REQUIREMENTS DOCUMENT

GROUP 4

2nd December 2016
Version 3

Contents

1 BACKGROUND

1.1 Edit History

Tristan Saumure Toupin: 2016-10-23, work on sections 2.1, 2.3, 2.5

Alexis Gigure-Joannette: 2016-10-24, work on sections 2.4, 3.1, 3.2, 4.0, added table of contents

Richie Piyasirisilp: 2016-10-24, work on sections 2.2, 2.6

Jake Zhu: 2016-10-28, Ported to LaTeX

Jake Zhu: 2016-11-12, Adjusted the purpose section to reflect changes in the Specifications Document v2.

Kareem Halabi: 2016-11-23, Confirmed compliance with requirements v3, grammatical changes, major changes to specificity

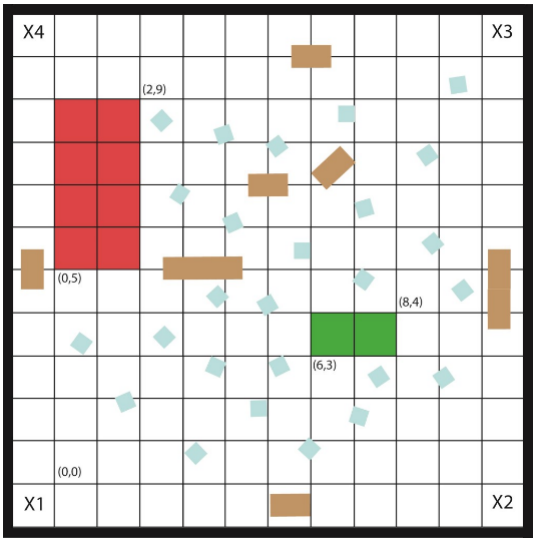
Kareem Halabi: 2016-12-2, Last minute fixes

2 CAPABILITIES

2.1 Purpose

The final product must be able to complete two roles: The Builder and the Garbage Collector. The Builder has to build a tower of Styrofoam blocks as high as it can inside a the Green Zone of the map see Figure 1 while the Garbage Collector must move Styrofoam blocks inside the Red Zone. The Builder is forbidden from entering the Red Zone and the Garbage Collector from the Green Zone. In both scenarios, the robot cannot damage the block, and it must navigate around the map while avoiding obstacles. This must be completed within 5 minutes against an opponent.

Figure 1: Example configuration of the map
(Obtained from client requirements document)



In order to complete any of these two tasks, the robot must receive parameters sent via a WiFi connection including the placement of the Green and the Red Zones, the roles of each robot on the field and in which starting corner they are located. After localizing with a

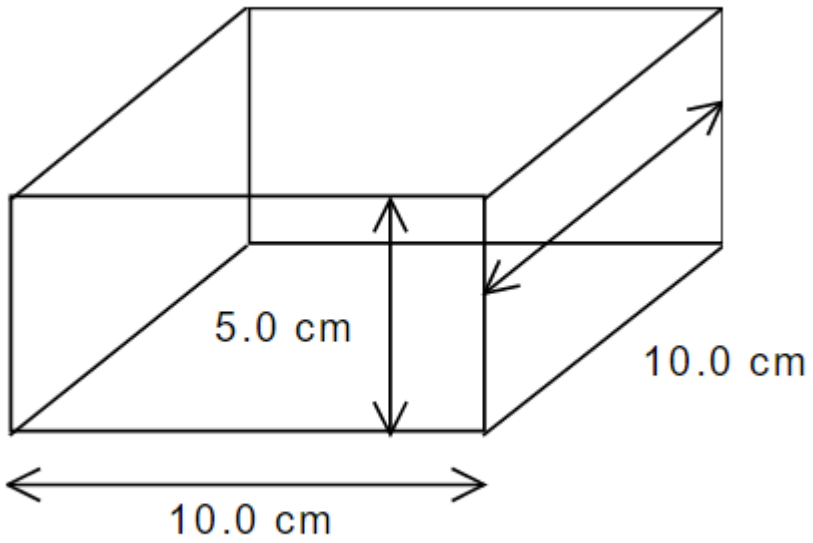
maximum time of 30 seconds, the robot must beep and then proceed to its task. Before the 5 minute time window has elapsed, the robot must return to its starting corner to complete the competition.

2.2 Scope

The capabilities of the team include software experience from courses such as COMP 202, 206, 250, ECSE 321, and prior personal projects. The team's hardware knowledge includes experience from FRC Robotics, McGill Chem-E Car, MEC, and prior labs. Limitations to this project include different availabilities, work times, and work ethics. Time management will also be challenging since this final project must be completed in less than two months.

The robot will compete on a 12'x12' wooden surface on the second floor of the Trottier Building. The Styrofoam blocks will be blue in color, will have the dimensions and orientation specified in Figure 2 (refer to Question 2 in section 1.2 of Prof/TA Meeting Minutes). The obstacles are wooden blocks of a light brown color with dimensions of 14cm X 10cm X 22.5cm

Figure 2: Dimensions and orientation of a Styrofoam block
(Obtained from client requirements document)



We must first finalize the design of our chassis for navigation, mechanical arms to grab the blocks, and our selection of sensors. Our plan is to design and build two prototypes; one with one EV3 brick and one with two. These will be tested and one model will be chosen as the final design.

2.3 Constraints

The software will be operated by one or two EV3 bricks. Therefore, the amount of computation and threads executed by the processor must be reduced to a minimum. The battery inside the robot has to operate for 5 consecutive minutes during the competition. In addition, the robot must be built with 3 or less Mindstorms kits. The product must stay within the 12'x12' enclosure while avoiding the opponent's zone (Green if Garbage Collector, Red if Builder) at all times. The robot has to be heavy enough so it does not slip and light enough so the motors can rotate easily. Its size must be kept small in order to pass through tight areas (e.g. between two obstacles). As for constraints on human resources, there is a maximum of 9 hours spent per member per week. In the event a member works less hours in one week, they can transfer unused hours to a future week but not to another member. (refer to Section 2.1 of the Prof/TA Meeting minutes)

2.4 User Functions

Once the code is started, the user can pass the parameters by calling the `getTransmission` method using a WiFi connection. At this point, the user cannot interact with the device until the competition is over. After the device receives the parameters, it operates autonomously until it returns to its starting position when the time limit of 5 minutes has elapsed.

2.5 Operating Environment

2.5.1 Floor

The product will be operating on a 12x12 wooden floor. The wooden floor is composed of four square segments of the same size. In between two segments, there is a small gap that may cause part of the robot to get stuck or skip a few degrees of rotation as it crosses it. This may have a significant negative impact on our odometry. The boards may not be necessarily clean, allowing dirt to accumulate on the wheels causing slips which can also affect odometry. A black line is traced on the wood at every foot, however these black lines may be pale due to attrition. There will also be walls placed around the four square segments which create gaps between the panels.

2.5.2 Lighting

The lighting is difficult to predict and may vary based on the location in the room, outside weather conditions and time of day as the second floor of the Trottier Building has many windows. Therefore, readings from the light sensor may be skewed. We will likely need to re-calibrate the sensor or use differential values for processing.

2.5.3 Ultrasonic Noise

Since there will be more that one robot on the floor there will probably be more that one ultrasonic sensor polling in parallel with ours thus our readings may be incorrect. A filter must be implemented on the light and ultrasonic sensors readings to avoid these issues.

2.6 Performance

Ideally, the sensors' response times should be instantaneous but that is not the case. The ultrasonic sensor needs a signal around 8 cm before it runs into an obstacle to respond in time and the light sensors polling frequency needs to be measured more accurately. As mentioned in "CONSTRAINTS" (section 2.3), the battery inside the robot has to operate for 5 consecutive minutes during the competition. It should be able to travel at least across the arena twice. This is so it can at least travel to a block, detect it, and bring it to either the red or green zone.

3 COMPATIBILITY

3.1 Component Re-Use

Existing components from our prior research and development phase can be re-used for this design project. However, these components will likely need to be refined to newer, ameliorated versions. The odometer is one of the components that will require the least amount of changes as its purpose and algorithm in our project is the same as it was in the laboratories. Software components such as obstacle avoidance, navigation and localization will be used as a reference, but they will be re-made to integrate the new software architecture, hardware design and constraints not present in the laboratories.

3.2 Compatibility with Third Party Products

The system must connect to the competition server using the `WiFiConnection` class that will be provided by the client. The WiFi capabilities of the robot will be provided by connecting a third-party USB WiFi adapter to the USB port of the brick. The software is programmed in Java using the LeJOS open-source library and will run on the EV3 flashed with the LeJOS firmware 0.9.1. Any built-in Java library can be implemented as long as it works with LeJOS. Use of any other third party libraries requires an explicit permission from the client. For the hardware, any material other than the Mindstorms kit can be used with the explicit permission of the client.

4 GLOSSARY OF TERMS

getTransmission method: Method passing initial parameters to the robot by the competitions server using WiFi connection

Green zone: Zone used by the builder

Mindstorms kit: Kit used to build the hardware of the robot

Red zone: Zone used by the garbage collector

WiFiConnection: JAVA Class provided to connect to the competitions server

Trottier Building: Lorne M. Trottier Building located at 3630 University Street, Montreal, Quebec, H3A 0C6