



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 3, March 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com



Control and Analysis of BLDC Motors Using Artificial Neural Networks

Mr. Swapnil U.Nalawade¹, Prof.M.S.Potdar²

PG Student, Dept. of Electrical Engineering, P.E.S College of Engineering, Aurangabad, Maharashtra, India¹

Associate Professor, Dept. of Electrical Engineering, P.E.S College of Engineering, Aurangabad, Maharashtra, India²

ABSTRACT: A simple network having input, output, and hidden layers and a collection of nodes is known as an Artificial Neural Network (ANN). Because ANN algorithms handle binary data more precisely, their use in electrical and electronics engineering always produces the desired outcomes. Because of its high speed, low maintenance, and great torque capability, the BLDC motor finds additional uses. Electronic closed-loop controllers switch DC current to the motor windings and produce magnetic fields in brushless direct current motors (BLDC motors). The speed of a BLDC motor can be regulated by altering the DC input voltage of the bridge converter that supplies the motor winding, according to this article. A PI-based speed controller is used to control the system. A PI controller is used to control the speed of the motor, which is modelled in MATLAB/Simulink.

KEYWORDS: Artificial Neural Network (ANN), Brushless Direct Current Motors, PI controller, MATLAB/Simulink.

I. INTRODUCTION

The most frequent motors seen in electric cars are brushless DC motors. Electric cars often have more than two motors for propulsion. A BLDC motor is a synchronous motor with a direct current supply. In BLDC motors, the mechanical commutator is replaced by an electronic servo system, which improves the accuracy of detecting rotor angle and control switches. Closed loop electronic controllers are also used to turn things on and off. The speed control of BLDC motors is critical in current control systems. Open-loop and closed-loop control systems are the two most common forms of control systems. The inner control loop is the torque or current loop, and the outer control loop is the voltage or speed loop, resulting in dual closed-loop control. The Pulse Width Modulation approach is used to change the motor's input voltage when it runs at a lower speed than the rated speed. When the motor runs faster than the rated speed, the flux is weakened as the exciting current or auxiliary flux is advanced. There have been several techniques to controlling the speed of BLDC motors proposed. Artificial intelligence is progressing in lockstep with computer technology, and it is increasingly being used to electrical and electronics engineering simulation data. In this paper, the speed control of BLDC motors is simulated using MATLAB/Simulink. The simulation's data is gathered and fed into an artificial neural network model. The TensorFlow library is used to train the data in ANNs. Different ANN topologies are proposed for different simulation data in order to achieve the best results.

II. BLDC MOTOR

A brushless DC motor is one that is devoid of brushes. There are no brushes or commutator, as the name implies. In a BLDC motor, commutation is accomplished by the use of an electronic circuit, which eliminates mechanical losses and boosts efficiency. If inefficient motors are replaced with more efficient BLDC motors, significant energy savings will be realised. A BLDC provides a number of advantages over other machine types. Because the mechanical commutator is no longer used, they require less maintenance. It also has a high power density. In comparison to induction motors, BLDC motors have reduced inertia, allowing for faster dynamic response to reference commands [1].

Because rotor magnets generate the magnetic flux in a BLDC motor, it has a higher efficiency [6]. Because of their outstanding performance in terms of high efficiency, quick reaction, and weight, precise and accurate control, high reliability, maintenance-free operation, brushless construction, and decreased size, it has become possible. There is a high torque-to-motor-size ratio, as well as thermal overload and under-load protection [7, 8, 9].

III. EXISTING SYSTEM

The use of an efficient and low-cost controller based on FPGA programming to control the speed of a BLDC motor is demonstrated by R. M. Pindoriya et al. [2]. This control has the potential to be used in a low-cost application because



of its simplicity. The modelling and testing findings confirmed the efficiency of the sinusoidal PWM technique for BLDC motor speed control and practical applications. R. Kandiban and R. Arulmozhiyal [3] discuss the performance of traditional PID controllers, fuzzy PID controllers, and adaptive fuzzy PID controllers. By utilising a standard PID controller, it is difficult to tweak the settings and get satisfactory control characteristics. Because the Adaptive Fuzzy has the capacity to satisfy control qualities while also being simple to compute, it is a popular choice. The results show that the Adaptive Fuzzy PID controller outperforms both the Fuzzy PID controller and the traditional PID controller in terms of control performance.

FarazdaqRafeeqYasien and Roaa Abbas Mahmood [4] offer a new BLDC motor control system that eliminates Hall sensor feedback signals and relies solely on the motor speed feedback signal. To generate PWM switching to three phase inverter derivation, a new control system using the space vector modulation (SVPWM) technology. The BLDC motor's speed was controlled using a PI controller. The sensor-less control system introduced by A. V. G. A. Marthanda and Dr. G. V. Marutheswar [5] provides a simple and high-performance motor drive. In addition, a maximum torque per ampere block is used to maximise torque generation efficiency without having to calculate the power factor angle. Because of its turn-off phase and trapezoidal back electromotive force, the space vector modulation (SVPWM) of a Brushless DC motor (BLDC) differs from that of a permanent magnet synchronous motor.

IV. PROPOSED SYSTEM

The proposed technique provides an efficient way to control a Brushless Direct Current Motor (BLDC). The proposed solution is based on adjusting the bridge converter's input DC voltage. The bridge converter's input DC voltage is controlled because it feeds the motor windings, which form a magnetic field and rotate the motor. The proportional integral controller is used to control the DC voltage input to the bridge converter (PI). The key gains, such as the Proportional and Integral gain parameters, are crucial. They have an impact on the PI controller's overall performance. For the given input, the PI controller is used to generate the same output, i.e., non-integration output. The difference between the actual and reference values is used to calculate the PI controller error.

V. SIMULATION AND RESULTS

MATLAB/Simulink is used to model the system. A bridge converter, BLDC motor, PI controller, and other electrical components are included in the circuit to replicate the system. The suggested system's circuit diagram is shown in Figure 1 using Simulink.

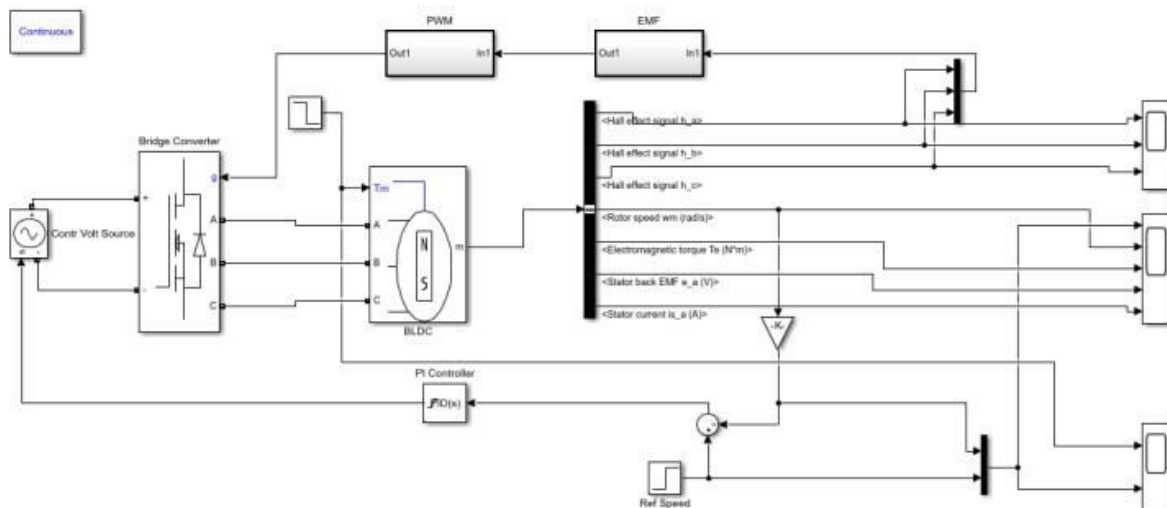


Figure 1 Circuit Diagram of the Proposed System using Simulink

The graphs in Figure 2 show time vs load torque and time versus actual and reference speed. Time is represented by the first X axis, which ranges from 0-75 seconds. For both plots, the X axis is identical. The BLDC motor's load torque is contained in the Y axes, which settles at 12 Newton-meter after around 50 seconds.

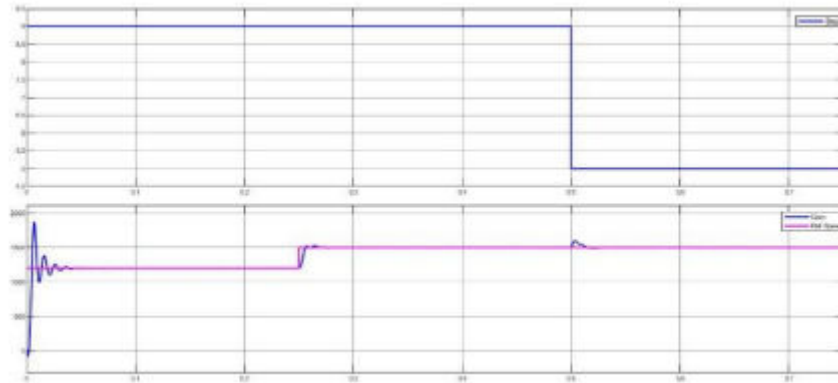


Figure 2 Load Torque (Nm), Reference and Actual rotor speed (rpm)

4 Y axes and a common X axis are shown in Figure 3. The time interval for the X axis is 0–75 seconds. Rotor speed, electromagnetic torque, stator back emf, and stator current are all represented on the Y axis.

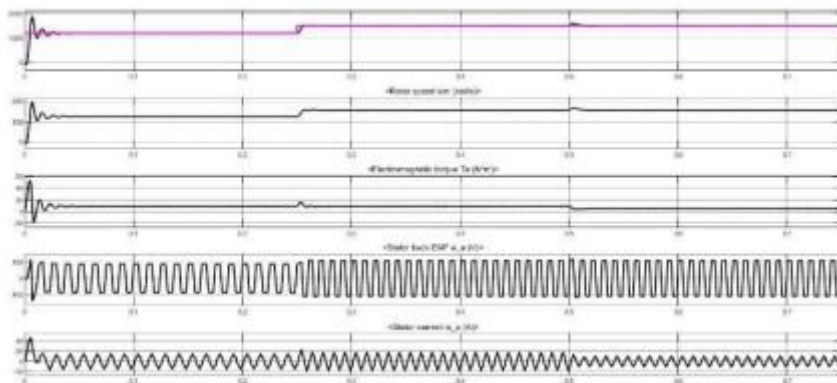


Figure 3 Reference and actual rotor speed (rpm), rotor speed (rad/sec), electromagnetic torque (Nm), Stator back emf a-phase (V), Stator current a-phase (A)

The BLDC motor's emf is shown in Figure 4. The X axis represents time, whereas the Y axes represent EMF a, EMF b, and EMF c. The EMF a, b, and c are constantly changing from - 1 to 1, i.e., [-1,0,1].

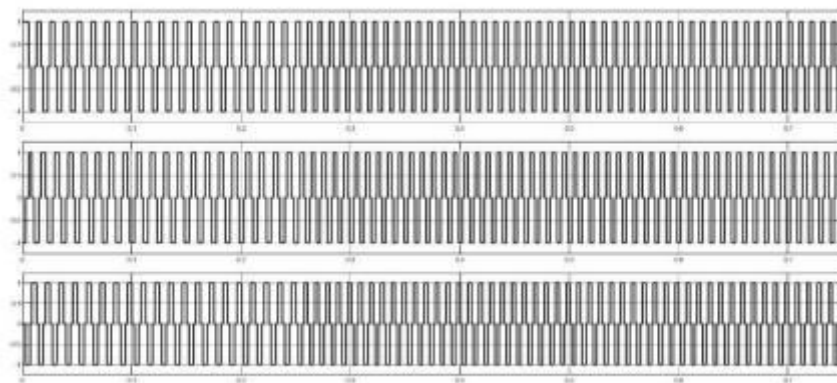


Figure 4 EMF a, EMF b, EMF c (V)

The X axis in Figure 5 represents the time interval 0 – 75 seconds. PWM A, PWM B, PWM C, PWM D, PWM E, and PWM F are the six PWM signal parameters on the Y axis.

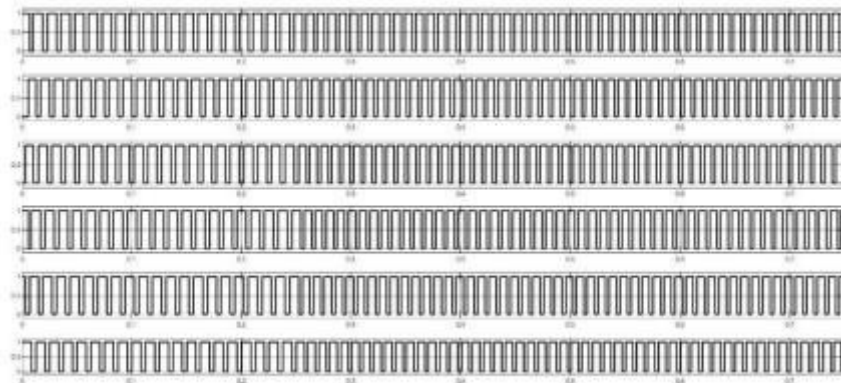


Figure 5 PWM signals

The time is measured along the X axis in Figure 6. Along the Y axis, Hall Signal A, Hall Signal B, and Hall Signal C. The Hall signal ranges from 0 to 1 depending on the time.

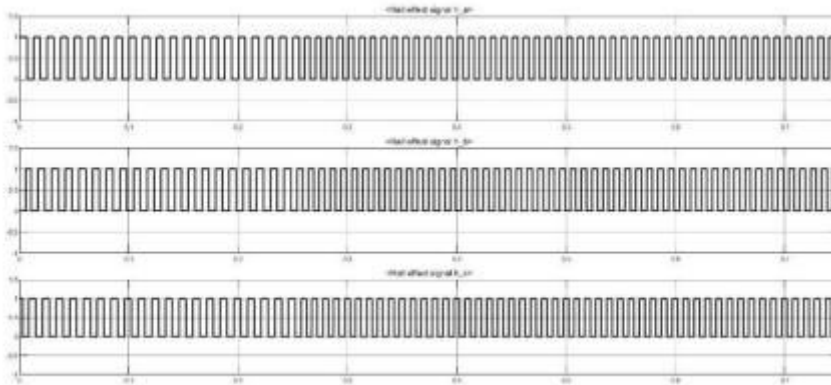


Figure 6. Hall Effect signals

VI. RESULTS

The data from the Brushless Direct Current motor simulation with PID controller simulation is collected in an excel sheet and then converted to a.csv file. Multiple parameters derived from simulation results are compared and fed into an Artificial Neural Network (ANN) (ANN). The experiment begins with the selection of parameters to compare, which are then fed into an artificial neural network (ANN) developed specifically for it.

VII. CONCLUSION

An efficient approach for controlling the speed of a BLDC motor is proposed in this research. The proposed method works by regulating the DC voltage input of the bridge converter that feeds the motor windings. A PI controller is used to control the input. The data is loaded into a binary Artificial Neural Network for various parameters derived from the simulation in the suggested system. The simulated results and the predicted result are identical. Each layer's activation function and neuron are changed and analysed in relation to the input data.

REFERENCES

- [1] A. Aboulnaga, P. C. Desai, F. Rodriguez, T. R. Cooke, and A. Emadi, "A novel low-cost high-performance single phase adjustable-speed motor drive using PM brushless DC machines: IIT's design for 2003 future energy challenge," in Proc. 19th Annu. Anaheim, CA, Feb. 2004, pp. 1595-1603.
- [2] R. M. Pindoriya, S. Rajendran, P. J. Chauhan, "Speed Control of BLDC Motor using PWM Technique", International Journal of Advance Engineering and Research Development (IJAERD) ETCEE-2014 Issue, March 2014.



- [3] R.Kandiban and R.Arulmozhiyal, “Speed Control of BLDC Motor Using Adaptive Fuzzy PID Controller”, Procedia Engineering, Elsevier, Volume 38, 2012, Pages 306-313.
- [4] FarazdaqRafeeqYasien and Roaa Abbas Mahmood , “Design New control System for Brushless DC motor Using SVPWM”, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 1, 2018, pp. 582-589.
- [5] A.V.G.A.Marthanda and Dr. G. V. Marutheswar, “A Three Phase Sensor Less Field Oriented Control For BLDC Motor”, International Journal of Advance Engineering and Research Development, Volume 4, Issue 11, November 2017.
- [6] Dian-Sheng Sun, Xiang Cheng, Xu-Qiang Xia “Research of Novel Modeling and Simulation Approach of Brushless DC Motor Control System”, IEEE, 2010.
- [7] Radu Duma, Petru Dobra, Mirela Dobra &IoanValentinSita,”Low Cost Embedded Solution for BLDC Motor Control”, Manuscript received August 23, 2011.
- [8] R.NejatTuncay, OzgurUstun, Murat Yilmaz, Can Gokce, UtkuKarakaya, “Design and Implementation of an Electric Drive System for In-Wheel Motor Electric Vehicle Applications”, IEEE, 2011.
- [9] S.S.Bharatkar, RajuYanamshetti, D.Chatterjee, A.K.Ganguli, “Performance Comparison of PWM Inverter Fed IM Drive & BLDC Drive for Vehicular Applications”, IEEE, 2009
- [10] Sachin S. Bharatkar, RajuYanamshetti, D. Chatterjee, A.K. Ganguli, “Performance Comparison of an efficient IM Controller and BLDC Drive for Vehicular Applications”, Journal of Modelling and Simulation of Systems, 2010, Vol.1/issue.3.
- [11] Fang Lin & Hock Guan Yea,” Advanced PM Brushless DC Motor Control & System for Electric Vehicles” IEEE, 2000.
- [12] P. Devendra, Madhavi TVVS, K Alice Mary, Ch. Saibabu,“Microcontroller based control of three phase BLDC motor”, Journal of Engineering Research & Studies, Volume II, Issue IV, October-December 2011.



**Impact Factor:
7.569**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details