International Journal of Advanced Computer Technology
ISSN: 2319-7900 www.ijact.org Volume 11, Issue 2, April 2022

Speed Control of BLDC Motor Using Microprocessor

Bhupendra Singh Niranjan[1], Dr Sarika Shrivastava[2], Arjun Kumar[3], Vishal choudhari4, km Roli Maurya[5] Adarsh Mishra[6]
[1,3-6]Department of EE, MGIMT Lucknow India
[2]Department of EE, AITM Varanasi India
[1]bhupendraorai@gmail.com,[2]sarikashri@yahoo.com
[3]kumararjun38008@gmail.com,[4]vishalchaudharyvishu12@gmail.caom,
[5]rolimaurya0209@gmail.com [6]adarsh1999satyam@gmail.com

ABSTRACT: This paper presents a method of speed control Brushless DC Motor (BLDC) using a microprocessor. Brushless DC motor plays a vital role in all applications such as ling fans, pumps, automotive drivers, and robotic Automations, and Many technologies are available in the motor from controlling the speed of the motor as per the designed applications. In this regard, for control of speed in a BLDC motor application, using Ardunio Board with PWM Technique be used Speed Control of BLDC motor with various Techniques such as using mobile applications, 100th based BMS from the mobile phone. Brushless DC motors (BLDC) find wide applications in industries due to their high power density and ease of control. These motors are generally controlled using a three-phase power semiconductor bridge. In order to start and provide a proper commutation sequence to turn on the power devices in the inverter bridge, the rotor position sensors are required. The power devices are commutated sequentially every 60 degrees based on the rotor position. The motor requires suitable speed controllers to achieve the desired level of performance. In the case of permanent magnet motors, speed control is usually achieved by using a proportional-integral (PI) controller. Although conventional PI controllers are widely used in the industry due to their simple control structure and ease of implementation, these controllers pose difficulties where there are some control complexities such as nonlinearity.

Keywords: BLDC Motor, Microprocessor,

I. INTRODUCTION

Permanent-magnet excited brushless DC motors are becoming increasingly attractive in a large number of applications due to performance advantages such as reduced size and cost, reduced torque ripples, increased torque-current ratio, low noises, high efficiency, reduced maintenance and good control characteristics over a wide range in the torque-speed plan [1]. In general, Brushless DC motors such as fans are smaller in size and weight than AC fans using shaded poles or Universal motors. Since these motors can work with the available low voltage sources such as 24-V or 12-V DC supply, it makes the brushless DC motor fans convenient for use in electronic equipment, computers, mobile equipment, vehicles, and spindle drives for disk memory, because of their high reliability, efficiency, and ability to reverse rapidly. Brushless dc motors in the fractional horsepower range have been used in various actuators in advanced aircraft and satellite systems [1-4]. Most popular brushless DC motors are mainly three phases [5-7] controlled and driven by full-bridge transistor circuits. With permanent magnet excitation, it is necessary to obtain additional torque components. These components can be obtained due to a difference in magnetic presence in both quadrature and direct axis; therefore, reluctance torque is developed, and torque null regions are reduced significantly [2-3]. This paper describes a brushless DC motor with distributed winding and a unique form of PM-rotor with a particular stator periphery, which develops a speed control system for a BLDC motor using a closed-loop control technique. The proposed system uses a microcontroller of the 8051 family and a rectified-power supply. A set of IR transmitters and photodiode are connected to the microcontroller for counting the number of rotations per minute of the DC motor as a speed sensor. Optocoupler is connected to trigger the MOSFET to drive the BLDC motor, duly interfaced to the microcontroller. A matrix keypad is interfaced with the microcontroller to control the motor's speed.

II. BLDC Motor and its Working principle

As their name implies, brushless DC motors do not use brushes. The brushes deliver current through the commutator with brushed motors into the coils on the rotor. So how does a brushless motor pass current to the rotor coils? It doesn't—because the coils are not located on the rotor. Instead, the rotor is a permanent magnet, and the coils do not rotate but are instead fixed in place on the stator. Because the coils do not move, there is no need for brushes and a commutator shown in Figure 1. Since the rotor is a permanent magnet, it needs no current, eliminating the need for brushes and commutators. Current, the fixed coils are controlled from the outside. With the brushed motor, rotation is achieved by controlling the magnetic fields generated by the coils on the rotor, while the magnetic field generated by the stationary magnets remains fixed. To change the rotation speed, you change the voltage for the coils. With a BLDC motor, it is the permanent magnet that rotates; rotation is achieved by changing the direction of the magnetic fields generated by the surrounding stationary coils. To control the rotation, you adjust the magnitude and direction of the current into these coils [6].

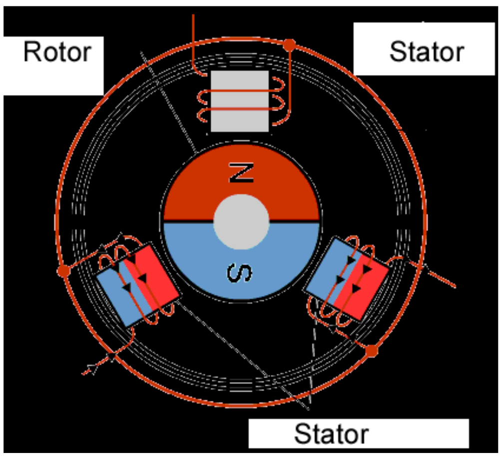

FIG. 1 A BLDC Motor

III. Basic working

This BLDC motor speed control with rpm display system works on the principle of switching dc supply. The switching dc supply is gained by changing the supply voltage duty ratio. In this system, the motor drive circuit is triggered at different duty ratios, and when it is triggered at different duty ratios, the motor runs at different speeds. Here for demonstration purposes, a fan speed is controlled through a microcontroller. When the up switch is pressed, the microcontroller sets the duty ratio from 10% to 80%, and then this duty ratio voltages are given to the motor drive circuit, which sets the speed of the motor from 0 to 100%.

Similarly, for decreasing the speed of the motor down switch is pressed again and again until the desired speed is acquired to display the rpm of this motor at LCD in IR sensors have been used here, which are interfaced with a microcontroller. The microcontroller counts each revolution of the motor after receiving the speed signal from IR sensors and then displays this speed at LCD in the form of percentages like 10%,20%80% or 100%. So, we can drive the BLDC motor at our desired speed [4-5].

IV. BLDC Motor Control Schemes

The control schemes of BLDC motors are mainly classified in two ways: sensor-based control and Sensorless control. In sensor-based control, a Hall sensor is used to detect the position of the rotor magnet and give a signal used to give appropriate excitation to the stator winding. Hall sensor works on the Hall effect, which states that when a current-carrying conductor is placed in the magnetic field, it exerts a transverse force on the conductor. The sensor-based control scheme is shown in Figure 2. Microcontroller based control using Hall sensors gives effective control on BLDC motors. The sensorless drive principle is based on detecting the rotor position using EMF detection techniques. Various position and velocity estimation methods are based on the induced Back EMF detection. Various microcontrollers and DSP controllers are available for sensorless control.

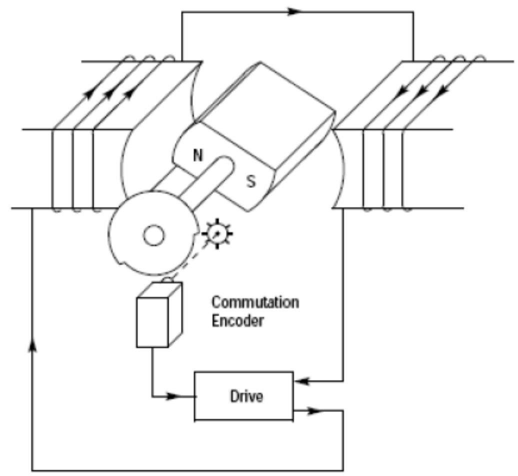

Fig.2 Sensor-based control

V. Advantages of BLDC Motors

A BLDC motor with three coils on the stator will have six electrical wires (two to each coil) extending from these coils. In most implementations, three of these wires will be connected internally, with the three remaining wires extending from the motor body (in contrast to the two wires extending from the brushed motor described earlier). Wiring in the BLDC motor case is more complicated than simply connecting the power cell's positive and negative terminals; we will look more closely at how these motors work in the second session of this series. Below, we conclude by looking at the advantages of BLDC motors. One significant advantage is efficiency, as these motors can control continuously at maximum rotational force (torque). Brushed motors, in contrast, reach maximum torque at only specific points in the rotation. For a brushed motor to deliver the same torque as a brushless model, it would need to use more giant magnets. This is why even small BLDC motors can deliver considerable power. The second significant advantage related to the first is controllability. BLDC motors can be controlled using feedback mechanisms to deliver the desired torque and rotation speed

ISSN: 2319-7900 www.ijact.org Volume 11, Issue 2, April 2022

precisely. Precision control reduces energy consumption and heat generation and, in cases where motors are battery-powered—lengthens the battery life. BLDC motors also offer high durability and low electric noise generation, thanks to the lack of brushes. The brushes and commutator wear down with brushed motors due to continuous moving contact and produce sparks where contact is made. Electrical noise, in particular, is the result of the intense sparks that tend to occur in the areas where the brushes pass over the gaps in the commutator. This is why BLDC motors are often considered preferable in applications where it is essential to avoid electrical noise.

VI. Hardware specification of microcontroller-based BLDC motor speed control

The speed control of the BLDC motor through the microcontroller's main required components are 8051 series Microcontroller, LCD, LED, Crystal, Relay driver IC, Resistors, Capacitor, Diodes, Voltage Regulator, RF Transmitter, RF Receiver and BLDC fan [7-8].

Conclusion

The hardware for closed-loop control of BLDC motor using microcontroller is designed using the PWM technique speed of the BLDC motor was controlled, and it was made to run at exactly entered speed. In future, this hardware will be implemented in dSPACE, and the speed control will be observed.

References

[1]. An Introduction to Sensorless Brushless DC Motor Drive Applications with the ST72141Application Note. AN1130, STMicroelectronics; Geneva, Switzerland: 2000.

[2]. Duane H. (2002) Brushless Permanent Magnet Motor Design. University of Maine, Orno, USA 2nd ed.

[3]. Arindam Bhattacharjee, Gaurav Ghosh, Vijay Kumar Tayal, Pallavi Choudekar, "Speed Control of BLDC Motor through Mobile Application via Secured Bluetooth", Recent Development Control & Power Engineering (RDCAPE), 2017.

[4]. A. Khanna and P. Ranjan, "Solar Powered Android Based Speed Control of DC Motor via Secure Bluetooth", IEEE, 2015.

[5]. Ankesh N.Nichat, Sheikh Kadir Ali, Yogesh D. Solanke, Amit M.Dodke, "Wireless Speed and Direction Control of DC Motor by Using Radio Frequency Technology.

[6]. Hemalatha, M. C., Nagarajan, M. R., Suresh, P., Shankar, G. G., & Vijay, A. (2017). Brushless DC Motor Controlled by using the Internet of Things. IJSTE-International Journal of Science Technology & Engineering, 3(09), 373-377.

[7]. Lefley, P., L. Petkovska, and G. Cvetkovski. Optimization of the design parameters of an asymmetric brushless DC motor for cogging torque minimization in Power Electronics and Applications (EPE 2011), Proceeding of the 2011- 14th European Conference on 2011.

[8]. G.H. Jang and M.G. Kim, "A Bipolar-Starting and Unipolar-Running Method to Drive an HDD Spindle Motor at High Speed with Large Starting Torque," IEEE Transactions on Magnetics, Vol. 41, no.2, pp. 750- 755, Feb. 2005.

Author's Profile

Arjun Kumar- Pursuing B Tech(EE) Final Year from MGIMT Lucknow UP, Affiliated AKTU Lucknow.

Vishal Choudhary- Pursuing B Tech(EE) Final Year from MGIMT Lucknow UP, Affiliated AKTU Lucknow.

Adarsh Mishra - Pursuing B Tech(EE) Final Year from MGIMT Lucknow UP, Affiliated AKTU Lucknow.

Km Roli Maurya - Pursuing B Tech(EE) Final Year from MGIMT Lucknow UP, Affiliated AKTU Lucknow.