COMP 581: Introduction to Robotics

Fall 2018
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Lab 4: Bug Race

Deadline

November 28, 2018 at the beginning of class. For the late policy, see the course syllabus. **Before the due time, each team member should individually submit your team's code in a zip file on Sakai**; see specific instructions in the Code section below**.**

The Objective

The primary purpose of this lab is to build and program a robot capable of moving as quickly as possible from a start location to a known goal location in an unknown environment while avoiding static obstacles.

Robot Design Requirements

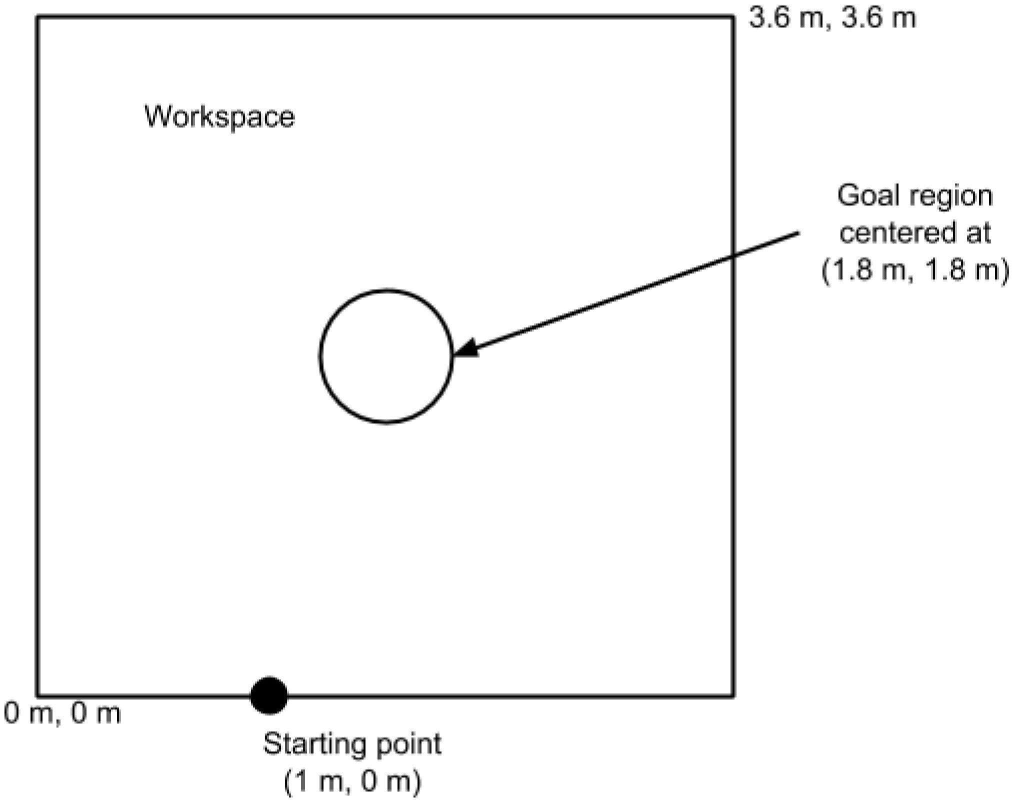
Your robot must be built only using pieces from your Lego Mindstorms kit. Your should design your robot such that the dark gray center button may be pressed without moving the robot and such that pushing the button does not disrupt any of the sensors. Your robot should remain in one piece at all times, its diameter with respect to the ground should not exceed 40 cm, and its diameter shall not change substantially during the task. All measurements will be made with respect to the *measuring point*: a distinct point of your choosing that is on the **frontmost surface** of your robot. More specifically, your robot will be placed on the ground behind a starting line drawn on the ground, and your chosen measuring point must be a point on your robot directly above the starting line, and no part of your robot is permitted to be in front of the starting line. Your robot should be designed to accomplish the task autonomously without any human intervention (except for pushing the dark gray center button as required).

The Task

You will place your robot behind a starting line such that its measuring point will be on a specific *starting point* (100 cm, 0 cm) on the starting line. The *goal point* is located at (180 cm, 180 cm) and the *goal region* is defined as the region that is within 30 cm of the goal point. (Note that goal point will be free of an obstacle but that some of this goal region may be occupied by an obstacle.) All robot motion must be completed within the 360 cm x 360 cm workspace, with the sole exception that the robot may exit the workspace if it remains within 30 cm of an obstacle.

The objective for your robot is to autonomously move from the starting point to the goal region as fast as possible while staying in the workspace. Upon pushing the orange button, your robot should begin the task. Upon reaching the goal region, the robot should stop and beep.

In the workspace will be between 2 and 6 obstacles. Your robot will not know the shapes or locations of the obstacles before starting the task. Each obstacle will be comprised of bumpable, ultrasonic reflective walls that are at least 17 cm tall. Each obstacle will be a closed shape comprised of straight and curved segments and may contain corners. It is not necessarily a convex shape. No gap on the ground between two obstacles will be less than 50 cm wide.



This lab is to be completed in a single run, without pressing any buttons after it has begun or picking up your robot (except as defined in the Points section below). All robot motion must be completed within the specified workspace. The task must be completed in under 3 minutes.

Points

Points Awarded:

- Attempt: 40 points. You will receive these points simply by having LeJOS successfully installed, showing up to the Robotics Lab on the lab due time, submitting your code on

Sakai **on time**, and having your robot attempt the course.
- Moving around obstacles: 20 points. If your robot stops in the goal region, you will receive full credit for moving around obstacles. If your robot does not stop in the goal region, some points will be awarded if your robot follows the wall of at least one obstacle it encounters, based on the number of edges followed.
- Goal accuracy: 20 points. Points will be awarded based on proximity to the goal point when your robot stops. If your robot does not stop autonomously before the time limit, no goal accuracy points will be awarded.
- Time: 20 points. Points will be awarded based on time elapsed from when your robot's dark gray center button is pressed at the beginning until the robot stops. Faster completion will be awarded more points. If your robot does not stop in the goal region, no points for time will be awarded.

Penalties:
- Exit workspace: There will be a 10 point penalty if, after crossing the start line, your robot exits the feasible workspace and is more than 30 cm away from an obstacle. Robots that exit the workspace by more than 30 cm may, at the discretion of the instructor, have their runs terminated.
- Pick up robot: You may, at your discretion and only once, pick up your robot, press a single button, and put it down at the start position (i.e., as you would set up the robot when starting a run). If you choose to do this, you will receive a 10 point penalty. Note that the 3 minute timer continues unchanged.
- Exceed time limit: If your robot does not stop by 3 minutes, then your run will be terminated and no further points after 3 minutes will be earned.

Code

To complete this lab you will use a subset of the leJOS API:
http://www.lejos.org/ev3/docs/
Important: You may only use classes from the following packages in Java and the leJOS API: any class in the java.io, java.lang, java.util, lejos.utility, lejos.hardware, and lejos.hardware.* packages. Note that the classes must be implemented in one of these packages; a class that simply inherits from one of these packages is not permissible. For example, you cannot use a class in lejos.robotics.

A robot relying on a Java class from a package not listed above will be disqualified. Also, any robot using Wi-Fi or Bluetooth communications in any way will be disqualified.

You must submit on Sakai a zip file of your Java source code files. The zip file should include the Java source code files you wrote (which should have a .java file extension). Do not submit Java class bytecode files (which have a .class file extension) or JAR files (which have a .jar file extension). In the comments at the top of the Java source file containing your main method, please include the names and PID's of all team members.

You should feel free to discuss concepts in the course with other students in natural language (e.g. English). You should not share any programming code with others and must write all the robot's programming code yourself. If you access any sources other than the textbook or documents on Sakai, you must cite them in comments at the top of your code and send an e-mail to the instructor with the citation. You must fully understand your code and be able to reproduce the algorithmic approach without references if asked. The Honor Code is in effect for these policies.

Good luck!