CMPEN 497 – Humanoid Robotics

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Project #2
Intro to Robotics Programming

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Contents

1 Project Overview **2**

2 Intermediate Submission - Due Friday, March 3 **3**

3 Final Submission - Due Friday, March 17 **3**

4 Grading Breakdown (100 Points) **3**

5 Extra Credit **3**

1 Project Overview

In this project, you will use principles of forward kinematics, inverse kinematics, dynamics, and stability to design motions that will have the TonyPi robots complete a variety of tasks. You will select **four** tasks from a list of provided tasks on the Canvas page for this project. Each task will involve programming the servos of the robot to move while collecting data from some of the robot's onboard sensors. You will need to record a video of your robot completing the selected tasks. Once you have collected the onboard sensor data from your robot, you will need to plot graphs of the data for your writeup. Exactly which plots you will need to make have yet to be determined, but we will post this information when it becomes available.

The current list of tasks is:

1. Stacking cubes on top of each other
2. Accurately tossing a ball into a bin
3. Carefully sitting down and standing back up from a seated position
4. Designing a dance that is at least 30 seconds long
5. Running/walking at 3 different speeds (to compare them)
6. Stepping over hurdles
7. Doing various exercises like push-ups, sit-ups, etc.
8. Walking up and down stairs

Exact details about each task will be posted Canvas as we finish preparing them, and we may add more tasks throughout the course of the project. Check the Canvas page frequently to see if there are new tasks you are interested in. We will also post announcements when new tasks are posted. Additionally, we will allow you to propose your own task task to complete if you think of something that interests you but isn't on the list. You must get any tasks that aren't on the list **preapproved** by Addison.

Each task will provide its own unique challenges. Some tasks may rely more on using forward kinematic principles while others may be more oriented toward inverse kinematics. Some may require precise kinematic control while involving little dynamics, but others may pose tricky dynamics problems that threaten the stability of the robot. Almost all tasks will require you to keep the stability of the robot in mind so that it does not fall over.

Your writeup should include information about how you accomplished each task, any difficulties you ran into while completing each task, plots of the onboard sensor data during your tasks, and a description of how you kept the robot stable during each task.

We will provide some starter code and an example of a simple motion for this project so you have some reference for how your code should be structured in general. This starter code will also contain helper functions for you to use. Additional documentation will be provided with all starter code. Addison will work on completing examples of all provided tasks to prove that they are doable and to serve as visual examples of what we may expect. Videos of the completed examples will be posted on Canvas.

We hope that you can have fun with this project and be creative with your solutions and approaches.

2 Intermediate Submission - Due Friday, March 3

In order to make sure you're staying on track with this project, we will have an intermediate submission along the way. This will allow us to give you feedback and assistance so that there aren't any surprises at the time of the final submission. **You must complete this intermediate submission**.

You will need to submit a list of the tasks you plan on completing as well as information about what progress you've made by this time. It should just be a single text document and any videos of tasks you've completed with the robots.

3 Final Submission - Due Friday, March 17

For your final submission, you should create a zipped directory that contains working source code, videos of a robot performing each task, and your writeup document. Please mention any extra credit you did in your writeup.

Minimum included files:

- 4 source code files
- 4 videos of a robot completing a task
- Writeup document

4 Grading Breakdown (100 Points)

- 20 points: Selected task 1
- 20 points: Selected task 2
- 20 points: Selected task 3
- 20 points: Selected task 4
- 20 points: Writeup
  - 5 points per task

5 Extra Credit

Possible ideas for extra credit will be listed alongside each related task. You may also choose to do an additional task that is more complex than the provided tasks for extra credit. You must get additional tasks approved **ahead of time**. Otherwise, they will not count toward extra credit.

Another idea for extra credit is to plot the base of support (BoS) and center of mass (CoM) for your robot while it completes a task. This process should be automated using the available gyroscope and/or accelerometer data along with the joint angle information.