Department of Electrical and Computer Engineering
Design Principles and Methods
Course ECSE-211

November 22, 2016
Version 3

Design Project Specifications

The basic task has been described as follows:

Construct an autonomous robot capable of finding and manipulating Styrofoam blocks, while navigating within an enclosed area populated with known obstacles placed within a 12' x 12' enclosure (Figure 1). The task of the robot is to compete one-on-one with an opponent in the construction of a tower using Styrofoam blocks.

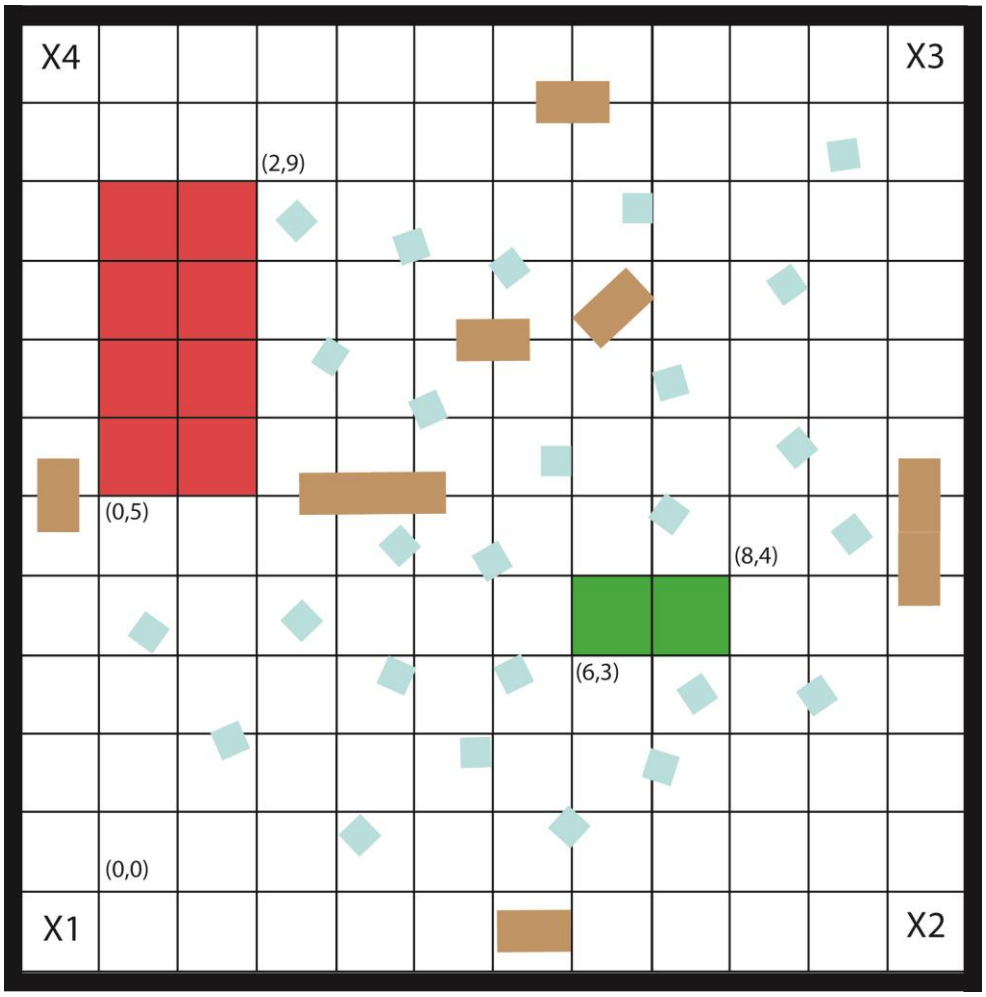

Figure 1

At the start, the competition arena will be set up in a layout similar to that shown in Figure 1. Approximately 10-20 Styrofoam blocks will be randomly distributed throughout the arena except in the 4 corners labeled X1-X4, and the Red and Green zones. The floor will also be populated with approximately 5-10 wooden blocks at arbitrary positions and orientations, again except for the excluded zones. Each robot will

be placed in one of the 4 starting corners. *The initial heading of the robot and its position in the starting corner will be specified by one of the competition officials*. Once the robots are in the starting position, you will be instructed to start your code in the usual manner by pressing the Enter button on the EV3 console, after which you may no longer physically or electronically contact your robot. At this point, your robot will establish a connection to the competition server using the `WiFiConnection` class (that will be provided to you). Note that your robot is not allowed to move until it retrieves the parameters for the current run using the `getTransmission` method. The parameters are as follows:

Parameter		**Description**	**Values**	**Units**
BTN		Builder Team Number	[1,17]	integer
BSC		Builder Starting corner – tells the robot into	[1,4]	integer
		which corner it has been placed.		
CTN		Collector Team Number	[1,17]	integer
CSC		Collector Starting Corner	[1,4]	integer
LRZx		x coordinate of lower left corner of Red Zone	[-1, 11]	tiles
LRZy		y coordinate of lower left corner of Red Zone	[-1, 11]	tiles
URZx		x coordinate of upper right corner of Red Zone	[-1, 11]	tiles
URZy		y coordinate of upper right corner of Red Zone	[-1, 11]	tiles
LGZx		x coordinate of lower left corner of Green Zone	[-1, 11]	tiles
LGZy		y coordinate of lower left corner of Green Zone	[-1, 11]	tiles
UGZx		x coordinate of upper right corner of Green Zone	[-1, 11]	tiles
UGZy		y coordinate of upper right corner of Green Zone	[-1, 11]	tiles
n.b. [-1,5] = {-1,0,1,2,3,4,5}			2 (any)	integer

Example:

Assume that a robot is placed in position X1 for the field configuration shown in Figure 1 and assigned the role of Builder. It will receive the following set of parameters *(1,1,15,2,0,5,2,9,6,3,8,4).*

Upon receipt of the parameters, each player localizes and begins the game. *Note that, once the parameters have been received the robot will start – it cannot be touched by a team member at this point; there cannot be further button pushes. The clock time starts from the time the parameters are transmitted by the server.* The total playing time

allowed is 5 minutes.

If a robot is designated as a Builder, then it immediately starts locating and moving Styrofoam blocks to the Green zone. The goal is to construct the tallest tower possible within a 5-minute interval. Note that the entire structure must fit within the Green zone, otherwise a penalty will be assessed. Worse, the structure is liable to be pulled down by the opponent. The Builder is forbidden from entering starting corners X1-X4 and the Red zone. Failure to do so results in the forfeiture of the round and the loss of any points accumulated.

Similarly, if a robot is designated as a Garbage Collector, it immediately starts locating and moving Styrofoam blocks to the Red zone, removing "debris" from the playing area, depriving the Builder of material with which to construct the tower. It is forbidden from entering the Green zone or disturbing the contents within. As with the Builder, it must stay out of corners X1-X4. Again, failure to do so results in the forfeiture of the round and the loss of any points accumulated.

Both robots compete against each other through the accumulation of points. The Builder seeks to build the tallest structure using the most blocks, while the Garbage collector goes about removing Styrofoam blocks from the playing area. In addition to avoiding obstacles, robots must not collide with each other, with a collision immediately terminating the round, and the robot responsible forfeiting all points accumulated in that round.

Note that neither robot is allowed to damage the Styrofoam blocks in any way during collection, i.e. it cannot "stab" the block to move it.

Note – each robot must complete its task and return to its starting corner within the 5-minute time limit.

Scoring is on a points-based system, with 1 point each awarded for demonstrating the following capabilities: localization, intentional navigation, collision avoidance, block detection, block manipulation, landing a block to its designated destination, and returning to the starting corner. Both robots also receive 1 point for each block that they deliver to their designated zone. In addition, the Builder's blocks are weighted by height above the ground. For example, a stack of 3 blocks is worth 6 points, with the bottom block worth 1 point, the second block worth 2 points, and the third block worth 3 points. Each robot will play an equal number of rounds as Builder and Garbage Collector, so there is an equal opportunity for all players to score maximum points.

Robots will be required to localize in 30 seconds or less, or else be required to forfeit the round. *In order to determine when localization has completed, the robot will make a sound signal. Note that this will be the ONLY sound signal made during localization. If several sound signals are made, the robot may be disqualified.*

The competition will proceed in two rounds, with each robot getting two turns in each

round, one as Builder and the other as Garbage Collector, for a total of 4 runs. To "pass", a robot must successfully demonstrate each of the capabilities listed above at least once during the 4 runs. The winner of the competition is the team that has the most points at the end of the day.

Details

1. The dimensions and layout of the field are shown in Figure 1. To facilitate operations, the floor is comprised of nine 4'x4' hardwood-covered metal panels that lock together. The surface of each panel is marked with a 4'x4' grid that aligns precisely with adjacent panels. These are intended for navigational purposes, which were covered during one of the one-week labs.
2. Obstacles will consist of wooden blocks (the kind found in the lab) and can be placed anywhere (as shown), except for the red and green zones.
3. At the start of each round, both teams will be directed to place their robots in one of the 4 corners shown, at a random position and orientation within the corresponding tiles. When executing its localization routine, your robot must always keep the center of rotation within the tile (this implicitly limits the footprint of your robot). Localization must be completed in 30 seconds or less.
4. You will be provided with a Wifi class as described above.
5. For the purposes of the course, a successful design is one that can perform each role successfully during the 4 opportunities afforded.
6. For the competition (which has nothing to do with your final grade), the 3 teams with the most points will be awarded prizes and bragging rights.
7. You may use up to 3 Mindstorms kits to fabricate your design. Any other material used must be with the explicit permission of the instructors. Further, any such materials will be posted to an "additional bill of materials" list on MyCourses which may then be used by other groups.

As further information becomes available, this list will be expanded accordingly.

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Appendix 1 – Styrofoam Block Description