

DC Motor Speed Control Using Arduino & L298N Motor Driver

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Abstract

The focus of this project is on developing a DC motor speed controller using an Arduino microcontroller and an L298N motor driver module. The goal is to create a flexible and effective system that can control the speed, direction of a DC motor through PWM signals generated by the Arduino. The project utilizes the Arduino platform for its flexibility, ease of programming, and wide availability of resources, while the L298N motor driver is used to easily control the speed, direction of DC motors. By integrating these components, the project aims to create a robust and user-friendly motor control system suitable for various applications such as robotics, automation, and prototyping. The methodology involves interfacing the Arduino with the L298N motor driver and configuring it to generate PWM signals to control the motor speed. Additionally, the project explores methods to ensure smooth speed transitions, precise speed control, and reliable operation of the DC motor. Practical experiments are conducted to validate the system's performance under different operating conditions. The expected outcome of this project is a functional DC motor speed controller capable of adjusting the motor speed over a wide range with high precision. The system's adaptability, user-friendliness, and cost-effectiveness render it appropriate for both amateur and professional uses. This initiative lays the groundwork for future study and growth in the robotics and automation fields while also advancing motor control technologies.

Keywords: Speed control, PWM, Motor driver, DC Motor.

INTRODUCTION

DC motors find extensive use in a variety of fields like robotics, automation, and electromechanical systems due to their simplicity, reliability, controllability. However, ensuring accurate control over their speed and direction is crucial for many applications. This necessitates the creation of effective motor control systems. This study presents a DC motor speed regulator that utilizes an Arduino microcontroller and an L298N motor driver module. The Arduino platform is selected for its ease of

programming, flexibility, and strong community support. The L298N motor driver module is employed for its capability to effectively manage both the speed and direction of direct current motors. The primary objective of this project is to create a motor control system that is both flexible and efficient, and that is capable of controlling the speed and direction of a DC motor by means of Pulse Width Modulation (PWM) signals that are created by the Arduino development platform. By combining these elements, the project aims to produce a sturdy and user-friendly solution suitable for a wide range of applications [1].

This introduction emphasizes the significance of precise motor control, the components chosen, and

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the overall objectives of the project. Subsequent sections will explore the methodology, implementation specifics, experimental findings, and conclusions of the project, contributing to the progress of motor control technology and its applications in robotics, automation, and beyond.

LITERATURE REVIEW

The development of DC motor speed controllers using Arduino microcontrollers and motor driver modules has been a subject of interest in both academic and practical contexts. Various studies and projects have explored different aspects of motor control, including hardware design, software implementation, and application-specific optimizations. This literature review seeks to present a comprehensive summary of pertinent literature within this domain.

1. *Arduino-Based Motor Control Systems:* Numerous studies have demonstrated the versatility of Arduino microcontrollers in motor control applications. Arduino is widely favored by both hobbyists and professionals due to its user-friendly interface, open-source design, and strong community backing. Researchers have delved into the compatibility of different Arduino models with various motor driver modules in order to create economical and effective motor control solutions [2].
2. *Motor Driver Modules:* The selection of an appropriate motor driver module is crucial for achieving reliable and efficient motor control. The L298N motor driver module, known for its robustness and ease of use, has been widely adopted in Arduino-based motor control projects. Studies have evaluated the performance of the L298N module in terms of motor speed regulation, current handling capacity, and compatibility with different DC motor types.
3. *Pulse Width Modulation (PWM) Methods:* PWM serves as a widely utilized approach for regulating the velocity of DC motors. Studies in this field frequently explore PWM methods executed through Arduino's inherent PWM functions or separate PWM components. Investigations have concentrated on enhancing PWM characteristics like frequency and duty cycle to attain seamless speed regulation and reduce motor noise and vibration [3].
4. *Software Development:* The software aspect of motor control systems involves programming Arduino microcontrollers to generate PWM signals, interface with motor driver modules, and implement control algorithms. Literature has explored various programming techniques, including PID (Proportional-Integral-Derivative) control, closed-loop feedback systems, and motor ramping algorithms, to enhance speed control accuracy and stability.
5. *Applications and Case Studies:* Beyond the technical aspects, literature has highlighted diverse applications of Arduino-based motor control systems, including robotics, automation, mechatronics, and educational projects. Case studies have demonstrated real-world implementations of these systems in practical scenarios, showcasing their versatility and effectiveness [4].

METHODOLOGY

Component Selection: The initial phase involves collecting the essential components required for the project. This includes an Arduino microcontroller board (such as Arduino Uno or Arduino Mega), an L298N motor driver module, a DC motor, a power source, and connecting wires (Figure 1).

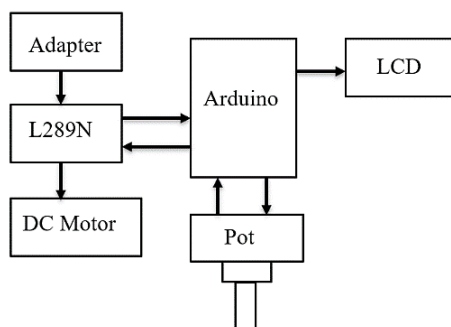


Figure 1. Block Diagram.

Circuit Design and Wiring: Design the circuitry for interfacing the Arduino with the L298N motor driver module and the DC motor. Consult the datasheets and technical documentation of the components for information regarding pin configurations and connection specifications. It is essential to ensure correct wiring and connections to prevent any potential damage to the components [5].

Arduino Programming: Develop the Arduino code for producing PWM signals to manage both the speed, direction of the DC motor. When programming, compiling, and uploading code to the Arduino board, use the Arduino Integrated Development Environment (IDE). Integrate functions for moving forward, moving backward, halting, and regulating the speed.

Motor Driver Configuration: Configure the L298N motor driver module according to the requirements of the DC motor. Adjust jumper settings and voltage selection for optimal performance. Ensure proper connections between the motor driver module and the Arduino board.

Testing and Calibration: Test the motor control system by running the Arduino code and observing the motor's behavior. Verify that the motor responds correctly to commands for speed and direction control. Fine-tune the PWM parameters to achieve desired speed ranges and smooth transitions.

Performance Evaluation: Assess the effectiveness of the motor control system across various operating conditions. Measure the motor speed using a tachometer or encoder feedback, if available. Assess the system's reliability, accuracy, and responsiveness to control inputs.

Safety Considerations: Ensure that the motor control system operates within safe voltage and current limits to prevent overheating and damage. Implement appropriate safety measures such as overcurrent protection, motor stall detection, and emergency stop functionality [6].

COMPONENTS

Arduino Uno R3

The Arduino Uno R3, a popular microcontroller board, is frequently employed in projects involving motor control due to its versatility and ease of use. When paired with the L298N motor driver, it becomes a robust platform for DC motor speed control. The L298N motor driver can manage two DC motors in both directions, supporting a maximum current of 2A for each channel (Figure 2). By connecting the motor driver to the Arduino Uno R3 and programming it using the Arduino IDE, you have the ability to accurately adjust the speed and direction of DC motors. This configuration enables a broad spectrum of uses, ranging from robotics to automation projects, where precise motor control is crucial [7].



Figure 2. Arduino Uno R3 [7].

L298N Motor Driver

The L298N motor driver module is a highly adaptable integrated circuit frequently utilized for managing the speed and direction of DC motors in a range of applications, including robotics and automation. With its dual H-bridge design, it enables the independent operation of two DC motors, supporting a maximum voltage of 46V and a current capacity of up to 2A for each channel (Figure 3). The module accepts standard logic level inputs for motor direction control and pulse width modulation (PWM) signals for speed control, making it compatible with microcontrollers like Arduino. Built-in protection diodes safeguard against back electromotive force, while external components such as capacitors and resistors may be necessary for optimal operation [8]. Equipped with heat sinks for efficient heat dissipation, the L298N module offers ease of use and reliability, making it a popular choice for motor control applications.

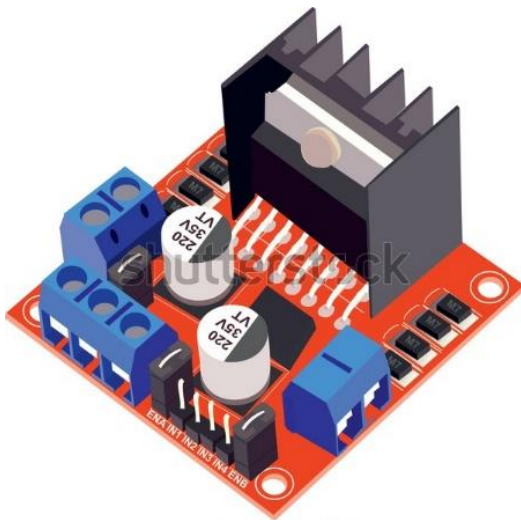


Figure 3. L298N Motor Driver [8].

DC Motor

A DC motor capable of reaching 12,000 RPM (revolutions per minute) offers high-speed operation suitable for various applications requiring rapid rotational motion (Figure 4). These motors are commonly used in scenarios such as high-speed machining, centrifuges, high-speed fans, and some types of propulsion systems.



Figure 4. DC Motor [9].

When selecting a DC motor with a specific RPM requirement, it's essential to consider other factors such as torque, voltage, current, and size, depending on the application's needs. Additionally, control mechanisms such as PWM (Pulse Width Modulation) may be employed to adjust the motor's speed as necessary.

For precise recommendations or specifications regarding a DC motor with a target speed of 12,000 RPM, it would be best to consult with motor manufacturers or suppliers, as they can provide detailed information on available motor models that meet your requirements.

LCD I2C

LCD Module: The LCD module typically consists of a display panel, controller, backlight (optional), and interface circuitry. The display panel contains the liquid crystal material responsible for forming characters, symbols, or graphics. The controller interprets commands from the microcontroller and controls the display output accordingly (Figure 5).

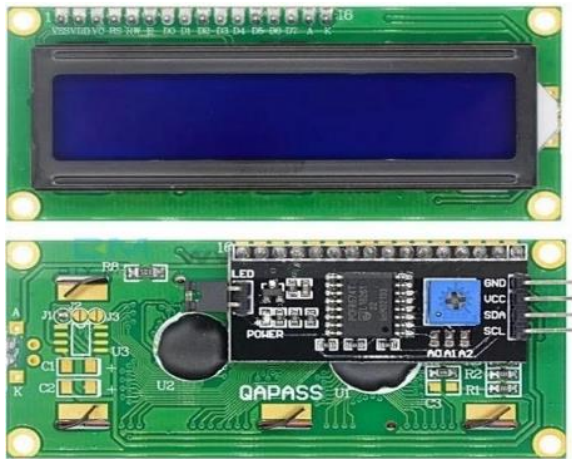


Figure 5. LCD I2C [10].

The I2C interface enables communication between the microcontroller and the LCD module using only two wires: SDA (Serial Data Line) and SCL (Serial Clock Line). This approach streamlines the wiring process and reduces the number of pins required on the microcontroller.

I2C Backpack: In many cases, the LCD module is equipped with an I2C backpack or interface board that handles the conversion between parallel and I2C communication protocols. The backpack typically includes an I2C-compatible chip (such as PCF8574) and associated circuitry for interfacing with the LCD module.

Various libraries and Arduino sketches are available to facilitate the integration of LCDs with I2C interface into Arduino projects. These libraries provide functions for initializing the LCD, writing text or custom characters, controlling the cursor, and adjusting backlight settings.

POT (10K)

A “pot 10k” refers to a potentiometer with a resistance value of 10 kilohms ($k\Omega$). Potentiometers, frequently referred to as “pots,” are adjustable resistors widely utilized in electronic circuits to regulate voltage or current levels. The components are made up of a resistive track and a movable wiper that is capable of being modified in order to alter the resistance between the wiper terminal and the remaining terminals (Figure 6). An overview of the primary features and characteristics of a 10k Ω potentiometer is presented below.

The resistance of the potentiometer is measured at 10 kilohms, equivalent to 10,000 ohms. This value determines the range of resistance that can be varied by adjusting the wiper position.

Three Terminals: The outer terminals of a potentiometer are connected to the ends of the resistive track, while the central terminal is connected to the wiper. In general, a potentiometer is made up of three terminals.



Figure 6. POT [11].

Adjustable Resistance: By rotating the shaft or slider of the potentiometer, the position of the wiper along the resistive track can be adjusted, thereby changing the resistance between the middle terminal and one of the outer terminals.

Linear or Logarithmic Taper: Potentiometers are available in different taper types, including linear and logarithmic (audio) taper. Linear potentiometers have a uniform change in resistance per unit angle of rotation, while logarithmic potentiometers provide a logarithmic response suited for volume or audio control applications.

CONCLUSION

In conclusion, the speed control of DC motors is a crucial aspect of many applications, ranging from robotics to industrial automation. Through the utilization of techniques such as PWM (Pulse Width Modulation) and appropriate motor driver modules like the L298N, precise control over motor speed and direction can be achieved. This not only enhances the efficiency and performance of systems but also allows for tailored solutions to meet specific requirements. With the advancement of technologies like Arduino microcontrollers and I2C-enabled components, implementing speed control for DC motors has become more accessible and versatile. Overall, the ability to effectively control the speed of DC motors contributes significantly to the functionality and optimization of a wide array of electromechanical systems.

RESULT

The result of DC speed control methods, such as using techniques like Pulse Width Modulation (PWM) and appropriate motor driver modules, is effective control over By adjusting the duty cycle of the PWM signal, one can control the average voltage supplied to the DC motor, thereby managing its speed. This level of control facilitates smooth acceleration, deceleration, and the ability to maintain consistent speeds as needed for specific applications (Figure 7).

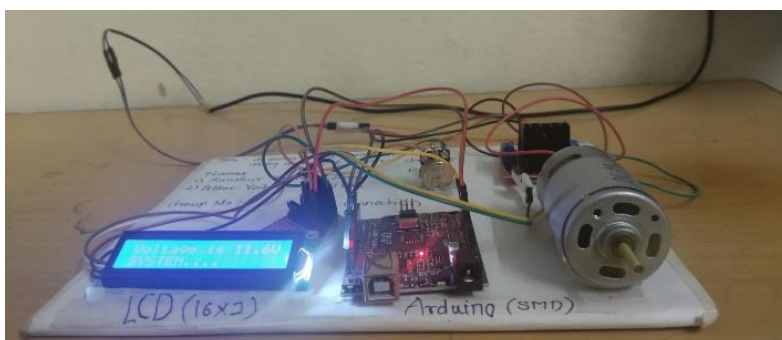


Figure 7. Final Project.

Furthermore, employing motor driver modules like the L298N enhances the capability to control larger DC motors with higher currents, offering robustness and reliability in various applications. The incorporation of microcontrollers, such as Arduino, offers a foundation for the application of sophisticated control algorithms, including PID (Proportional-Integral-Derivative) control, which facilitates enhanced precision and responsiveness in speed regulation.

Overall, the result of DC speed control methods is improved performance, efficiency, and versatility in a wide range of applications, including robotics, automation, electric vehicles, and industrial machinery. These methods empower engineers and developers to create innovative solutions that meet specific speed control requirements with precision and reliability

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