ESE 313

Spring 2008

(Pilot Version)

Robotics and Bioinspired Systems

Laboratory Overview

Joel Weingarten, Lab Instructor
D. E. Koditschek, Course Lecturer
Sam Russem Lab TA

Introduction

In this course, laboratory grades will be based on a combination of group project work and individual pre-lab preparation. Echoing the discussion in the Course Description Document, Groups will author a sequence of reports that move from literature review to hypothesis formation to experimental design and implementation and finally to the production of a technical paper. In contrast, Individual credit (**I**) will be earned largely on the basis of a series of warm-up laboratory exercises that this document will introduce.[1]

Although these Warm-Up Labs capture the essential components of the robot's operation and logging environment, we will of course only scratch the surface of what you might do in your group projects. When, in the second part of the course, your group determines that there is some specific skill or capability that has not been taught and has inadequate available tutorial materials, the Lab Instructor and TA will offer office hour tutorial support in exchange for your group's taking notes and adding them up to the EduBot Wiki.

Warm-Up Lab Schedule and Summary of Topics

Lab 1: EduBot Terrain Classification

Schedule

Week 0 (1/17) – Pre-lab 1 Assignment Handout
Week 1 (1/24) – Pre-lab 1 Assignment Due; Lab 1 Activities
Week 2 (1/31) – Lab 1 Activities; Pre-lab 2 Assignment Handout
Week 3 (2/5) – Lab 1 Write-up Due

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[1] Recall from the Course Description document that the complete basis for individual credit (**I**) is as follows. We will require write-ups of three lab warm-up exercises (60% **I**), written "source acquisition" (10% **I**)and annotated bibliographical literature (10% **I**) documents, a written review of a group project proposal presentation (10% **I**), and a written review of a group technical report (10% **I**).

Activity

Students run the robot over flat ground, then on slopes capturing data from their runs. After the data has been collected both visual inspection and as a coding exercise students try to use the PD associated data to classify the terrain.

Hypothesis 1: recorded PD error data can be used for simple offline terrain classification

Resources

Warm-up Lab Manual 1 which includes tutorials on:
1.) Running the robot in simulation
2.) Running the physical robot
3.) A basic introduction to MatLab.

Sources for terrain classification: With notes from Prof. Koditschek)

[1] J.E. Jackson, W. InterScience, and J. Wiley, A User's Guide to Principal Components. Wiley, 1991.
(I haven't used the book but it's got a lot of citations and cursory inspection suggests it covers the ground nicely from a "user's" rather than "theorist's" point of view.) .

[2] A. Daffertshofer et al., "PCA in studying coordination and variability: a tutorial," Clinical Biomechanics, vol. 19, pp. 415-428, May 2004.
(This is a decent tutorial applied much closer to home for the course: analysis of kinematic motion.)

[3] A.K. Jain, R.P.W. Duin, and J. Mao, "Statistical Pattern Recognition: A Review," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 22, pp. 4-37, 2000.
(A fairly complete guide to the large literature - perhaps a bit advanced but quite comprehensive and good view and refs. to associated ideas and literature)

[4] Shlens J. A Tutorial on Principal Component Analysis. La Jolla, CA 92037: Salk Institute for Biological Studies; 2005.
http://www.snl.salk.edu/~shlens/pub/notes/pca.pdf
(A very nice, relatively short and simple account with matlab code in the appendix)

Lab 2: EduBot Stair-Climbing

Schedule

Week 2 (1/31) – Pre-lab 2 Assignment Handout
Week 3 (2/7) – Pre-lab 2 Assignment Due; Lab 2 Activities
Week 4 (2/14) – Lab 2 Activities
Week 5 (2/21) – Lab 2 Activities
Week 6 (2/26) – Lab 2 Write-up Due

Activity

Using a simple ‘c’ interface, students will code a feed-forward gait to climb a replica of the Art Museum steps (exact same dimensions). Students will be a able to prescribe piecewise linear trajectories for each of the 6 legs of EduBot to produce the desired behavior.

Hypothesis 1: intuitive manual adjustment of the RHex clock parameters can achieve stair-climbing with ½ - circle legs.
Hypothesis 2: feed-forward gaits can produce a large set of stable locomotives behaviors

Resources

[1] E.Z. Moore et al., "Reliable stair climbing in the simple hexapod 'RHex’," *Proceedings- IEEE International Conference on Robotics and Automation,* vol. 3, pp. 2222-2227, 2002.

Lab 3: EduBot Motion-Capture

Schedule

Week 5 (2/21) – Pre-lab 3 Assignment Handout
Week 6 (2/28) – Pre-lab 3 Assignment Due; Lab 3 Activities
Week 8 (3/18, 3/20) – Lab 3 Activities
Week 9 (3/25) – Lab 3 Write-up Due

Activity

Learn to use the MoCap (motion capture) system in the GRASP laboratory and then run EduBot through mocap and collecting data for each run. Plot the trajectory of the robot using MatLab. Detect sources of yawing in EduBot.

Hypothesis: trajectory yawing is due to body orientation changes at specific gait phases and are a function of leg touchdown conditions – e.g., differences in touchdown time/angle/assymetry in the mechanical structure

Resources

To Be Determined:

Additional Lab Requirements

In addition to the warm-ups themselves students will be required to keep journals of their progress on the final project, Develop and create a technical tutorial and meet with course staff to discuss their ideas for their final project. Below is an outline of each of these requirements.\

Journals:

Students are expected to complete two journal entries a week via the wiki. At the professional level, engineers are asked to carefully document and record all work. You will be doing something similar throughout this course, writing short journal entries using the Journal link in your User page on the wiki. Journal entries are short and easy to write, simply make a bulleted list describing what you have worked on since your last entry. Bullets can be as detailed as you would like, though it is only required of you to write a sentence or two for each task. See the TA example on the wiki site to see how detailed your bullets can be and how to use the Journal template.

Tutorials:

We have provided a variety of tutorial material for this course, but documentation is still incomplete. At some point during the semester, your group must create a tutorial for some equipment or procedure used in class. See the tutorials section of the wiki for examples. Tutorials should be thorough and will be graded. Your group can complete this assignment at any point in the semester. Please consult with a TA or lab instructor before deciding on a topic, and feel free to show them preliminary work to check for completeness.

Research Paper Consultation:

Before starting the term research project each group will need to schedule a consultation with one of the course staff. This consultation must be scheduled before the end of week 6 of the course. For the consultation each group should prepare 2-3 proposed research projects that they would like to investigate. For each idea, a brief description (one paragraph) of the project should be prepared that outlines the hypothesis that is being studied and an initial plan on how the project would be implemented (see example on course wiki). Through the consultation the group and the course staff will come to an agreement on the term project that will be investigated.