BRUSHLESS DC MOTOR CONTROLLER

Y. Sai Madhuri[1], G. Vineela[2], M. Anusha[3], D. Tejaswi Reddy[4], S. Areef Basha[5], Dr. N. Sambasiva Rao[6]

[1]*Student, Electrical and Electronics Engineering, NRI Institute of Technology, Andhra Pradesh, India*

[2]*Student, Electrical and Electronics Engineering, NRI Institute of Technology, Andhra Pradesh, India*

[3]*Student, Electrical and Electronics Engineering, NRI Institute of Technology, Andhra Pradesh, India*

[4]*Student, Electrical and Electronics Engineering, NRI Institute of Technology, Andhra Pradesh, India*

[5]*Student, Electrical and Electronics Engineering, NRI Institute of Technology, Andhra Pradesh, India*

[6]*Professor and Head, Department of EEE, NRI Institute of Technology, Andhra Pradesh, India*

ABSTRACT

As the demand for high productivity rises, new requirements placed on electrical motor-related mechanisms. The need for inexpensive Brushless DC (BLDC) motors has increased. industrial uses have increased. an easy BLDC motor control method for inexpensive motor driving applications utilizing There are now general-purpose microcontrollers, and this paper is presented. The suggested design will permit the user to either clockwise or counter clockwise rotation of the motor direction. The sensor will provide information based on the rotor position. a controller circuit's response. the controller circuit follows will stabilize the current flow after the stator. The Additionally, a design controller circuit is used. The total Microcontroller circuit, logic gates, and switching are used in the design. (MOSFET/BJT) devices, a BLDC motor, and sensors

Keywords— *BLDC motor, Microcontroller, Sensor, BJT, MOSFET.*

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1. INTRODUCTION

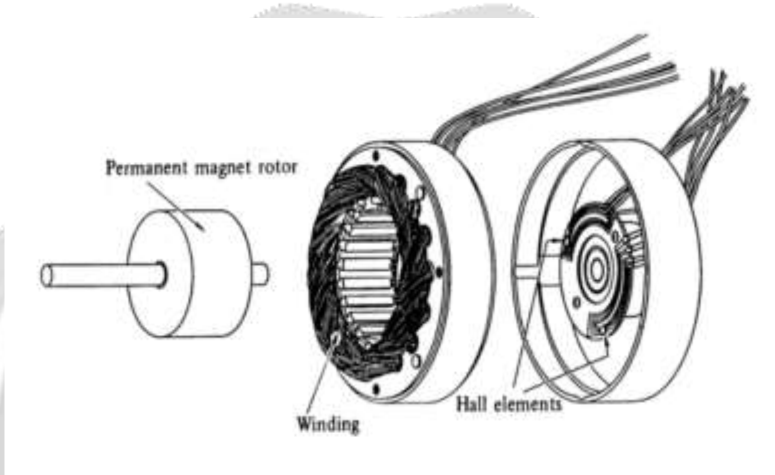
Permanent magnets are used in electrical devices. as opposed to electromagnetic stimulation, numerous advantages like simpler and minimal excitation losses building, increased effectiveness, and quick dynamic performance and high power or torque per volume. The PM Excitation was not used in the early 19th century because of the inferior calibre of PM components. When the development of the usage of PM excitation systems was resurrected by Alnico, although has only been used for small and insignificant dc motors. machines that commutate [1].

Permanent magnets are used in electrical devices. as opposed to electromagnetic stimulation, numerous advantages like A synchronous electric motor is a brushless dc (BLDC) motor. electric motor that is powered by direct current (DC) and which has a commutation that is electronically regulated. system rather than a system based on mechanical commutation brush on. For these motors, the voltage, current, and torque RPMs have a linear relationship. The electromagnets in a BLDC motor do not move; instead the armature is still while the permanent magnets spin static. This circumvents the issue of how to transfer current. to an armature in motion. This is accomplished through the brush systems. An electronic controller takes the place of assembly. The controller uses a solid state-static circuit rather than a commutator/brush system to carry out the same power distribution as in a brush dc motor.

2. DURABLE BLDC MOTOR STRUCTURES

Modern permanent magnet synchronous motors are built very similarly to brushless dc motors in terms of structure. An example of a three phase brushless dc motor is shown in Figure 1. The rotor is made up of one or more magnets, while the stator windings resemble those of a polyphase ac motor. In contrast to ac synchronous motors, brushless dc motors have magnetic poles that can be used to detect the position of the rotor and generate signals that operate electronic switches, as seen in figure 2. Although some motors use optical sensors, the hall element is the most typical position pole sensor [2].

Fig-1. Internal Structure of BLDC Motor



Two phases brushless dc motors are also frequently utilized for straightforward construction and drive circuits, despite the fact that Three Phase motors are the most outer box and efficient. The cross sections of a two-phase motor with an auxiliary salient a shown in Figure 3 [2].

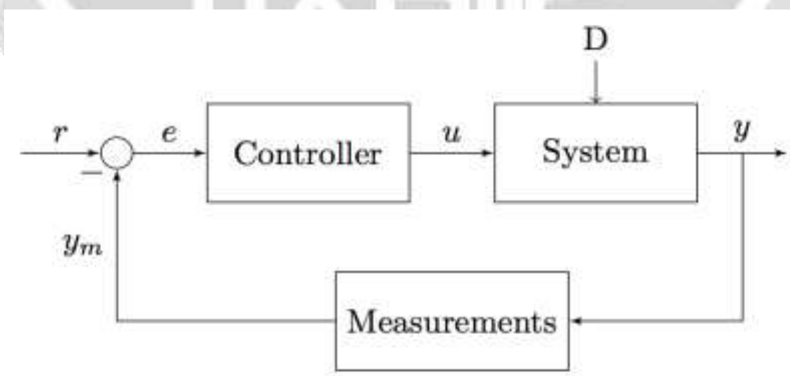


Fig-2 Block Diagram of BLDC Motor

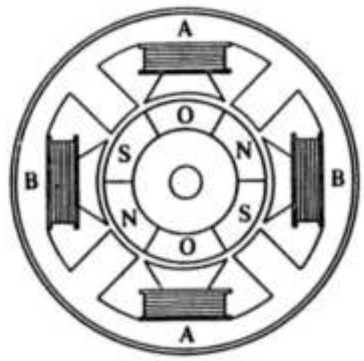


Fig-3 Double Phase BLDC Motor

3. BRUSHLESS DC MOTOR DESIGN

The proposed brushless DC motor will be constructed with in two stages. Phase A and Phase B are the two phases. When looking at Figure 4, the current is entering Phase A. by FA and is currently departing by SA. Phase B is the case. now using FB to exit and SB to enter. Should the two phases neutral pole will be when there is current flowing in the same direction. created. When two currents are flowing in opposing directions, there is necessary to build a pole. In that case, between SA and SB South A pole is produced. The rotor's North Pole will therefore make an effort to align with the stator winding's south pole.

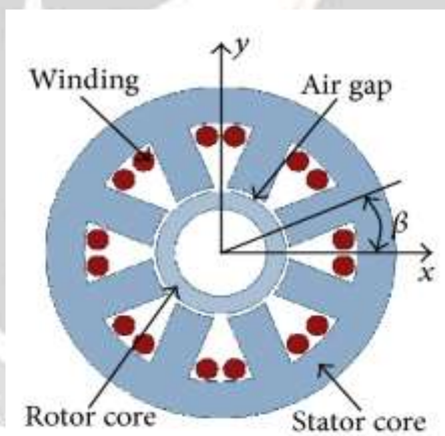


Fig-4. Brushless DC motor

As seen in picture 5, phase A's current entering is identical to that seen in figure 4. The current enters phase B through SB and exits through FB. In light of this, the south pole will move to its new location between SB and FA. Additionally, a neutral pole will be built between SA and SB. The rotor will attempt to align with this new position as a result. As a result, the rotor will rotate 45 degrees clockwise.

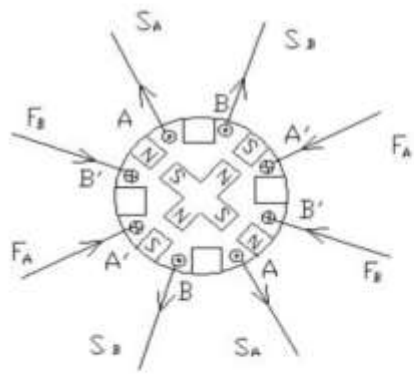


Fig-5. Brushless DC motor

Considering figure 6, the current entering phase B is identical to that in figure 5. Phase A's current enters through SA and exits through FA. In order to take up this new location between FA and FB, the south pole will move. There will be built a neutral pole between SB and SA. To correspond with this new position, the rotor will attempt to move. As a result, the rotor will turn another 45 degrees. The rotation is currently roughly 90 degrees in total.

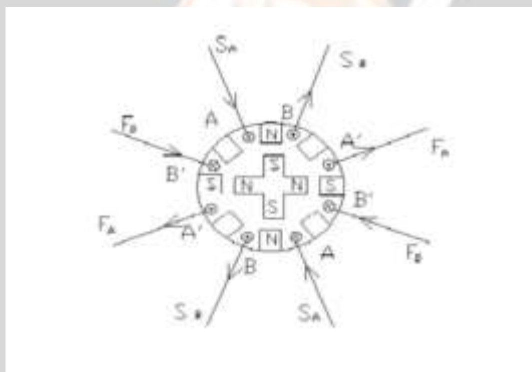


Fig-6. Brushless DC motor

Similar to figure 5, the current enters phase A in figure 7 for that phase. The current enters phase B via SB and exits via FB. As a result, the rotor's south pole will move to the new location. Thus, the rotor will rotate 45 degrees in the clockwise direction. The rotor will turn clockwise in this manner.

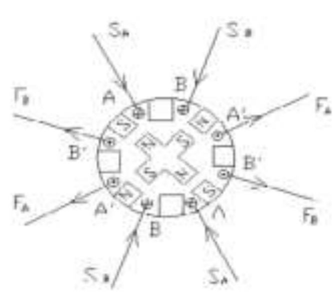


Fig-7. Brushless DC motor

When rotating counter clockwise, the switching will happen in the following order: figure 7, figure 6, figure 5, figure 4.

4. STATOR CURRENT SWITCHING

Semiconductor devices will be used to control the stator current's direction. The switches could be BJT or MOSFET. The positions of the switches are depicted in figure 8. Four switches connect each phase. S1, S2, S3, and S4 are their numbers. Phase A in Figure 4 now enters via FA and exits via SA. In order to flow the stator current from SB to FB in phase A, the figure 8 switch's S2 and S3 must be closed, while S1 and S4 must be open. The rotor will turn 45 degrees as a result. The corresponding switch in figure 8 will turn on and off for figures 5, 6, and 7.

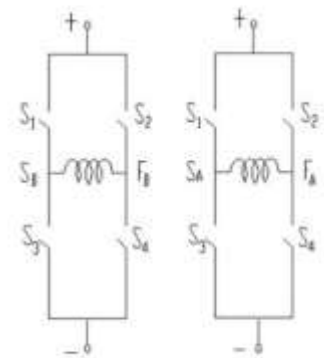


Fig-8. stator switching of phase B and phase B

Phase A switching is shown in Tables I and II. for various posts, Phase B. The precise table matches the stator switching discussions from earlier. The rotor advances from position 1 to position 2 for clockwise rotation. placement 4. The rotor moves in counter clockwise rotation. from place four to place one. the switch is turned on represented as binary one and the switch being turned off shown as a binary 0

TABLE I. For phase A(S_A-F_A)

Switch	Position 1	Position 2	Position 3	Position 4
S1	0	0	1	1
S2	1	1	0	0
S3	1	1	0	0
S4	0	0	1	1

TABLE II. For phase B(S_B-F_B)

Switch	Position 1	Position 2	Position 3	Position 4
S1	1	0	0	1
S2	0	1	1	0
S3	0	1	1	0
S4	1	0	0	1

The switch s2 and s3 are turned on for positions 1 and 2 for phase A, according to table I. And for positions 3 and 4, switches S1 and S4 are both turned on. Table II shows that for phase B, switches s1 and s4 are turned on for positions 1 and 4, and switches s2 and s3 are turned on for position 2. The switches for positions 1, 2, and 3 are all turned on.

Table-III: Switching Sequence of Clockwise And Counter Clockwise Rotation in Terms of Angle

Switch	0°	45°	90°	135°	180°	225°	270°	315°	360°
SA1	0	0	1	1	0	0	1	1	0
SA2	1	1	0	0	1	1	0	0	1
SA3	1	1	0	0	1	1	0	0	1
SA4	0	0	1	1	0	0	1	1	0
SB1	1	0	0	1	1	0	0	1	1
SB2	0	1	1	0	0	1	1	0	0
SB3	0	1	1	0	0	1	1	0	0
SB4	1	0	0	1	1	0	0	1	1

From Table-III

• The switches s1 and s4 are off and s2 and s3 are on during the A phase when the rotor position is 0 degrees. Switches s1 and s4 are turned on for B phase, whereas switches s2 and s3 are off.

• When the rotor is in the 45-degree position:

For the A phase, switches S1 and S4 are off, while S2 and S3 are on. For B phase, switches S1 and S4 are off, while S2 and S3 are on.

• When the rotor is in the on position, it is at a 90-degree angle:

For the A phase, switches S2 and S3 are off, while S1 and S4 are on. For B phase, switches S1 and S4 are off, while S2 and S3 are on.

• When the rotor is in the on position, the angle is 135 degrees:

For the A phase, switches S2 and S3 are off, while S1 and S4 are on. Switches s1 and s4 are turned on for B phase, whereas switches s2 and s3 are off.

• When the rotor is in the on position, the switches s1 and s4 are off and s2 and s3 are turned on for the A phase. Switches s1 and s4 are turned on for B phase, whereas switches s2 and s3 are off.

• At 225 degrees while the rotor is in the on position:

For the A phase, switches S1 and S4 are off, while S2 and S3 are on. For B phase, switches S1 and S4 are off, while S2 and S3 are on.

• The position is 270 degrees when the rotor is on:

For the A phase, switches S2 and S3 are off, while S1 and S4 are on. Switches s1 and s4 are turned on for B phase, whereas switches s2 and s3 are off.

• When the rotor is in the on position, the angle is 315 degrees:

For the A phase, switches S2 and S3 are off, while S1 and S4 are on. Switches s1 and s4 are turned on for B phase, whereas switches s2 and s3 are off.

• When the rotor is in the on position, it is in a 360-degree position:

For the A phase, switches S1 and S4 are off, while S2 and S3 are on. Switches s1 and s4 are turned on for B phase, whereas switches s2 and s3 are off.

In the discussions above, the user can alter the rotor position by adjusting the stator's phase A and phase B switching positions.

By doubling the common part of the switching sequence, Figure 9 depicts a wave pattern. The controller circuit design requires knowledge of the wave shapes. For each position where a switch is flipped, the waveform described will turn on and off.

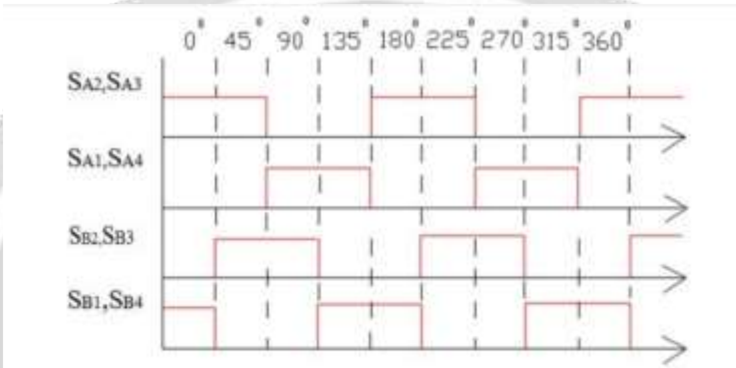


Fig-9 Waves Based on Table-3

Degrees	C1	C2	C3	C4	CW/ CCW	A14	A23	B14	B23
0°	1	0	0	0	0	0	1	0	1
45°	0	1	0	0	0	1	0	0	1
90°	0	0	1	0	0	1	0	1	0
135°	0	0	0	1	0	0	1	1	0
180°	1	0	0	0	0	0	1	0	1
225°	0	1	0	0	0	1	0	0	1
270°	0	0	1	0	0	1	0	1	0
315°	0	0	0	1	0	0	1	1	0
360°	1	0	0	0	0	0	1	0	1
315°	0	0	0	1	1	0	1	1	0
270°	0	0	1	0	1	1	0	1	0
225°	0	1	0	0	1	1	0	0	1
180°	1	0	0	0	1	0	1	0	1
135°	0	0	0	1	1	0	1	1	0
90°	0	0	1	0	1	1	0	1	0
45°	0	1	0	0	1	1	0	0	1
0°	1	0	0	0	1	0	1	0	1

Table-IV: Truth Table of Sensor Output for Clockwise and Counter Clockwise Direction

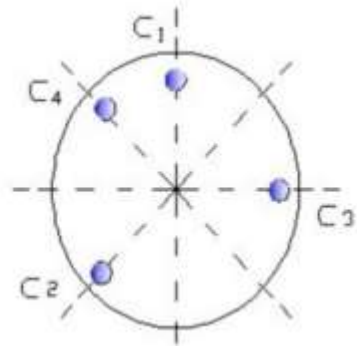


Fig-10: Sensor Position for BLDC Motor

The C1, C2, C3, and C4 sensors are connected to the such as the BLDC motor in figure 10. Let's look at the tables. IV, BLDC motor signals are arriving from sensors as depends on the rotor position for input. According to that, the stator current will be managed by a controller circuit. in the desk A different signal IV termed CW/CCW will be used. define. Thus, this signal is controllable by the user. According if the user enters 1 (high) on CW/CCW into table IV. pin, the rotor will turn in a clockwise direction. If the user agrees to the rotor will rotate if the CW/CCW pin is set to 0 (Low). Counter clockwise. If the rotor is, take into account the figure 3.20. precisely on the location of Sensor C1, and C1 is therefore interrupted. C2, C2, and C3 are low since C1 is high (logical 1). Now, if the user would provide a high (1) CW/CCW value, the 45-degree signal must be provided by the controller circuit to Rotor angle adjustment from 0 to 45 degrees. Then A23 and B23 According to the wave form, are low, A14 and B14 are high. Likewise from 45 degrees to 90 degrees, 90 degrees of figure 9. 180 degrees to 135 degrees, 135 degrees to 180 degrees, and 225 degrees degree, between 225 and 270, and between 270 and 315 from 315 to 360 degrees.

5. CONTROLLER DESIGN USING MICROCONTROLLER:

The controller circuit based on a microcontroller is finished. simulated with proteus software and an at mega 32 processor. Despite the challenges we have in obtaining sensors, the Annual switches provide the sensor signal. We have restrictions on purchasing brushless dc motors as well LEDs are used to represent the stator winding. The LEDs are used to display the current's direction. In the stator windings replace the LEDs in the main circuit DC motor without brushes. Considering figure 13, the four manual input the sensors that are connected are shown as c1, c2, c3, and c4. using the engine.

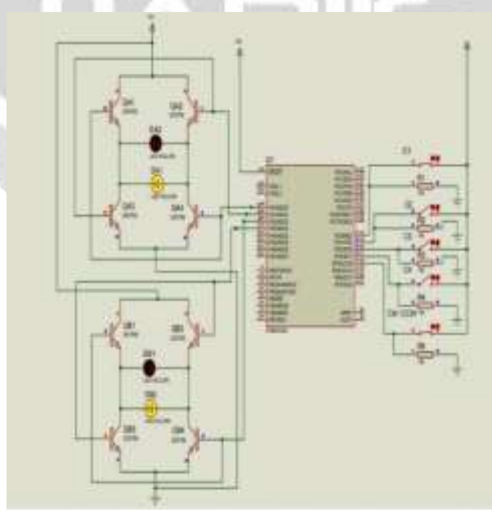


Fig-11. Microcontroller control circuit

6.CONCLUSION:

A novel, less expensive, and clearer BLDC motor controller method has been given. Microcontrollers are used to model and analyse brushless DC motor controllers. The outcomes of simulations assist in creating hardware that produces the desired outcomes. The new aspect of the suggested BLDC controller architecture is that it is inexpensive, easy to install, and can use readily available, low-cost microcontrollers and ICs. The entire BLDC controller that was designed in the past is pricey and challenging to understand. However, the suggested controller is simpler to grasp, and this makes it ideal for usage in a variety of applications.

7.REFERENCES

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