MOTOR SPEED CONTROL USING PID

Lab Project: Control System (EEE325)

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Submitted To

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ABSTRACT

This project presents an investigation into the speed control of a DC motor using a Proportional-Integral-Derivative (PID) controller. The objective of the study was to design and implement a PID control system to regulate the speed of a DC motor and analyze its performance in terms of speed accuracy, response time, and stability.

The project begins by providing a brief introduction to the importance of speed control in DC motor applications and the role of PID controllers in achieving precise control. It highlights the advantages of PID controllers, which combine proportional, integral, and derivative control actions to achieve robust and efficient motor speed regulation.

Moreover, we have compared the results of DC Motor with and without PID. As it was seen that, steady state error was also improved.

CHAPTER I

Introduction

1.1 Introduction

Motor speed control plays a crucial role in various industrial applications, ranging from robotics and automation to manufacturing and transportation. Precise control over motor speed enables efficient operation, improved productivity, and enhanced system performance. The purpose of this project is to design and implement a motor speed control system using a Proportional-Integral-Derivative (PID) controller, a widely used control technique known for its simplicity and effectiveness.

The PID controller is a popular choice for motor speed control due to its ability to handle diverse system dynamics. It combines proportional, integral, and derivative control actions to minimize the speed error between the desired setpoint and the actual motor speed. The proportional term provides an immediate response to deviations, the integral term eliminates steady-state errors, and the derivative term improves transient response and stability.

The project will involve both hardware and software components. The Arduino will serve as the control unit, interfacing with the motor driver and speed sensor. The software code will implement the PID control algorithm, enabling real-time measurement and adjustment of the motor speed.

CHAPTER II

Circuit Components

2.1 Circuit Components

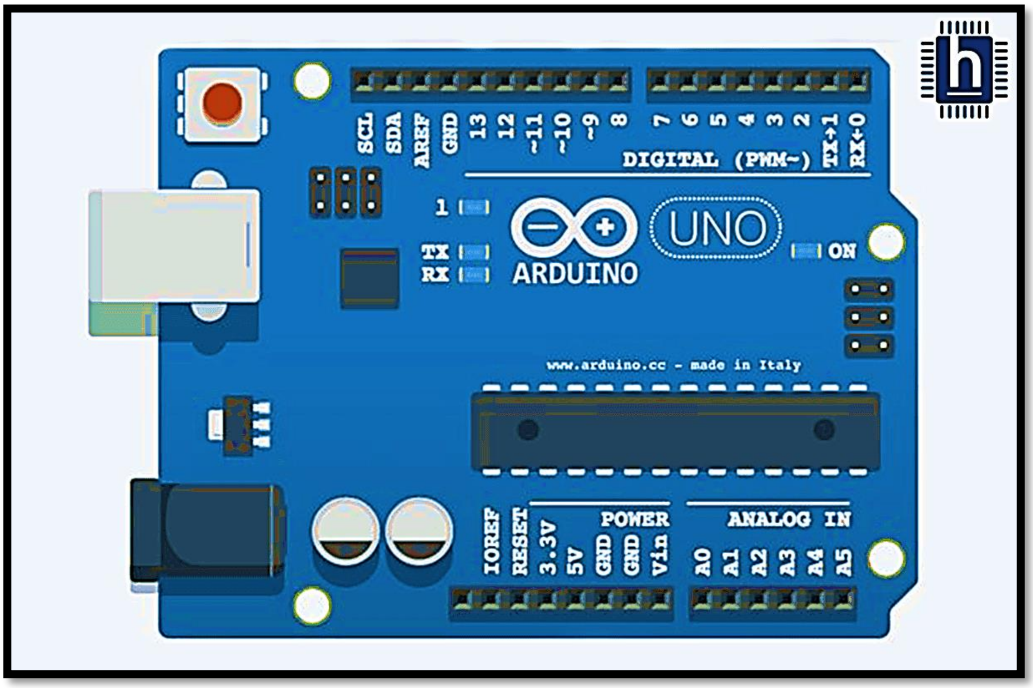
Following components are required for our project;

- Arduino UNO
- Potentiometer
- L293D
- Battery

2.1.1 Arduino UNO

Arduino Uno is an open-source microcontroller board based on the ATmega328P microcontroller. It is one of the most widely used boards in the Arduino family and is commonly chosen for various electronics projects and prototyping.

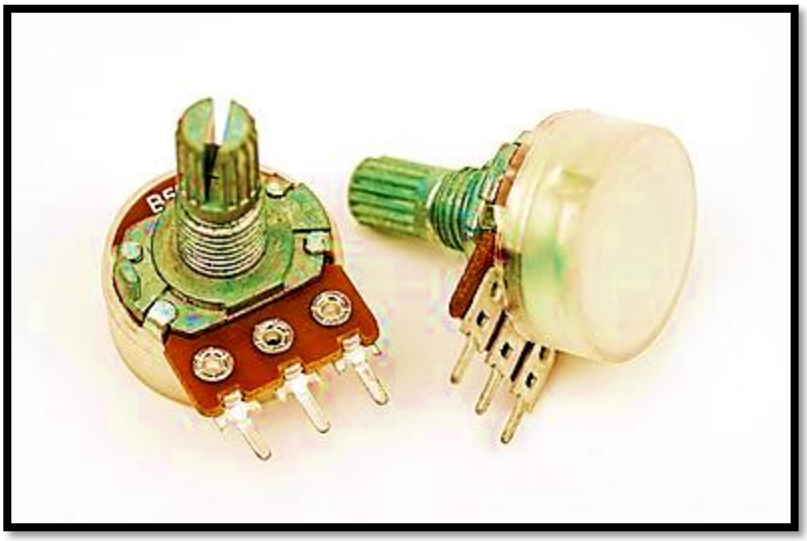
Figure 1



2.1.2 Potentiometer

A potentiometer, often referred to as a pot, is an electrical component that allows for variable resistance in an electronic circuit. It is widely used in various applications for controlling voltage, current, or signal levels.

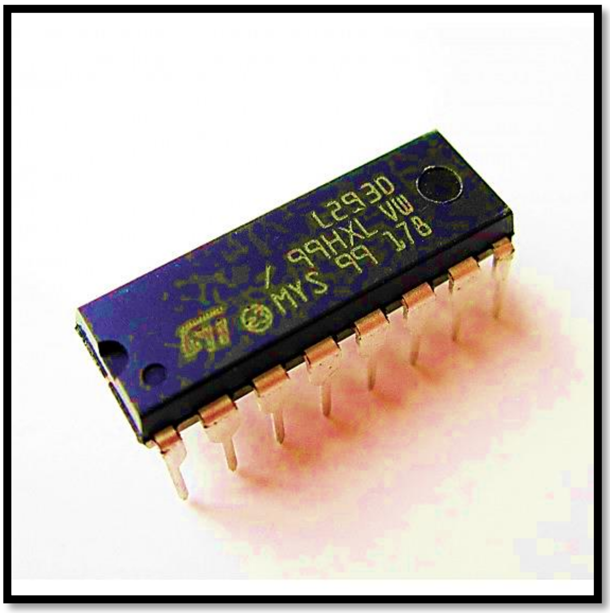
Figure 2



2.1.3 L293D

The L293D is a popular integrated circuit (IC) used for driving small to medium-sized DC motors or stepper motors in electronic projects. It is commonly used in robotics, automation, and motor control applications. The L293D is controlled using logic-level input signals. It has separate input pins for controlling the motor direction (IN1, IN2, IN3, IN4) and an enable pin (EN) for PWM speed control. By varying the logic levels applied to these pins, the L293D can control the motor's speed and direction.

Figure 3



2.1.4 Battery

A battery is a device that converts chemical energy to electrical energy. A battery's chemical reactions involve the flow of electrons from one material (electrode) to another via an external circuit. The flow of electrons generates an electric current, which can be used to perform work.

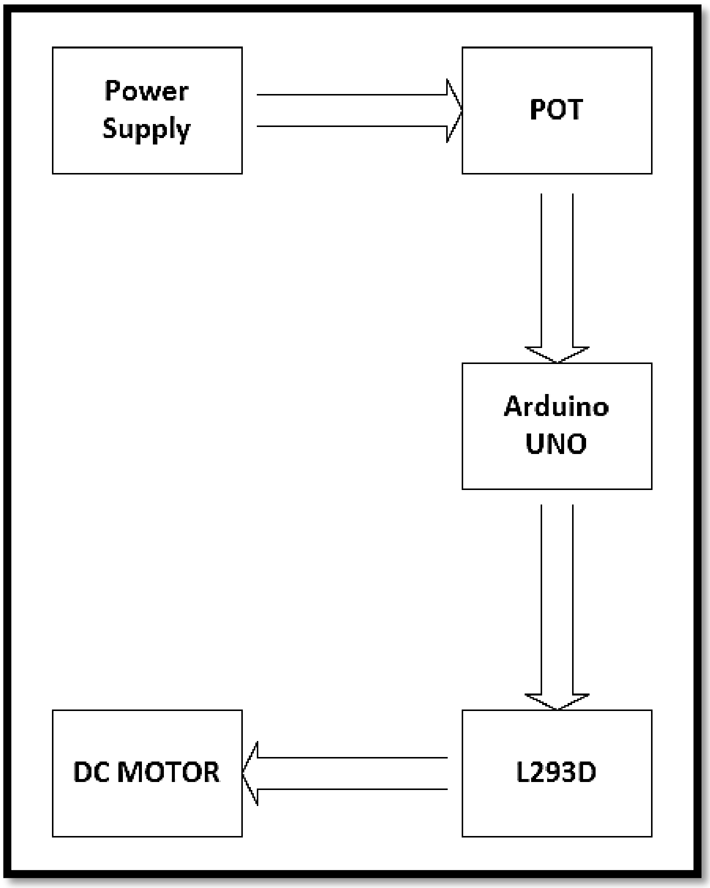
Figure 5

CHAPTER III

Circuit Diagram & ItsWorking

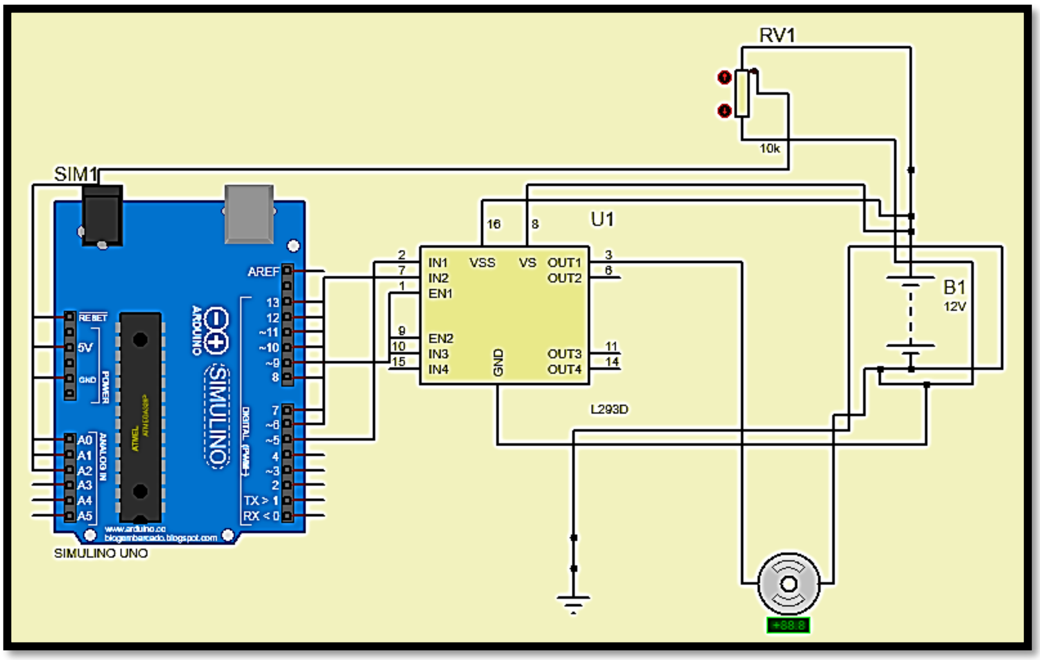
3.1 Block Diagram

Figure 6



3.2 Circuit Diagram

Figure 7



3.3 **Mathematical Model**

*Transfer function: G(s) = K / (s * (T * s + 1))*

Where:

- **G(s)** is the transfer function.
- **s** is the complex variable representing the Laplace transform domain.
- **K** is the gain of the system.
- **T** is the time constant of the system.

In the case of a 5V DC motor, the transfer function can be approximated as:

Transfer function: G(s) = K / (s + T)

*Proportional Term: P(t) = Kp * e(t)*

*Integral Term: I(t) = I(t-1) + (Ki * e(t) * Ts)*

*Derivative Term: D(t) = (Kd / Ts) * (e(t) - e(t-1))*

Control Signal: u(t) = P(t) + I(t) + D(t)

$$e = S.P - PV = 250 - 240 = 10$$

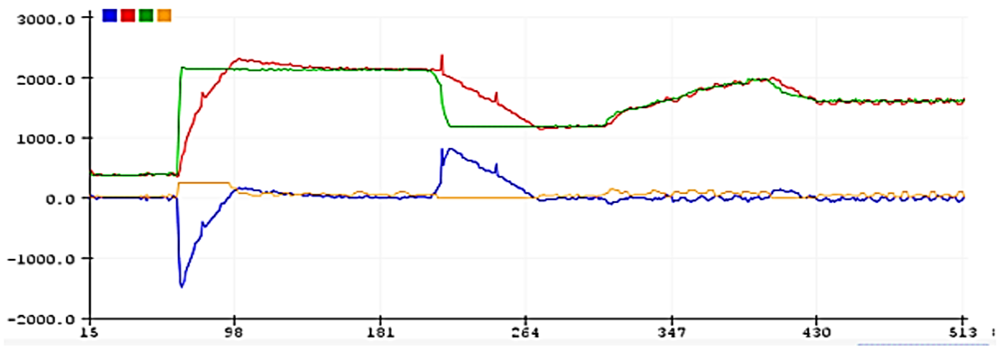
$$P = kp * e = 10 * 2 = 20$$

$$I = ki * \sum e^x dt = (0.0001)(e1 + e2 + e3)(0.1) = 3E - 4$$

$$D = kd * \left(\frac{de}{dt}\right) = \frac{(0.0001)(30 - 20)}{0.1} = 0.01$$

$$OP = P + I + D = 20.0103$$

3.4 **GRAPH**

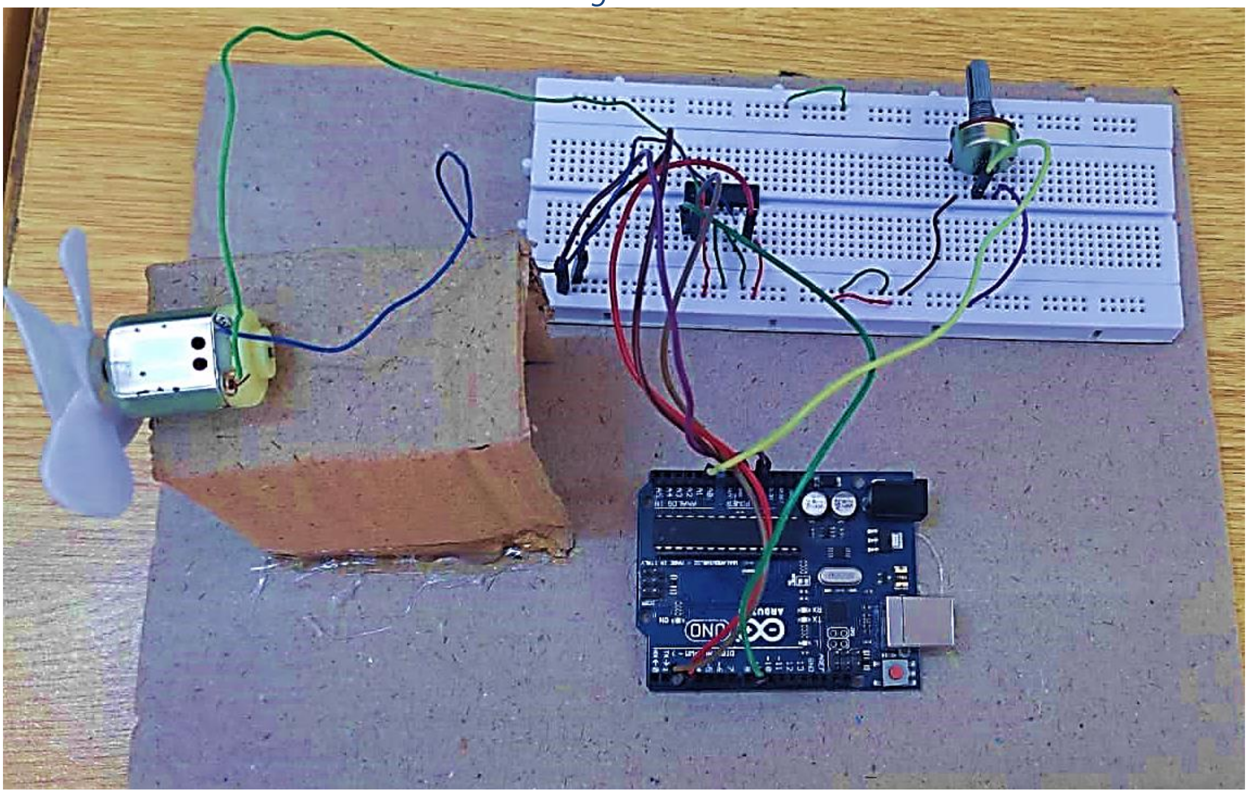


3.5 Working Principal

The setup includes a motor, a speed sensor, a Arduino or controller unit, and a motor driver circuit. The Arduino receives inputs from the speed sensor, calculates the control signal using the PID algorithm, and provides the appropriate control output to the motor driver. The motor driver circuit receives the control output from the microcontroller and provides the appropriate voltage or current to the motor. It controls the motor's power supply, enabling it to rotate at the desired speed.
The performance of the motor speed control system can be evaluated by monitoring various parameters, including steady-state error, response time, settling time, overshoot, and stability

3.6 Hardware Result

Figure 8



3.7 Applications

The applications of this project include the following applications:

- ✓ Industrial Automation
- ✓ Heating, Ventilation, and Air Conditioning (HVAC) systems
- ✓ Electric vehicles (EVs) for maintaining desired speeds
- ✓ Computer Numerical Control (CNC) machines use motors for precise positioning and movement
- ✓ Motor speed control is crucial in robotics for precise movement control of robotic arms, mobile robots, and drones

CHAPTER IV

Advantages & Conclusion

4.1 Advantages

- ✓ The PID control algorithm allows for accurate and precise control of motor speed. It continuously adjusts the motor input based on the feedback from the speed sensor, minimizing speed variations and maintaining the desired speed setpoint with high accuracy.
- ✓ The PID control algorithm enables quick and responsive adjustments to changes in the motor speed setpoint or external disturbances. It allows for rapid corrections, ensuring that the motor reaches and maintains the desired speed in a timely manner.
- ✓ The advantages of PID-controlled motor speed extend to various applications, including robotics, industrial automation, HVAC systems, electric vehicles, CNC machines, and more.

4.2 Conclusion

The PID control algorithm proved to be highly effective in maintaining precise motor speed control. It continuously adjusted the motor input based on feedback from the speed sensor, resulting in accurate speed regulation and minimizing deviations from the desired setpoint.

The inclusion of the integral term in the PID control algorithm effectively eliminated steady-state error, allowing the actual motor speed to closely match the desired setpoint over time. This led to improved speed control accuracy and minimized deviations from the desired speed.