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Pulse Width Modulation Based DC Motor Closed Loop Speed Controller

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Abstract
Regulating the speed of a DC motor using a microcontroller and the pulse width modulation (PWM) technique is the primary objective of this project. Every robotics project relies heavily on DC motor control. Rotating a DC motor with high or low speed limitations is necessary in many applications. We employ the PWM approach for this purpose. In a pulse width modulation (PWM) circuit, the average on time may be adjusted from zero to one hundred percent by adjusting the on-to-off ratio, which results in a square wave. This allows for the delivery of power to the load to be varied. Compared to a resistive power controller, a pulse width modulation (PWM) circuit is more efficient. When set to 50% load power, the PWM uses approximately 50% of full power, with nearly all of that power going to the load. In contrast, a resistive controller uses about 71% of full power, with half of that power going to the load and the other 21% going to waste heating the series resistor. Pulse width modulation has the added benefit of allowing the pulses to reach the entire supply voltage. This allows them to generate more torque in a motor by more readily overcoming the internal motor resistances. An on-board computer, coded using embedded C instructions, is utilized in this project. The on-board computer may talk to the input and output modules. In order to show the current speed of the DC motor, the LCD acts as the output module. The speed of the motor may be adjusted using the control buttons.

Keywords; ATmega328P, L239D driver, IR sensor, PWM.

1. Introduction

Mechanical or electrical methods might be used to regulate the speed of a dc motor. Mechanical, bulky gear was once the norm for controlling the speed of dc drives. Although these drives were previously expected to be replaced by AC drives, the advancement has propelled them back to a position of considerable significance. Cranes, excavators, printing presses, hoists, machine tools, mine winders, paper mills, and rolling mills are a few major uses. As servo methods for positioning and tracking, fractional horsepower dc drives see extensive use [1]. A controlled rectifier takes a constant direct current and outputs a changeable DC voltage. Controlled rectifiers and dc choppers revolutionized current industrial equipment and variablespeed drives by continually supplying a variable dc voltage [2]. Controlling armature or field excitation allows adjustable speed drives to be operated across a wide range. The widespread availability of analog digital chips for use in firing or regulating circuits, such as transistors and thyristors, has increased the controllability of dc drives in countless fields [3]. Microprocessors and microcontrollers have shrunk in size and speed while dropping in price thanks to recent advancements in semiconductor technology. the fourth one.Justifying their usage is the possibility of using microprocessors to control all or part of an electrical function. The primary goal of this project is to learn about the hardware and software components of a closed-loop speed control system for DC motors that uses microcontrollers and provides the operator with warnings when overload is imminent. Taking a signal that represents the desired speed and driving a motor at that speed is what a motor speed controller is all about.

2. Literature Survey

Anyone can operate the microcontrollers with ease because of how user-friendly they are. Less human interaction is needed to operate the microcontrollers, which in turn lowers the cost of labor [2]. The crystal of

the microcontroller is the source of the clock in this case [6]. The versatility of DC motors' speed-torque properties makes them very versatile [3, 4]. Speed may be controlled in countless ways. As an example, a method for controlling the armature voltage and the excitation level [7]. One way to generate binary signals with two distinct periods is using pulse width modulation. From zero all the way up to the period (T), the width (W) of a single pulse can change [11, 12]. The fundamental idea is to regulate power consumption by shifting the duty cycle [13].
Electric fan usage is often energy wasted due to human behavior. Another common human need is for things that are easy to use and don't waste energy. This project integrated with an automated system that uses the ambient temperature to regulate speed, thereby reducing the need for external forces. "Tomorrow will be more exceptional than today" advancements are a need that this project's microcontroller-based programmed fan framework must meet. When the temperature of the earth varies, the electric fan will automatically adjust its speed. This electric fan system incorporates installed controlled programming and consists of a sensor, controller, driver, and engine.

3. Block Diagram

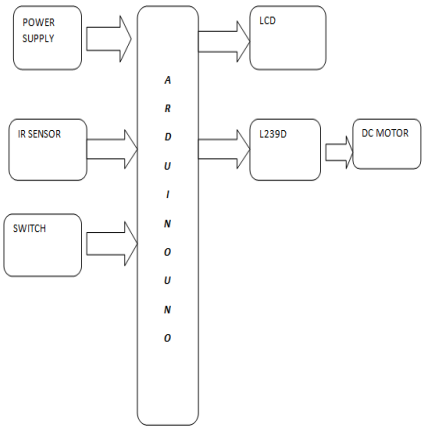


Fig 3.block diagram

3.1 Pulse Width Modulation

Pulse width modulation is a modulation technique used to encode a message into a pulsing signal. The average value of voltage fed to the load is controlled by turning the switch between supply and load on and off at a fast rate. The longer Switch is on compared to the off periods, the higher the total power supplied to the load.fig:1 represents the PWM.

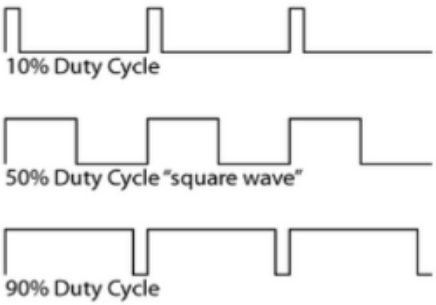
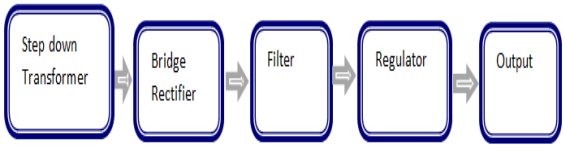


Figure 3.1.PWM Wave

3.2 Power Supply Block diagram:

A power supply block diagram represents the flow of electrical energy from AC input to regulated DC output through components like transformer, rectifier, filter, and voltage regulation.



3.2 Block diagram of power supply

3.3 Arduino-Uno Microcontroller Board

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino. Cc it is easy-to-use hardware and Software. Arduino can input various sensors as input and reproduce the given output required for actuators, motors, etc. It's user friendly to those who have an awareness of basic electronics and C programming language. Arduino platform mainly contains a Hardware Board called Arduino Board & Software Arduino IDE to program it. Other external hardware as Sensor Modules, Motors, Arduino UNO, and Arduino Software (IDE)- 1.0. The Uno is a microcontroller board based on the ATmega328P. The Arduino consists of 14 digital input/output pins in which 6 are PWM outputs, and 6 are analog inputs, a USB connection, a power jack, and a 16MHz quartz crystal, an ICSP header, and a reset button. The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, Mac, OS, Linux) written in the embedded programming language. It is used to write and load programs on the Arduino board to rise from room temperature. The sensors can convert the result, which involves the change of output voltage, which triggers the detection.

Fig.3.3 arduino uno

3.4 LCD

LCD signifies Liquid Crystal Display. An electronic display module, LCD finds its application in various electronic gadgets namely screens of calculators, mobile phones, television sets, computers etc. In this proposed module we utilize the 16× 2 LCD display. The representation- 16× 2, is indicative of the pixel matrix, having 16 columns and 2 rows, and thereby a possibility of having 32 characters. In here, each character is respectively made of 5× 8 pixel dots, thus making per character pixel count to be 40 pixels. The LCD display is easy to afford and extremely compatible.

Fig.3.4 LCD display

3.5 IR SENSOR

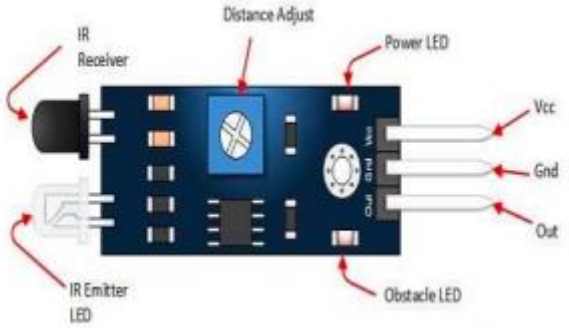
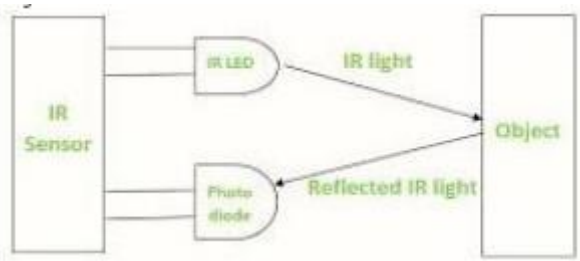


Fig.3.5 IR sensor

The infrared sensor is used to emits light to sense the object in the surroundings. It can measure the temperature of an object and detects the movement of things. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These.



types of radiations are invisible to our eyes, but the infrared sensor can detect these radiations. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received. An IR sensor consists of an IR LED and an IR Photodiode; together, they are called Photo coupler, or Opt coupler the IR Transmitter is a LED that emits infrared radiations are called IR LED. The IR LED looks like a regular LED, the radiations emitted by IR LED are invisible to the human eye.

3.6 DC MOTOR

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, Page | 25 either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. In this project, we use 12V DC motor.

Fig.3.6 dc motor

3.7 L293D Motor Driver

A microcontroller that normally operates on 5V or 3.3V cannot be directly used to control a DC motor operating on higher voltage and current rating. This is why we commonly use Motor Driver modules like the L293D Motor Driver Module and the L298N Motor Driver Module. While the L293D motor driver module can be used for basic low current application the L298N Motor driver module is a high current motor driver with some additional features that are commonly used with Arduino and Raspberry Pi for Robotics applications. The L298N Motor Driver module is based on the L298 Dual Full-Bridge Driver IC and can control the speed and direction of two DC motors (Motor A and Motor B) simultaneously. The voltage rating of these motors can be between 5V to 35V and the peak current value can be up to 2A. The pinout diagram of the L298N Motor Driver Module is shown below.

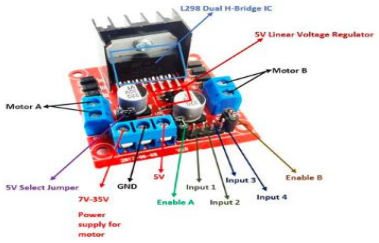


Fig.3.7 L293D Motor Driver

The motors to be controlled (Motor A and B) are connected to screw terminals. The voltage required to power the motor is provided to the Motor Power and Ground screw terminal, the voltage range should be between 7V to 35V. The L298 IC requires 5V to operate, this is why we have a built-in 5V Linear Regulator. If the operating voltage of the motor is less than or equal to 12V than the built-in regulator will power the driver IC, and this regulated 5V can also be obtained as an output voltage from the 5V screw terminal which can be used to power your microcontrollers like Arduino. If the operating voltage of the motor is greater than 12V then the built-in regulator will not be able to handle it, so we have to disconnect the regulator by removing the 5V Select Jumper pin and provide a separate 5V power as an input voltage to the 5V screw terminal to power our L298N Driver IC.

4. Project Working Model

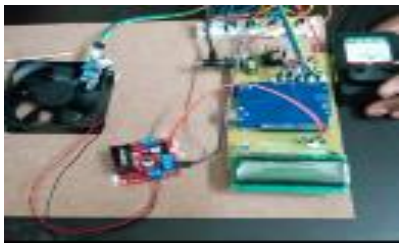


Fig.4.1 Project final output

5. Conclusion

An automated closed-loop system for controlling the speed of a dc motor using a microcontroller is now available. The ATmega328P microcontroller will be used to operate a permanent magnet DC motor with speed feedback via a tachogenerator. We will ensure that the system is designed to be user-friendly, allowing anybody to easily run it. The status of the system may be seen on the LCD display. Once the user is aware of the circumstance, they may adjust the load as needed.

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