Lab 1: Reactive Behaviors and State Machines

CSCI 3302: Introduction to Robotics

Report due 9/9/20 @ 11:59pm

The goals of this lab are to understand

- Basic reactive behaviors such as attraction and avoidance
- How to compose multiple behaviors into more complex ones
- The notion of state and basic ways of implementation

You need:

- A functional Python 3.7 or 3.8 development environment
- Webots robot simulation software (https://cyberbotics.com/)

Overview

A very simple way to program a robot is to directly tie its sensor input to wheel motion. Examples include obstacle avoidance, for example "turn right if you see an obstacle in front", light following or avoidance, or line following. One type of these robots is a "Braitenberg Vehicle". It would be quite limiting, however, if robots would exhibit always the same behavior when presented with stimuli. To achieve more complex behaviors, robots need to switch between different operational modes based on the context they're in. In the first part of this lab, you will play with different standard behaviors. You will then create a simple finite state machine and switch between different behaviors to accomplish a complex task.

Instructions

Each group must develop their own software implementation and turn in a lab report. **You are encouraged to engage with your lab partners for collaborative problem-solving**, but are expected to understand and be able to explain everything in your write-up. If your group does not finish the implementation by the end of the class, you may continue this lab on your own time as a complete group.

Part 1: Introduction to Webots

1-A) Review the Getting Started with Webots section on the Cyberbotics website:
https://cyberbotics.com/doc/guide/getting-started-with-webots

1-B) Follow the first three tutorials on the Webots website to familiarize yourself with the software interface and components: https://cyberbotics.com/doc/guide/tutorials

1. First Simulation:
   https://cyberbotics.com/doc/guide/tutorial-1-your-first-simulation-in-webots
2. Modifying the Environment:
   https://cyberbotics.com/doc/guide/tutorial-2-modification-of-the-environment
3. Modifying the Appearance of Objects:
   https://cyberbotics.com/doc/guide/tutorial-3-appearance
4. Creating a Robot Controller:
   https://cyberbotics.com/doc/guide/tutorial-4-more-about-controllers

[End Week 1 of Lab]

Part 2: World Creation and Controller Programming

Create an environment with the following in it:

1) 2m x 2m rectangular floor surrounded by walls.
2) An e-puck robot in the center
3) Two obstacles (O1 and O2) of your choosing, on opposite sides of the e-puck.
   O1 must be in front of the robot, at least 10cm away
   O2 must be further than 10cm away from the robo, directly behind the robot.

Implement a state machine-based controller that recreates the following behavior:

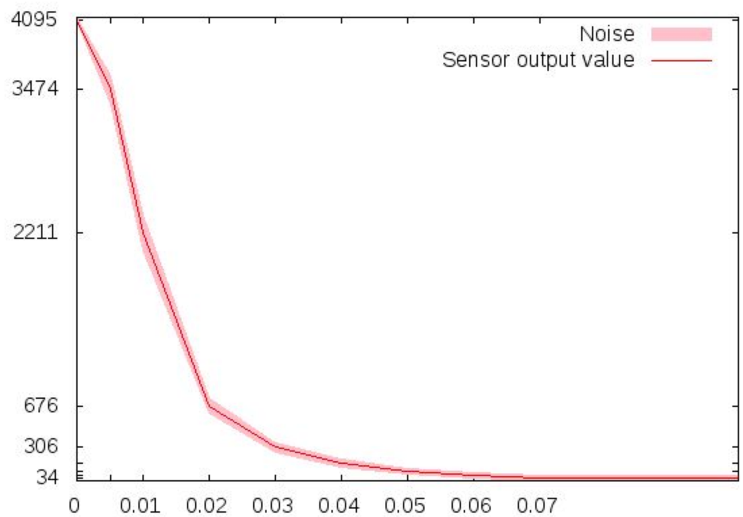
The robot drives forward. The robot continues until its sensor reads a value from its front distance sensor showing it's within 0.05m of the detected object. Once at that distance, the robot turns 180 degrees and drives until its front sensor says it is within 0.05m of another object. Once arriving at within 0.05m of the object, it will rotate clockwise until the left distance sensor (ps5) reads <0.06m. Finally, it will continually drive forward as long as the left distance sensor reads <0.05cm, otherwise it will stop in place and wait forever.

HINT: Planning your answer for Part 3 - #3 before writing code will make this easier.

HINT: You can manually time out how long the robot should actuate its wheels to turn around, or you can use the distance sensors behind it to tell when you've finished turning.

HINT: Use the lookup table below to map distance sensor values to distances:

Light Intensity



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Part 3: Lab Report

Create a report that includes/answers the following:

1. The names of everyone in your group

2. Screenshots of your world from Tutorial 1, 2, 3, and 4.

3. A drawing of your state machine. Make sure all the states and transitions are labeled and that it is faithful to your implementation.

4. Were you able to get your controller to complete the task? If not, which parts failed? Why?

5. A statement indicating whether you have worked with Python before, and if so, describe your experience.

6. How much time did you spend programming **Part 2** of this lab?

Please submit a zip file containing your Lab Report in PDF form, your Webots world file (.wbt), and Controller file (.py) on Canvas.