Modeling and Designing of Matlab Based Speed Control of DC Motor Using PWM Technique

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ABSTRACT

Machines have served the humanity starting from a simple ceiling fan to higher industrial applications such as lathe drives and conveyor belts. This research work aims at providing an appropriate software based control system because it provides computer featured applications, prevents rapid signal loss, reduces noise while also significantly improves the steady state and dynamic response of the motor. In this research paper, we have worked on DC motors due to its significant advantages over other types of machine drives. 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 fulfill all requirements to speed control of DC motor. PWM based speed control system consists of electronic components (integrated circuits, Sensors etc.). In this paper, to control the speed of DC motor using Pulse Width Modulation (PWM) method. Microcontroller is used to generate PWM. MATLAB is used to drive the motor . Rectifier circuit is used for power supply to circuit and motor. This paper shows that precise and accurate control of small DC motors can be done efficiently without using costly components and complicated circuit.
Keywords : PWM, Lathe, Integrated Circuits, Commercial.

I. INTRODUCTION

"Electricity plays a very important role in our life".In this project we discover technology for the safety purpose and to reduce the men power or automation, of DC motor by controlling its speed by (PWM)

- To control speed of dc motor.
- Can be used for different application
- Reliable.
- Fast response.
- Power losses reduces.

Earlier the utilization of electrical energy was simple and straight forward; generation of electricity & its consumption was a linear process, but now a day's electrical power system is one of the complex networks in the world with the invention of new techniques of power control and equipment which have better energy efficiency and efficient control with fast and smart switching [1, 2]. Since the development of semiconductor devices in the decades of the 1950s the use of it has been increased not only in the field of electronics or communication engineering but electrical engineering too. In Earlier days the switching of electric power for the operation of electrical equipments was either through manual or through electromechanical switches, but due to fast speed, accuracy and high range the power electronics and solid state controllers and converters have been used worldwide and in the last two decades their use increases very rapidly[3]. The inversion process of converting DC into AC has taken place for many applications such as renewable energy technology, HVDC transmission, Adjustable speed drives[and high frequency industrial heating processes. The applications using variable frequency inverters are increasing day by day due to its user friendly approach for common men while the technology behind this is very advanced. The aim of this Project is to review, classify and illustrate the pulse width modulation techniques. Here is a comparison among Cycloconverter,

LCI and PWM supply is given in the table shows that how the technology has advantages over other twofor different uses in electrical engineering systems pulse width modulation techniques have proven superiority over other techniques [2-5].

Pulse width modulation is the method of choice to control modern power electronics circuits. The basic idea is to control the duty cycle of a switch such that a load sees a controllable average voltage[6]. To achieve this, the switching frequency or repetition frequency of the PWM signal is chosen high enough that the load cannot follow the individual switching events. Switching, rather than linear operation of the power semiconductors, is of course done to maximize the efficiency because the power dissipation in a switch is ideally zero in both states. There are many different ways to control the speed of motors but one very simple and easy way is to use Pulse Width Modulation and Matlab. To Control the whole process easily Matlab is used. Basically Matlab is a tool for numerical computation and visualization. The basic data element is a matrix, so if you need a program that manipulates array-based data it is generally fast to write and run in MATLAB (unless you have very large arrays or lots of computations, in which case you're better off using C or Fortran).

Table 1. Comparison between Technologies

S.No	Control factor	Cyclo-converter	LCI	PWM
1	Speed(in drive)	limited	wide	wide
2	Dynamic response	Excellent	Good	Excellent
3	Torque pulsation	Low	High	Very low
4	Stability	Good	Moderate	Very good
5	Volumetric -power density	moderate	good	Very good

Advantages

- It allows quick and easy coding in a very high level language.

- Rich data types: Complex number,Three dimensional matrix, structure, cell array, etc.
- Lots of users: economists, mathematicians, engineers
- High-quality graphics and visualization facilities are available.
- MATLAB M-files are completely portable across a wide range of platforms.
- EXTENSIVE documentation (type 'helpwin')

II. PROBLEM FORMULATION

Constantly supplying power to a device seems wasteful, in part due to the amount of energy wasted as heat when using a resistor to limit the amount of current delivered to the motor. Also, when using a resistor, if the load changes, the amount of current presently being used by the device has to be redistributed over the new load. Because of Newton's first law, motors require a significant amount of energy to start turning. This initial energy requirement depends on the size of the motor used. Main problem is that programing of matlab for Pulse Width Modulation. Selection of components (which types of component are perform well and give better output like motor etc.)Pulse width modulation need a program whose generate 0 and 1 signal in dc supply, so that to generate this type of signal need specific program. Potential problem with PWM control High frequencies in PWM signal may produce undesirable oscillations in the motor (or whatever device is driven by the amplified PWM signal).To make a stable and accurate speed control system of DC Motor via PMW and Matlab.

III. MOTIVATION

A project is made to control the speed of DC motor more easily and as well as accurately or stable. In previous year a Speed Control methods are used have many disadvantages like copper losses and heating problem, need some force and rheostat controlling equipments are used which result large current drawn by the motor.

So our group research on the speed control system and found a new way of speed control of Dc motor (easily and accurately) with help of Pulse width modulation and Matlab. In pulse width modulation and Matlab system a

supply of dc motor is controlled (Input supply). Through controlling the dc supply, speed of dc motor will be change and also rotation of the motor (forward and reverse).

Objective

The aim of our project was to implement a complete speed control system for a DC motor by using PMW and Matlab.

a) 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 fulfill all requirements to speed control of DC motor.
b) MATLAB and Pulse Width Modulation is used to drive the motor easily or accurately.
c) Implementation of PWM Signal Generator.
d) Implementation of MATLAB Software.
e) Pulse width modulation is a great method of controlling the amount of power delivered to a load without dissipating any wasted power.

IV. METHODOLOGY

The use of pulse width modulation to control a small motor has the advantage in that the power loss in the switching transistor is small because the transistor is either fully "ON" or fully "OFF". As a result the switching transistor has a much reduced power dissipation giving it a linear type of control which results in better speed stability. But before we start looking at the in's and out's of pulse width modulation we need to understand a little more about how a DC motor works. So how do we control the flow of current through the motor. Well many people attempt to control the speed of a DC motor using a large variable resistor (Rheostat) in series with the motor as shown in figure 1.
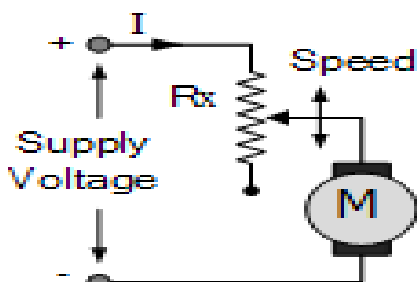

Figure 1. DC motor

While this may work, as it does with Scalextric slot car racing, it generates a lot of heat and wasted power in the resistance. One simple and easy way to control the speed of a motor is to regulate the amount of voltage across its terminals and this can be achieved using "**Pulse Width Modulation**" or PWM.

As its name suggests, pulse width modulation speed control works by driving the motor with a series of "ON-OFF" pulses and varying the duty cycle, the fraction of time that the output voltage is "ON" compared to when it is "OFF", of the pulses while keeping the frequency constant. The power applied to the motor can be controlled by varying the width of these applied pulses and thereby varying the average DC voltage applied to the motors terminals. By changing or modulating the timing of these pulses the speed of the motor can be controlled, ie, 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 as shown in figure 2.In other words, the wider the pulse width, the more average voltage applied to the motor terminals, the stronger the magnetic flux inside the armature windings and the faster the motor will rotate and this is shown below. 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. Figure 3 shows the 5V pulses with 0% through 50% duty cycle.
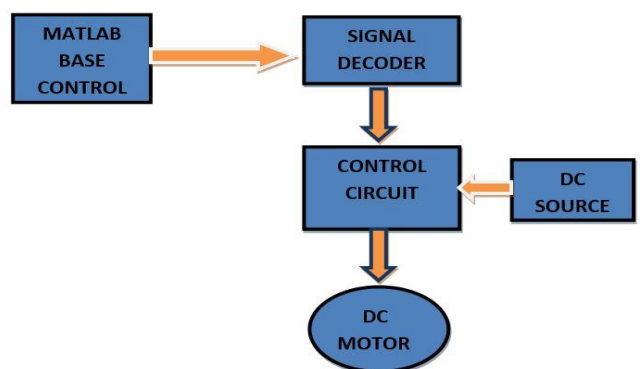

Figure 2. Block Daigram

Figure 3: Pluses with 0% through 50% duty cycle

Pulse Width Modulation :- The use of pulse width modulation to control a small motor has the advantage in that the power loss in the switching transistor is small because the transistor is either fully "ON" or fully "OFF". As a result the switching transistor has a much reduced power dissipation giving it a linear type of control which results in better speed stability.Also the amplitude of the motor voltage remains constant so the motor is always at full strength. The result is that the motor can be rotated much more slowly without it stalling. So how can we produce a *pulse width modulation* signal to control the motor. 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.
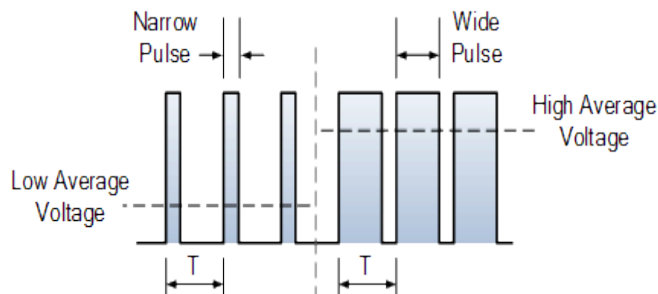

Figure 4: pulse width

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. For Controlling process matlab is used.

The contolling processes is done by Micro Controller and Mirco controller is operated by Matlab. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems. **MATLAB** (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language.

A. *Software Used (Matlab*)

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical
- User Interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or Fortran. The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation. MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

B. Hardware

1. DC motor: It is the devices that convert electrical power into mechanical power. It can be traced to disc-type machines conceived and tested by Michael Faraday, who has formulated fundamental concepts of electromagnetism as shown in figure 5.
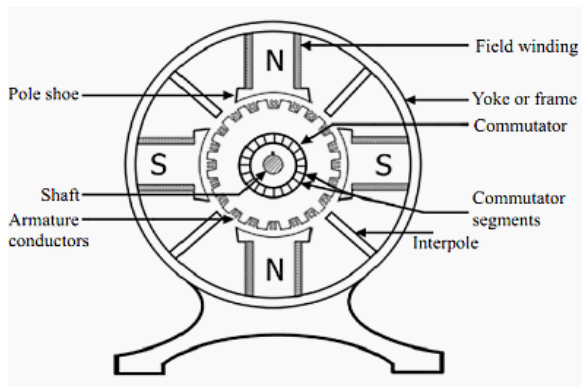
Figure 5 : DC motor

DC motor uses electricity and a magnetic field to produce torque, which causes it to turn. It requires two magnets of opposite polarity and an electric coil, which acts as an electromagnet. The repellent and attractive Electromagnetic forces of the magnets provide the torque that causes the motor to turn. It also consists of one set of coils, called armature winding, inside a set of permanent magnets, called the stator. Applying a voltage to the coils produces a torque in the armature, resulting in its motion.

2. Pulse Width Modulation : It has been widely used in, power electronic applications, such as power converters and inverters, motor drive, and active power filters .There are many different ways to control the speed of motors but one very simple and easy way is to use Pulse Width Modulation**.** The power applied to the motor can be controlled by varying the width of these applied pulses and there by varying the average DC voltage applied to the motors terminals. 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. In other words, the wider the pulse width, the more average voltage applied to the motor terminals, the stronger the magnetic flux inside the armature windings and the faster the motor will rotate . The use of pulse width modulation to control a small motor has the advantage in that the power loss in the switching transistor is small because the transistor is either fully "ON" or fully "OFF". As a result the switching transistor has a much reduced power dissipation giving it a linear type of control which results in better speed stability.

Micro-Controller : The ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family figure 6. The Atmel 8bit AVR RISC-based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer /counters with compare modes, internal and external interrupts, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz.
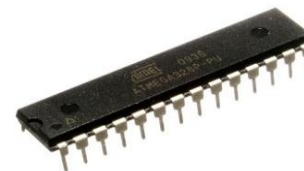

Figure 6: Micro-controller

V. RESULT

MATLAB and Pulse Width Modulation is used to drive the motor easily or accurately. 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.In pulse width modulation and Matlab system a supply of dc motor is controlled (Input supply). Through controlling the dc supply, speed of dc motor will be change and also rotation of the motor (forward and reverse).Speed of motor is easily control.

VI. CONCLUSION

Speed control of DC motors is very simple and easy by using Pulse Width Modulation**.** The power applied to the motor can be controlled by varying the width of these applied pulses and thereby varying the average DC voltage applied to the motors terminals. So here PWM analysis carried out for speed control of DC Motor. The different Parameter like current of Motor are analyzed with help of Matlab. This simulation shows that by

using PWM topology the motor can operate forward and reverse direction successfully. In implementing this work frequency, independent PWM output with variable duty cycle that can vary from 0% to 100% is to be generated. Furthermore, an LCD display was fabricated to display the output. This kind of setup provides a complete user interface unit. Hence the system is complete stand-alone and user friendly. The industrial application needs high performance motor drives. The dc motor is used as an adjustable speed machine for this wide range of option is evolved. The advantages of dc motor are vibration free operation, quiet, independent knowledge of the system position and good efficiency. If a system must be accurate, quiet, fast and efficient then dc motor is the good choice.

VII.   ACKNOWLEDGMENT

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