Speed Control of DC Motor Using Microcontroller

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Abstract – This paper presents speed control of DC motor using an 8051 series microcontroller. The speed of DC motor is directly proportional to the voltage applied across its terminals. Hence, if voltage across motor terminal is varied, then speed can also be varied. This paper uses the above principle to control the speed of the motor by varying the duty cycle of the pulse applied to it. The paper uses two input buttons interfaced to the microcontroller, which are used to control the speed of motor. PWM (Pulse Width Modulation) is generated at the output by the microcontroller as per the program. The program can be written in assembly language or in embedded C. The average voltage given or the average current flowing through the motor will change depending on the duty cycle (ON and OFF time of the pulses), so the speed of the motor will change. A motor driver IC is interfaced to the microcontroller for receiving PWM signals and delivering desired output for speed control of a small DC motor.

Index Terms – DC motor, 16×2 LCD, microcontroller, motor driver IC L293D.

1. INTRODUCTION

Direct current (DC) motors have variable characteristics and are used extensively in variable-speed drives. DC motor can provide a high starting torque and it is also possible to obtain speed control over wide range. It is important to make a controller to control the speed of DC motor in desired speed. DC motor plays a significant role in modern industrial. These are several types of applications where the load on the DC motor varies over a speed range. These applications may demand high-speed control accuracy and good dynamic responses. DC motors are suitable for belt-driven applications and the applications where great amount of torque is required.

In train and automotive traction, fuel pump control, electronic steering control, engine control and electric vehicle control are good examples of these. In aerospace, there are a number of applications, like centrifuges, pumps, robotic arm controls, gyroscope controls and so on. For precise speed control of servo system, closed-loop control is normally used. Basically, the block diagram of the speed control of DC motor using microcontroller is as shown in Figure 1. The MAX 232 which is used to insert the program in the microcontroller 89C51 by using computer.

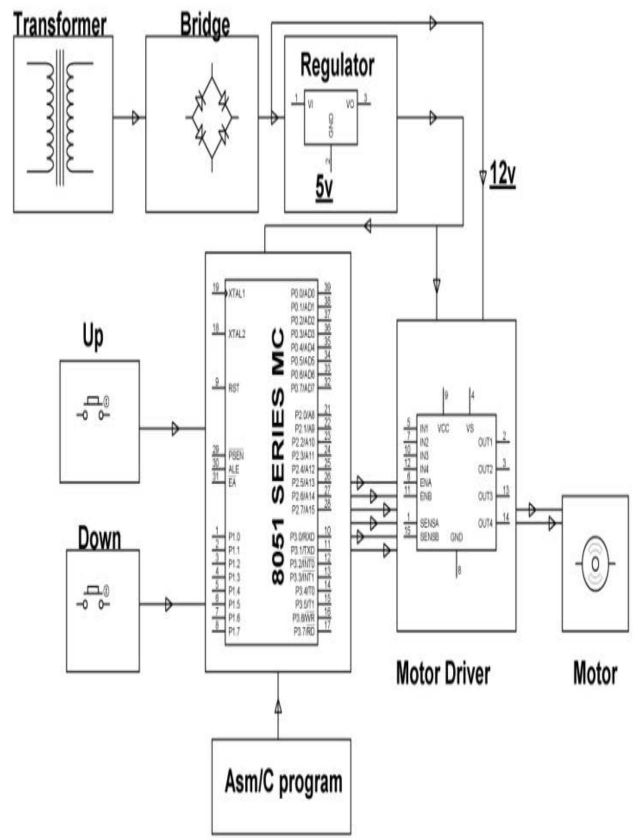


Fig.1: Block diagram of the speed control.

2. METHODOLOGY

Following sub topics are covered in methodology:

- Pulse Width Modulation
- power supply
- motor driver
- Microcontroller
- LCD display

2.1 Pulse Width Modulation:

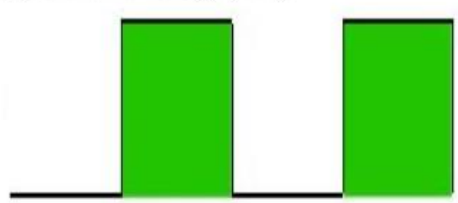
Pulse width modulation (PWM) is a method for binary signals generation, which has two signal periods (high and low). The width of each pulse varies between 0 and the period (T). The main principle is control of power by varying the duty cycle. Here the conduction time to the load is control of power by varying the duty cycle. Here the conduction time to the load is controlled. Let for a time t_1, the input voltage appears across the load i.e. ON state and for t_2 time the voltage across the load is zero.

- The duty cycle can be varied from 0 to 1 by varying t_1, T or f. Therefore, the output voltage V_0 can be varied from 0 to Vs by controlling k, and the power flow can be controlled.
- As the time t_1 changes the width of pulse is varied and this type of control is called pulse width modulation (PWM) control.

For better understanding of PWM these diagrammatic representations can be use. Figure 2 represent the waveforms obtained as output at different voltage requirements.

High speed signal (90%): The shaded part of the signal represents the ON time and the part of it represents time when it is not receiving any voltage.

Signal with half voltage (50%):



Signal with low voltage (10%):

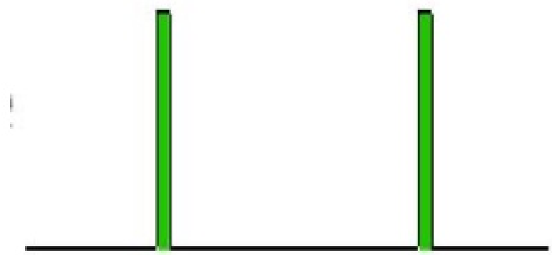


Fig.2. Wave form at different duty cycles

2.2 power supply:

Power supply is the main part of the system. The electronic system requires DC supply for operation. Here step down transformer which is used for step down 230V AC supply into 12V DC supply. After that full wave bridge rectifier is used to convert from AC to DC. Figure 3 is circuit diagram conversion process of power supply. During the positive half-cycle of voltage, diodes D_2 and D_4 are conducting and diodes D_1 and D_3 are reverse bias. Therefore, current flows through the winding, diode D_2, load and diode D_4. During negative half-cycles of voltage, diodes D_1 and D_3 conduct, and diodes D_2 and D_4 are reverse bias, therefore current flow through diode D_3, D_1 and load. In each condition the current flow in the same direction.

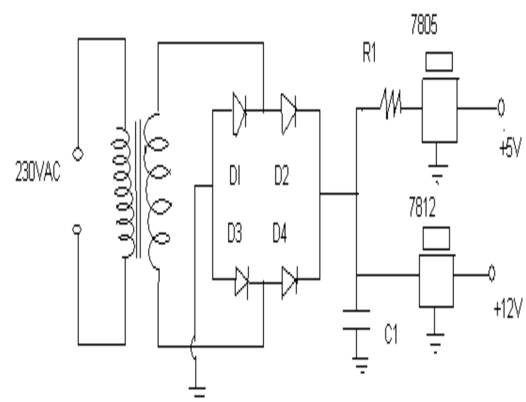


Fig.3. Circuit diagram of power supply

2.3 Motor driver:

L293D is a dual H-bridge motor driver integrated circuit (IC). In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. L293D has two set of arrangements where one set has input 1, input 2, output 1 and output 2 and other set has input 3, input 4, output 3 and output 4, according to above figure 4.

- If pin no 2 and 7 are high then pin no 3 and 6 are also high. If enable 1 and pin number 2 are high leaving pin number 7 as low then the motor rotates in forward direction.

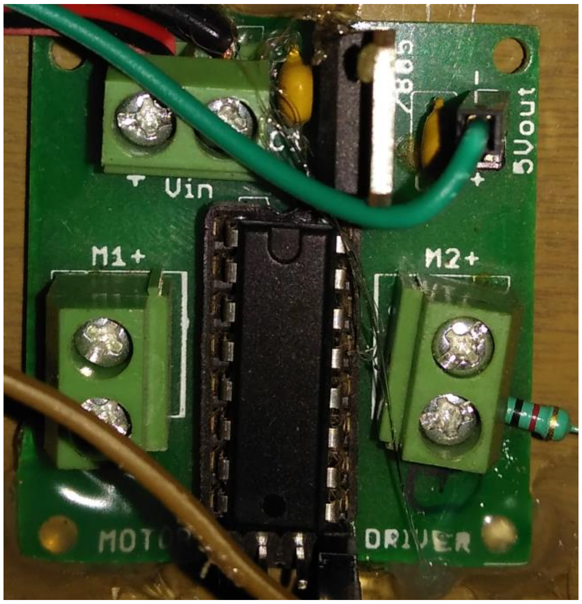


Fig.4.Schematic diagram of motor driver IC L293D

2.4 Microcontroller:

The 89C51 has been specifically developed for control applications. As mentioned earlier, out of the 128 bytes of internal RAM, 16 bytes have been organized in such a way that all the 128 bits associated with this group may be accessed bit wise to facilitate their use for bit set/reset/test applications. These are therefore extremely useful for programs involving individual logical operations. One can easily give example of lift for one such application where each one of the floors, door condition, etc may be depicted by a single hit. The 89C51 has instructions for bit manipulation and testing. Apart from these, it has 8-bit multiply and divide instructions, which may be used with advantage.

The pins of 89C51 are wired as:

- Pins from port 2 i.e., P2.0 (21) to P2.7 (28) to LCD data pins.
- Pins from port 3 i.e., P3.0 (10) to P3.2 (12) to LCD control pins.
- XTAL 1 (19) and XTAL 2 (18) to crystal
- Pins from port 3 i.e., P3.3 (13) to P3.5 (15) to Keyboard
- Pins from port 3 i.e., P3.6 (16) to Motor Driver IC L293d
- Pins No.9 is reset pin
- Pin No. 20 is grounded
- Pin No. 40 connected to 5V supply

<u>Features of 89C51</u>

- 4k ROM (EPROM)
- 128 byte RAM
- Universal asynchronous receive-transmit (UART)
- 32 input-output port lines
- Two, 16-bit timer/counters
- Six interrupt sources and
- On-chip clock oscillator and power on reset circuitry.

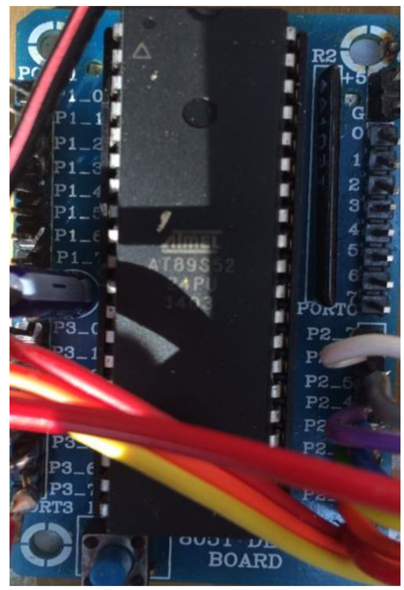


Fig.5.Schematic diagram of 89C51

2.5 LCD Display:

A general purpose alphanumeric LCD, with two lines of 16 characters.

LCDs with a small number of segments, such as those used in digital watches and pocket calculators, have a single electrical contact for each segment. An external dedicated circuit supplies an electric charge to control each segment. This display structure is unwieldy for more than a few display elements.

The "R/S" bit is used to select whether data or an instruction is being transferred between the microcontroller and the LCD. If the Bit is set, then the byte at the current LCD "Cursor" Position can be read or written. When the Bit is reset, either an instruction is being sent to the LCD or the execution status of the last instruction is read back.

We will discuss how a 16×2 LCD is interface with AT89C51. LCD 16×2 is used as output by the controller to display data to user. The 16×2 LCD display have 16 number of data can be written on 2 lines.

The pins are wired as:

Pins	**Pin description of LCD**
1	Ground
2	Vcc
3	Contrast Voltage
4	"R/S" _Instruction/Register Select
5	"R/W" _Read/Write LCD Registers
6	"E" Clock
7 - 14	Data I/O Pins

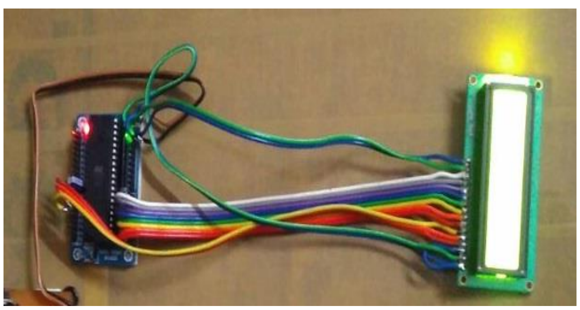


Fig.6.Schematic diagram of LCD interface with 89C51

3. HARDWARE

Below figure 7 shows the connection of power supply in which diode bridge rectifier with filter is used. Power supply converts the AC supply into the pure form of DC supply with the help of filter.

Fig.7.Connection of power supply on PCB

Above figure 6 shows the LCD interface with microcontroller 89C51.

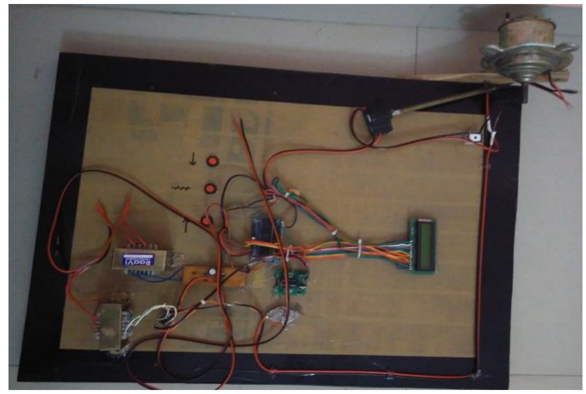


Fig.8.Final schematic circuit with motor and all component combination

In figure no. 8 bimetallic type thermostat is used with combination of relay only for protect motor from overheating. Separate step down transformer 230/18 volt which is used here for driving the motor.

4. RESULTS AND DISCUSSIONS

In fig 9 as the PWM changes the speed of the DC motor is changes. Hence speed of the DC motor is controlled by PWM technique.

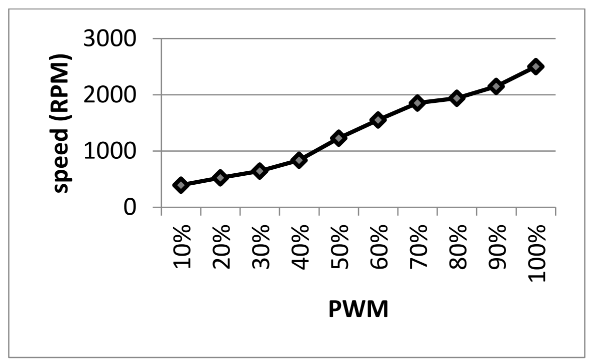


Fig.9. PWM in % vs. speed

5. CONCLUSION

It is quite clear from the above discussion that Speed Control of DC motor using microcontroller by using PWM may be a comprehensive system that controls the speed of a motor by giving instructions to the microcontroller to reduce the manual work. The technology saves money too and gives a return on investment.

Finally we conclude that this method is one of the best methods for controlling the speed of the DC motor.

6. FUTURE SCOPE

1. Speed control of DC motor by using microcontroller can deal with robotics while moving their arms and joints. We can move their arms in whatever directions we want to move it. By just

changing the power supply connections in the circuit we can move the arms of a robot in any direction. This will become the more important technique used in robotics and plays a prominent role in their movement.

2. Within no time this will shows their importance in the industrial area by using this technique with changes in the circuit diagram.

3. DC motors are widely used in industry because of its low cost, wide range of speed and torque, less complex control structure so better future of this project.

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