Radiation Clean-Up Robot Design Project

1.0 Introduction

After the nuclear accident in Fukushima Daiichi nuclear disaster, it was necessary to remove radioactive materials from within the reactor as part of the cleanup effort. Unfortunately, this environment is hazardous to human life so robots were needed to perform some of this work. Some of the areas in this environment are very heavily shielded or are subject to very high levels of ionizing radiation which limits the use of radio control. These robots need to complete the clean-up tasks with the minimum of outside control or direction. Examples of robots that were used are found in http://www.popularmechanics.com/technology/engineering/robots/3-robots-that-braved-fukushima-7223185#slide-1,

Your design team works for an engineering consulting company that has entered into the competitive bidding process to win the contract for the design and construction of an autonomous robot which will enter the nuclear reactor core and perform repairs. (For those students reasonably opposed to nuclear power, they can imagine that they are designing a robot capping a deep ocean oil well which has blown out.)

Your robot will have to find a specified target within a constrained search area. Once it finds the target, it will collect an object located on top of the target and move it to a location outside of the search area. For the purposes of this project, the target will be an infrared light source. You will design a carrier for the object so that your robot will be able to lift and move it easily.

Figure 1 – iRobot 510 PackBot Designed for Bomb Disposal and Toxic Waste Handling

2.0 Robot Challenge Specifications

1) **Search Area:** Your robot will have to search an area of 2.29 metres by 2.29 metres. A minimum 5 cm wall surrounds the search area. Your robot should not exit the search area during the tests.

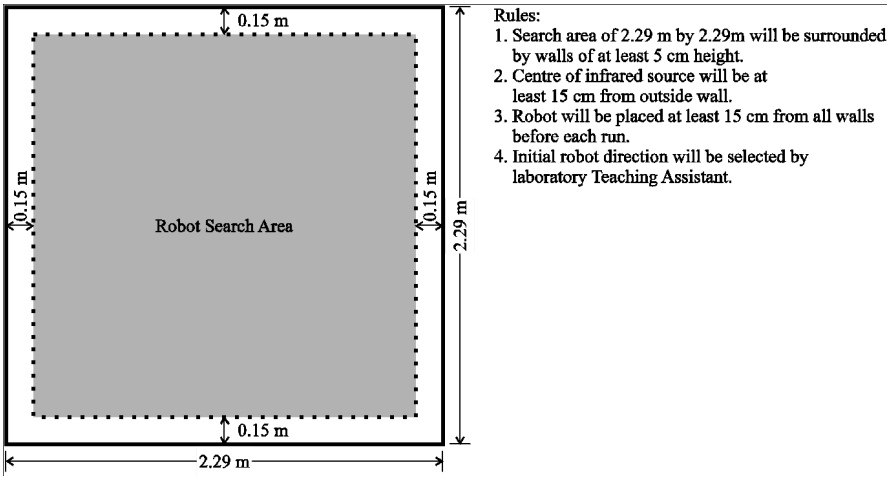

Figure 2 – Search Area Diagram with Rules

2) **Starting Position and Direction:** Your robot will start at least 15 cm from all walls. The initial facing and placement of the robot will be selected by the laboratory Teaching Assistant. Your robot should be able to successfully complete the search task starting from any direction.

3) **Interaction with Walls:** Your robot should not require manual assistance to avoid getting wedged next to walls or corners. This can be done with a design that will not get caught by walls or by using sensors to detect wall collisions and taking appropriate corrective action. At minimum, your robot should be able to detect frontal collisions.

4) **Radioactive Source:** The radioactive source will be simulated by an infrared source. The physical dimensions of the source are given below. The infrared source will be located at least 15 cm from the edge of the search area. The source will flash at a rate of 10 Hz so you can differentiate its signal from the background infrared radiation more easily.

5) **Simulated Repair** To simulate the repair, your robot must collect an object which has been placed on the top of the infrared source. If your robot moves the infrared source by hitting it too hard or knocking it over, this indicates that your robot has compromised the nuclear reactor or oil well. If this happens, your robot has increased the environmental contamination instead of decreasing it.

   Your robot will be judged on the creativity and capability. For example, the speed with which your robot can find the target and moving the object will determine part of your grade. The originality of how your robot picks up the object on the target will also be considered.

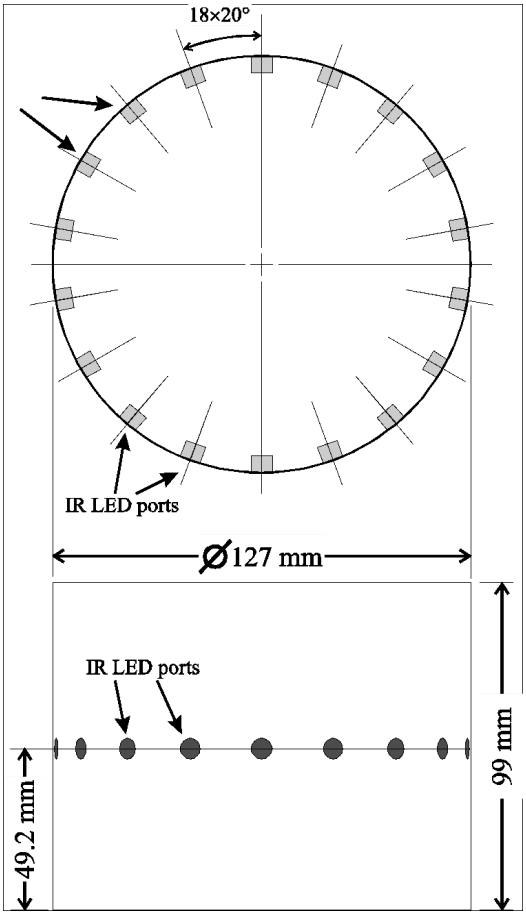

Figure 3 – Diagram of Source

6) **Robot Locomotion:** Your robot will be marked based on its speed and its turning radius. Remember that you are building a scale model of what will be a much larger robot, if your design is selected. Marks will be deducted if your robot drags its wheels on the ground when moving. If your VEX robot drags its wheels on the ground, this might be only a minor inconvenience. Wheel dragging in a large robot would be a major problem creating unnecessary wear and tear on the robot components.

7) **Job Completion:** The robot should signal job completion. You must specify the nature of this signal before the final testing of the robot.

8) **Time:** Your robot should complete the task as quickly as possible. The time taken to complete the task will be considered when marking your project.

3.0

Deliverables

Milestone #	Title	Group/Individual	Due	% of Design Project grade
1	Concept sketches	Individual	(Week of Feb 16) At start of Lab	10%
2	Mechanical systems test	Group	(Week of Feb 23) In Lab	25%
3	Electrical systems test	Group	(Week of March 9) In Lab	25%
4	Software systems test and Integrated operation	Group	(Week of March 23) At start of Lab	40%
				100 %