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Speed Control of DC Motor by Pulse Width Modulation

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Abstract **—Direct current (DC) motor has already become an important drive configuration for many applications across a wide range of powers and speeds. The ease of control and excellent performance of the DC motors will ensure that the number of applications using them will continue to grow for the foreseeable future. The role of speed control in dc motors is very crucial in the achievement of desirable outputs. There are several methods for controlling the speed of dc motors. All the control strategies utilize the output speed error and its derivative as feedback damping signals. But Pulse width modulation is an effective method for adjusting the amount of power delivered to an electric load. The main advantage of PWM is that power loss in the switching devices is very low. Accurate and precise control of small DC motors can be done effectively and efficiently without using complicated circuitry and costly components.**

Keywords- **Speed Control, micro controller, IR sensor, DC motor, Mosfet, Pulse Width Modulation.**

I. INTRODUCTION

Speed controllers of DC motor are very useful for controlling the robotic motion and automation systems in industry. In this paper controller presented uses the pulse width modulation (PWM) technique for speed control of DC motor. Using ATmega16 microcontroller generate the PWM wave for speed control of DC motor, we need a variable-voltage DC power source to control the speed of the DC motor. When the DC motor is on, it takes certain time to reach at full speed. As soon as the power source is on, the DC motor starts gaining speed and if we switch off the power source before it reaches at rated speed, it starts to goes down. In quick succession of switching on and switching off are done, the motor rotate at a lower speed between zero and rated speed. In this paper we used PWM method so it switches the motor on and off with a pulse wave. The main objective of this paper is to become easy with the implementation of hardware of ATmega16 microcontroller based speed control of DC motor, IRF640N & IRFZ44N MOSFETs are used for motor drive and infrared sensor is used to count the speed, it give senses of occurring overload to the operator at overload condition and speed display on LCD screen. For the required speed the speed controller takes signal represent and to drive a motor at required speed.

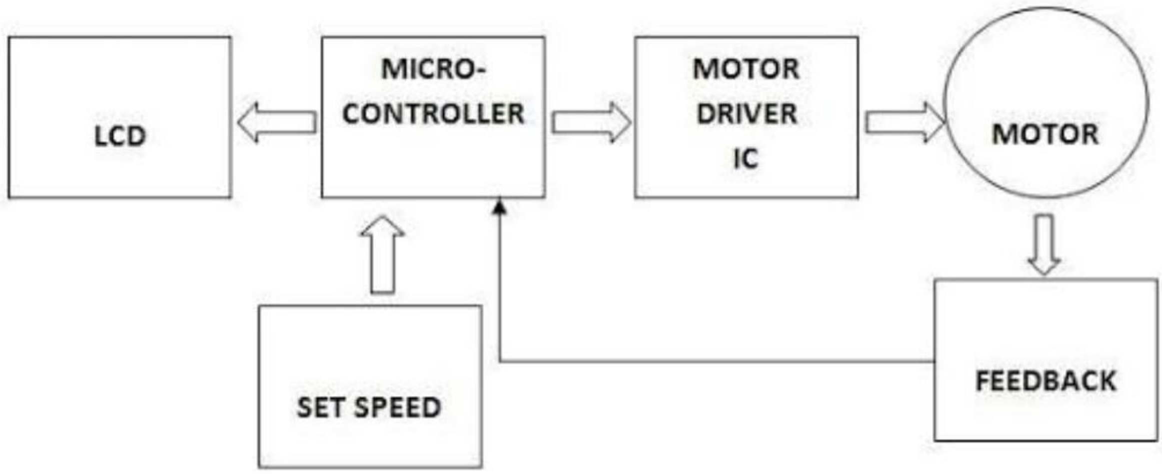

Fig. 1 Block Diagram

II. Methodology

2.1. Pulse Width Modulation:

PWM has many of the characteristics of a control system. A simple method to control the speed of a DC motor is to control driving voltage, when the voltage is high the speed would be high. In many applications normal voltage control would cause lot of power loss on control system, so PWM method is mostly used in DC motor speed control application. When applying PWM controlling method, keep in mind that using a motor is as low pass system. PWM method is the high frequency avoided and we know that large motor is mainly inductive so avoid high frequency, hence will not perform well using high frequencies. This method work on low frequency so lower frequency is better than higher frequency. .We can easily understand by example. On an Off time is referred to as "duty cycle". The figure 2 shows the waveforms of 10%, 50% and 90% duty cycle signal. As we can see in figure 2, for 10% waveform 10% duty cycle signal in on and 90% off while a for 90% waveform 90% duty cycle signal is on and 10% off. These signals are send to motor. The end result of the PWM is that power is send to the motor and it can adjust from 0% to 100% duty cycle with stable control and high efficiency.

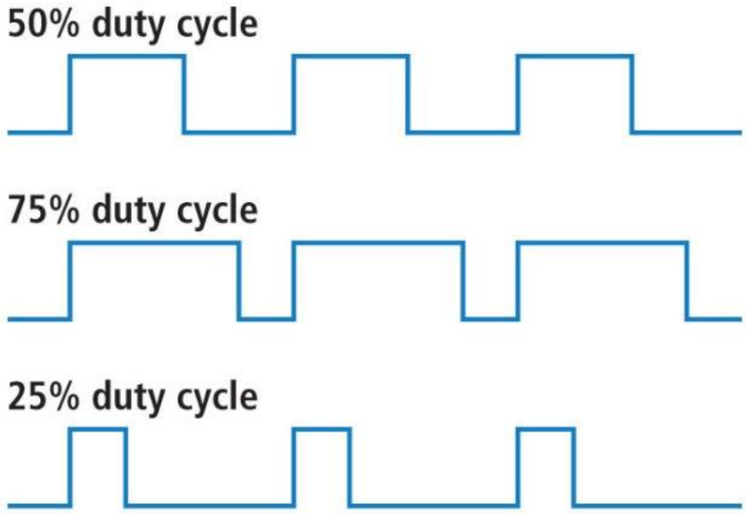

Fig.2 Wave Form at Different Duty Cycle

2.2. Power Supply:

The Power Supply is a Primary requirement for the project work. The required DC power supply for the base unit as well as for the recharging unit is derived from the mains line. For this purpose centre tapped secondary of 12V-012V transformer is used. From this transformer we getting 5V power supply. In this +5V output is a regulated output and it is designed using 7805 positive voltage regulator. This is a 3 Pin voltage regulator, can deliver current up to 800 milliamps. Rectification is a process of rendering an alternating current or voltage into a unidirectional one. The component used for rectification is called 'Rectifier'. A rectifier permits current to flow only during positive half cycles of the applied AC voltage. Thus, pulsating DC is obtained to obtain smooth DC power additional filter circuits required.

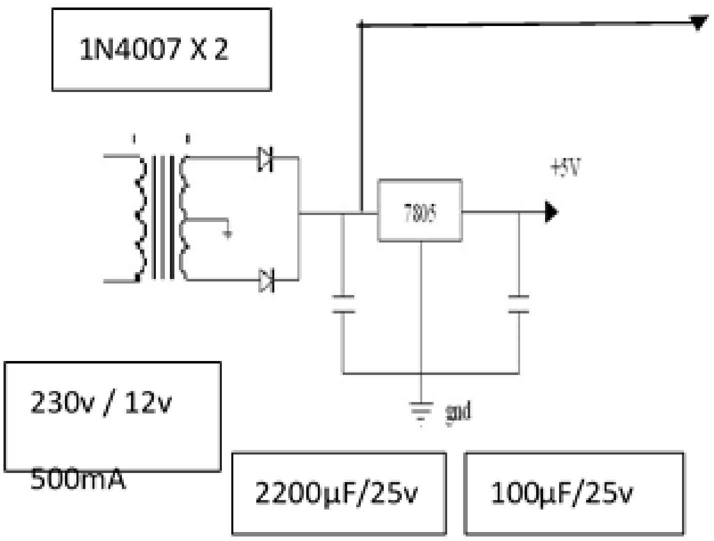

Fig.3 Process Diagram

2.3. Motor and Motor Drive

The purpose of a motor speed controller is to take a signal representing the demanded speed, and to drive a motor at that speed. The controller may or may not actually measure the speed of the motor. If it does, it is called a Feedback Speed Controller or Closed Loop Speed Controller, if not it is called an Open Loop Speed Controller. Feedback speed control is better, but more complicated, and may not be required for a simple robot design. Motors come in a variety of forms, and the speed controller's motor drive output will be different dependent on these forms. The speed controller presented here is designed to drive a simple cheap starter motor from a car, which can be purchased from any scrap yard. These motors are generally series wound, which means to reverse them; they must be altered slightly. Below is a simple block diagram of the speed controller. We'll go through the important parts block by block in detail.

1) The speed of a DC motor is directly proportional to the supply voltage, so if we reduce the supply voltage from 12 Volts to 6 Volts, the motor will run at half the speed. How can this be achieved when the battery is fixed at 12 Volts? The speed controller works by varying the average voltage sent to the motor. It could do this by simply adjusting the voltage sent to the motor, but this is quite inefficient to do. A better way is to switch the motor's supply on and off very quickly. If the switching is fast enough, the motor doesn't notice it, it only notices the average effect.

2) When you watch a film in the cinema, or the television, what you are actually seeing is a series of fixed pictures, which change rapidly enough that your eyes just see the average effect - movement. Your brain fills in the gaps to give an average effect. Now imagine a light bulb with a switch. When you close the switch, the bulb goes on and is at full brightness, say 100 Watts. When you open the switch it goes off (0 Watts). Now if you close the switch for a fraction of a second, and then open it for the same amount of time, the filament won't have time to cool down and heat up, and you will just get an average glow of 50 Watts. This is how lamp dimmers work, and the same principle is used by speed controllers to drive a motor. When the switch is closed, the motor sees 12 Volts, and when it is open it sees 0 Volts. If the switch is open for the same amount of time as it is closed, the motor will see an average of 6 Volts, and will run more slowly accordingly.

3) As the amount of time that the voltage is on increases compared with the amount of time that it is off, the average speed of the motor increases. This on-off switching is performed by power MOSFET. A MOSFET (Metal-Oxide-Semiconductor Field Effect Transistor) is a device that can turn very large currents on and off under the control of a low signal level voltage. For more detailed information, see the dedicated chapter on MOSFET) The time that it takes a motor to speed up and slow down under switching conditions is dependent on the inertia of the rotor (basically how heavy it is), and how much friction and load torque there is. The graph below shows the speed of a motor that is being turned on and off fairly slowly.

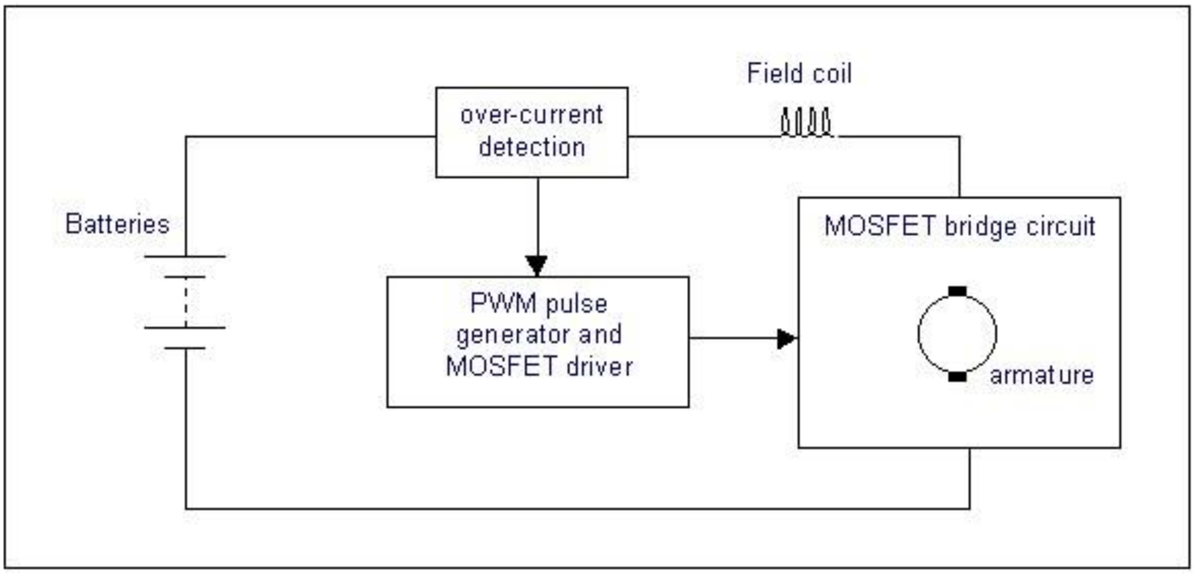

Fig.4 Block Diagram of Speed Controller

2.4. LCD Display:

We will discuss how a 16*2 LCD is interface with ATmega16. 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 data may be latter (A-Z) or number (0-9) or any symbols. LCD display we can see in the figure 7 and its connection need some important components which are given below.

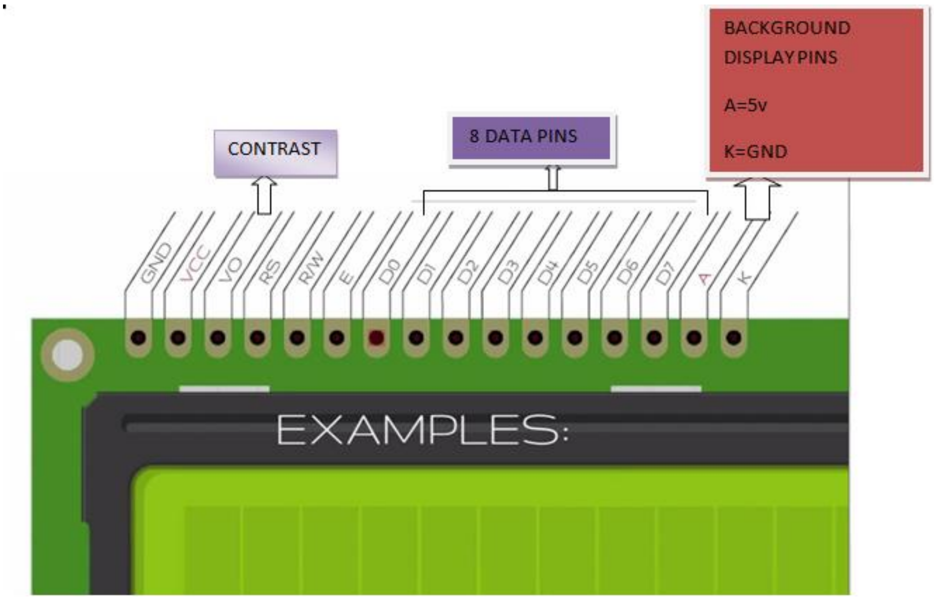

Fig. 5 LCD Display

2.5. ATmega16:

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CSIC microcontrollers.

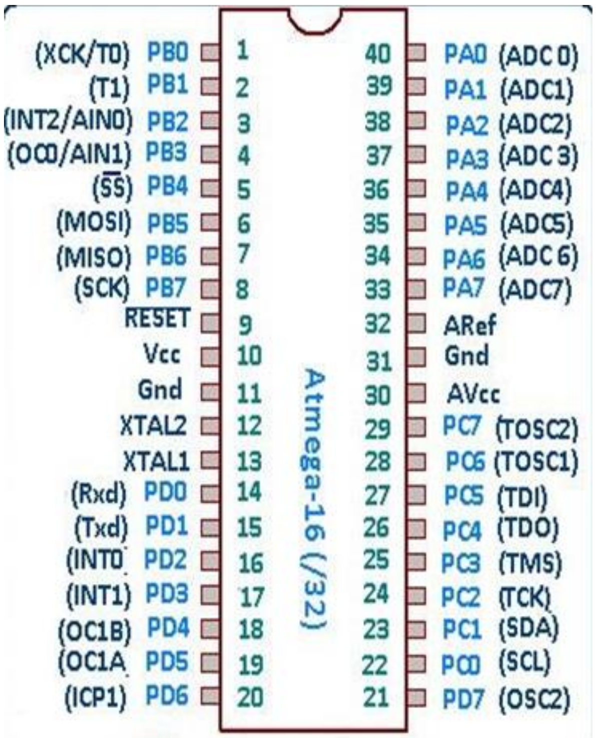

Fig. 6 Pin Diagram of Atmega16

Features of ATmega16:

• High-performance, Low-power Atmel® AVR® 8-bit Microcontroller
• Advanced RISC Architecture
– 131 Powerful Instructions – Most Single-clock Cycle Execution
– 32 x 8 General Purpose Working Registers
– Fully Static Operation
– Up to 16 MIPS Throughput at 16 MHz
– On-chip 2-cycle Multiplier
• High Endurance Non-volatile Memory segments
– 16 Kbytes of In-System Self-programmable Flash program memory
– 512 Bytes EEPROM
– 1 Kbyte Internal SRAM
– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
– Data retention: 20 years at 85°C/100 years at 25°C
– Optional Boot Code Section with Independent Lock Bits
• Peripheral Features
– Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
– One 16-bit Timer/Counter with Separate Prescaler, Compare Mode.
– Real Time Counter with Separate Oscillator
– Four PWM Channels
– 8-channel, 10-bit ADC
– Byte-oriented Two-wire Serial Interface
– Programmable Serial USART
– Master/Slave SPI Serial Interface
– Programmable Watchdog Timer with Separate On-chip Analogue Comparator
• Special Microcontroller Features
– Power-on Reset and Programmable Brown-out detection
– Internal Calibrated RC Oscillator
• External and Internal Interrupt Sources
– Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, and Power-down. Operating Voltages 4.5V - 5.5V for ATmega16
• Speed Grades 0 - 16 MHz for ATmega16
• Power Consumption @ 1 MHz, 3V, and 25°C for ATmega16
– Active: 1.1 mA
– Idle Mode: 0.35 mA

III. Future Scope

DC motor plays a significant role in modern industries. They is widely used in industry because of its low cost, less complex control structure and wide range of speed and torque so better future of this project.

In this project we are used pulse width modulation technique, it is a modern technology in solid state field and it provide smooth speed control of motor.

Now a day PWM technique are using in fuzzy logic control system, so PWM method is very efficient and reliable method to control the speed of motor so it future is also bright in the modern era with fuzzy logic.

IV. Hardware

Below shows hardware schematic diagrams in which step wise figure are mentioned with output result of power supply is also mentioned.

Components required:

1. ATmega16 microcontroller
2. 16*2 LCD display
3. IRF640N & IRFZ44N Mosfet
4. IR sensor
5. Variable Resister 10K

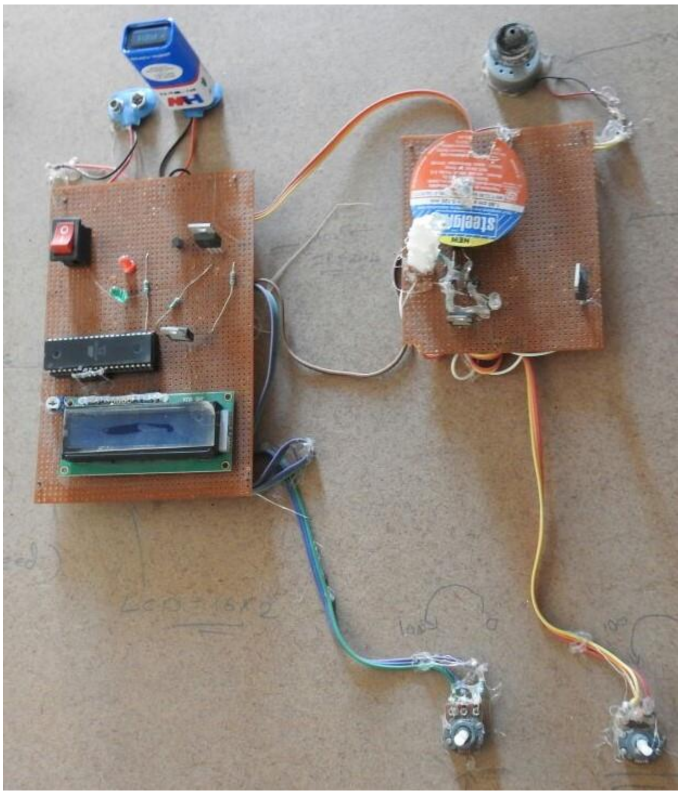

Fig. 7 Bread board connection diagram during implementation of project

In figure shows the bread board connection during implementation of project, all the components are interconnected on board first and then run motor after run we have measure speed of the motor shaft then at no load speed motor give 100% output and when the motor decrease the speed after apply the load on the shaft of motor the speed starts decrease and it reaches below the set value of motor speed then microcontroller generate pulse width modulation signal it gives to the motor driver and it increases the voltage of the source and motor regain their speed at desired.

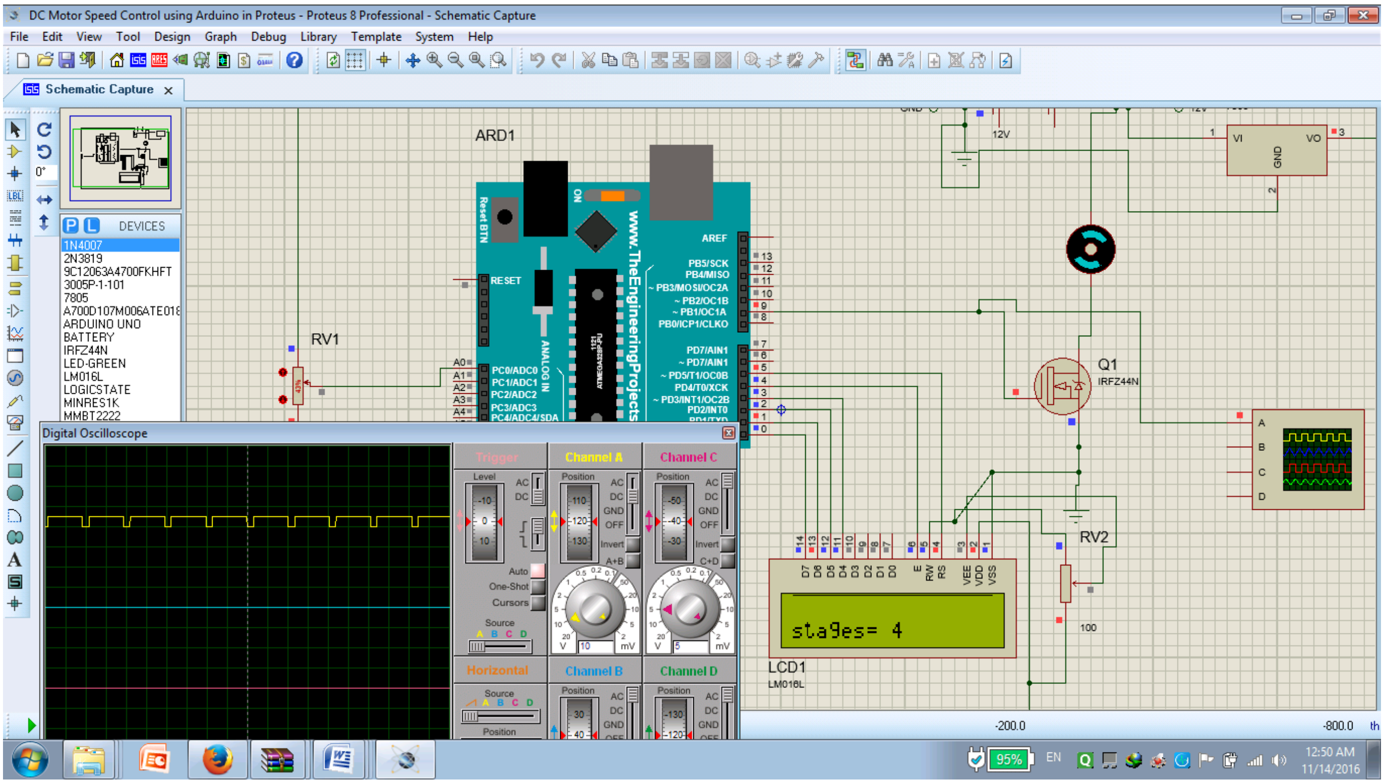

Fig.10 Simulation Result from Proteus

V. Conclusion

We have designed fixed speed control system for DC motor, which has reliability, precision and adaptability for different system ratting with response. It means the motor will run at fixed speed at any load condition. When amount of load is applied the speed does not vary and software is made according to the requirement of speed control. This designed system and implemented automatic speed control system of DC motor, it control the speed of DC motor by using PWM method.

VI. Referance

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