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ECE 4161/5196 Lab 3 Report

Demonstration points:

Requirements:
Req. 1 The robot will be tested on a surface decided by the course instructor. _____
Req. 2 Only the motors may be used (No sensors). _____
Req. 3 A LabVIEW program will be written that will use the motors to travel 2 meters, make a 90° turn, and repeat process until the robot has completed a 2x2 meter square. _____
Req. 4 Robot will operate autonomously. _____
Req. 5 The demonstration area where the square is marked on the ground will be available to students for testing purposes prior to the final demonstration. _____
Req. 6 Robot should run in a continuous loop so that accuracy after many squares have completed may be tested. (Optional-At request of course instructor) _____
Req. 7 The velocity of the robot throughout the loop must be consistent. (If the robot moves forward at 5 rad/s, then it must also turn at 5 rads/s) _____
Req. 8 Solved equations must be included in the lab report. Also include tweaked values vs. theoretical values. _____

Pre-Lab:

1. Calculate the "straight away" time for the robot to move a distance of 1 meter if the angular velocity is 8.4 $\frac{rads}{s}$.

Circumference of the wheel = $\pi d = \pi \times 0.098m = 0.3078m$

Distance to be covered = 1m

$\therefore$ No of wheel Revolutions = $\frac{1m}{0.098\pi m} = \frac{1m}{0.308m} \approx 3.25$ $(0.3078m \approx 0.308m)$

$\therefore$ No of motor Revolutions = $3.25 \times 83 = 269.75$

$\therefore$ Time taken = $\frac{\text{No of Motor Revolutions}}{\frac{2\pi}{\omega}} = 5.11$ sec

Ans:- The "straight away" time for the robot to move a distance of 1meter with angular velocity of 8.4rad/s is $\boxed{5.11 \text{ sec}}$

2. Calculate the 90 degree turn time for the robot if the angular velocity is 8.4 $\frac{rads}{s}$

Width of the robot = 36.2 cm (from the point of contact of one wheel to the other)

$\therefore$ Distance to be covered in 90° turn = $\frac{\pi \times (0.362)}{4} = 0.284m$

Circumference of the wheel = $\pi \times 0.098m = 0.3078m$.

$\therefore$ No of wheel Revolutions = $\frac{0.284m}{0.308m} = 0.92$ turns

$\therefore$ No of motor Revolutions = $0.92 \times 83 = 76.36$ rev.

$\therefore$ Time taken = $\frac{(\text{No of Motor Rev})}{2\pi/\omega} = \boxed{1.44 \text{ sec}}$

Ans:- Time taken to take 90° turn with angular velocity 8.4rad/s = $\boxed{1.44 \text{ sec}}$

3. For the robot to move forward or backwards both of the motors must be spinning in the same direction.

   True / **False** (circle one)

4. For the robot to turn the motors must be spinning in opposite directions.

   True / **False** (circle one)

General Learning Objectives: *Note the BOLD headings for each section*

The general learning objectives of this lab was to enhance the users' skills in the use of LabVIEW. By programming the DaNI robot and controlling the motors through the program, the users were able to understand how motors can be controlled by using the LabVIEW software. These learnt skills were to be used to program the robot to follow a predefined 2m x 2m square.

General Steps Needed to Complete the Lab:

The general steps needed to complete this lab were to follow the tutorial provided to us. The pre-lab calculations were carried out to aid the implementation of the lab. Once the program was created, it was executed and relevant changes were made to it based on various test runs. The corrections were done to the program till an acceptable straight line robot motion was achieved and the lab task was completed.

Procedure / Detailed Steps to Complete the Lab:

The lab experiment was broken down into 6 steps:

1. The DaNi 2.0 robot was connected to the computer using a LAN cable. It was ensured that the motors were switched off and only the main supply was on. The successful connection of the robot was indicated by the LAN icon on the windows task bar.

2. LabVIEW was then opened and then using the Robotics 2011 plugin, the hardware was detected. Furthermore, proper function of the motor, ping sensor and servos was confirmed using the Roaming VI.

3. A new VI was then created under the Project file. This VI was used to run the motors on the DaNI 2.0 robot. In order to create this program, the Initialize, Close and two Write DC Motor icons were placed in the back panel of the VI. A flat structure sequence was added which included one of the Write DC Motor icons in each of the frames; therefore, the flat sequence structure had two frames. In order to make the motors run continuously, a while loop structure was added around the DC Motor icons. Next, two timers were placed inside each of the frames which determined how long the motors were running at the determined settings in that frame. Finally, the speeds of the motors were added as constant to the Write DC Motor icon. All wires were then connected in order to complete the program. Figure 1 shows this completed program. The values of the motor speed & timers were based on the Lab 3 tutorial values.

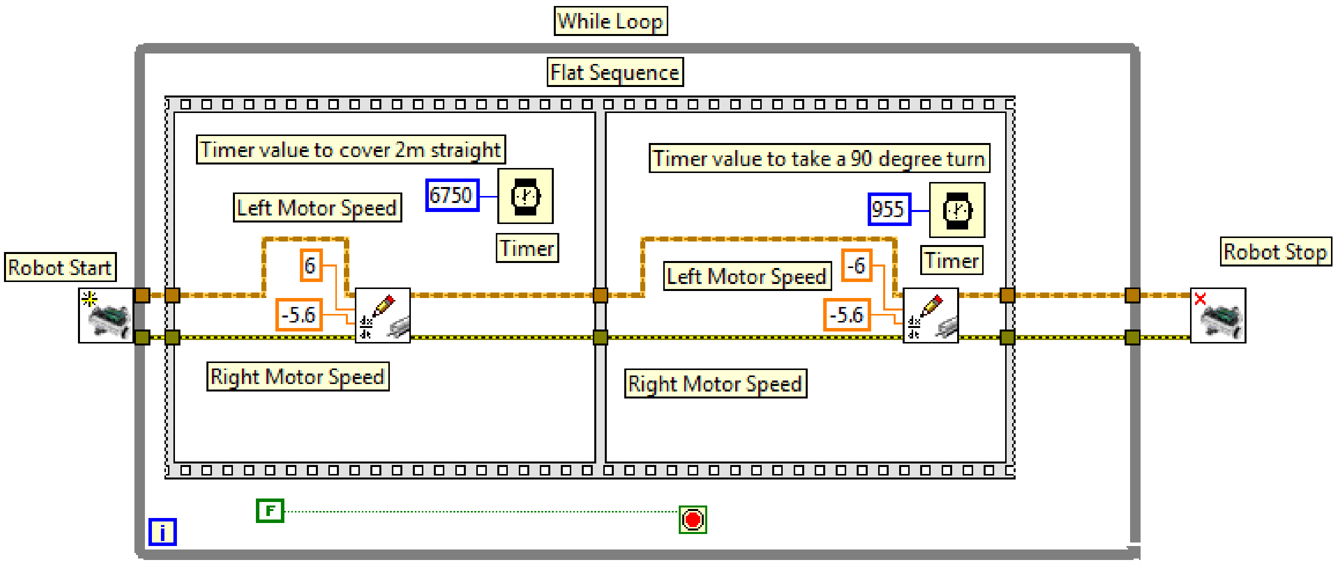

Figure 1: Lab View Program

4. The values for the timer were calculated in accordance with the pre-lab exercise.

a) The straight away time for the robot to move a distance of 1 meter with angular velocity 6 rad/sec was calculated as follows:
Circumference of the Wheel= π * 0.098 m =0.3078m= 0.308 m (approximately).
Distance to be covered= 1m
No of Wheel Revolutions: 2m/ 0.308 m=6.50 rev
No of Motor Revolutions: 6.50*83=539.5 rev
Time taken to cover 2m distance= No. of Motor Revolutions/2 π/ ω
= 539.5*(2 π*6)$^{-1}$=**14.310 seconds**

b) The 90° turn time for the robot with angular velocity 6 rad/sec was calculated as follows:
Circumference of the Wheel= π * 0.098 m =0.3078m= 0.308 m (approximately).
Width of the robot (from the point of contact of one wheel to the other) =36.2cm
Distance to be covered= (π * 0.362)/4 m=0.284 m
No of Wheel Revolutions: 0.284m/ 0.308 m=0.92 rev
No of Motor Revolutions: 0.92*83=76.36 rev
Time taken to cover 0.284m distance= No. of Motor Revolutions/2 π/ ω
=76.36*(2 π*6)$^{-1}$=**2.025 seconds**

5. Once the LabVIEW program was created, this was then uploaded onto the DaNI 2.0 robot. The program was made to run continuously and the robot was placed inside the 2x2 meter square. Deviations in the robot motion were noticed. Such as the robot motion was further than the 2x2 meter box. Values of the timer time were then altered in order to get the motors to run inside the 2x2 meter requirement. The robot was then made to run for 3 or more laps nonstop, and it was noticed that it would begin to stray away from the course. A quick test of the motors by moving the robot forward showed that one of the motors was moving slightly quicker than the other. By slightly changing the values of one of the motor's speed inside the program, the robot's wheel motion was aligned.

6. In order to meet the demonstration requirements the required fine tuning was done. And the demonstration of the robot traversing the around the 2x2 meter square was then delivered. Figure 2 shows the robot inside the 2x2 meter square along which it traversed.

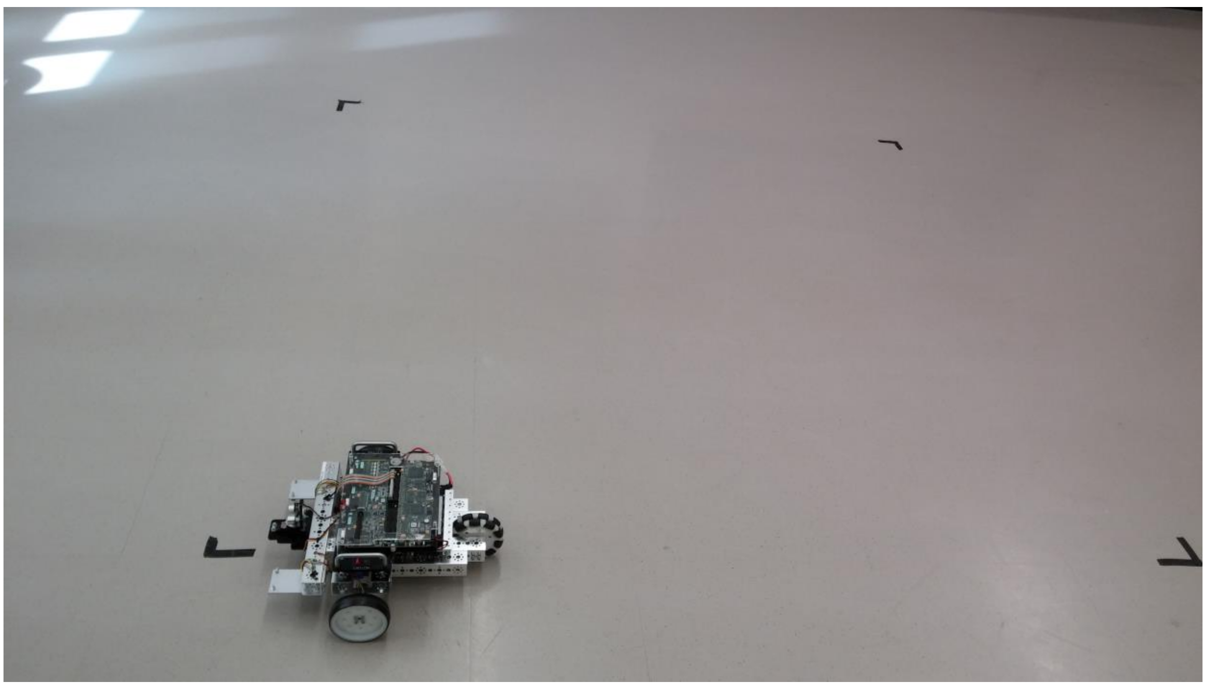

Figure 2: Robot Traversing 2x2 meter square

Observations while completing/testing the Lab:

It was observed that although both motors were actuated with the same angular velocity the robotic platform did not follow a straight line motion. Thus, it was inferred that one of the motors was moving faster than the other. For instance with both left and right motor speeds configured to 6 rad/s the robot gained motion in the left direction. Thus it was inferred that the right motor was moving faster than the left. The speed of the right motor was reduced to compensate for the direction gain.

It was noticed that the values of timer which provided acceptable results were lesser than the theoretical values. For instance the time to move 2 m distance in a straight line with both wheels having 6 rad/sec speed was calculated as 14.310 seconds compared to the used value of 6.75 seconds. This was also observed for the 90 degree turn time. The calculated time was 2.025 seconds whereas the value which provided acceptable result was 0.955 seconds. The possible reason for this deviation was the slipping of wheels, delay in the drive system & the friction involved with the floor surface.

Lessons Learned:

In this lab we learned the following concepts & implementations.
a. To actuation of a motor for a given time interval using timer.
b. To correct robot platform motion, using different speeds for left and right motors .Thus, straight line motion was achieved.
c. The usage of the flat sequence.
d. The timer values which gave the acceptable results varied from the actual theoretical timer values due to various factors such as friction, delay in drive system & slipping of wheels.