BIRZEIT UNIVERSITY

Faculty of Engineering & Technology
Electrical & Computer Engineering Department

Interfacing Techniques ENCS4380

Task #3: Demonstrate the Usage of an Encoder to Control and Monitor a DC Motor

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❖ **Abstract:**

In this task, we explore the implementation of an encoder to control and monitor a DC motor, emphasizing its application in precision automation systems. By integrating an encoder with a DC motor, we achieve accurate feedback on the motor's position, speed, and direction. The encoder converts the motor's rotational position into an electrical signal, which we process with a microcontroller to adjust the motor's operation dynamically. This closed-loop control system enhances performance by continuously monitoring the motor's parameters and making real-time adjustments. Our experimental setup demonstrates significant improvements in control accuracy and response time, highlighting the encoder's pivotal role in optimizing DC motor operations for various industrial applications.

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❖ Theory:

1) DC Motor with Encoder:

Micro DC motors with encoders are important components in precision control applications. A micro DC motor operates on the fundamental principles of electromagnetism, where electrical energy is converted into mechanical rotation through the interaction of a magnetic field and current-carrying conductors. The encoder is used only for reading the position, the direction and the speed of the shaft. It consists of an optical or magnetic sensor that detects the rotation of a coded disk attached to the motor shaft. As the motor spins, the encoder generates a series of electrical pulses corresponding to specific angular positions. These pulses are interpreted by the microcontroller, allowing for fine-tuned control of the motor's operation. The integration of encoders with micro DC motors enhances their functionality, making them suitable for applications requiring high precision, such as robotics.

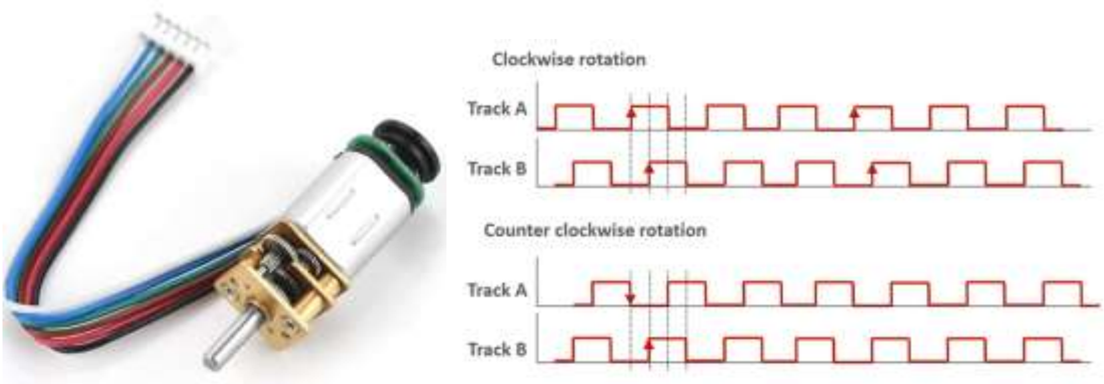

Figure 1: DC motor with Encoder

2) H-Bridge:

An H-bridge is an essential electronic circuit used for controlling the direction and speed of a DC motor. It consists of four switches, arranged in an H-like configuration, that allow current to flow through the motor in either direction. By toggling these switches in different combinations, the H-bridge can reverse the polarity of the voltage applied to the motor, thereby changing its rotation direction. Additionally, by using pulse-width modulation (PWM) techniques, the H-bridge can control the motor's speed by varying the duty cycle of the voltage signal.

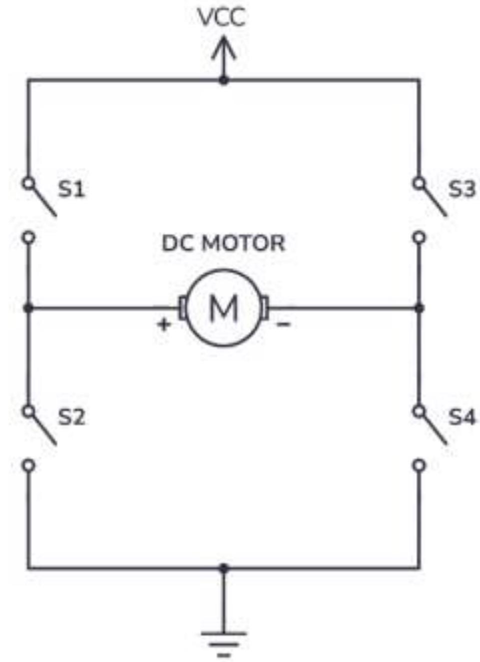

Figure 2: H-Bridge

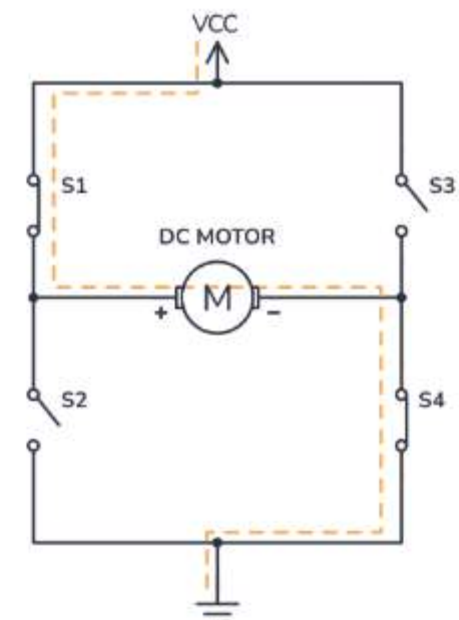

Figure 3: H-Bridge that makes the DC motor CW

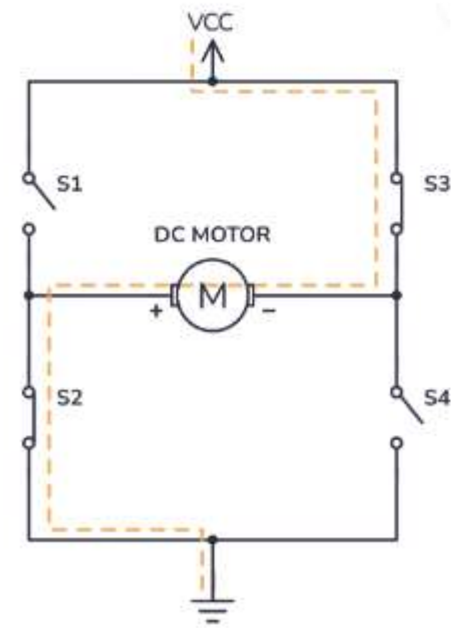

Figure 4: H-Bridge that makes the DC motor CCW

3) Joystick:

A joystick is an intuitive input device used for controlling various electronic systems, from gaming consoles to industrial machinery. It consists of a pivoting stick on a base, detecting angle and direction relative to its resting position through two potentiometers or sensors for the x-axis and y-axis. Movement of the stick generates analog signals, which are converted to digital signals by an analog-to-digital converter for processing. The data is interpreted by the microcontroller, translating user input into specific actions. This ergonomic design provides a natural interface, making joysticks essential in both recreational and professional applications.

Figure 5: Joystick

4) **16x2 LCD Display:**

An LCD 16x2 is a common alphanumeric display module used in embedded systems. It has two rows, each with 16 characters, allowing for a total of 32 characters. The display uses a liquid crystal solution to present characters formed by a 5x8 dot matrix. It is controlled via a parallel interface. The module typically features a backlight and adjustable contrast, ensuring visibility in various lighting conditions. Its ease of use and low power consumption make it ideal for displaying information in numerous electronic projects.

Figure 6: 16x2 LCD Display

❖ **Procedure:**

First, we implement the circuit on Tinkercad as the simulation is first, the circuit is as shown below,

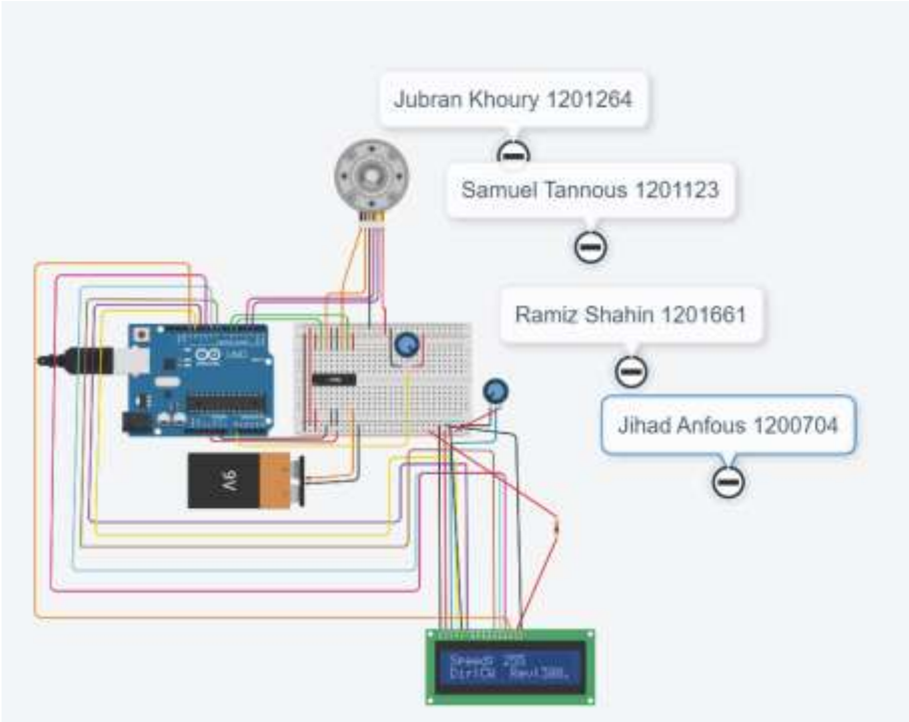

Figure 7(simulation on Tinkercad)

Then this was applied into hardware connection as shown,

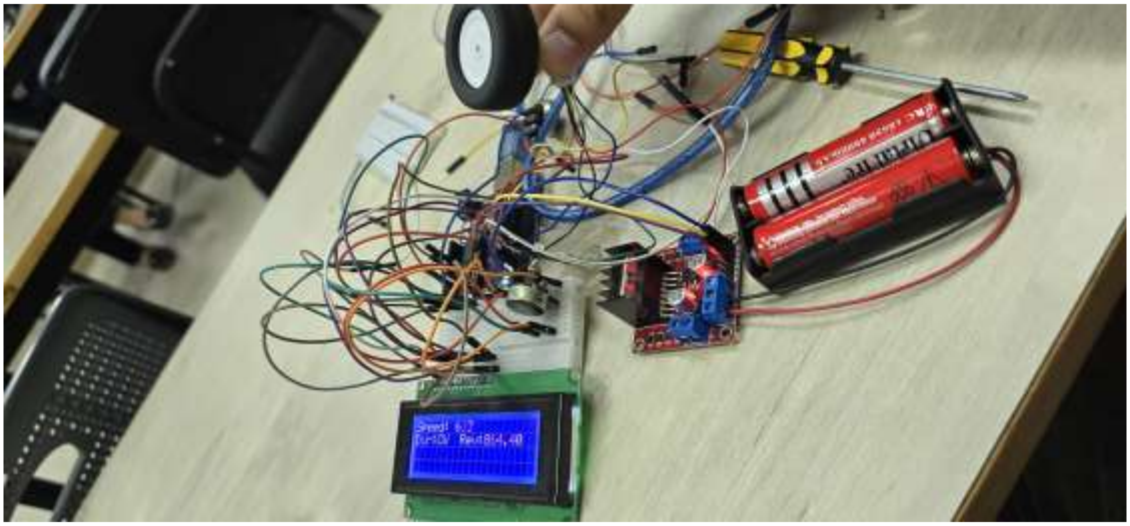

Figure 8(hardware connection in the lab)

❖ Conclusion:

In conclusion, we demonstrated the effective use of an encoder to control and monitor a DC motor. By integrating the encoder, we achieved precise feedback on the motor's position, speed, and direction, enabling us to implement a robust closed-loop control system. Throughout our experiments, we observed significant improvements in control accuracy and response time, validating the encoder's critical role in enhancing the performance of DC motor operations. Our findings highlight the potential for applying this technology in the robot that we will build at the end of the course.

❖ **Appendix:**

Tinkercad : https://www.tinkercad.com/things/bzAjMdiQxBM-task3?sharecode=Uh9rDUNmDTZgus2NMdWXfZ0FtRmz6-BOhlQOkC_1FuE