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Modified Microcontroller based Speed Control of DC motor using PWM

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Abstract

In present time, the use of DC motor in industrial applications is very wide. Properties like easy controllability, effective and precise output makes it suitable for large commercial purposes. Speed control of DC motor has been always one of the prime issue and plays a vital role where the speed needs to be precise and a correcting signal is needed to operate the motor at constant speed. In this paper, we discuss PWM (Pulse Width Modulation) technique to form a closed loop system for the speed control of DC motors. The system consists of Microcontroller 51 series 89S52, L293D motor driver, optical sensor, comparator and 16x2 dot matrix LCD display. The optical sensor detects the instantaneous speed at which the motor is running. The microcontroller varies the duty cycle continuously in a closed loop system until the speed comes to a predetermined level.

Keywords: *DC motor, PWM, microcontroller, LCD, L293D, 89S52, closed loop.*

1. Introduction

When a DC motor is switched on, it requires some time to acquire full speed or rated speed s per its basic property. If we switch off the motor before it acquires full speed, it goes back to its stationary position, which has been proved in many existing papers [1]-[4]. The basic idea is to continuously switch on and off the motor so that it runs at a speed between zero and its rated speed. For this we use PWM technique that provides pulse waves to periodically switch on and off the motor. In this work AT59S52 microcontroller has been used to generate PWM wave. To control the speed, we require a variable-voltage DC power source. The L293D IC is used to drive the motor and an optical sensor is used to measure speed and provides the display on an LCD screen.

PWM varies the duty cycle of the motor. Duty cycle is the percentage of time of “high” pulse to “low” pulse. When the speed of the motor is less than the predetermined value, the microcontroller increases the duty cycle until the speed reaches to the specified value. Similarly if the speed of the DC motor is higher than the predetermined value, the microcontroller reduces the duty cycle until the speed reaches to the specified value. Varying the duty cycle simply means varying the time for which the motor is switched on.

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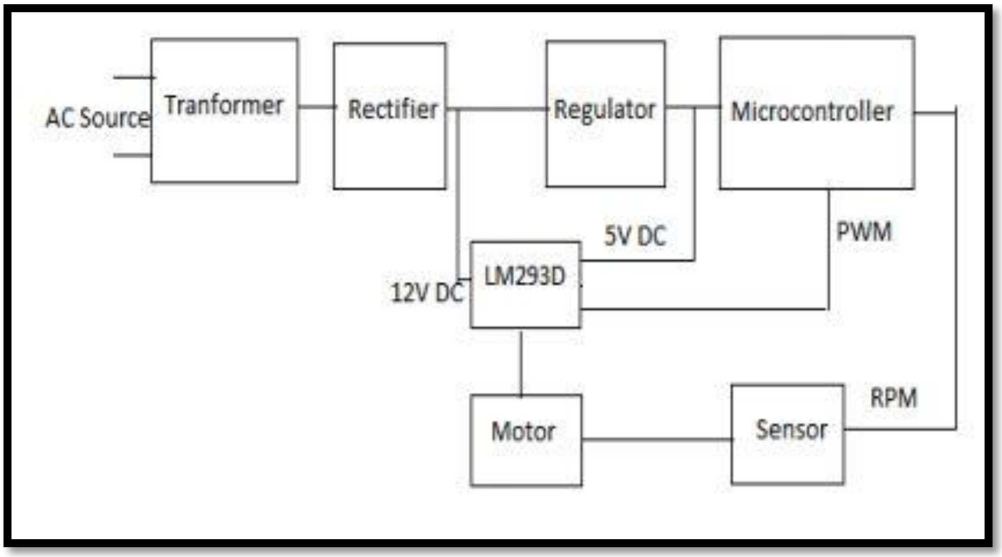

Figure 1. Block diagram

2. Components used

1. AT89S52 microcontroller
2. L293D motor driving IC
3. IR optical sensor
4. 16x2 LCD display
5. Capacitors 3- 104 pF
6. Resistors 2- 220-1 K

2.1 AT89S52 microcontroller

The microcontroller AT89S52 is general purpose low-power, easy programmable and high-performance CMOS with word size of 8-bits. It comprised 8 K bytes flash memory on board to cater for storing instant data and is in-system programmable. The microcontroller has on-chip flash, which can be reprogrammed in system or by using a non-volatile memory programmer and has other additional features like: 8K bytes of flash, 256 bytes of RAM, 32 I/O lines, watchdog timer, 2 data pointers, 3 16-bit counters, a six-vector two-level interrupt architecture, a full-duplex serial port, an on-chip oscillator and a clock circuitry. These features make this microcontroller complete in providing various services required for executing stationary tasks as per the application in demand and functions based on the applications.

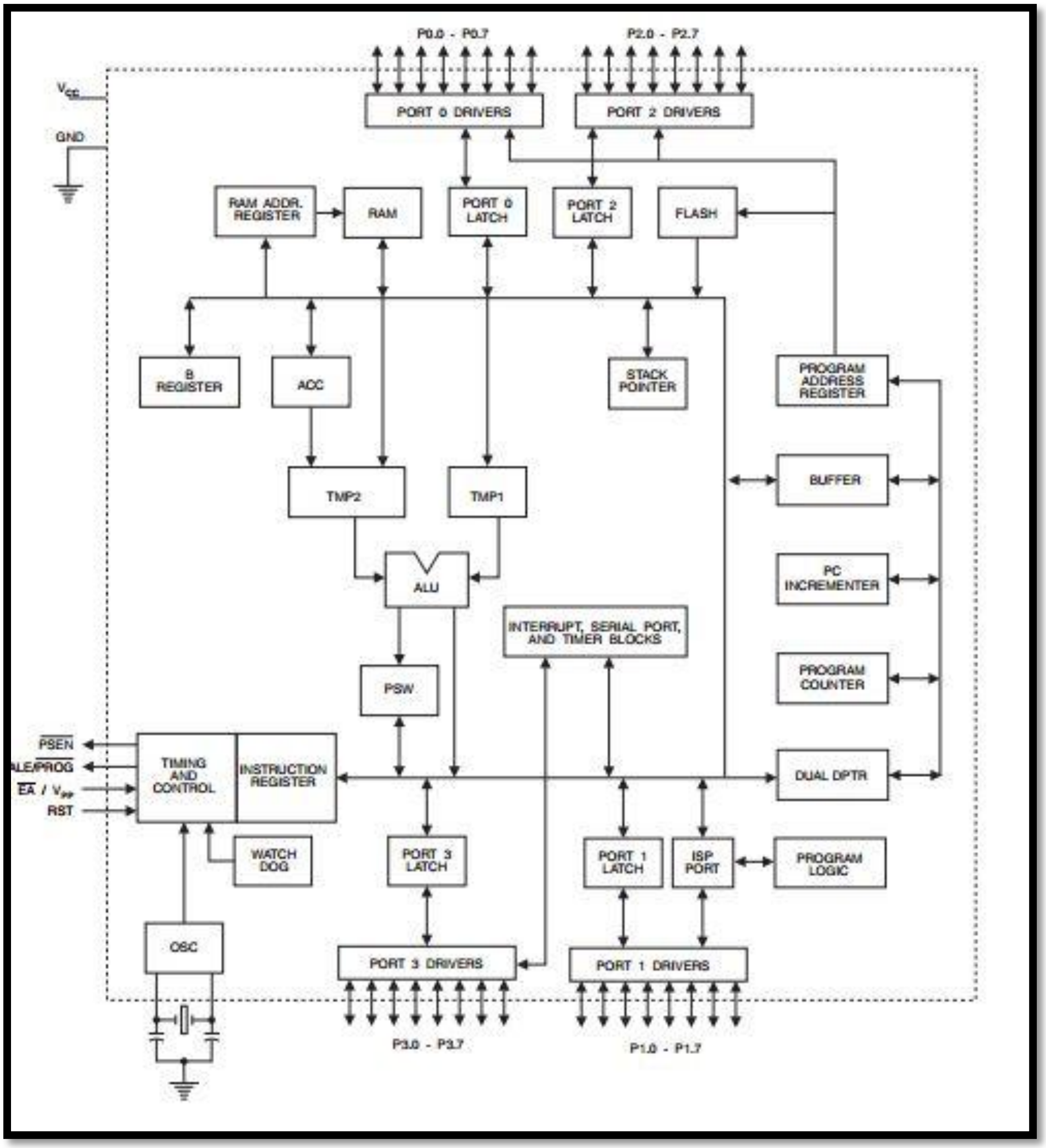

Figure 2. Block diagram of AT89S52 microcontroller

2.2 L293D motor driver

This motor driver IC is used to drive the motor in either direction. The microcontroller works on low voltage whereas the motor operates on relatively high voltage and thus voltage cannot be supplied from microcontroller and so motor drivers are used for this purpose. It works on the principle of H bridges. Figure 3 shows pin diagram of L293D motor driving IC. It consists of 2-H bridges with two output ports.

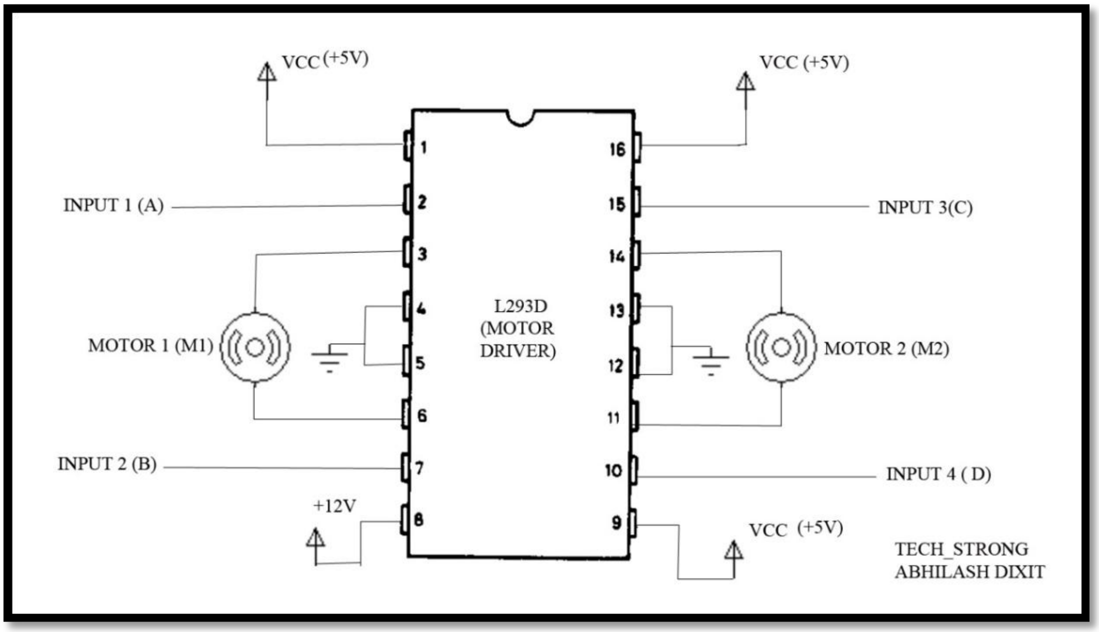

Figure 3. Pin diagram of motor driver

2.3 IR sensor

IR sensor is used to measure the speed of the motor. It transmits a continuous light beam on to the motor. When this light beam is obstructed, it gives an output. The transmitter is connected to a battery in series. This sensor works along with a 555 timer which works in MONOSTABLE mode. The function of various pins can be seen in figure 5. At pin 6 timing capacitor is connected and pin 7 is connected to ground. The timing can be varied according to the requirements. The 555 timer can also be used for pulse generation, PWM, PPM (Pulse position modulation), sequential timing, precision timing, etc.

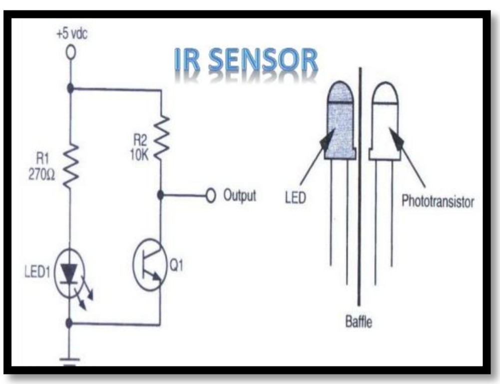

Figure 4. IR sensor

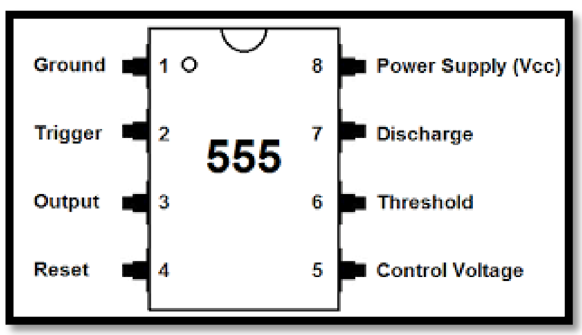

Figure 5. 555 timer

3. Methodology

The DC machine are now a days becoming popular due inherent qualities and applications. It would generally be simpler to vary the driving voltage of a motor to control its speed. If the voltage is high, the speed would also be high. Although it is easy to control the speed of the DC motor would be to vary the driving voltage, it would cause major power loss on the control system. So PWM is a much widely used method for speed control of DC motors. We know that the DC motor is a low pass system and the PWM is high frequency avoided. Also large motors are highly inductive so the system will not work properly at high frequencies. The operating principle is to vary duty cycles of the motor using PWM. The percentage time for which pulse is high to the time for which pulse is low is called the duty cycle. In figure 6, the waveforms of 10%, 50% and 90% duty cycle have been shown. In first waveform (10% duty cycle), the signal is high for 10% of total time and rest 90% denotes off duty cycle. Similarly for second waveform 50% on cycle and 50% off cycle and again in third waveform, the on cycle is for 90% of time and 10% is the off cycle. It is seen here that the average DC voltage value for 0% duty cycle is zero; whereas with 25% duty cycle the average value is 1.25V (25% of 5V). Similarly at 50% duty cycle the average value is 2.5V, and when the duty cycle is increased to 75%, the average voltage is 3.75V and it is in the same pattern for other duty cycles when considered. It is to mention here that the maximum duty cycle can be 100%, which will be equivalent to a DC waveform. Thus, it is clear that we can vary the average voltage across a DC motor by varying the pulse-width, and hence its speed. The voltage and current requirements of the motor has been met by using multi buffer IC package.

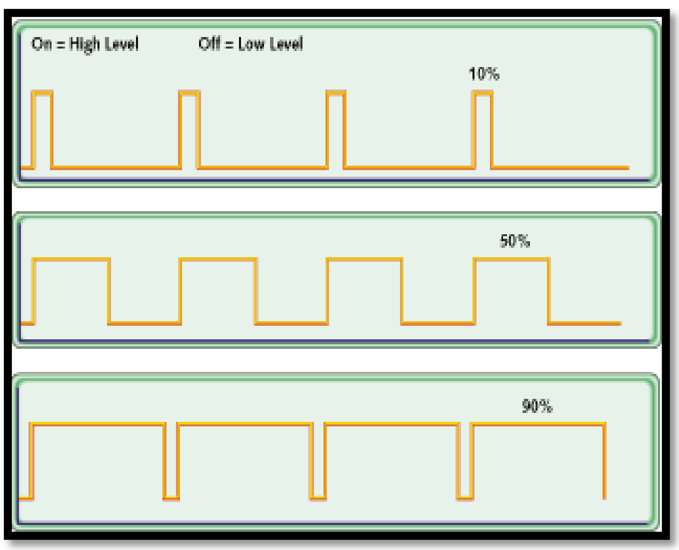

Figure 6. Waveforms of different duty cycles

4. Conclusion

It is to conclude here that proposed design of a fixed speed control system for DC motor is highly reliable and precise. It has adaptability for different system ratings with proper response. It implies that the motor will run at a constant speed at any load condition. The software or programming is done according to the requirements of the speed control. Figure shows the hardware mode of the system with verified output test on CRO.

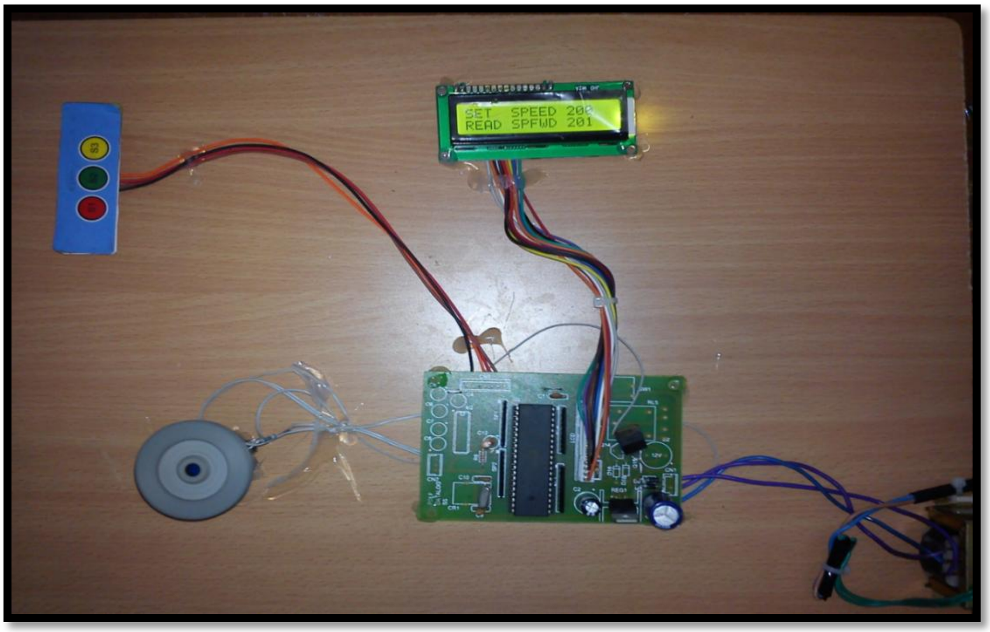

Figure 7. PWM system for DC motor speed control

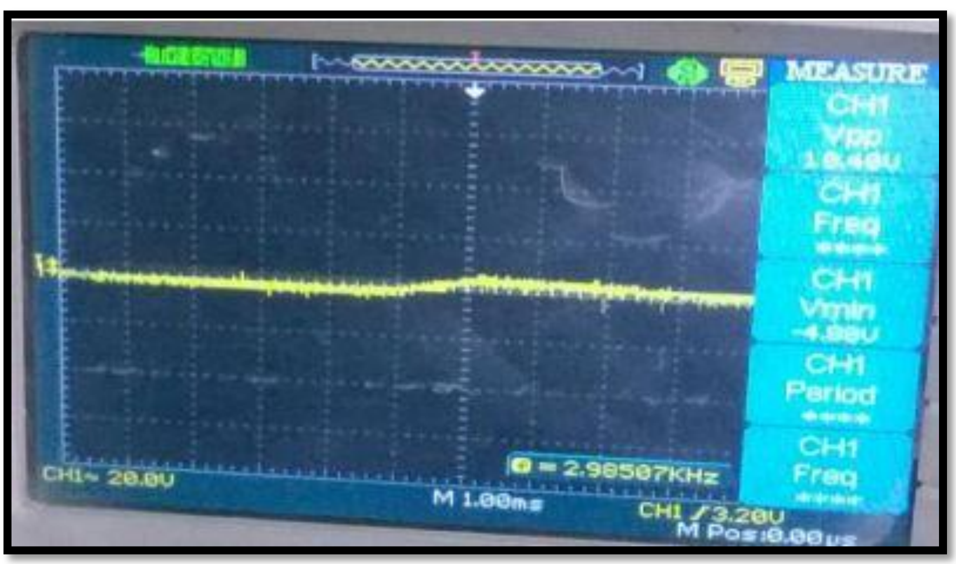

Figure 8. Output of power supply after testing on CRO set with verified result

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