Constraint Document

Project: Design an Autonomous Robot

Task: To design an autonomous robot that is capable of navigating to a predetermined position while avoiding obstacles and firing objects at two targets. This is to be done in the shortest time possible.

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# Environmental Issues

Environmental issues that will affect the operation of the robot are ambient noise, ambient light conditions and the type of floor used in the competition.

1. Ambient Noise

Because the ultrasonic sensor’s reading is based on sounding technology, background noise such as chatter, cheering or pings from other robot can affect the accuracy of the sensor. Since the competition will be held in the lobby area of the Trottier building, the amount of noise will vary greatly. Furthermore, there are classrooms around the area, and thus when the classes end, there will be a sudden high influx of people who will create a lot of noise. Also, during the competition, most of the students taking this course will also be present, with the judges, professors, and the TAs, so the ambient noise will be much higher than the usual. All of these changes in sound level will affect the accuracy of the ultrasonic sensor, since the sensor needs to be able to receive the signal it sends. However, if there is a lot of noise, the signal may be distorted or lost, which will induce a lot of error. Due to this issue, cardboard may be installed on the sides of the sensor in order to reduce the amount of interference. (See the material proposal for more details on the cardboard.) Furthermore, a new filter will need to be designed in order to take the variance into account.

1. Ambient Lighting

The ambient lighting has an impact on the operation of light sensor, since it will get different readings from being in a brightly lit room than being in a dimly lit room. The competition is held in the lobby of the Trottier building. This lobby has large windows along an entire wall, which will unpredictably change the lighting of the room, since the lightning will be directly related to the weather and the time of day. This change in lightning will make the color readings for the wooden floor and the black lines to vary. This variance will be unpredicted, thus a differential filter needs to be created. This filter will have to detect a difference in color rather than the colors themselves.

1. Floor

The floor that will be used in the day of the competition may be slightly damaged during previous labs. For example, some grid lines, which will be used by the light sensor, are faded, making the sensor unable to detect those lines. Defective grid lines may make the light sensor unable to detect the gridline, which may induce a larger error on the odometer, since it will be unable to correct. Furthermore, there will be nine boards of nine grids connected together. The junction may have slight gaps or minor height differences due to the manufacturing of the boards, which will create the effect of a bump, similar to pot holes in the streets of Montreal. If any sensors, notably the light sensors, are placed too close to the ground, they may scratch the floor or the sensor, both undesirable situations.

# Hardware Constraints

This project will require, in addition to Lego Mindstorm kit, the use of two types of sensors – the ultrasonic sensor and the light sensor, which have innate disadvantages.

1. Lego Mindstorm kit

For this project, only 3 Mindstorm kits will be available to each team, which limits the maximum size of the robot, the amount of sensors available, and the amount of bricks available for use. A limitation on the amount of bricks will limit the amount of sensors capable of being implemented, since each sensor needs to be connected to a port. Because each brick has 7 ports and 1 USB port, 3 bricks will limit us to 21 ports, which means 21 sensors or motors, total. Furthermore, each kit only has a limited amount of sensors, which will further constrain the design. Also, each kit has a very limited supply of certain types of useful Lego piece, like the caster wheel.

1. Ultrasonic sensor

This sensor has very limited capabilities, since it has very high chances of inaccuracies, due to the ambient sound. Its accuracy will depend mostly on its filter. This sensor has a very limited range, since past 255cm, the ultrasonic sensor will be unable to accurately determine the distance. This distance also varies depending on the environment. Since the ultrasonic sensors’ position is fixed on the robot, the ultrasonic sensor will not be able to move, thus creating blind spots. The sensors have been placed strategically in order to try to avoid such situations. Furthermore, the ultrasonic sensor is unable to detect corners that are 45 degrees to it, because the wave will split at the corner and not be able to bounce back for the ultrasonic sensor to read.

1. Light sensor

The light value that it detects is dependent on the ambient lighting, thus the detection of the black line will depend on the quality of the filter.

1. Wheels

The wheels used will be constantly in contact with the floor through the project. Thus, the wear and tear on the wheels will lead to friction and slipping, which will affect the NXT’s navigation’s accuracy. Also, the wheels need to be able to support the weight of the whole robot in order for the robot to travel smoothly.

1. Caster Wheel

The caster wheel will get stuck in the unbalanced connections between the 4x4 grids, so it will need to be replaced in case the robot gets stuck and unable to proceed.

1. Batteries

Batteries play a big impact on the performance of the robot. It is necessary to assure that the team uses new batteries during the day of competition. Furthermore, the hardware design needs to take into consideration the fact that the batteries will need to be frequently changed, so the battery component of the brick must be easily accessible without having to break apart most of the hardware design to access.

1. General Hardware Design

The robot needs to be able to travel smoothly, thus the load on the robot cannot be too large. Also, the robot will also need to be able to avoid obstacle, and if the design of the robot is too large and too spread out or wide, then it has a higher risk of failing the obstacle avoidance.

# Software Constraints

The project is going to use Lego Mindstorm API “Lejos” to control the robot. Due to the fact that Lejos is an open-source software, there are concerns about its product development. Also, the coding will be done in Java, which is an object oriented language. Furthermore, the display cannot be accessed by more than one method at the same time, thus precautions must be taken in order to avoid this. Also, racing conditions must be avoided.

# Availability of Resources

(Refer to the Capabilities document)

# Budget

In the scope of this project, 7 weeks are allotted to complete this project, and each member has 9 hours every week. This totals to 63 hours per member, and 378 total for the project maximum to complete the project.

Financial constraint also limits the quality of this project. Each member is willing to donate 10$. The batteries and the final poster are the main areas where it will be spent. Some small accessories for the robot which the Lego kit doesn’t include will also need a budget.

# Glossary of Terms

N/A