SC 649

IIT Bombay
Systems and Control Engineering
Embedded Control and Robotics
Assignment 1

Deadline
Date: 23.08.2024, 11.59pm

Maximum Marks: 15

Instructions:

- Submit the answers to this assignment on or before the deadline at 11:59 p.m. on 23.08.2024. This is a strict deadline, and no request for any extension will be entertained.
- All the results and the associated observations/analysis must be compiled in a single PDF file. This PDF and the associated code must also be submitted in a single zip folder on Moodle on the relevant submission link.
  Label this folder in the form: FirstName_RollNumber_SC649_AS01.
- Report should contain the aim, methodology adopted/explanation, connection diagram, a picture of your hardware setup, results, observations, and conclusion.
- Please preserve the code and the report till the end of this semester.
- Assumptions made, if any, must be clearly stated and must be justified.
- Viva (5 marks) will be scheduled on the 24th and 25th of August; exact timings will be communicated later.
- In the case of group assignments, the contribution of each member of the group should be mentioned in a tabular format at the top.
- After the end of each question, the numbers to the right, in square brackets, indicate marks allotted to it.

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1. Pulse Width Modulation (PWM) is an efficient way to control analog electronics from purely digital pins. By quickly alternating between the two extremes, the sliding window average will be a function of the time spent in each of the states. The duty cycle, as mentioned in equation 1, is key to controlling the power given to the analog device in PWM. The duty cycle decides the time PWM output spends at the ON position.

$$\text{Duty Cycle} = \frac{T_{on}}{T_{on} + T_{off}} \times 100 \tag{1}$$

where, T_{on} & T_{off} are the time for which the signal is ON and OFF, respectively.

Please go on to the next page...

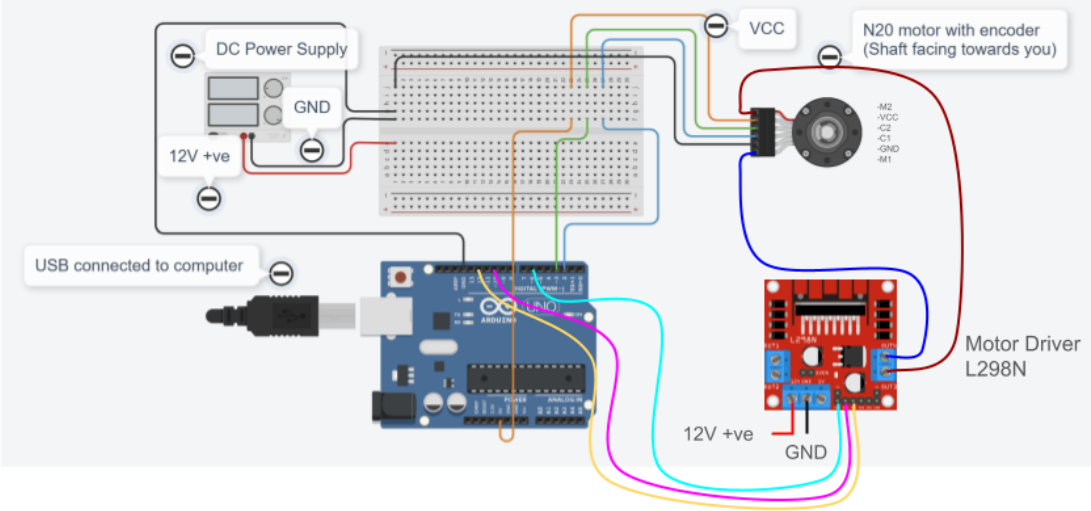

Figure 1: Connection diagram of N20 motor with L298N (motor driver) and Arduino UNO.

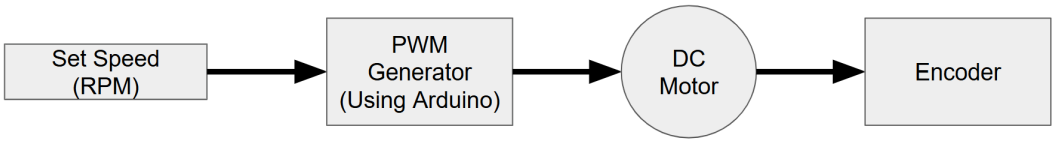

Figure 2: Open loop control of DC motor

The connection diagram for the assignment is shown in Figure 1.

Problem Statement 1:
In this question, you need to implement an open-loop controller, as shown in Figure 2 to control the speed and direction of the motor.

- Take user input from the serial monitor to determine the direction of motor rotation. You can take input as 1,-1, and 0 for clockwise, anticlockwise rotation, and stopping the motor, respectively.
- Take user input from the serial monitor for the required Duty Cycle.
- Generate PWM signals based on user input and control the speed and direction of the motor.
- Try generating PWM signals at different frequencies and observe the effects on motor behavior. Share your results in detail and your conclusions from it.

[04]

2. **Problem Statement 2:**
In this question, you need to interface the encoder with the motor, as shown in Figure 2, and read the data from it.

Question 2 continues on the next page...

- Do the necessary calculations and calibrations and based on that, calculate the motor RPM and make a map of duty-cycle to encoder count to motor-speed(RPM).
- Use the encoder data to determine if the motor is rotating clockwise or anticlockwise.
- Display the necessary information on the serial monitor.

[06]

NOTE: During the viva session, the evaluation of this assignment will be based on your ability to explain and reason for the methodology adopted and results obtained. All members of the group should be prepared with all the concepts mentioned.