ENPM 809T – Autonomous Robotics: Spring 2020

Master of Engineering Program in Robotics

Due Date Friday, April 17th, 2020

Submission Information

- This assignment explores the use of the Raspberry Pi GPIO library to generate PWM signals for control of a servo motor & gripper assembly
- This assignment begins to investigate the implementation of localization theory as applied to our robot vehicles
- The codes developed in this assignment will be implemented into the autonomy algorithms used by our robot vehicles
- Submit responses via Gradescope by 11:59 pm
- Question #1 may be completed as a group, however **each student must complete their own submission for Questions #2 and #3**

Question #1 (10 points)

The primary focus of this week's lecture was completing the assembly, wiring, and software testing of the parallel gripper. For reference, a time-lapse video of the full assembly process is available on the course YouTube page:

https://www.youtube.com/watch?v=poCsai98FII

To complete this portion of the assignment:

1. Complete the mechanical and electrical assembly of the servo gripper as detailed in the lecture notes.

2. Create and test the *servocontrol01.py* script as detailed in the lecture notes. Complete the associated (i.e. first) In-Class Exercise. ***Reminder to never exceed the bounds of the servo duty cycle!*** Upload the video to your YouTube account then include a link to the video in the .pdf uploaded to Gradescope. There is no requirement on length for this video.

3. Utilizing the script(s) developed in Assignments #4 and #5, add the distance measuring capability of the ultrasonic sensor to your teleoperation code. Each time the user commands the vehicle forward( ), reverse( ), pivotleft( ), or pivotright( ), record a distance measurement and print the distance value to the terminal window. This functionality will be used in the future for autonomous collision avoidance.

4. Utilizing the script(s) developed in lecture and in this assignment, build on item #3 above and add the servo functionality to your teleoperation code. Record a minimum 30 second time-lapse

video clip of yourself teleoperating the ground vehicle and servo gripper. Note: ***this time-lapse video should be recorded from the perspective of the Raspberry Pi***. A brief example is available on the course YouTube page:

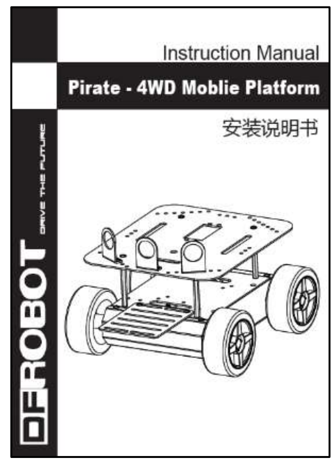
https://youtu.be/cfzaivvvfrQ

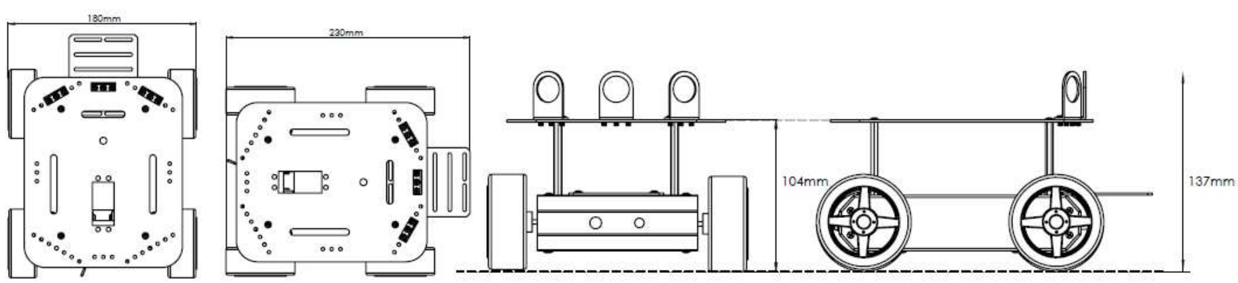
There is no need to include the block in your video – you may use any object of your choosing. Upload the video to your YouTube account then include a link to the video in the .pdf uploaded to Gradescope.

Question #2 (5 points)

Consider the Pirate, one of the robot ground vehicles we are building this spring. The instruction manual states that the motors used with this vehicle have a gear ratio of 1:120 (i.e. 1 wheel rotation for every 120 motor rotations). The wheels used with the robot measure 65 mm in diameter. The magnetic encoders on the motors register 8 ticks per motor revolution, where one tick is defined as a single change in signal from *either* HIGH (3.3V) to LOW (0V), or LOW to HIGH. Assuming no wheel slip:

(a) How many revolutions of each motor are required for the vehicle to move 1 meter in a straight line?
(b) How many encoder ticks are registered by the Raspberry Pi when the vehicle moves 2 meters in a straight line?



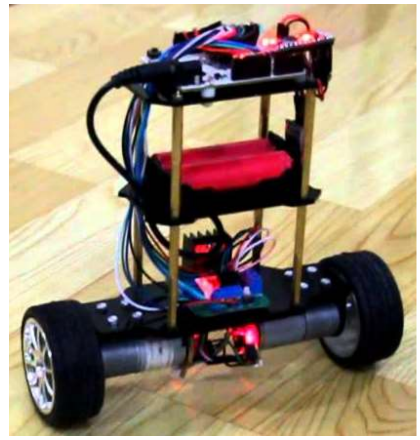


Complete Machine Weight: 710g
Wheel Diameter : 65mm
Highest Speed: 61cm/s

Motor Feature :

●Gear Ratio : 1:120

<u>Question #3</u> (5 points)



Consider a two-wheeled ground vehicle similar to the robot at right. The motors used in this vehicle have a 1:53 gear ratio. The wheels used in this robot measure 14 cm in diameter and the width of the robot is 30 cm (from the wheels on each side).

If the center of the robot is defined as the point along the wheel axes halfway between the wheels, how many revolutions of each motor are required for the vehicle to turn 180 degrees in place (i.e. the center of the robot remains above the same spot on the ground)? Assume no wheel slip and justify your answer with calculations and hand sketches.