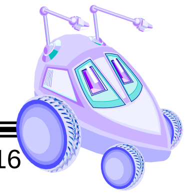

Lab 06

Homing – Hybrid Control

Reading: *Ch. 3 of the text*

Read this entire lab procedure before coming to lab.

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Purpose: The purpose of this lab is to use a type of locomotion called ***homing*** or ***docking*** with hybrid control to move the Arduino Robot toward a light beacon. There will be a static light source placed in the environment which the robot can easily sense. The goal will be for the robot to move toward the beacon and stop just before hitting it. There will be no fixed path to the beacon, the robot should follow walls until the beacon is sensed, it should then leave the wall, keep track of its state and use the move to goal behavior to dock on the source while avoiding any obstacles along the way. Lastly, the robot should then turn 180 degrees and return to the wall to continue following as near as possible to the spot where it left. This will only be possible if the robot has kept track of its state.

Objectives: At the conclusion of this lab, the student should be able to:

- Use the photoresistor to sense a light beacon in the robot's environment
- Implement a hybrid controller on a mobile robot
- Integrate homing and docking into the behavior-based controller designed in prior labs

Equipment: Arduino Robot

2 photoresistors

Sonar or infrared sensors

References:

Arduino Robot Getting Started:	http://arduino.cc/en/Guide/Robot
Arduino Robot Boards:	https://www.arduino.cc/en/Main/Robot
Arduino Language Reference:	http://arduino.cc/en/Reference/HomePage
Arduino Robot Library:	http://arduino.cc/en/Reference/RobotLibrary

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LAB PROCEDURE

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Part 1 – Homing or Docking

1. The hybrid control architecture that you will implement to home the robot includes a reactive layer (obstacle avoidance, wall following, move to goal, path update), middle layer (arbitrator), and deliberative layer (current state, path plan back to wall). This architecture is shown in Figure 1. Your code should be written in a modular fashion with functions such that it is evident where the planning, sensing and acting take place.

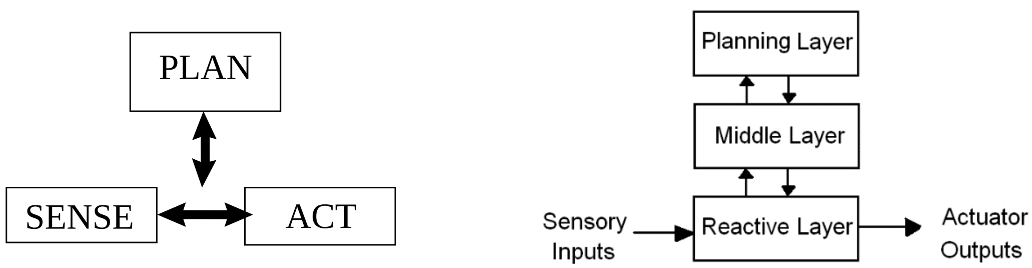

Figure 1: Homing Hybrid Control Architecture

2. The partial world map (representation) includes direction to the beacon and back to the wall with respect to the robot's current pose. This representation will be input into the deliberative layer for path planning. Updates to the path will be based upon feedback from the distance, heading and photoresistors. The middle layer will be used to make decisions about whether path updates are handled in the deliberative or reactive layer. The reactive layer will handle obstacle avoidance, wall following and move to goal behaviors. The robot should turn around and follow the path to drive back to the wall.

3. Based upon the above model, write code to home the Arduino robot to the light source (see Figure 2). The robot should come within one foot of the beacon without touching it.

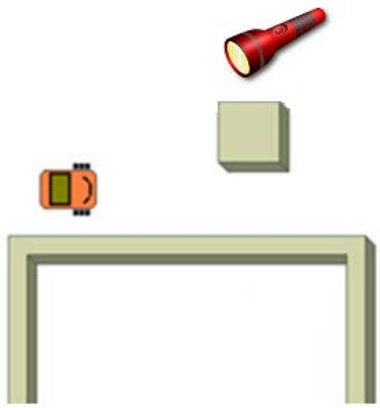

Figure 2: Robot homing

4. Test your final control algorithm for several different robot start points or beacon locations and summarize the results in your lab memo.

Part 2 – Docking the Robot and Return to the Wall

1. Improve the homing routine implemented in part 1 by docking the robot (back to the light) (see Figure 3). The robot should then follow the original path to drive back to the wall and continue to follow at the point where it left off.

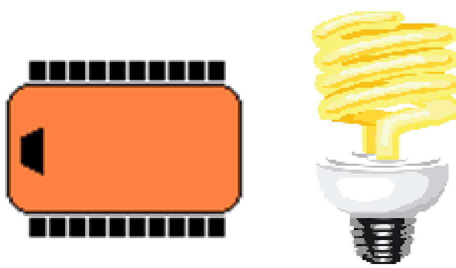

Figure 3: Robot Docking

2. It is your choice, the robot can continue around the wall or go back the way it came.

Demonstration:

The demonstration of the program for the lab will include three parts. In the first part, the robot will be placed in the environment, wander until it finds a wall and then follow the wall until the beacon is detected. The robot should then move to goal and stop within one foot of the beacon. In the second part, the robot should turn and dock on the beacon. Lastly, the robot should return to the wall as close as possible to where it left off and continue to follow the wall.

Bring your robot fully charged to class everyday.

Program:

The program should be properly commented and modular with each new behavior representing a new function call. The design of the subsumption architecture should be evident from the program layout. You should use the GUI, keypad, LCD and speech module as needed to illustrate robot state, input and output data.

Questions to Answer in the Memo:

1. What does the hybrid control architecture for your design look like? What was on the planning layer? Middle layer? Reactive layer?
2. What was your general strategy for planning the path back to the wall from the beacon?
3. How reliable was the photoresistor at detecting different objects at various shapes, sizes and distances. Compare and contrast sensor data.
4. How significant was the difference in photoresistor voltages for the left and right sides. How did you use this difference to extract directional information to move the robot toward the beacon?
5. How significant was the difference in sensor data based upon distance from the source? How did you use this difference to extract distance information to move the robot toward the beacon?
6. How did the architecture respond to differences in robot start position or beacon location?
7. How did the robot's hybrid controller respond to dynamic changes in the environment (i.e. other robots and people) and compare this to purely deliberative control.
8. Were there any challenges in implementing the homing routine?
9. What could you do to improve the robot homing?
10. How did docking the robot modify the control architecture or algorithm?

Memo Guidelines:

Please use the following checklist to insure that your memo meets the basic guidelines.

- ✓ Format
  - o Begins with Date, To , From, Subject
  - o Font no larger than 12 point font
  - o Spacing no larger than double space
  - o Written as a combination of sentences or paragraphs and only bulleted list, if necessary
  - o No longer than three pages of text
- ✓ Writing
  - o Memo is organized in a logical order
  - o Writing is direct, concise and to the point
  - o Written in first person from lab partners
  - o Correct grammar, no spelling errors
- ✓ Content
  - o Starts with a statement of purpose
  - o Discusses the strategy or pseudocode for implementing the robot remote control (includes pseudocode, flow chart, state diagram, or control architecture in the appendix)
  - o Discusses the tests and methods performed
  - o States the results and or data tables including error analysis, if required
  - o Shows any required plots or graphs, if required
  - o Answers all questions posed in the lab procedure
  - o Clear statement of conclusions

Grading Rubric:

The lab is worth a total of 30 points and is graded by the following rubric.

Points	Demonstration	Code	Memo
10	Excellent work, the robot performs exactly as required	Properly commented with a header and function comments, easy to follow with modular components	Follows all guidelines and answers all questions posed
7.5	Performs most of the functionality with minor failures	Partial comments and/or not modular with objects	Does not answer some questions and/or has spelling, grammatical, content errors

5	Performs some of the functionality but with major failures or parts missing	No comments, not modular, not easy to follow	Multiple grammatical, format, content, spelling errors, questions not answered
0	Meets none of the design specifications or not submitted	Not submitted	Not submitted

Submission Requirements:

You must submit your properly commented Sketch code & memo to the Moodle DropBox by midnight on Sunday. Check the course calendar for the lab demonstration due date.