REQUIREMENTS DOCUMENT

Team 14

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1.0 Table of Contents

2.0 Capabilities

2.1 Purpose

The overall purpose of the project is to build a competition robot out of *Mindstorm EV3* bricks and its respective components (sensors, motors and elements) which can navigate around an enclosed area, as well as identify, retrieve and manipulate objects which it encounters within its path. Depending on the nature of the encountered object (could be either a wooden block or a Styrofoam cube), the robot has to either avoid (in the case of a wooden block) or collect the object and move it to a designated area (in the case of a Styrofoam cube). The robot will perform in an end-of-semester competition, which will tentatively take place on Tuesday, November 29th 2016 from 8:30 AM to 5:30 PM, in the Lorne M. Trottier Building, located on 3630 University Street. At the beginning of each round, our robot will be assigned one of two roles: builder or garbage collector. If designated as the former, the robot will have to collect and move Styrofoam blocks to a predefined area known as the "green zone," to then construct the tallest tower it can within the same location. In the case of the latter, however, it has to simply locate and move Styrofoam blocks to another designated "red zone" so as to hinder the builder's goal by removing building material from the playing area. The robot will start each round at one of the four corners of the square arena and, upon reception of parameters, localizes itself and starts. The team will receive points based on the performance of the robot and how well it exhibits the capabilities described in section 2.2.6.

2.2 Scope

1. Date of competition: Tuesday, November 29th 2016 from 8:30 AM to 5:30 PM
2. Location of competition: Lorne M. Trottier Building, located on 3630 University Street
3. Competition format: Series of two rounds, one-versus-one. Each robot gets two turns in each round, one as builder and the other as garbage collector (see 2.2.7), for a total of 4 runs. The team with most points after all rounds are completed will win the competition.
4. Arena: 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.
5. Objects: 10-20 Styrofoam blocks of size 10 cm x 10 cm x 5 cm and 5-10 wooden blocks distributed randomly across the arena.
6. Predesigned parameters: At the beginning of each round, the robot will receive the following preassigned parameters through a connection with the competition's server: builder team number, builder starting corner (initial position of the robot in one of the arena's four squares), collector team number, collector starting number, x and y coordinates of the lower and upper right corners of the red zone, and x and y coordinates of the lower and upper right corners of the green zone.
7. Roles:
    i) Builder: The builder has to collect Styrofoam blocks, move them to the green zone and build a tower out of them.
    ii) Garbage Collector: The garbage collector has to collect Styrofoam blocks, move them to the red zone so as to limit the amount of Styrofoam blocks the builder can gather and hence, the size of its tower.
8. Predesigned zones:
    i) Green zone: This is the zone to which the builder has to move the Styrofoam blocks it has detected and where it has to build the tower. The green zone is smaller than the red zone.
    ii) Red zone: This is the zone to which the collector has to move the Styrofoam blocks it has detected. The red zone is bigger than the green zone.
    iii) X1, X2, X3, X4: These represent the four starting corners of the arena, with X1 being the lower-left corner, X2 the lower-right, X3 the upper-right and X4 the upper-left one.
9. Time limit: The total playing time is 5 minutes.
10. Capabilities: In addition to fulfilling the two roles described in 2.2.7, the robot has to perform localization, intentional navigation, collision avoidance, block detection and manipulation, landing a block to its designated destination, and returning to the starting corner.
11. Point attribution: The robot received one point for each capability described in 2.2.10. Furthermore, the robot receives one point for each block it delivers to its 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.
12. Prizes: Awarded prizes (TBD) and bragging rights.

2.3 Constraints

1. The robot shall be built out of a maximum of three *EV3 Mindstorm* bricks, with respective sensors and motors.
2. For a detailed description of all hardware-related limitations that come with the usage of the EV3 Mindstorm brick, including component and electronic constraints, please refer to section 2.1, “Hardware Available and Capabilities,” of the System Document.
3. The robot has a maximum of 12 ports for sensors and 12 ports for motors (4 of each per *EV3 Mindstorm* brick).
4. The robot has to start at one of the X1-X4 corners (2.2.8).
5. The objects (see 2.2.5) can be placed anywhere in the arena (2.2.4) aside from the predesigned zones (2.2.8)
6. The robot has to retrieve its predesigned parameters (2.2.6) from the *getTransmission* method of the *WiFiConnection* class provided.
7. The builder (2.2.7) cannot enter the red zone nor the X1-X4 corners (2.2.8); failure to do so will result in the forfeiture of the round and the loss of any points accumulated.
8. The garbage collector (2.2.7) cannot enter the green zone nor the X1-X4 corners (2.2.8); failure to do so will result in the forfeiture of the round and the loss of any points accumulated.
9. Robots have to localize in 30 seconds or less; failure to do so will result in the forfeiture of the round. Robots must also always keep the center of rotation within their assigned tile.
10. The robot will be awarded at least four opportunities to perform each role (2.2.7) successfully.
11. Robot shall not damage the Styrofoam blocks in any way, i.e. the robot will not stab the blocks in order to move them.
12. The robot cannot emit any sounds other than the one it emits after completing its localization.

2.4 User Functions

The user cannot interact with the robot once it has been initiated during the competition. However, for data logging during formal tests and experimentations, we can use technologies such as secure shell and secure copying protocol to retrieve information from the robot (see System Document section 3.0). It is also worthy to note that the device has to establish a connection with the competition's server in order to retrieve preassigned parameters.

2.5 Operating Environment

The robot is going to operate inside the Trottier building (2.2.2) and on hardwood-covered metal panels (2.2.4). Depending on the quality of the competition floor and its state, the slippage of the robot's wheels might be increased, and therefore its overall precision and accuracy might be affected, as well as performance in tasks such as localization and navigation. In another hypothetical scenario where the black grid lines would be worn off, our light sensor would be much more susceptible to error due to lack of visibility of the lines' colour, and were we to decide to implement a localization based on that, we would be at high chances of losing the round instantaneously. The ambient lighting in which the robot operates is undetermined as of yet, although it is known that the luminous intensity of the competition's location will be considerably lower than that of the laboratory rooms. Therefore, some discrepancies between the performance of our sensors within standard conditions (lab) and competition settings might occur. Furthermore, our robot will be executing its functions at the same time as another robot and, consequently, both robot's ultrasonic sensors could interfere with each other and present false readings.

2.6 Performance

1. As stated in 2.3.12, the robot needs to localize in less than 30 seconds.
2. After localization is complete, robot must make a sound signal
3. As stated in 2.2.9, the robot has only 5 minutes to display the capabilities stated in 2.2.10

3.0 Compatibility

3.1 Component Re-Use

From the laboratories completed in the first half of the semester, we can reuse several pieces of code such as:

- The wall follower controllers (Bang-Bang or P) from the first lab could be used to execute the obstacle avoidance task of the robot. For more information, please refer to Section 6.0, "Reusability," of our Systems Document.
- The odometer and the odometry correction from the second lab, alongside the navigation classes from the third lab, could allow the robot to correctly travel inside the competition floor. For more information, please refer to Section 6.0, "Reusability," of our Systems Document.
- The ultrasonic localization created in the fourth lab can be used to effectively localize the robot within its respective tile (2.2.8) under the time constraint imposed on 2.3.12. For more information, please refer to Section 6.0, "Reusability," of our Systems Document.

Also, we can use any of the classes and methods inherent to the leJOS EV3 API.

3.2 Compatibility with Third Party Products

As of now, there are no plans to use any third party products.

4.0 Glossary of Terms

Application Program Interface (API): Set of routines, protocols, and tools for building software applications.