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DC MOTOR SPEED CONTROL USING PWM TECHNIQUE

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ABSTRACT

In Industry DC motor is widely uses for speed control and load characteristics, it's easy controllability provide effective and precise output. So, application of DC motor is large for commercial purpose. Speed control of DC motor is very crucial in application where required speed is precision and correcting signal representing and to operate motor at constant speed, so we used PWM method which are full fil all requirements to speed control of DC motor. PWM based speed control system consists of electronic components (integrated circuit, Potentiometer etc.) In this Project 555 timer (NE55P) is being operated in a stable mode, which produce a continuous HIGH and LOW pulses. The 555 Timer is capable of generating PWM signal when set up in an astable mode. In this mode, the 555 IC can be used as a pulse width modulator with a few small adjustments to the circuit. The frequency of operation of the circuit is provided by the passive parameters of resistances and capacitors attached to it. The speed control of DC motor is important in applications where precision and protection are of essence. The variable speed drives, till a couple of decades back, had various limitations, such as poor efficiencies, larger space, lower speeds, etc., However, the advent power electronic devices such as power MOSFETs, IGBTs etc., and today we have variable speed drive systems which are not only in the smaller in size but also very efficient, highly reliable and meeting all the stringent demands of various industries of modern era. Direct currents (DC) motors have been used in variable speed drives for a long time. The versatile characteristics of dc motors can provide high starting torques which is required for traction drives. Control over a wide speed range, both below and above the rated speed can be very easily achieved. The methods of speed control are simpler and less expensive than those of alternating current motors. There are different ways of speed control of motors but, each has its own limitations and PWM technique is more efficient and cheap speed control method.

Keywords: *555 timer IC, diodes, capacitors, DC motor, battery*.

I. INTRODUCTION

DC motors continue to be the best solution for many industrial applications, particularly those requiring constant torque across the motor's entire speed range. The ease of controlling motor speed was a big part of their usage, several other DC motor characteristics make them the best choice in certain applications. DC motors develop full torque at low speed and across the full operating range from zero to base speed. This makes DC motors a good choice for driving constant-torque loads – such as conveyor belts, elevators, cranes, ski lifts, extruders and mixers. These applications are often stopped when fully loaded, and the full torque of the DC motor at zero speed gets them moving again without the need for over sizing. DC motors have a higher power density and are, therefore, smaller than an equivalent AC motor. They have no field coil in the stator, so the field coil space is saved, reducing the overall motor size. This becomes a substantial benefit in some space-constrained applications There are multiple ways to adjust the speed of a DC Motor manually. The simplest way to achieve this is with the help of a variable resistor i.e. we can adjust the speed of a DC Motor by using a variable resistance in series with the motor. But this method is usually not used for two reasons. The first reason is energy wastage i.e. the resistor dissipates energy as heat. The second reason is if we want to use any devices like microcontrollers or any other digital equipment for automating our DC Motor speed control, then this method cannot be used. A more efficient way to proceed is by using Pulse Width Modulation technique to Control the speed of our DC motor.

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II. LITERATURE SURVEY

The existing methods of DC motor speed control are through varying supply voltage or varying field flux with an external resistance in field circuit or varying armature voltage with a series armature resistance. But, these methods have, many drawbacks like more energy is being wasted in resistors. So, there is a need to look out for new methods of speed control of DC motors. Although, the equipment used for controlling only changes but, the method doesn't change. One of the power electronic methods that can be useful in speed control of DC motors is the PULSE WIDTH MODULATION (PWM) [6] technique. In this project, we implemented PWM technique to control the speed of DC motor, using a 555 IC timer and a mosfet [10]. PWM technique needs two independent waveforms viz, message wave and carrier wave, to give required output and to perform control. The 555 timer output pulses are changed by a potentiometer and are used as carrier waves and the supply voltage to the DC motor [9] is used as the message wave.

This technique eliminates the major drawbacks that are present in the conventional methods of speed control like the energy wastage and inaccuracy, slow operation, less efficiency etc. this method has many advantages including the scope to use the circuit for automated operations, high efficiency, accurate speeds can be achieved, quick responsive circuit etc. With more and better modifications, this method of speed control of DC motors can be made to be used in industrial applications and other places where speed control plays an important role. 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's future bright in the modern era with fuzzy logic.

III. DC MOTOR VOLTAGE CONTROL METHODS

- MULTIPLE CONTROL VOLTAGE:

In this method, the shunt field of the motor is connected permanently to a fixed exciting voltage but the armature is supplied with different voltages by connecting it across one at the several different voltages by means of suitable switchgear. The armature will be approximately proportional to these different voltages. The intermediate speeds can be obtained by adjusting the shunt field regulator.

- WARD-LEONARD SYSTEM:

This system is used where an unusually wide (up to 10:1) and very sensitive speed control is required as for colliery winders, electric excavators and the main drives in steel mills and blooming in paper mills.

The field of the motor (M1) is permanently connected across the DC supply lines whose speed control can be done. The other motor M2 is directly connected to Generator G. The output voltage of G is directly is fed to the main motor M1. The voltage of generator can be varied from zero to up to its maximum value by means of field regulator. By reversing the direction of the field current of G by means of the reversing switch which RS, generated voltage can be reversed and hence the direction of rotation of M1. It should be remembered that motor set always runs in the same direction. The addition of a flywheel whose function is to reduce fluctuations in the Power demand from the supply circuit. The chief advantage of system is its overall efficiency especially at right loads. It has the outstanding merit of giving wide speed Control from maximum in one direction through zero to the maximum in the opposite direction and of giving a smooth acceleration.

- PWM TECHNIQUE:

Pulse width modulation control works by switching the power supplied to the motor on and off very rapidly. The DC voltage is converted to a square wave signal, alternating between fully on (nearly 12v) and zero, giving the motor a series of power "kicks". Pulse width modulation technique (PWM) is a technique for speed control which can overcome the problem of poor starting performance of a motor [1]. PWM for motor speed control works in a very similar way. Instead of supplying a varying voltage to a motor, it is supplied with a fixed voltage value (such as 12v) which starts it spinning immediately. The voltage is then removed and the motor 'coasts. By continuing this voltage on/off cycle with a varying duty cycle, the motor speed can be controlled.

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IV. PULSE WIDTH MODULATION

Pulse-width modulation (PWM) or duty-cycle variation methods are commonly used in speed control of DC motors. The duty cycle is defined as the percentage of digital 'high' to digital 'low' plus digital 'high' pulse-width during a PWM period. Fig.2.7 shows the 5V pulses with 0% through 100% duty cycle. The average DC Voltage value for 0% duty cycle is zero; with 20% duty cycle the average value is 1.2V (20% of 5V). With 50% duty cycle the average value is 2.5V, and if the duty cycle is 80%, the average voltage is 4V and so on. The maximum duty cycle can be 100%, which is equivalent to a DC waveform.
Thus, by varying the pulse-width, we can vary the average voltage across a DC motor and hence its speed.

The average voltage is given by the following equation: ý = D. Ymax + (1- D) Ymin But usually minimum equals zero so the average voltage will be: ý = D. Ymax The circuit of a simple speed controller for a mini DC motor, such as that used in tape recorders and toys, is shown

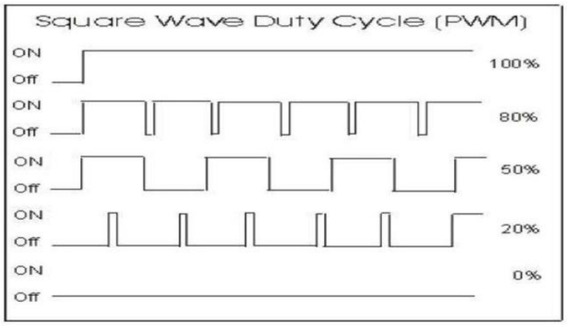

Figure 1: Voltages of various Duty cycles

V. DC MOTOR SPEED CONTROL USING PWM METHOD

The major reason for using pulse width modulation in DC motor control is to avoid the excessive heat dissipation in linear power amplifiers. The heat dissipation problem often results in large heat sinks and sometimes forced cooling. PWM amplifiers greatly reduce this problem because of their much higher power conversion efficiency. Moreover, the input signal to the PWM driver may be directly derived from any digital system without the need for any D/A converters. The PWM power amplifier is not without disadvantages. The desired signal is not translated to a voltage amplitude but rather the time duration (or duty cycle) of a pulse. This is obviously not a linear operation [3]. But with a few assumptions, which are usually valid in motor control, the PWM may be approximated as being linear (i.e., a pure gain). The linear model of the PWM amplifier is based on the average voltage being equal to the integral of the voltage waveform. Thus VS * Ton = Veq * T Where VS = the supply voltage (+12 volts) Ton = Pulse duration Veq = the average or equivalent voltage seen by the motor T = Switching period (1/f) The recommended switching frequency is 300Hz. The switching frequency (1/T), is determined by the motor and amplifier characteristics. The control variable is the duty cycle which is Ton / T. The duty cycle must be recalculated at each sampling time. The voltage of the motor is Veq. which is equal to the duty cycle times the supply voltage.

Block diagram
Pulse width modulation control works by switching the power supplied to the motor on and off very rapidly. The DC voltage is converted to a square wave signal, alternating between fully on (nearly 12v) and zero, giving the motor a series of power "kicks". Pulse width modulation technique (PWM) is a technique for speed control which can overcome the problem of poor starting performance of a motor.

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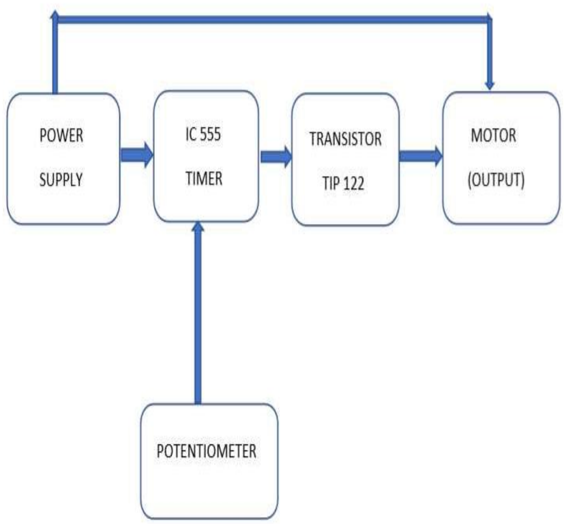

Figure 2: Block diagram of proposed Project

PWM for motor speed control works in a very similar way. Instead of supplying a varying voltage to a motor, it is supplied with a fixed voltage value (such as 12v) which starts it spinning immediately.

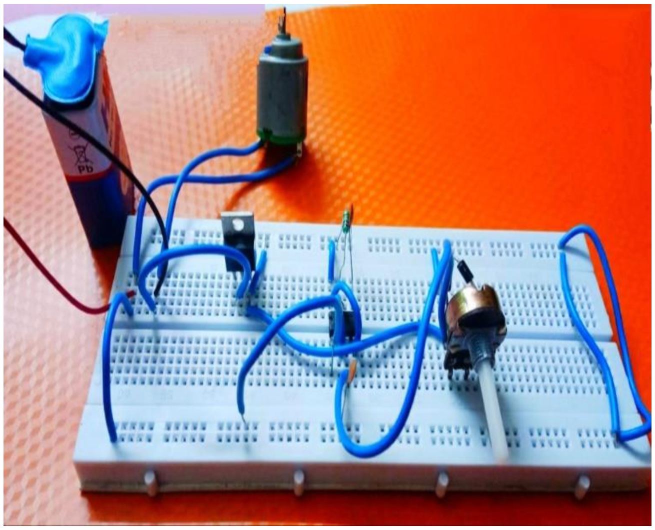

Figure 3: Hardware Implementation DC motor control using PWM Technique

The voltage is then removed and the motor coasts. By continuing this voltage on/off cycle with a varying duty cycle, the motor speed can be controlled. In wave form, the signal has a mark space ratio of 1:1, with the signal at 12v for 50% of the time, the average voltage is 6v, so the motor runs at half its maximum speed.

In wave form, the signal has mark space ratio of 3:1, which means that the output is at 12v for 75% of the time. This clearly gives an average output voltage of 9v, so the motor runs at 3/ 4 of its maximum speed.

VI. RESULTS AND FUTURE SCOPE

The speed control of the DC Motor is achieved successfully using PWM method of control. Various speeds are obtained by varying the resistance of the potentiometer thus, changing the pulse width of the 555 IC output pulses and the input voltage to the Dc Motor. The dc motor speed is controlled by using power electronic device, hence feasible to use in many high-power applications. The speed pulse train will be based on required input speed. This circuit is useful to operate the dc motors at required speed with very low losses. The circuit response time is fast. Hence high reliability can be achieved. The designed circuit was tested for various speed inputs satisfactorily. The method has a good scope ahead. We found out that this is very cheap and efficient speed control method where all components give reliable operation and we have checked it experimentally where the efficiency of rheostatic method is better than the PWM control method.

VII. CONCLUSION

The dc motor speed is controlled by using power electronic device and the PWM method is used to control the speed of dc motor. The speed of pulse trains will be based on required input speed. This circuit is useful to operate the dc motors at required speed with very low losses and low cost, this proves that this method is better and efficient than existing methods of speed control. The circuit response is fast. Hence high reliability can be achieved. The designed circuit was tested for various speed inputs satisfactorily. This method is already employed in traction system and due to its better advantages than conventional methods of speed control, it has a good scope ahead.

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