CLOSE LOOP SPEED CONTROL OF DC MOTOR USING LABVIEW

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ABSTRACT

Software interface for carrying out various electrical operations are finding more and more scopes in present day industry. Automatic speed control of a motor has vital importance as it finds its application in various fields like traction, locomotives, robotics, machine design etc. Thus, there is a great need for designing of a speed control scheme which provides optimum result in term of efficiency and automation. In this paper, an efficient and easy scheme to control and monitor the speed of a dc motor is illustrated. PWM technique is used to control the supply voltage, thus the scheme employs voltage control method for controlling the speed. The scheme is implemented using PIC16F887 and LabVIEW software, which will monitor and control the speed according to the user defined input value. Speed and PWM inputs are continuously displayed using a RG1602A V2.0 display. Thus, this methodology also provides a detailed information of speed controlling.

Keywords: *LabVIEW, Speed Control, DC Motor, Close loop Control, PWM*

1. INTRODUCTION

Conventional speed control methods for dc motors using additional resistance consume more power, thus are less efficient. This enhanced development in the field of electronic control of dc machine using various electronic and power electronic devices. Losses due to these devices are negligible thus efficiency of operation is high.

With the introduction of Internet of Things (IOT), stress is given on automation of various electrical operations with the help of software interface. This paper proposes an automatic speed control method of a dc motor. The speed of the motor varies as per the set value given to the interfacing software. It utilizes a close loop control of speed. The feedback is the measured speed value. This measured speed value is compared with the given set value which acts as reference. Now as per the requirement, the pulse width is either increased or decreased to obtain required voltage control at the supply. This scheme employs the voltage control method for regulating the speed of the motor.

The monitoring and controlling of the speed of DC motors through automation is necessary in industries [1]. Efficient and swift operation of speed control mechanism is of utmost importance in the present scenario. Close loop control of speed provides optimal speed control of a motor. The scheme illustrated in this paper uses LabVIEW as a system tool interface with PIC16F887 microcontroller.

2. EXISTING METHODS USING LABVIEW FOR SPEED CONTROL OF DC MOTOR

The use of ARDUINO and LabVIEW for controlling the speed of a SEDC motor has been nicely illustrated by Dr. Chemsa Ali in his paper [2]. This method used a PID controller for close loop control of the motor using LabVIEW. Pratap Vikhe et. al presented speed control of DC motor using PWM technique using LabVIEW [3]. R. Ranjani presented a method for the same using PID control by PWM using LabVIEW and My DAQ card [4]. S. Muruganandhan put forwarded an open loop speed control scheme for DC motor using NI ELVIS DAQ card with LabVIEW. They used chopper circuit for PWM technique [5].

3.VARIOUS TECHNIQUES USED IN THE MECHANISM

3.1 PWM: -

PWM is a technique that can control the power supply to the loads (in this case motor). The electrical signal is chopped into some discrete parts by controlling the switch ON and OFF at a very fast rate; thereby controlling the power applied to the motor. By changing or modulating the timing of these pulses, the speed of the motor can be controlled i.e. the longer the pulse is "ON", the faster the motor will rotate and likewise, the shorter the pulse is "ON" the slower the motor will rotate.

3.2 Duty Cycle: -

Duty Cycle is the fraction of time in which the system remains active (during on period) to the total time period of applied signal. A period is the combination of complete ON-OFF cycle Duty cycle (%) may be expressed as:

$$D=((PW/T) *100)\%$$

Where D is the duty cycle, PW is the pulse width (pulse active time), and T is the total period of signal.
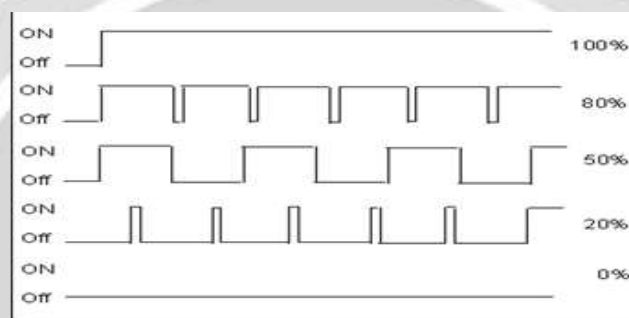

Fig-1: Square Wave Duty Cycle (PWM)

3.3 Transistor as a switch: -

The bipolar transistor can be operated as "ON/OFF" type switch by biasing the base terminal of the transistor and operating the transistor in cut-off region and saturation region. The transistor can be made to operate in Cut-Off region by applying a zero-input base current which results in maximum depletion layer, therefore not allowing the current to flow and the transistor is said to be switched "Fully-OFF". The Transistor can be made to operate in saturation region by biasing the transistor such that maximum amount of base current is applied which results in depletion layer being as small as possible, thereby allowing maximum current to flow through the transistor and then it is said to be switched "Fully-ON".

4. SOFTWARE USED

4.1 Proteus-

The Proteus is an electronic circuit design software which includes a schematic capture, simulation and Printed Circuit Board (PCB) Layout modules. Using this software, a virtual system modelling can be done. Proteus has the ability to simulate the interaction between software running on a microcontroller and any analog/digital electronics connected to it. It simulates I/O ports, interrupts, timers and all other peripherals present on each supported processor.

4.2 Micro C

The Micro C PRO for PIC is a powerful, feature-rich development tool for PIC microcontrollers. It is an embedded C compiler that allows us to convert a code written in C language to machine language. It is designed to provide the programmer with the easiest possible solution to develop applications for embedded systems without compromising performance or control.

4.3 LabVIEW:-

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is a Graphical User Interface (GPU), that provides different sensors that can be connected together so we can monitor, control and analyze the performance of a system. It is a "Virtual Instrument" that enables a user interface to be built and it contains the programming code. It provides more flexibility than other laboratory instrument because it is software based. LabVIEW is a powerful platform that provides a variety of applications like in industries and automation, home, research labs and many more. They are:

i) VI Front Panel: The LabVIEW front panel is the panel that user see in application output. It enables us to interact with the VI, inputting controls and also seeing results. It can be likened to the front panel of a test instrument or other piece of equipment.
ii) VI block panel: The LabVIEW VI block diagram is where the functionality of the VI is programmed in G. The block diagram defines the functionality while providing a visual representation of it.

5. CIRCUIT DESCRIPTION

The system designed to run a DC motor senses the speed, controls the operation and maintains the speed at the set RPM. The system is enabled to communicate with a PC to receive data for the set RPM and operate the DC motor accordingly. There is also a display which constantly shows the relevant data. A majority of the system components operate on 5V DC. Yet, the power source here is a 12V DC adapter which is responsible to supply the requisite power to the circuitry and the motor. The supply is passed through a LM7805 voltage regulator which provides and maintains the voltage at 5V to be utilized by all other circuit components other than the motor.

The main component of this system is the PIC16F887 Microcontroller IC package which is a 40 pin, 8-bit device having inbuilt Flash Program Memory and RAM. This IC is responsible for interpreting the data from the sensors, calculating and displaying the result and giving the desired output. The microcontroller needs a clock signal to maintain its timely functioning and co-ordination with the other devices. This system uses a 12MHz crystal oscillator to maintain its clock.

The display used here is RG1602A V2.0 which is a 16x2 Alphanumeric Backlit display. This display is very easy to interface with the microcontroller as it can be interfaced using only 4 pins and can be set up in the program by just including a predefined code for a predefined port. The display works using certain commands which are used to operate the display as desired.

The component facilitating the system as a speed sensor is a prefabricated board designed by means of LM358P IC which operates with an IR Transmitter Receiver setup. The component is interfaced with the main IC so as to count the number of pulses and hence calculate the speed.

The component which facilitates the microcontroller to operate the motor as per the requirements is a BD139 general purpose NPN transistor. This transistor is connected in a common base configuration as seen in the circuit diagram. The base is connected to the IC by means of 1 kilo ohm resistor which receives pulses and controls the motor accordingly. The 6V DC motor is connected to the supply through a 500ohm resistor and the collector emitter terminals of the transistor.

The technique of Pulse Width Modulation is utilized for driving the motor. Since the microcontroller operates on a 12MHz, hence each cycle is of a duration of 8.33e-9 second. Each cycle can have an output of either 1 or 0. The duration of the pulse is dependent upon the number of cycles with high output which is varied from 0 to 255 (since an 8-bit microcontroller is used) w.r.t the current speed and the required speed.

The system communicates with the PC by means of CP210x USB to UART Bridge parallel communication device. It is an integrated circuit board which acts as an interface to decode and encode data between PC and IC.

Fig. 2: Circuit Diagram of the model

6. SOFTWARE BACK-END

Fig-3: Block Panel of VI

7. WORKING

As shown in the model the shaft of the motor is provided with a disc. The IR (infra-red) sensor senses the gap in the disc and sends a signal through the gap. The microcontroller counts the number of gap pulses for a certain time. This will give the number of cycles for that certain time. Now the speed can be calculated using the formula –

Speed (in RPM) = ((No. of pulses by IR sensor) *60)/(T)

Where, T= time for which IR sensor counts the pulse in second. This speed is the "measured speed" of the dc motor. If the measured speed is less than the "set speed", "Pulse Width" is increased in value 'by steps of 1' and vice versa. The pulse width modulated output is fed to the transistor which acts as motor driver. If the load increases, speed decreases. Under that situation, pulse width increases and the system tries to regain the set speed by increasing the pulse width. Again, if the load decreases, the motor speed increases and the system attempts to regain the set speed by decreasing the pulse width.

The set speed is the user input and can be changed from the PC as per the requirement.

8. RESULTS

Table 1: Observations taken from the system.

Set RPM	Bottom RPM	Top RPM	Bottom Pulse Width	Top Pulse Width	RPM Error	Percentage Duty Cycle
1000	960	1020	199	204	-4% to +2%	78% to 80%
1200	1200	1200	211	211	0%	82%
1400	1380	1440	216	220	-2% to +4%	84.7% to 86.3%

As the speed is set the system achieves it in short time. After this the speed oscillates and the maximum error in the speed is documented. During this oscillation the value of the pulse width also oscillates which has also been documented in percentage.

Fig. 4:-System operating at a RPM of 1200.

Fig-4 shows the various parts of the system like the motor disc, IR Board, microcontroller and other parts of the circuit. Here the speed is set at 1200 RPM and the system maintains that speed by varying the pulse width.
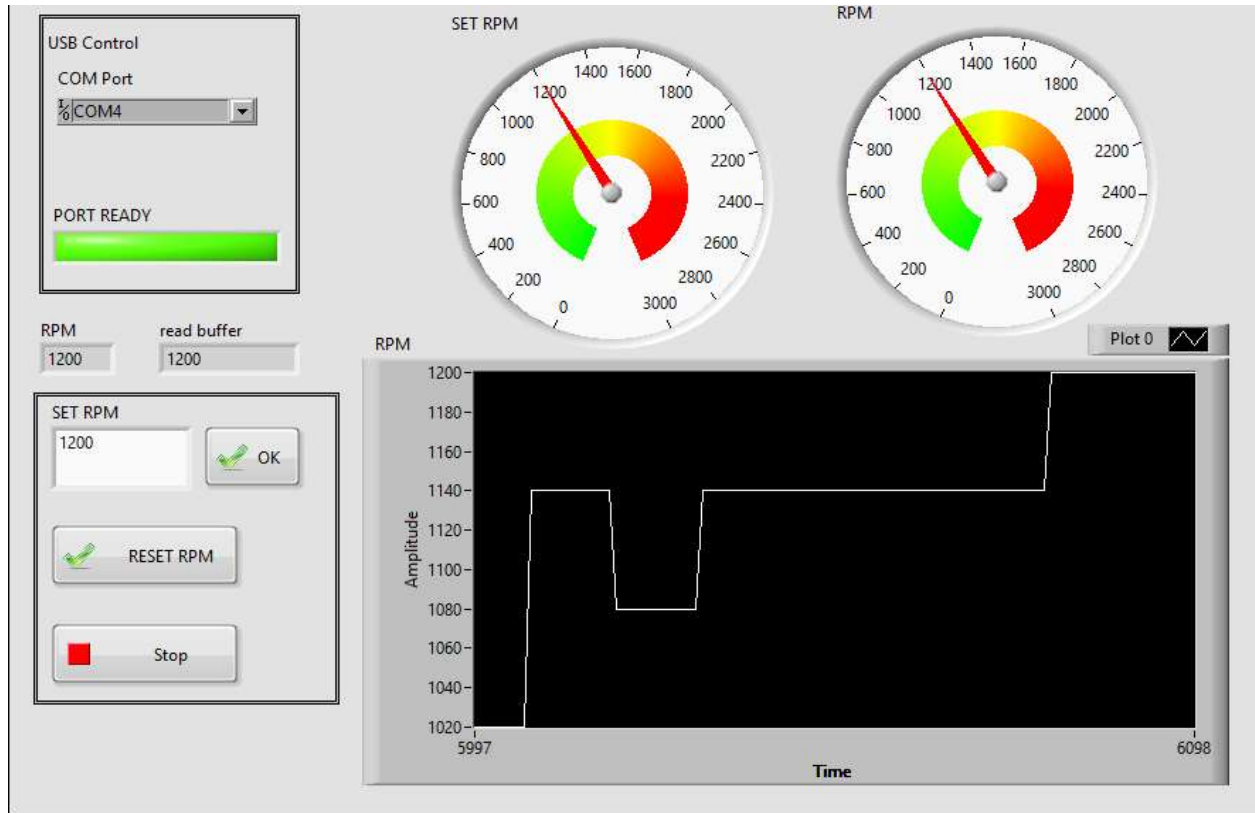
Fig. 5: LabVIEW Front Panel showing I/O And O/P

Fig.5 shows two dials having the input and output speeds. The panel can also reset the speed as desired. The graph in the panel shows the variation of speed. The panel acts as both as a control and observation panel of the system.

9. CONCLUSION

This paper deals with the design and development of speed control scheme of a DC motor. The speed of the DC motor is controlled with the help of LabVIEW using PWM technique via PIC 16F887. This method serves to be a cost-efficient method for controlling the speed of a DC motor and also more efficient and accurate than other systems. The method implemented can be used for various industrial applications and also helps in maintaining the stability of a system.

10. REFERENCES

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