91.450, Robotics I
Fall 2003
Prof. F. Martin

Lab 3: Braitenberg Vehicles, Emergence, Meta-Sensing and Randomness

<u>Out:</u>   Friday, 19 September 2003
<u>Due:</u>   Friday, 26 September 2003

<u>Reading:</u> Sections 2.4 through 2.6 of Martin, before Monday's lab

Part I: Individual Questions

The questions in this section should be answered individually. You will turn in your answers with your lab report. Each team will turn in one lab report (written jointly) and two sets of answers to the questions in Part I (written individually).

> **Problem 1:**
> Search the web for applications of intelligent robots. Pick 4 different applications, describe them briefly (3-4 sentences) and give the web page link.
>
> **Problem 2:**
> Read the article ("Silicon Babies", *Scientific American*, December 1991) (***to be handed out***). List the 7 topics of AI (Murphy, pages 35 – 36) and give examples of robots or researchers addressing each topic.
>
> **Problem 3:**
> Exercise 2.7 (Murphy, p. 64).
>
> **Problem 4:**
> Exercise 3.9 (Murphy, p. 101).
>
> **Problem 5:**
> Describe your line following robot from Lab 2 as a Braitenberg vehicle. (Read Martin 2.4-2.4.3 for a description of Braitenberg vehicles.)

Part II: Lab

In Lab 2, you designed code that would avoid obstacles and follow lines. In this lab, you will be creating robots that are attracted to light, that use local variables to keep track of internal state and that use randomness to prevent them from getting stuck in an emergent loop.

For this lab, you may use the Handy Bug from Lab 1 and 2 or you may choose to redesign the robot with a different drive train. With the competition coming up in a few

weeks, any additional experimentation you do with building with Lego will be useful. (Section 4.5 has a nice presentation of how to build with Lego. I highly recommend that you read it.) However, all exercises can be completed with the Handy Bug. I leave this choice to you.

You only need to write one lab report for your group. I would prefer that your work in lab and your lab reports be collaborative work. One partner should not be writing the lab report alone. It is important that each person work on each section of the lab, since the upcoming midterm will be a solo event.

For any exercises that ask you to write code, please turn in the code with your lab report. Please comment your code appropriately.

A. Light sensors

Type in the program in Section 2.4.5 and test it with the CdS sensors from your kit (these look like clear LEDs). Write up the answers to Light Sensor Exercises 1-4 on p. 81 – 82.

B. Shielding light sensors

Do the Light Shielding Exercise on p. 83. With your new shielding, what are the readings when the sensor is pointed directly at the flashlight? How do the readings change as it turns away from the light source (10°, 20°, 45°, 90°)?

C. Normalizing light readings to motor commands

Write up the answers to Normalizing Exercises 1-3 on p. 85.

D. Light-seeking

Do 1 & 2 under Light Seeking Exercises on p. 85. For 3, implement the following two improvements: add a third light sensor for ambient light and use that value to adjust your eye sensors. Also, rewrite the code to accentuate the difference between the two eye sensors. During staffed lab hours, please demonstrate this improved light follower for me. (You can continue to work on this lab if I'm not around – you'll just need to reload the code to show it to me during lab hours.)

E. Light and touch sensitivity

Do the two exercises in Section 2.5.1.

F. Randomness

Answer Question 1 in Section 2.6.1. Does your robot now compare more favorably to weasel ball? (No need to debate whether acting like weasel ball is a favorable or

unfavorable proposition. I just want to know if your robot is acting more like weasel ball now than it was without randomness.)

Now rewrite your code as described in Question 2 in Section 2.6.1. Describe the altered behavior.

For extra credit: write a program that makes your robot have a similar behavior to weasel ball. Since weasel ball has no bump sensors, your code should not make use of them. In addition to turning in your code, show me your robot before 4pm on Tuesday, 24 September.

G. Emergence and meta-sensing

Reload your code from Section 2.3 and experiment as described in the second paragraph on p. 90 (corner oscillation). If you do not see the oscillation described after several tries, note this. You do not need to change your code to introduce the oscillation as Martin suggests.

Complete the exercises and questions in Section 2.7.3. Note that the code in Figure 2.28 and 2.29 has typos. In both figures, the last line of code is duplicated outside the last function. Cross out these two lines in your book.

Exercise 3 introduces you to multitasking in IC. Be sure to read Section E.3.8 (again, since you should have already read all of Appendix E, which describes the features of IC).