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Speed Control of 2-Pole DC Motor using PWM Proteus VSM 7.9 & AVR STUDIO (Software)

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Abstract

The project reveals speed control of DC motor using PWM technique. In present days the power semiconductor devices have completely revolutionized the control of drives especially in the area of control usage of thyristors igbt's power MOsFET etc. was increased. The digital circuit can be interfaced to microcontroller. So that speed can be controlled by Microcontroller. This project is mainly concerned on design and implementation of bidirectional dc motor speed by using microcontroller ATmega16 and PROTEUS VSM software. Through the keypad we can achieve any speed at the time of running & also in initial starting period. Pulse Width Modulation (PWM) technique is used which is generated using microcontroller Atmega16 the PWM signal generated will drive the motor driver circuit. By varying the duty cycle the voltage across the motor is varied. PROTEUS VSM software is used to provide a graphic user interface (GUI) for the user.
Keywords: ATmega16, DC MOTOR, LCD 16*2, MOTOR DRIVER L293D, PWM

I. INTRODUCTION

Speed control means intentional change of the drive speed to a value required for performing the specific work process. Through this concept we can control speed of a motor on its running condition. Speed control is a different concept from speed regulation where there is natural change in speed due change in load on the shaft. Speed control is either done manually by the operator or by means of some automatic control device. In the past, speed controls of dc drives are mostly mechanical and requiring large size hardware to implement. The development has launched these drives back to a position of formidable relevance, which were hitherto predicted to give way to ac drives. Some important applications are: rolling mills, paper mills mine winders, hoists, machine tools, traction, printing presses, and textile mills. Through this work we can bring motor speed in any rpm with the help of setting counter through keypad.

II. COMPONENT & OVERVIEW

A. *Speed control methods in a DC motor:*

The motor speed can be controlled by controlling armature voltage and armature current. It is obvious that speed control is possible by varying Flux per pole, Φ (Flux control), resistance Ra of armature circuit (Rheostat Control) ,applied voltage V (Voltage Control). The above methods have some demerits like a large amount of power is wasted in the controller resistance. Hence, efficiency is decreased. It needs expensive arrangement for dissipation of heat produced in the controller resistance. It gives speeds below the normal speed. By these data that are acquainted we can draw a conclusion that these electric and electromechanical methods are less adaptive so electronic techniques are used for speed control. These methods provide higher efficiency, greater reliability, quick response, higher efficiency. One such technique is Pulse Width Modulation (PWM). We apply this technique in our project so as to control the speed of the DC motor.

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B. 2-Pole Permanent Magnet Motor:

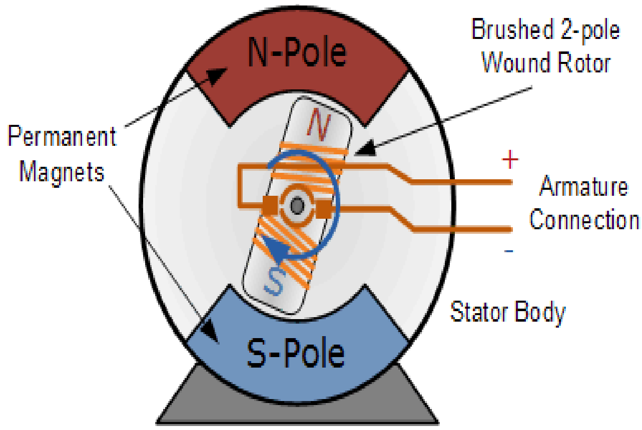

Fig. 1: Two Pole Permanent Magnet Motor

The magnetic field produced by the stator's permanent magnets is fixed and therefore cannot be changed but if we change the strength of the armatures electromagnetic field by controlling the current flowing through the windings more or less magnetic flux will be produced resulting in a stronger or weaker interaction and therefore a faster or slower speed. Then the rotational speed of a DC motor *(N)* is proportional to the back emf *(V_b)* of the motor divided by the magnetic flux (which for a permanent magnet is a constant) times and electromechanical constant depending upon the nature of the armatures windings *(K_e)* giving us the equation of: $N \propto V/K_e\phi$

C. Controller Overview

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.

D. Pulse Width Modulation

PWM is a very efficient way of providing intermediate amounts of electrical power between fully on and fully off. A simple power switch with a typical power source provides full power only, when switched on. PWM is a comparatively recent technique, made practical by modern electronic power switches. The microcontroller, ATmega16 has four PWM Channels. Among them, timer/counter 0 and 2 are featured with PWM. We have used timer/counter0 (8-bit) to generate PWM for varying the speed of DC motor. We used fast pwm mode. Again, it has 2 different mode of operation-inverted and non-inverted mode. Inverted mode is used here.

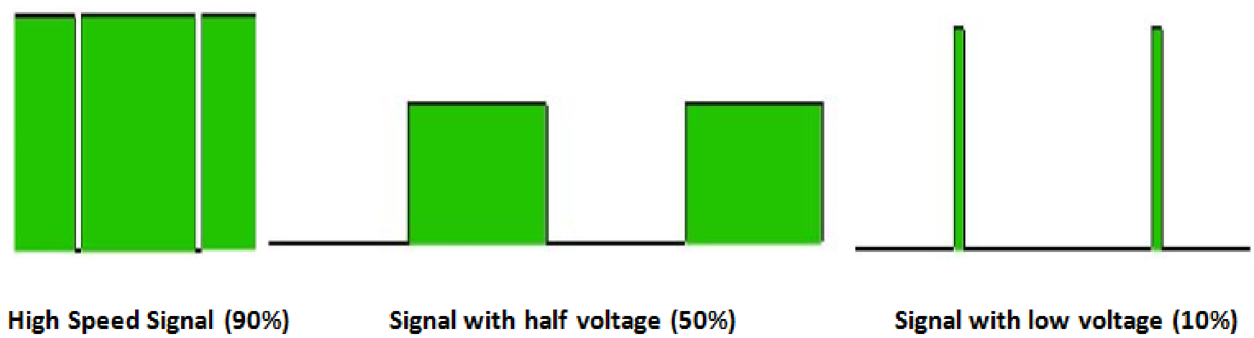

Fig. 2: Pwm Diagrammatic Representations

E. Modes of Operation[2]:

The mode of operation, i.e., the behavior of the Timer/Counter and the Output Compare pins, is defined by the combination of the Waveform Generation mode (WGM01:0) and Compare Output mode (COM01:0) bits. The Compare Output mode bits do not affect the counting sequence, while the Waveform Generation mode bits do. The COM01:0 bits control whether the PWM output generated should be inverted or not (inverted or non-inverted PWM). For non-PWM modes the COM01:0 bits control whether the output should be set, cleared, or toggled at a compare match.

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F. Fast PWM Mode [2]

The fast Pulse Width Modulation or fast PWM mode (WGM01:0 = 3) provides a high frequency PWM waveform generation option. The fast PWM differs from the other PWM option by its single-slope operation.

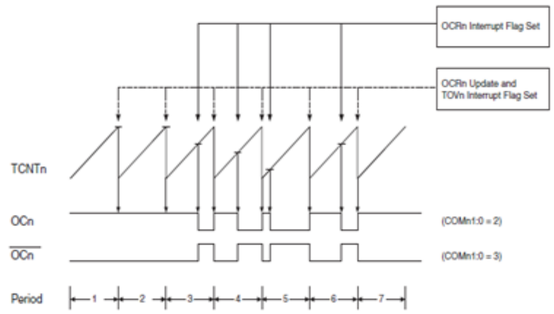

Fig. 3: Fast PWM Mode, Timing Diagram

The counter counts from BOTTOM to MAX then restarts from BOTTOM. In non-inverting Compare Output mode, the Output Compare (OC0) is cleared on the compare match between TCNT0 and OCR0, and set at BOTTOM. In inverting Compare Output mode, the output is set on compare match and cleared at BOTTOM. Due to the single-slope operation, the operating frequency of the fast PWM mode can be twice as high as the phase correct PWM mode that uses dual slope operation. This high frequency makes the fast PWM mode well suited for power regulation, rectification, and DAC applications. High frequency allows physically small sized external components (coils, capacitors), and therefore reduces total system cost. In fast PWM mode, the counter is incremented until the counter value matches the MAX value. The counter is then cleared at the following timer clock cycle. The timing diagram for the fast PWM mode is shown in Figure 1. The TCNT0 value is in the timing diagram shown as a histogram for illustrating the single-slope operation. The diagram includes non-inverted and inverted PWM outputs. The small horizontal line marks on the TCNT0 slopes represent compare matches between OCR0 and TCNT0.

III. EQUATION

Counter Between 0 – 255
0= 0%, 255= 100%
The Function sets the duty cycle of pwm output generated on OC0 PIN. The average voltage on this output pin will be
$V_{out} = \frac{duty}{255} V$; Duty=maximum count, V=supply voltage, VOUT =Terminal voltage
The average voltage at output is given by Va= $1/T \int V0 dt = t1/T\, Vs = (f\times t1)\, Vs \quad (f=1/T) \quad = kVs \; (k=f\times t1)$
The rms value of output voltage is $V0 = (i/T \int V0^2 dt)^{1/2} = k\, Vs$
The output power and is given by $P = 1/T \int V0 \times i\, dt = 1/T \int V0^2/R\, dt = kVs^2/R$
T is the total time period =t1+t2,
k = t1/T is the duty cycle, R=Resistance.

IV. RESULTS & DISCUSSION

Through this work we can control speed of motor on it running time. Also we can change speed from any speed to any required speed without going in sequential way.

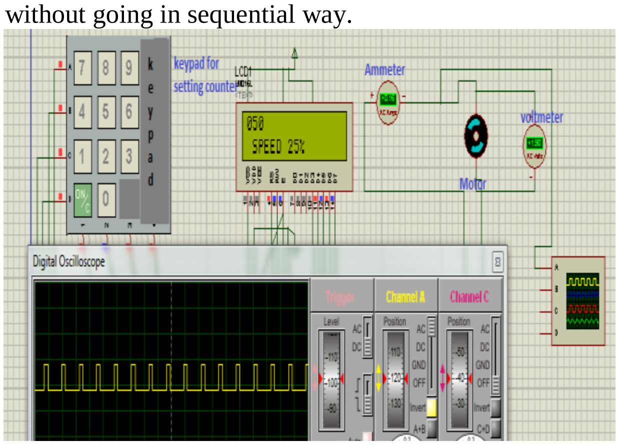

Fig. 4: SPEED 25%

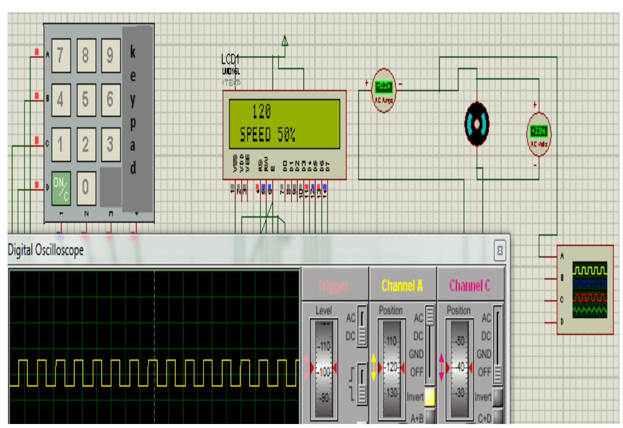

Fig. 5: SPEED 50%

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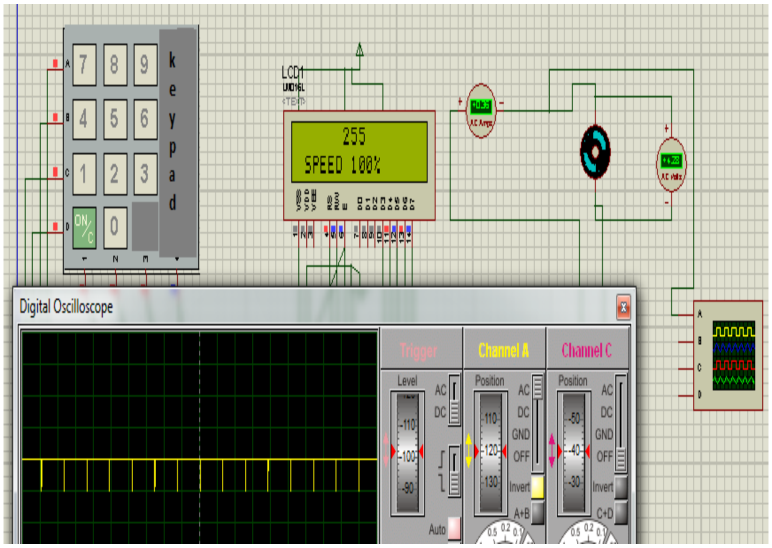

Fig. 6: SPEED 100%

V. CONCLUSION

The microcontroller based speed control of dc motor has been introduced. Controlling a permanent magnet DC motor by setting PWM counter which finally result in change in duty cycle. The system will be made user friendly so that anybody can operate the system without any trouble. LCD display will used to show the information of the system. Knowing the required speed user can change the amount of duty cycle if necessary.

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