International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

PERFORMANCE OF BLDC MOTOR WITH SPEED CONTROL TECHNIQUE

S. S. Sable[1], Shantanu J. Surange[2], Chetan N. Shirole[3], Aniket P. Pardesi[4], Tejas S. Jagtap[5]D.Y.Patil Institute of Engineering and Technology, Ambi, Pune
Dhobale Santosh D[6].
Jaihind College of Engineering Kuran

ABSTRACT

The Speed Control of BLDC Motor using Microcontroller and PWM Technique. Brushless DC (BLDC) motors are becoming more common in a variety of motor applications such as fans, pumps, automotive drives & robotic automations. We have a lot of technologies that can be used to control the speed of BLDC motor. Those systems and techniques we are discussing in this paper. We have seen various techniques to control Brushless Direct Current (BLDC) motor like techniques using mobile application, Bluetooth module, by sending SMS from mobile phone, etc. But for those technologies there are different mythology and platforms. And these types of systems are very much expensive. Because of this these expensive systems are not affordable by everyone. Our main aim to design a system which is advanced, useful, easy to handle and cheapest. That's why we are control the speed of BLDC motor using Microcontroller & PWM technique.

Keywords-BLDC (Brushless DC Motor), PWM (Pulse Width Modulation)

INTRODUCTION

In this project, we will show How Speed Control of BLDC Motor can be implemented using microcontroller and Pulse Width Modulation (PWM). Most of the industrial process requires to be run on the parameters where speed of the drive is concerned. The speed control of BLDC motor is important in application where protection are of necessary. Purpose of a motor speed controller is to take a signal representing the required speed and to drive a motor at that speed.

In this project controller presented uses the pulse width modulation (PWM) technique for speed control of BLDC motor. We use BLDC Motors in many systems in our day to day life. all BLDC Motors which are operated by DC power supply. Most of the times we will have to adjust the speed of the motors as per our requirement. A CPU Fan for example, must be operated at high speed when the CPU is preforming heavy tasks like games or video editing. But for normal usage like editing documents, the speed of the fan can be reduced. Although some systems have an automatic adjustment system for fan speed, not all systems possess this functionality. So, we will have to adjust the speed of the DC Motor ourselves occasionally. The circuit is used to control speed of BLDC motor by using PWM technique.

The speed control of the BLDC motor is archived by varying the duty cycles (PWM Pulses) from the microcontroller according to the program. The microcontroller receives the percentage of duty cycles from the keypad and delivers the desired output to switch the motor driver so as to control the speed of the BLDC motor and display it on the LCD display.

LITERATURE REVIEW

literature survey on speed control of BLDC motor by PWM method:

"Speed Control of BLDC Motor using Pulse Width Modulation Technique" by **Akshay Rathod**. This paper discusses the implementation of PWM based speed control of a BLDC motor using an Arduino microcontroller. The authors have analyzed the performance of the motor under different duty cycles and shown the effectiveness of PWM based control.

"Speed Control of BLDC Motor using PWM Technique" by **S.R. Balachandar** . This paper presents a comprehensive study of the PWM based speed control of a BLDC motor. The authors have analyzed the various parameters that affect the speed control, such as frequency, duty cycle, and voltage. They have also discussed the implementation of PWM based control using a microcontroller and a dedicated PWM controller.

"A Review of Speed Control Techniques for BLDC Motor Drives" by **Ebrahim Babaei** . This paper provides an overview of various speed control techniques for BLDC motors, including PWM based control. The authors have compared the advantages and disadvantages of different techniques and highlighted the importance of PWM based control for high-performance applications.

"Speed Control of BLDC Motor using Arduino and L298N Motor Driver" by **Akash Kumar Jha**. This paper presents the implementation of PWM based speed control of a BLDC motor using an Arduino microcontroller and an L298N motor driver. The authors have shown the effectiveness of PWM based control in achieving precise speed control.

Overall, these studies demonstrate the effectiveness and versatility of PWM based speed control for BLDC motors, and provide insights into the implementation and performance analysis of the technique.

METHODOLOGY

Brushless DC motor is defines as a permanent synchronous machine with the rotor position feedback. It is generally controlled using a 3 phase power bridge semi- conductor. This motor requires rotor position sensors which helps for starting and providing the commutation sequence. This leds to turn on the power devices in the inverter bridges. The power devices are commutated sequentially every 600, based on the rotor position. Due to this the problem associated with the brush and commutator is eliminated for example sparking. This makes BLDC motor more rugged as compared to a dc motor. The BLDC consists of four main components as Power converter, permanent magnet-synchronous machine sensor, and control algorithm. The role of power converter is to transform the power from source to the permanent magnet- synchronous machine sensor. The structure of control algorithm depends on the type of brush less dc motor, there are two classes voltage source based drives and current source based drives.

Speed control of BLDC motor is essential for making the motor work at desired rate. Speed of a brushless dc motor can be controlled by controlling the input dc voltage / current. The higher the voltage more is the speed.

Many different control algorithms have been used to provide control of BLDC motors. The motor voltage is controlled using a power transistor operating as a linear voltage regulator. This is not practical when driving higher-power motors. High- power motors must use PWM control and require a microcontroller to provide starting and control functions.

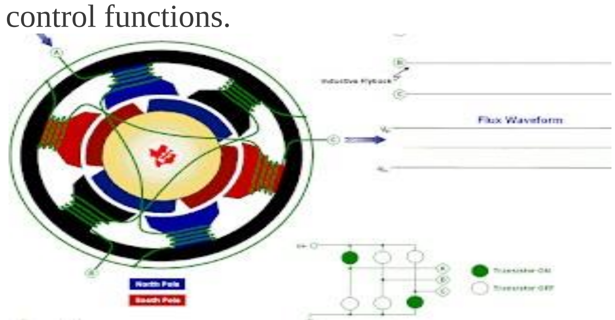

Fig.1: Construction of BLDC motor

The control algorithm must provide three things:

- PWM voltage to control the motor speed
- Mechanism to commutate the motor

- Method to estimate the rotor position using the back-EMF or all sensors

Pulse-width modulation is used to apply a variable voltage to the motor windings. The effective voltage is proportional to the PWM duty cycle. When properly commutated, the torque-speed characteristics of the BLDC motor are identical to a dc motor. The variable voltage can be used to control the speed of the motor and the available torque. The commutation of the power transistors energizes the appropriate windings in the stator to provide optimum torque generation depending on the rotor position. In a BLDC motor, the MCU must know the position of the rotor and commutate at the appropriate time.

PWM TECHNIQUE:

Pulse-width modulation (PWM) or duty-cycle variation methods are commonly used in speed control of BLDC 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

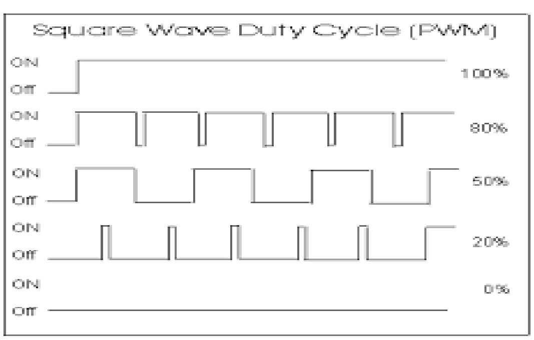

Fig 2. 5V Pulses With 0% Through 100% Duty Cycle

Thus, by varying the pulse-width, we can vary the average voltage across a BLDC 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

BLDC motor speed control using PWM method:

The major reason for using pulse width modulation in BLDC 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. 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 that the motor sees is thus Veq, which is equal to the duty cycle times the supply voltage.

Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

Principle

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. 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. The wave forms in the below figure to explain the way in which this method of control operates. In each case the signal has maximum and minimum voltages of 12v and 0v.

Pulse Width Modulation Waveforms

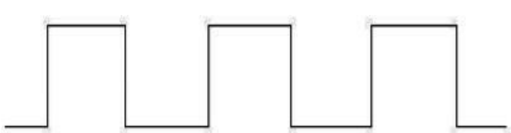

Fig 3. Mark space ratio (50% duty cycle)

1] 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.

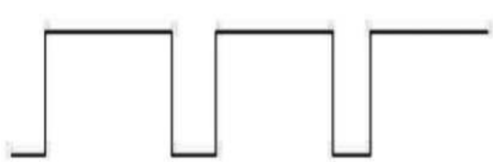

Fig 4. Mark space ratio (75% duty cycle)

2] 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.

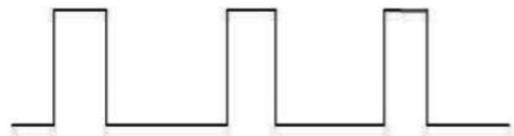

Fig 5. Mark space ratio (25%dutycycle)

3] In wave form, the signal has mark space ratio is 1:3, giving an output signal that is 12v for just 25% o the time. The average output voltage of this signal is just 3v, so the motor runs at 1/4 of its maximum speed.

By varying the mark space ratio of the signal over the full range, it is possible to obtain any desired average output voltage from 0v to12v. The motor will work perfectly well, provided that the frequency of the pulsed signal is set correctly, a suitable frequency being 30Hz.setting the frequency too low gives jerky operation. And setting it too high might increase the motor's impedance.

Circuit Diagram

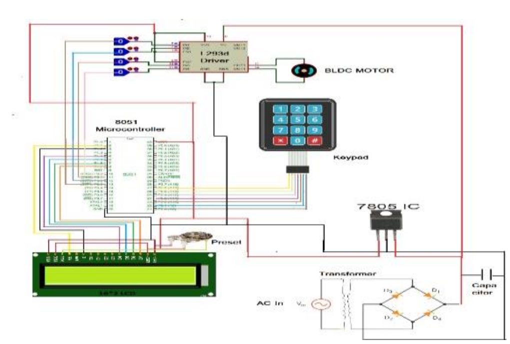

Fig 6. Circuit Diagram of speed control of BLDC motor by using PWM.

HARDWARE SETUP

The hardware is designed and the operation has been done based upon the program written in the microcontroller for the Closed loop control of the BLDC motor and thespeed is also controlled by using PWM technique.

OPERATION PROCEDURE

1. Press '#' once display shows the store Max RPM.
2. Press '#' again to store Max.RPM.
3. Press '*' to get the required RPM. Display shows % of Req_RPM:
4. Enter the required percentage using
5. Keypad.
6. Press '#' to save the required RPM.

FUTURE WORK

1. BLDC motor plays a significant role in modern industries. They are widely used in industry because of its low cost, less complex control structure and wide range of speed and torque so better future of thisproject.
2. In this project we are used pulse width modulation technique, it is a modern technology in solid state field and it provide smooth speed control of motor.
3. 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 future is also bright in the modern era withfuzzy logic.

CONCLUSION

The BLDC motor speed is controlled by using power electronic device and the PWM is used which to control the speed of BLDC motor. The speed pulse train will be based on required input speed. This circuit is useful to operate the BLDC motors at required speed with very low losses and low cost. The circuit response time is fast. Hence high reliability can be achieved. The designed circuit was tested for various speed inputs satisfactorily.

REFERENCES

1. *Jeetender Singh Chauhan, Sunil Semwal / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622*
2. *Arvind, S.K., Arun, T.A., Madhukar, T.S., &Deka, J., (2014). Speed Control of DC Motor using PIC 16F877A Microcontroller. Multidisciplinary Journal of Research in Engineering and Technology, 1(2), 223-234.*
3. *Obed, A.A., &Basheer, A.(2011).Effect of duty cycle and chopper frequency of PWM DC to DC converter drive on performance characteristics of DC motor. The fourth International scientific Conference of Salahaddi University-Erbil, 87-92.*
4. *A Khoei Kh. Hadidi, "Micro Processor Based Closed- Loop Speed Control System for DC Motor Using Power MOSFET", 3rd IEEE international conference on Electronics, Circuits and Systems(1996) vol.2, pp.1247-1250*
5. *J Nicola Bianchi, SilverioBolognani, Ji-HoonJang,Seung-Ki Sul," Comparison of PM Motor structures and sensor less Control Techniques for zero-speed Rotor position detection" IEEE transactions on power Electronics, Vol 22, No.6, Nov 2006*
6. *G.Madhusudhanrao, B.V.SankerRam, B.SampathKumar, K.Vijay Kumar," Speed Control of BLDC Motor using DSP", International Journal ofEngineering Scienceand Technology Vol.2(3),2010*
7. *M. Nasrul, A. Satar, and D. Ishak, "Application of proteus VSM in modelling brushless DC motor drives," in Proc. 4th International Conference on Mechatronics,IEEE, Kuala Lumpur, Malaysia, May17-19,*
8. 1G.SanthoshKumar, S.Arockia Edwin Xavier "BRUSHLESS DC MOTOR SPEED CONTROL USING MICROCONTROLLER" ISSN (PRINT): 2393-8374, (ONLINE):2394-0697,VOLUME-2, ISSUE-2,2015