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Arduino Based Speed Control of DC Motor by Using LabVIEW

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ABSTRACT - Speed of a DC motor varies proportional to the input voltage. With a fixed supply voltage the speed of the motor can be changed by switching the supply on and off so frequently that the motor notices only the average voltage effect and not the switching operation. This project focuses on controlling the speed of a DC motor using PWM technique. The project basically consists of Arduino and motor driver, thermal sensor, current sensor. The program is written in LabVIEW to take the input values from the user, then rotates the motor by varying duty cycle pulse on the motor. Arduino along with LabVIEW are used to create the virtual instrument for designing a real time embedded controller for controlling the speed of a DC motor in an open loop control system.

KEYWORDS: Arduino, PWM, LabVIEW

I. INTRODUCTION

DC Motor plays a crucial role in research and laboratory experiments because of their simplicity and low cost. The speed of the motor can be controlled by three methods namely terminal voltage control, armature rheostat control method and flux control method. Here in this project terminal voltage control method is employed. 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 techniques available for the speed control of DC motors. The phase control method is widely adopted, but has certain limitations mainly it generates harmonics on the power line and it also has got p.f. when operated lower speeds. The second method is PWM technique, which has got better advantages over the phase control.

II. LITERATURE REVIEW

Motor control are realized with two approaches: Hardware and Software through the application of Visual Basic (VB). A permanent magnet moving coil dc motor adjustable speed drive control is implemented with hardware setup and software program in Visual Basic code. The main feature used in Hardware and Software is their peripherals (parallel port peripherals) are used to interface with hardware and software medium like simulation. We have connected the hardware with the 32 bit parallel port cable to the CPU. As we increase the load on the DC motor the voltage of the Driver circuit decreases, which leads the connected LEDs to glow showing that we have reached to the peak value of the motor RPM. The output of the given system is achieved from the GUI of the LABVIEW; the coding is done in the Visual Basic.

The DC Motor is an attractive piece of equipment in many industrial applications requiring variable speed and load characteristics due to its ease of controllability. Speed of a DC motor varies proportional to the input voltage. With a fixed supply voltage the speed of the motor can be changed by switching the supply on and off so frequently that the motor notices only the average voltage effect and not the switching operation. This paper focuses on controlling the speed

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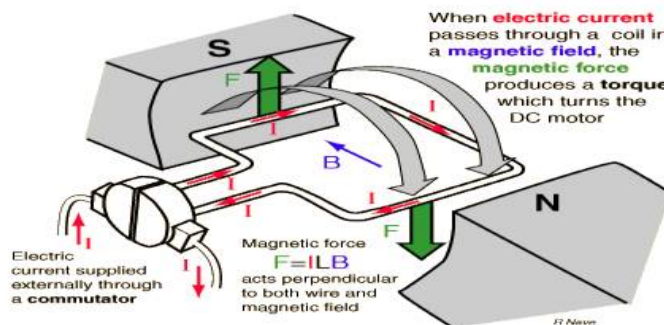
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and direction of a DC motor using PWM technique (varying duty cycle of a square wave) and Data Acquisition Systems. DAQ card along with LabVIEW are used to create the virtual instrument for designing a real time embedded controller for controlling the speed and direction of a DC motor.

III. METHODOLOGY

DC motor:

A DC motor is a machine that converts electrical energy into mechanical energy. The operation is based on simple electromagnetism, i.e. "when a current carrying conductor is placed in an external magnetic field it experiences a force which is proportional to the current and the external magnetic field." A torque is generated by the magnetic reaction and the armature revolves and this induces a voltage in the armature windings which is opposite in direction to the outside voltage applied to the armature, when current is passed through the armature of the DC motor, and hence is called back voltage or counter e.m.f. The back voltage rises till it becomes equal to the applied voltage as the motor rotates faster, the speed at which the DC motor rotates depends on two factors - the armature current as well as the strength of the magnetic field acting on the armature. The stronger the field, the slower is the rotation rate required to produce a back voltage huge enough to counteract the applied voltage. Hence, the speed of the DC motor can be controlled by varying the field current. Every DC motor consists of six parts: axle, stator, rotor, commutator, field magnet and brushes. The stator holds the motor casing as well as the two permanent magnets which help to generate the external magnetic field. The rotor rotates with respect to the stator; it has windings which are electrically connected to the commutator.



DC motor working principle.

IV. BLOCK DIAGRAM

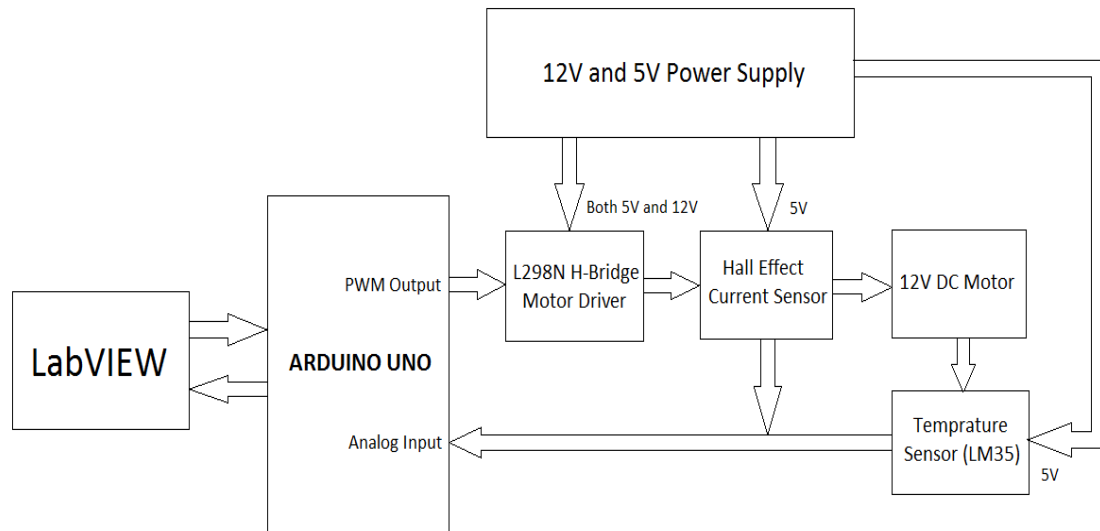
Below figure shows block diagram of speed control of DC motor using LabVIEW. This project is divided into two sections. First is controlling and another is showing real time parameters (Current and Temperature) on LabVIEW. Arduino UNO is used for controlling motor. Arduino is basically a microcontroller which has several inputs and outputs. By interfacing LabVIEW and Arduino we give instructions to Arduino as well as we read analog data from Arduino. The PWM output of Arduino is given to H-Bridge motor driver (L298N). By controlling the PWM output of the Arduino in LabVIEW we control the speed of the DC motor. The Hall Effect current sensor is connected in series with the motor to measure current and a temperature sensor is used to read the temperature of the motor. The outputs of both sensors are in analog, these analog signals are read by Arduino and these parameters are shown on LabVIEW. The power required for the motor driver and sensors is provided by 12V and 5V power supply.

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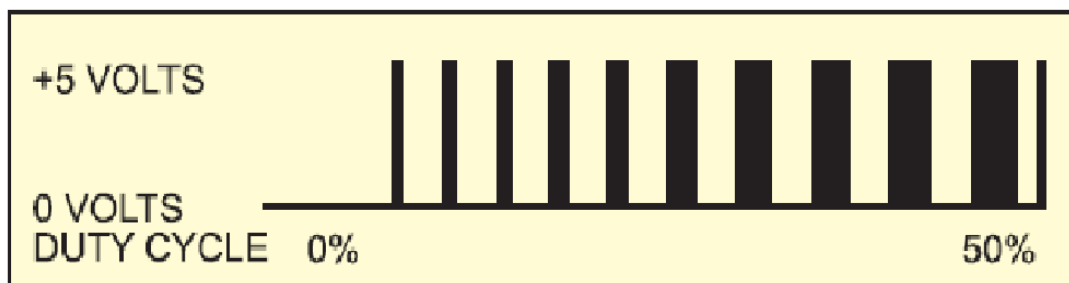
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PWM Technique:



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.

5V Pulses With 0% Through 50% Duty Cycle

The average DC voltage value for 0% duty cycle is zero; with 25% duty cycle the average value is 1.25V (25% of 5V). With 50% duty cycle the average value is 2.5V, and if the duty cycle is 75%, the average voltage is 3.75V 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.

V. HARDWARE DESCRIPTION

Arduino Uno:

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino are able to read input light on a sensor, a finger on a button, activating a motor, turning on an LED, publishing something online. The arduino uno is microcontroller board based on ATmega328(datasheet).it has 14 digital input/output,16 MHz ceramic resonator,a USB connection, power jack and ICSP header and reset pin.it contains everything needed to support the microcontroller.

H-Bridge Driver (L298N):

An H-bridge an electronic circuit that enables a voltage to be applied across a load in either direction H-Bridges are typically used in controlling motors speed and direction, but can be used for brake the motor. An H-Bridge is a circuit

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that can drive a current in either polarity and be controlled by Pulse Width Modulation (PWM). Pulse Width Modulation is a means in controlling the duration of an electronic pulse.

Temperature Sensor(LM35):

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade). LM35 measure temperature more accurately than a using thermister.it can generates a higher output voltage than thermocouple and may not require that the output voltage be amplified. the operating temperature range from -55 to +150°C The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

Hall Effect Current Sensor(ACS712):

The device consists of a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which the Hall IC converts into a proportional voltage. Device accuracy is optimized through The Allegro ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. Typical applications include motor control, load detection and management, switchmode power supplies, and overcurrent fault protection.

VI. SOFTWARE DESCRIPTION

LabVIEW:

Laboratory virtual instrument engineering workbench is a system design platform and development environment for a virtual programming language from national instrument.the programming language usrd in LabVIEW is 'G' is adataflow programming language. LabVIEW development system is spreading out in industry, research fields, controls and monitoring designs, automatic measurement systems, machine controls, robotics. LabVIEW is system engineering software for applications that require test, measurement and control with rapid access to hardware and data insights.

VII. ADVANTAGES

- 0 In this method absence of rheostatic control hence power loss is negligible.
- 0 By using this method we can control many motors via central arduino.
- 0 Due to LabVIEW we can control as well as displaying various parameters related to speed, armature current and temperature.
- 0 In this method we can control above as well as below rated speed of motor.
- 0 We can control many motors with different speed and different temperature.

VIII. CONCLUSION

Concluding the project we can say that the speed of dc series motor is controlled by PWM technique along with the Arduino interfacing. Multiple motor control is achieved by L298N via Arduino and LabVIEW. LabVIEW provides better interface with the dc series motor, Arduino and L298N.one more additional advantage of LabVIEW is that it can be used as displaying as well as controlling device in system.

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