THE REQUIREMENTS DOCUMENT

Project: DPM Final Design Project
Task: Document the requirements which must be met throughout the project.

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Brendan Marks - 2019/11/24 - Revise entire document

1.0 TABLE OF CONTENTS

2.0 CAPABILITIES

2.1 PURPOSE

Design and construct an autonomous machine that can navigate a closed course and launch a ping-pong ball into a bin residing at a known location outside the perimeter of the "island" by receiving instructions via WiFi. At the start of a round, two players will be placed in their respective corners at a random orientation and started. A set of game parameters will be downloaded from the game and started. Once received, the machine must cross the river over to the central island through the tunnels. On the island, obstacles with screens are randomly located. Plus, while moving, each player must avoid hitting each other.

2.2 SCOPE

The robot must operate inside a 15' x 9' field with the origin located in the lower left hand corner, (0, 0).

There are three zones:

1. Red Zone → the starting spot for player one
2. Green Zone → the starting spot for player two
3. Yellow Zone → the central island

Each of them is surrounded by a virtual river (blue regions), connected to the island (yellow zone) by tunnels. Each zone corresponds to a rectangular region defined by its lower left (LL) and upper right (UR) corners relative to the origin.

Two other zones are added out of the field, which are the layouts where bins are placed and where the ball should be thrown. Each team (green and red teams) has its corresponding bin zone.

The robot is however limited by a few design challenges implicit in this task:

- Must fit the dimensions of the tunnel (how large, how high)
- 4 rounds with at least one ball launched correctly (i.e. reaching the bin)
- Balls carried on the robot itself - This design is not necessary but gives more opportunities to reach the bin.
- Reasonable speed since there is a time limit of 5 minutes
- A certain number of beeps must be added at different times :
    - 3 beeps after localization
    - 3 beeps after navigation to and through the tunnel as well as reaching the launch position
    - 5 beeps after returning to the starting corner - end of the demonstration

The project is meant to be a one-shot operation on competition day on November 27^{th}, the deadline of the project, but may be implemented in further projects and future designs.

2.3 CONSTRAINTS

For a list of constraints imposed by the clients on design and budget, refer to the Constraints Document. For a list of basic parameters of the system and their limits, refer to the System Document. For a list of dimensional limits on the robot or the field, refer to Section 2.2 of the Requirements Document.

2.4 USER FUNCTIONS

The user may only physically interact with the robot before the demonstration begins; after filling the checklist, someone must press the start button on the EV3 in order to begin the demonstration. The user may interact with the robot via WiFi briefly at the beginning of the demo. The desired team, the starting corner and the coordinates of the island, tunnel and bin must be provided by the user to the robot via a WiFi connection. During operation, the user cannot interact with the robot nor the field of play both physically or through WiFi.

2.5 OPERATING ENVIRONMENT

The device will operate on the competition floor composed of 15’ x 9’ tiles of 30,48 cm each. The competition surface is composed by two starting zones (red and green), by the island (yellow) and by the river (blue).Tunnels are positioned between the starting zones and the island. In the island obstacles with screens can be located at any position. In addition, inside two zones outside of the perimeter field are located two bins (one for each team) to receive the ball(s).

Adjacent tiles may differ in height, so the intersections between them may not be leveled and could slightly affect the robot’s navigation and odometry. As for the conditions of the competition room, the lighting will be ambient and should not affect the performance of the device. However, external sounds could possibly affect the algorithm of data processing and decrease the reliability of the detecting range of the ultrasonic sensor.

2.6 PERFORMANCE

For performance requirements on rules and time limits, refer to section 2.2. A success is achieved if the robot can launch at least once, a ball into the bin.

3.0 LIST OF UNKNOWNS

3.1 UNKNOWNS AND QUESTIONS

Existing components and software can be reused and leveraged. For specific components that will be reused, refer to sections 5.0 and 6.0 of the System Document.

4.0 COMPATIBILITY

4.1 COMPONENT REUSE

The team is allowed to use previous software programs created in labs 1 to 5. Each team is also provided up to 3 Lego Mindstorms kit worth of parts available. In addition, a MakerBot Replicator 2 rapid prototyping machine is available for fabricating parts for those inclined. Additional materials may also be purchased but these must receive prior written approval from the instructor. Finally, all computation must be done on board the EV3 brick(s); no offloading to an external machine is permitted.

4.2 COMPATIBILITY WITH THIRD PARTY PRODUCTS

Judging from experience acquired during the 5 labs which were conducted, the robot should not need to interface with or connect to any devices other than those supplied by the Lego Mindstorms kit. External libraries may be used for software if they are found to be useful for calculations during the final design project. However, a MakerBot replicator 2 rapid prototyping machine is available and additional materials can be added with the approval of the instructor.

5.0 GLOSSARY OF TERMS

Field : The entire surface that is physically reachable.