**CS/ME 301: Introductory Robotics Laboratory**

**Assignment 0**: Actuation and Sensing, Familiarization with Robot SDK

**Code Due:** Jan. 15th (2:29pm) **Demo Due:** Jan. 15th (2:30pm) **Report Due:** Jan. 18th (11:59pm)

This assignment will focus on robot actuation and sensing. The tasks will be to setup the software to connect to your robot, become familiar with the robot SDK, write two robot gaits using the SDK, gather data, and write up a report.

**Instructions: Part A**

**1.** Check out a robot kit from the instructors.

To begin, read the General Robot Hardware Information in the **Robot Instructions** page on Canvas. Verify that all parts are in your kit.

Also read through the Best Practices section of the **Robot Instructions** page on Canvas.

Fill out the checklist google form before beginning to begin software setup. Only one form needs to be filled out for your group, but make sure both teammate names are the form.

*Let the instructors know* when you have filled it out to be cleared before moving on to setup.

**NOTE:** Make sure both partners read ALL instructions before powering on the robot. Any damage resulting to the robot due to not adhering to guidance in the documentation will result in working with a damaged robot for the entire quarter.

**NOTE:** Burnt motors will not be replaced. They will be disconnected and the team will work for the remainder of the quarter without that joint/leg.

**2.** Connect to the robot.

Once cleared, follow the Setup and How to Connect to the Robot steps within the **Robot Instructions** on Canvas.

Setup your personal machines by opening an SSH terminal. SSH will be used to run code on the robot. (If your team does not have a personal machine to use, please see the instructors.)

**3.** Begin exploring the SDK.

Once connected, you should have terminal access on the robot. If you are new to commandline interfacing, refer to the cheatsheet and reach out to the instructors with any questions. Please follow the file structure best practices described on the cheatsheet.

The SDK files are located within the `cs_me_301_pi6/board_demo` directory. To access and view the contents of this folder, execute the following commands:

```
unzip cs_me_301_pi5.zip
cd cs_me_301_pi5/board_demo
ls
```

These files are also available on Canvas, and brief descriptions are provided in the File Structure Framework in the **Robot Instructions** page on Canvas.

Read through the python files to become familiar with the SDK functionality. The files ending in `<>_demo.py` provide example code. The rest of the assignment will focus on getting comfortable with the SDK.

Return to the Best Practices section of the **Robot Instructions** page on Canvas. Follow the Exploring the SDK instructions to experiment with different motor values. Keep in mind that if motors are burnt while exploring the SDK and not adhering to the rules outlined for best practices, the motors will **not** be replaced.

**Instructions: Part B**

**1.** Copy the assignment template file to become your assignment file (filling in your group letter for x).

```
cp asn_template.py asn0_x.py
```

**2.** Write a script in your asn0_x.py file to lift each of the robot's legs one at a time to determine which servo ID corresponds to each servo motor.

Hint: Reference the code in `bus_servo_turn.py` for an example on how to move a servo motor.

**3.** Write code to read from the sonar sensor. Stream its output to the terminal for 1 second.

**4.** Characterize the sensor readings.

Gather 10 readings from the sensor for each of 3 distances from an object: 10, 20, and 30 cm.

**5.** Choose two of the following three common gaits to implement: wave, ripple, and tripod.

For each, implement one version of the gait that makes **smaller** movements (i.e., smaller changes in motor commands), and one version that makes **larger** movements. The characteristics of each gait are the following:

**Wave:** This gait is characterized by moving only one leg forward (or backward) at a time and cycling through all of the legs, creating a "wave" effect.

**Ripple:** This gait is characterized by a pair of legs, one on each side of the body, being lifted and moved forward (or backward) simultaneously, followed by the next pair and so forth, creating a "ripple" effect.

**Tripod:** This gait is characterized by having three legs always in contact with the ground, while the other three legs are used to propel the body forward (or backward).

**6.** Gather data on your chosen gaits.

For each of the 4 developed gaits, gather 3 repetitions each of the following datapoints: (1) distance travelled (in x **and** y) over 10 seconds, and (2) distance travelled (in x **and** y) in 30 seconds.

Be prepared to show all 4 of your gaits on demo day.

## Report

Each group member is to submit their **own** report. While it is expected that the raw data for each student will match that of their partner, the presented figures, tables and analyses must be performed by each student individually, and be their own work. ***Refer to the Lab Report Guide*** for further details, and see the Syllabus for more about plagiarism/cheating.

One goal of this report is to become familiar with the reporting style expected in this class. Since minimal code is developed for this assignment, the METHODS and DISCUSSION sections will be considerably less complex than in future assignments. In addition to the guidelines set out in the Lab Report Guide, the following questions/considerations should be addressed in the Assignment 0 lab report:

I. INTRODUCTION:
Describe/define a robot, sensors, actuators, effectors.
Identify and describe the most common types of (simple) sensing and actuation technologies, and the different layers of sensor processing.

II. METHODS:
Describe all of the sensors and actuators on the robot platform – how they work, what they are used for. Use terminology from the readings.
Provide a description of your implementation of steps B-3 and B-5.
Be sure to clearly describe your planned experimental work (i.e., planned measurements, and what they will tell us).

III. RESULTS:
Report the measurements from steps B-4 and B-6.
Report averages, with standard deviations.
Be sure to clearly describe all data collection procedures and testing conditions.

IV. DISCUSSION:
Discuss the relationship between the sonar measurements and distance.
Discuss the performance of each of your developed gaits, and how performance changes with motor speed. What are the advantages and disadvantages of each gait?
How accurate do you expect each of your measurements are, and why?
What are some potential sources of noise and/or uncertainty?