AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

Faculty of Engineering

Lab Report

Experiment # 09

Title: Implementation of a motor control system using Arduino: Digital input, outputs, and PWM.

Date of Perform	6 April 2023	**Date of Submission**	9 April 2023
Course Title	MICROPROCESSOR AND EMBEDDED SYSTEMS		
Course Code	COE3104	**Section**	C
Semester	Spring 2022-23	**Degree Program**	BSc in CSE
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Table of Contents

Experiment Title

Implementation of a motor control system using Arduino: Digital input, outputs, and PWM.

Abstract

This experiment aims to familiarize students with PWM signals generated by the Arduino and microcontroller-based DC motor speed control using the L298N driver. The experiment combines the concepts of PWM and H-bridge to achieve complete control over the DC motor's speed and direction. The L298N driver is used to control the direction and speed of two DC motors with voltages ranging from 5 to 35V and a peak current of up to 2A. The students will learn about the duty cycle, which is the ratio of the on-time to the time period of the PWM signal, and how it affects the motor speed. They will also learn about the H-bridge configuration and how it can change the direction of the current flow through the motor. The students will use a potentiometer to vary the duty cycle of the PWM signal and a push button switch to change the rotation direction of the motor.

Introduction

The Arduino and microcontroller-based DC motor speed control is an essential concept for students studying electrical and electronics engineering. In this experiment, the students will learn how to use the PWM signals generated by the Arduino to control the speed of the DC motor. They will also learn how to use the L298N driver to control the direction of rotation of the DC motor. The L298N driver is a dual H-bridge motor driver that allows speed and direction control of two DC motors simultaneously. The students will learn about the duty cycle, which is the fraction of the on-time to the time period of the PWM signal, and how it affects the motor speed. They will also learn about the H-bridge configuration and how it can change the direction of the current flow through the motor. The students will use a potentiometer to vary the duty cycle of the PWM signal and a push button switch to change the rotation direction of the motor. By the end of the experiment, the students will have a good understanding of PWM signals and how they can be used to control the speed of a DC motor.

Theory and Methodology

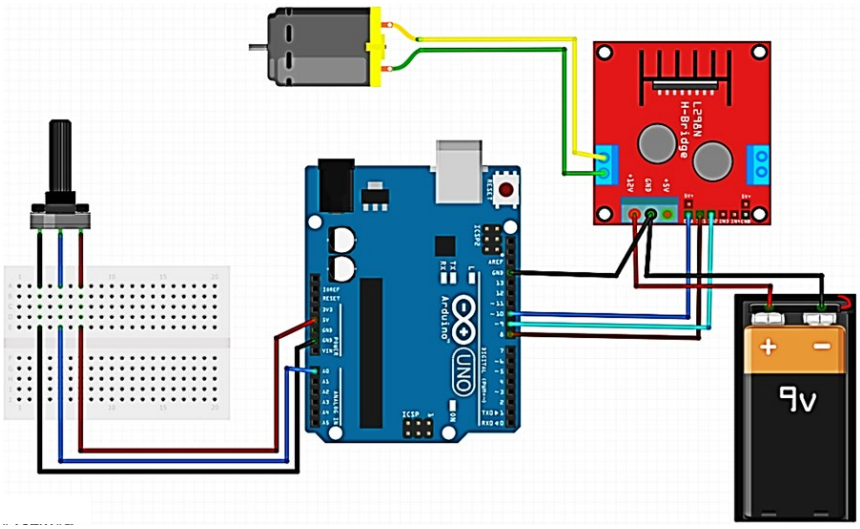
Microcontrollers and Arduino are digital devices that can only provide digital output in the form of logical LOW and logical HIGH signals. However, sometimes analog output is required, which is achieved through Pulse Width Modulation (PWM) technique. PWM involves varying the width of a pulse while keeping the frequency constant, generating an analog signal from a digital source. The duty cycle, which is the ratio of the pulse's ON duration to the time period, determines the motor speed. To drive motors, which require high current and voltage, transistors are used in conjunction with PWM. The transistor acts as a switch, short-circuiting the Emitter (E) and Collector (C) terminals when the PWM signal is in a HIGH state and opening when the PWM signal is LOW, allowing the motor to run at the desired speed.To control the direction of rotation, an H-Bridge circuit containing four switching elements such as transistors or MOSFETs is used. The motor is at the center, forming an H-like configuration. By turning on two switches simultaneously, the direction of the current flow can be reversed, thereby changing the rotation direction of the motor. By combining the PWM and H-Bridge methods, complete control over the DC motor can be achieved. The L298N is a dual H-Bridge motor driver that provides speed and direction control of two DC motors simultaneously. The module can drive DC motors with voltages between 5 and 35 V, with a peak current of up to 2

A.The L298N module has two screw terminal blocks for motors A and B, a ground pin screw terminal block, a VCC for the motor, and a 5 V pin that can either be an input or output. The Enable A and B pins enable and control the motor speed, while the Input 1 and Input 2 pins control the direction of rotation of motor A, and inputs 3 and 4 for motor B. If input 1 is LOW and input 2 is HIGH, the motor moves forward, and vice versa. When both inputs are the same, the motor stops. By connecting a push-button switch to pin 2 of the Arduino, the circuit can be used to control the speed of the motor using a potentiometer and change the rotation direction using the push button.

Experimental Procedure

1. The experiment began by gathering all the necessary components, including an Arduino UNO board, a DC motor, an L298N motor driver, a potentiometer, a push-button switch, and some jumper wires.
2. The DC motor was connected to the L298N motor driver through the screw terminal blocks, ensuring that the positive and negative leads were connected correctly.
3. The motor driver was connected to the Arduino board using jumper wires. The ENA and ENB pins of the motor driver were connected to PWM pins 5 and 6 on the Arduino board.
4. The input pins IN1, IN2, IN3, and IN4 of the motor driver were connected to digital pins 2, 3, 4, and 7 on the Arduino board, respectively.
5. The potentiometer was connected to the 5V and GND pins on the Arduino board, with the wiper connected to analog pin A0.
6. The push-button switch was connected to digital pin 8 on the Arduino board.
7. The Arduino code was uploaded to the board, which included the necessary code for generating the PWM signals and changing the motor direction based on the potentiometer and push-button switch inputs.
8. The potentiometer was then used to vary the duty cycle of the PWM signal, thereby controlling the motor speed, while the push-button switch was used to change the motor direction.
9. The experiment was repeated several times with different duty cycle values and push-button switch inputs to observe the changes in motor speed and direction.
10. The experiment was concluded by disconnecting all the components and storing them safely for future use.

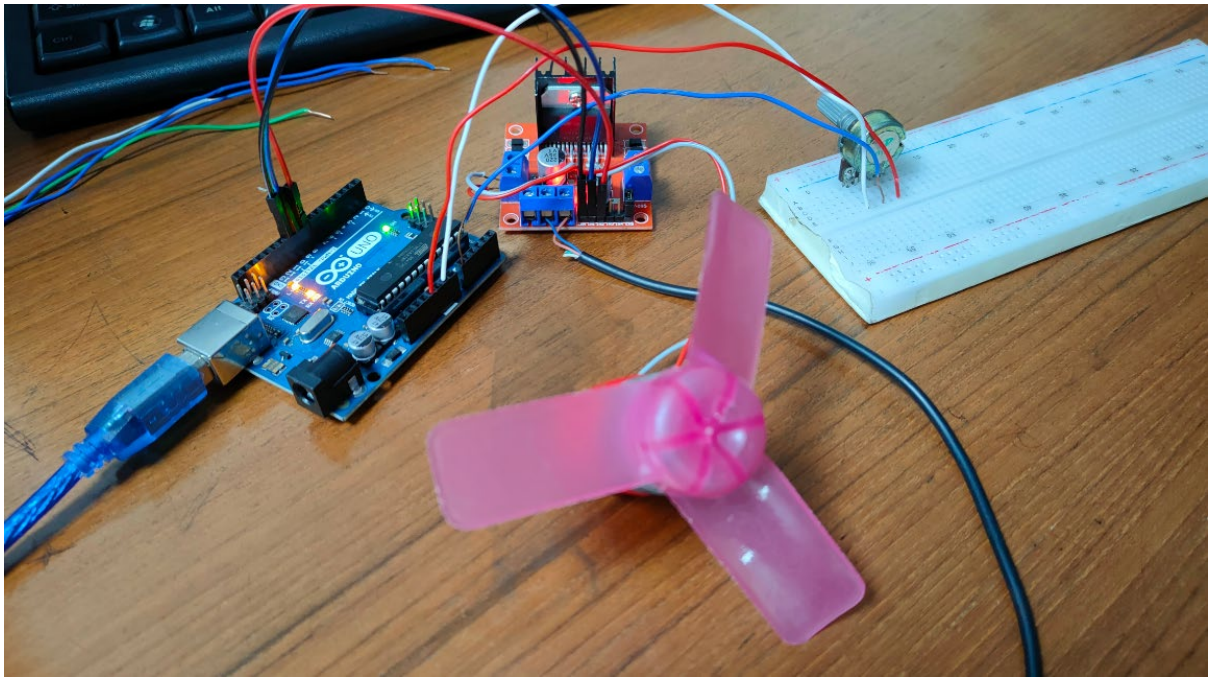
Circuit Diagram



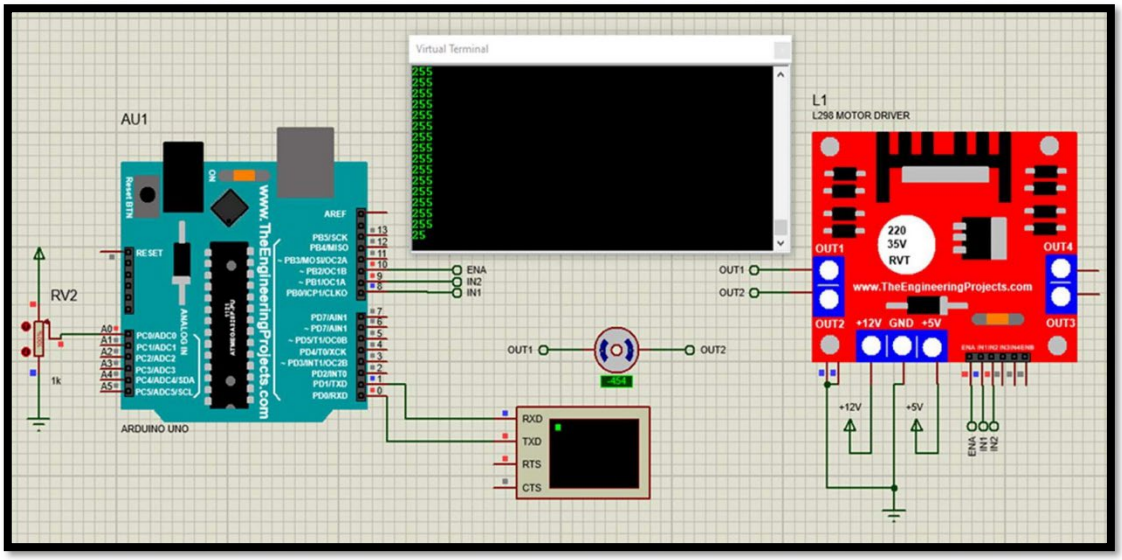
Components List

- ✓ L298N Driver
- ✓ 12 V High Torque DC Motor
- ✓ Arduino Board
- ✓ Potentiometer
- ✓ A DC power supply
- ✓ Breadboard and Jumper Wires

Hardware Output Results



Simulation



Code/Program

Clockwise

```
int in1 = 8;
int in2 = 9;
int ConA = 10;
int speed1;

void setup() {
  Serial.begin(9600);
  pinMode(2, INPUT);
  pinMode(8, OUTPUT);
  pinMode(9, OUTPUT);
  pinMode(10, OUTPUT);
}

void TurnMotorA1(){
  digitalWrite(in1, HIGH);
  digitalWrite(in2, LOW);
  float analogvalue = analogRead(A0);
  int PWMvalue = map(analogvalue, 0, 1023, 0, 255);
  analogWrite(ConA, PWMvalue);
}

void TurnMotorA2(){
  digitalWrite(in1, LOW);
  digitalWrite(in2, HIGH);
  float analogvalue = analogRead(A0);
  int PWMvalue = map(analogvalue, 0, 1023, 0, 255);
  analogWrite(ConA, PWMvalue);
}

void loop() {
  float analogvalue = analogRead(A0);
  int PWMvalue = map(analogvalue, 0, 1023, 0, 255);

  if (digitalRead(2) == LOW){
    TurnMotorA1();
  }
  else if (digitalRead(2) == HIGH){
    TurnMotorA2();
  }
}
```

Anticlockwise

```
int in1 = 8;
int in2 = 9;
int ConA = 10;
int speed1;

void setup() {
  Serial.begin(9600);
  pinMode(2, INPUT);
  pinMode(8, OUTPUT);
```

```
  pinMode(9, OUTPUT);
  pinMode(10, OUTPUT);
}

void TurnMotorA1() {
  digitalWrite(in1, LOW);
  digitalWrite(in2, HIGH);
  float analogvalue = analogRead(A0);
  int PWMvalue = map(analogvalue, 0, 1023, 0, 255);
  analogWrite(ConA, PWMvalue);
}

void TurnMotorA2() {
  digitalWrite(in1, HIGH);
  digitalWrite(in2, LOW);
  float analogvalue = analogRead(A0);
  int PWMvalue = map(analogvalue, 0, 1023, 0, 255);
  analogWrite(ConA, PWMvalue);
}

void loop() {
  float analogvalue = analogRead(A0);
  int PWMvalue = map(analogvalue, 0, 1023, 0, 255);

  Serial.print("Digital Value = ");
  Serial.print(PWMvalue);

  float analogVoltage = (PWMvalue * 5.00) / 255.00;
  Serial.print("Analog Voltage = ");
  Serial.println(analogvalue);

  if (digitalRead(2) == LOW) {
    TurnMotorA1();
  }
  else if (digitalRead(2) == HIGH) {
    TurnMotorA2();
  }
}
```

Code Explanation

The code is written to control a DC motor using an Arduino board. The motor is controlled by two input signals, in1 and in2, that determine the direction of rotation. A third input signal, ConA, is a PWM signal that controls the speed of the motor.

The code starts by declaring the pin numbers for the input and output signals using the int data type. The setup() function sets the modes of these pins as either inputs or outputs using the pinMode() function.

There are two functions in the code, TurnMotorA1() and TurnMotorA2(), which control the direction and speed of the motor in one direction and another direction, respectively. These functions are called in the loop() function when the input signal on pin 2 is detected to be either high or low.

When pin 2 is detected as low, the TurnMotorA1() function is called, which sets in1 to LOW and in2 to HIGH to make the motor spin in a counter-clockwise direction. The analogRead() function reads an analog voltage value from pin A0 and maps it to a PWM value using the map() function. This PWM value is then written to the ConA pin using the analogWrite() function to control the speed of the motor.

When pin 2 is detected as high, the TurnMotorA2() function is called, which sets in1 to HIGH and in2 to LOW to make the motor spin in a clockwise direction. The rest of the code is the same as in TurnMotorA1().

Discussion & Conclusion

In this experiment, we learned about pulse width modulation (PWM) and its use in controlling the speed of a DC motor. We also learned about the L298N motor driver and how it can be used with the Arduino to control the direction and speed of a DC motor. By combining these two concepts, we were able to create a circuit that allows us to control the speed and direction of a DC motor using a potentiometer and push button switch.this experiment provided an introduction to PWM and its use in controlling the speed of a DC motor, as well as the L298N motor driver and its use with the Arduino to control the direction and speed of a DC motor. By following the experimental procedure, we were able to create a functional circuit that allowed us to control the speed and direction of a DC motor using a potentiometer and push button switch. This experiment provides a good foundation for further exploration and experimentation with DC motors and their control using microcontrollers and other electronic components.

References

- AIUB Lab Manual
- https://www.arduino.cc