team will participate in 4 rounds for which a cumulative score will be determined. The score is based on points awarded for exhibiting each of the behaviors required to play the game: localization, navigation, traversing the river, avoiding obstacles, reaching the search area, finding and connecting to the stranded vehicle, and returning to the starting corner. These points effectively validate the components of your design. On top of this we also record how long it takes for you to complete the entire process. These figure prominently in ranking the performance of the teams with respect to the "competition".

Materials

Each team has up to 3 Lego Mindstorms kits worth of parts available. In addition, a MakerBot Replicator 2 rapid prototyping machine is available for fabricating parts for those inclined. You may also purchase additional materials, but these must receive prior written approval from the instructors. Send your requests to the instructors via email to get your materials approved. Another note – all computation must be done on board the EV3 brick(s); no offloading to an external machine is permitted.

Final Notes

This document subject to change as we iteratively incorporate feedback, but the specifications can be considered stable. As of this writing, two vehicle designs are being considered, both fabricated out of Lego pieces from the standard kit. These are shown in Figures 2 and 3 respectively. The corresponding LXF files can be found in the Project folder on myCourses.

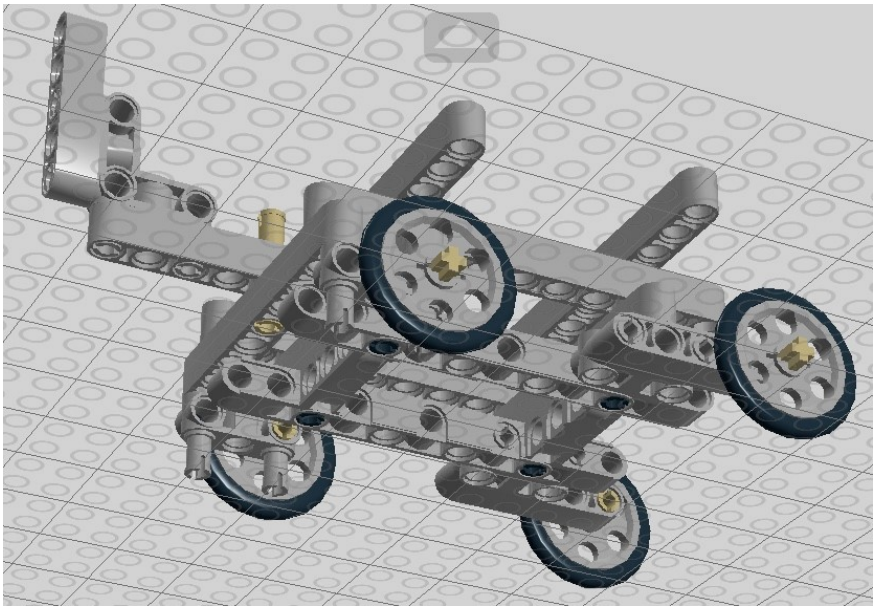

Figure 2 – Single Articulated Vehicle

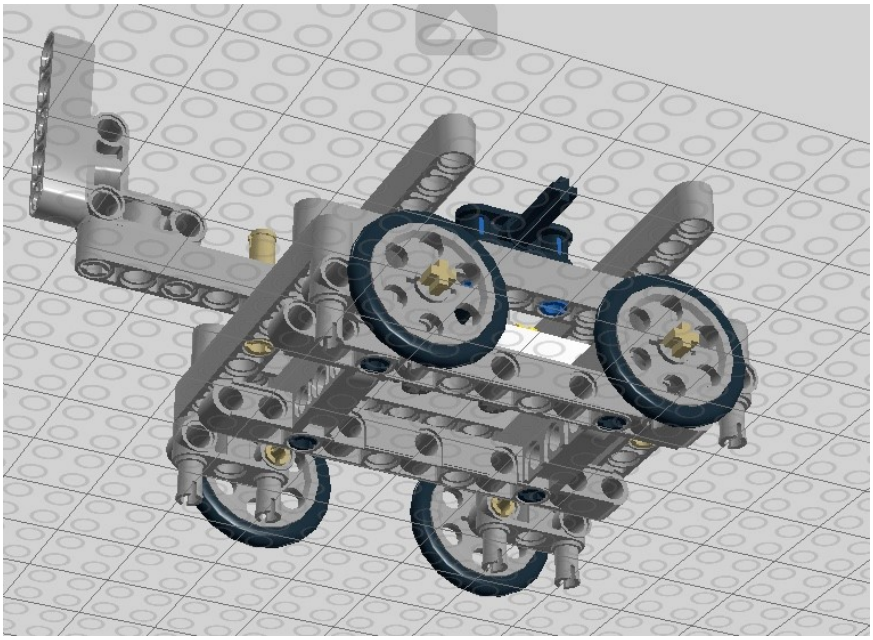

Figure 3 – Double Articulated Vehicle

Final Considerations

You are being evaluated on your robot's ability to complete the various tasks that make up the game, so it is important to show what your machine can do. Unless your machine does nothing at all, you will be awarded points for what it can do.