THE REQUIREMENTS DOCUMENT

Project: DPM final project (Preliminary)
Task:

The main tasks in this project can be classified as total five of them: Localization, Navigation through Bridge, Navigation to Ring Sets, Ring Scanning and Color Detection, and Return Trip. The details of those tasks will be provided later in this document.

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[18/10/2018] Shaodi: Created Requirements Document
[07/11/2018] Shaodi Sun: Updated requirement document based on project description version 2

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1.0 CAPABILITIES

1.1 PURPOSE

The overall purpose of this project is to create an autonomous vehicle capable of localizing and navigating through a closed course to detect and collect colored rings and unload them after returning to the starting point.
In order to achieve that, there are five tasks that need to be done.

1. Localization: The vehicle should be able to localize itself after being placed in one corner in a random orientation, the start key is being pressed, and required set of parameters are being delivered to the player.
2. Navigation through Bridge: After started, the player shall be able to navigate through a tunnel to get on the "island" by provided parameter set.
3. Navigation to Ring Sets: The player shall be able to navigate to their individual ring set using the provided parameters
4. Ring Scanning and Color Detection: After reached the ring set, the player shall be able to scan for rings and detect the its respective color.
5. Return trip: After detected rings, the player then shall be able to return to the starting point and unload rings. The player can either return with one single ring or place the ring in storage and attempt to grab more.

Before performing the five tasks, a Wi-Fi class will be used to deliver all game-related parameters to player. Details of parameters will be provided later in the scope section.

1.2 SCOPE

1. Time: The project will be delivered as a competition which all the tasks should be completed within five minutes (may be increased later).
2. Environment: The player will perform all tasks inside a 15 x 9 grid with a side length of 30.48centimeter panel. The origin (0,0) is placed at lower left corner of the whole panel. Two teams participated in competition will start from respective corners, marked as green corner (lower right) and red corner (upper left). There will be a river around the start corner, marked as blue and tunnels for the player to cross the river. For the green team, the tunnel connecting the green zone overlaps by one square whereas for the red team, the tunnel connecting the red zones joints the boundaries. The ring sets for both teams will be placed in a central island, marled as yellow.
3. Parameters: After starting competition, both players will be given a total of 16 parameters for them to decide their positions and navigation. The parameters are coordinates of the facilities in the field, which includes team starting out from red zone and their starting corner, team starting out from green zone and their starting corner, lower left and upper right corner of red zone, lower left and upper right corner of green zone, lower left and upper right corner of red tunnel footprint, lower left and upper right corner of the green tunnel footprint, lower left and upper right corner of the red player ring set, and the lower

left and upper right corner of the green player ring set. For the coordinate pairs, the Wi-Fi dialog will pass them individually.

4. Indication of completion of tasks: As what specified in project instruction handout, the player shall be able to beep after completing specific tasks. First, the player shall beep after localizing itself. When arriving at ring set, the player shall beep for three times. When detecting rings, the player shall beep one time if the ring is blue, beep twice if the ring is green, beep three times if the ring is yellow, and beep for four times if the player detect an orange ring. After return to its start point and unload all rings, the player shall halt and issue a sequence of five beeps.
5. Performance: Each team will can participate in four runs, and the design will be deemed as "successful" if the player succeeds in delivering as least one ring during the series of runs.

1.3 CONSTRAINTS

1. Size: The physical constraint of the design is being placed by the dimension of tunnel. Since the size of the machine is limited, the number of rings that can be transported each time is limited also.
2. Time: There is a time limit to complete tasks. We assumed that the nominal time limit is 5 minutes from receipt of parameters to completion of tasks. The time limit will be finalized after Beta demo.

1.4 USER FUNCTIONS

The device will wait for user input, i.e., pressing a start button, to start the competition. After that, the user is not allowed to interact with the device until tasks are completed.

1.5 OPERATING ENVIRONMENT

The player will be operated in a field composed of 15 x 9 grid squares with side length of 30.48 centimeters. The panel is a wooded, light brown panel with black grid lines on top of it for navigation purpose. The competition will be held indoors, in a lab with constant temperature and humidity, so external influences like weather and sounds can be neglected. However, the light is a variable in the while design and it will affect the performance, so the light sensor needed to be carefully tested for desired performance.

1.6 PERFORMANCE

The user input will, and only will happen in the beginning of the competition, so the response time shall be fast enough for testing and debugging purposes. And the robot shall have as fast as possible response to receipt of parameters to start earlier.
And as mentioned in the SCOPE, the speed shall be faster enough because of the time limit. But the speed shall be appropriate fast to make sure that the sensor fetches value accurately. Sometimes, the light sensor does not detect a black line if the robot moves too fast.

2.0 LIST OF UNKNOWNS

2.1 UNKNOWNS AND QUESTIONS

List all the questions you have on the project here. In particular the unknowns. You should also, for each one, produce a sentence which describes how you intend to resolve it. As the project progresses, this list should become shorter and the answers should be used to modify your understanding of the requirements.

3.0 COMPATIBILITY

3.1 COMPONENT RE-USE

All the hardware and software component from the research and development phase, i.e, from Lab 1 to Lab 5, can be re-used in the final project. The main component is this project would be the LEGO EV3 kit and leJOS API.

3.2 COMPATIBILITY WITH THIRD PART PRODUCTS

All the parts that we will be used building the robot are from LEGO, so no other hardware suppliers will be interfaced in this project. The operating environment, i.e, the lab and panel is available to us during the whole development phase, so we can use them to test our sensors and motors for desired performance. For now, we are using Eclipse as IDE and leJOS as plugin as software support, but we may interface with other software support later in the development phase for accuracy. There are also 3D printers available if some specific-shaped pieces are needed for design.

4.0 GLOSSARY OF TERMS

Note that this document should be reviewed with the "Clients" and should be developed in conjunction with them.