International Journal of Electronic and Electrical Engineering.
ISSN 0974-2174, Volume 7, Number 3 (2014), pp. 321-326

http://www.irphouse.com

# Performance Analysis of Brushless DC Motor Using Intelligent Controllers and Minimization of Torque Ripples

**Vishal Srivastava[1], Ashish Chourasia[2] and Shaba Anjum[3]**

[1,2,3]*Electrical Engineering Department, Delhi Technological University, Delhi*

**Abstract**

Brushless DC motor (BLDCM) is a high performance, low maintenance cost, adequate torque, high speed, high reliability motor and widely used in industries having several advantages over other type of motors. The reason of popularity is due to its simpler speed control with enhanced performance by the use of electronic commutation. The above mentioned characteristics and properties of BLDC motor provide a large research domain in Electrical drives. This paper presents a simulation study of Speed Control of BLDC motor for performance analysis and comparison using intelligent controller (ANFIS) with conventional controller (PI, PID). The further study will be used for minimizing the ripples in Torque and Speed along with admissible current control. The simulation study and analysis of results will form the basis of the conclusion.

**Keywords**: Brushless DC motor (BLDCM), Electronic commutation, Speed Control, ANFIS (intelligent controller), PI, PID (Conventional Controller), Ripples.

## 1. Introduction

The Permanent Magnet Brushless DC (BLDC) motor is the ideal choice for applications that require high power-to volume ratio, high reliability, and high efficiency. BLDC motor is considered to be a high performance motor and is capable of providing large amounts of torque over a vast speed range. BLDC motors are a derivative of the most commonly used DC motor and they share the same torque and speed performance curve characteristics.[5]. A BLDC motor requires an inverter and a rotor position sensor to perform commutation process because a permanent magnet synchronous motor does not have brushes and commentators in DC motors [5].

Consumers now demand for lower energy costs, better performance, reduced acoustic noise, and more convenient features [4]. These BLDC motors are not limited to household applications, but these are suitable for other applications such as medical equipment's, transportation, HVAC, motion control and many industrial tools [6]. ANFIS controller provides feasibility and easy in accessing the controllers in terms of linguistic variables .Schemes based Adaptive Neuro-Fuzzy Controller Based on Emotional Learning Algorithm [2-4] meant for speed control of brush less direct current (BLDC) drives have been implemented. The modeling and simulation analysis for BLDCM which provides a good foundation and method for system design and verifying intelligent control strategy. The performance is observed with Conventional Speed controller and ANFIS speed controller and comparison is done to know which gives the better results. The drive system is dependent on the position and current sensors for control.

## 2. Control Schemes for Speed Control of BLDC motor drive system

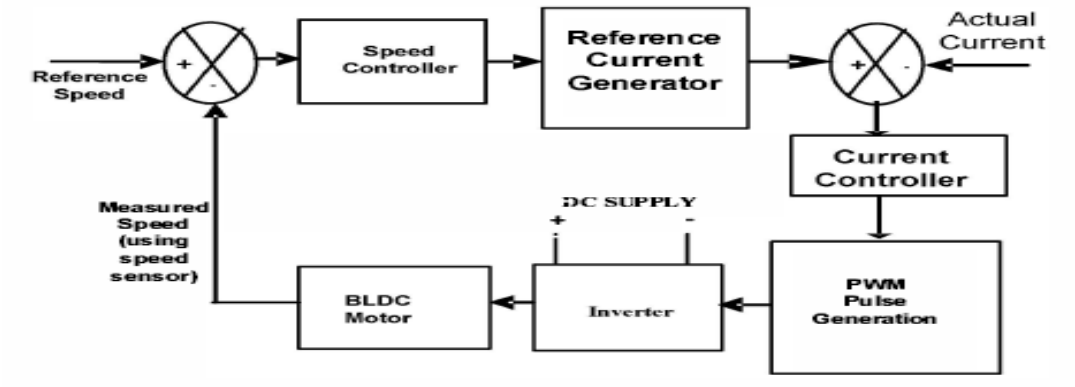



**Fig. 1**

**Conventional Speed Controller-** The actual speed of BLDC motor is obtained using the speed/position encoder and is compared with the set value and the error is processed by the Conventional speed controller as shown in Fig.1 to get the reference torque.

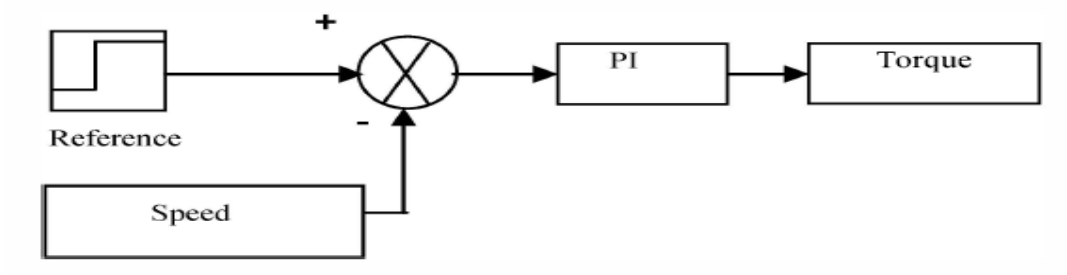



**Fig. 2**

**ANFIS Speed Controller-** The ANFIS Controller does not require a mathematical model of the system and it works on a structure prepared from the knowledge base. In ANFIS Speed controller the inputs used are the speed error and rate of change of speed error.

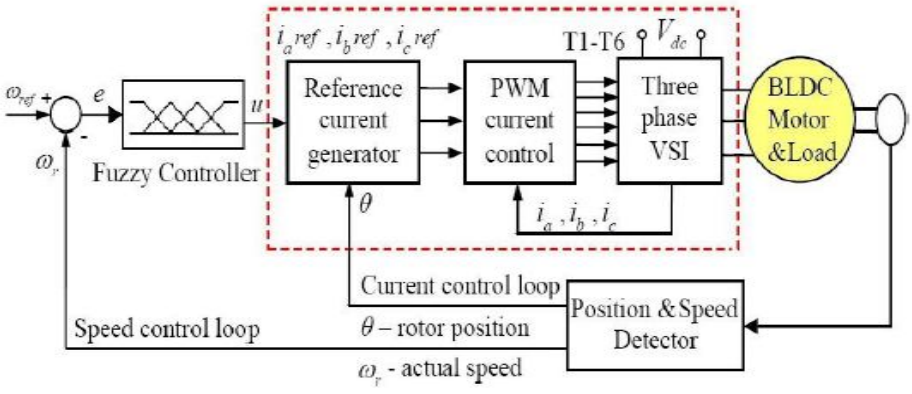



**Fig. 3**

## 3. Implementation of Simulation Model in MATLAB/ SIMULINK

According to the mathematical model given above, the complete motor drive is simulated in MATLAB/ SIMULINK environment. A double-loop control scheme is used in this system, where the outer loop is speed loop with PI controller and the inner loop is current loop with hysteresis controller. The entire drive is divided into several functional blocks, which includes BLDCM body block, speed PI controller block, current hysteresis controller block, current reference block, inverter block and commutation logic block. By the logical combination of these blocks, the simulation model of BLDCM drive is implemented.

## 4. Simulink Model of Speed Control of Brushless DC using Conventional Controllers

### 4.1 With Conventional Controller

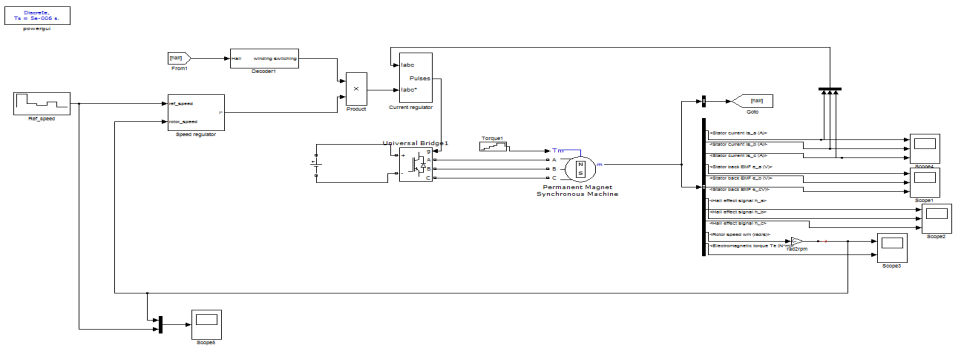


**Fig. 4**

### 4.2 With ANFIS Controller

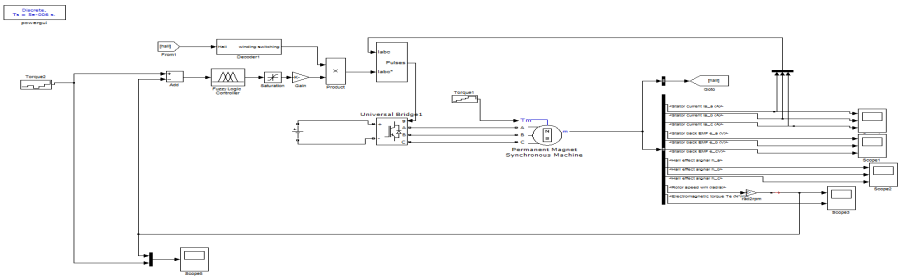
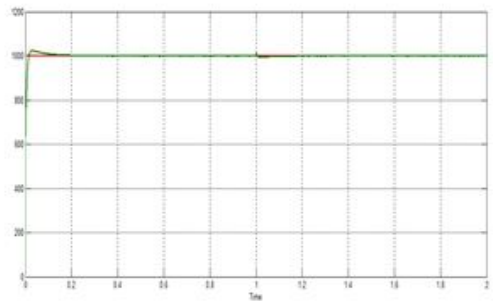


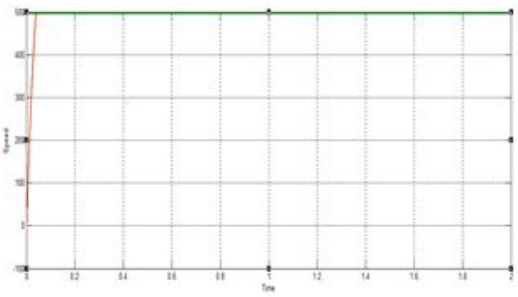
**Fig. 5**

## 5. Simulation Results

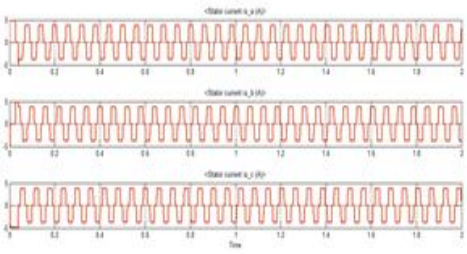
Modeling and simulation of a 3 phase, 4 poles, and 6.2 Nm PMBLDC motor is carried out using MATLABI SIMULINK. The performance characteristics are presented. The purpose of the simulation is to evaluate the performance of the PMBLDC drive system when Conventional speed controller is used and comparing its performance when ANFIS speed controller is used. By using ANFIS controller the speed is improved and current as well as Torque come in admissible value and ripples is also minimized.



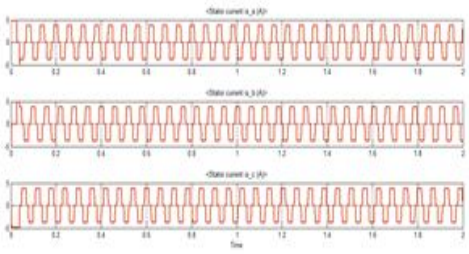
Speed



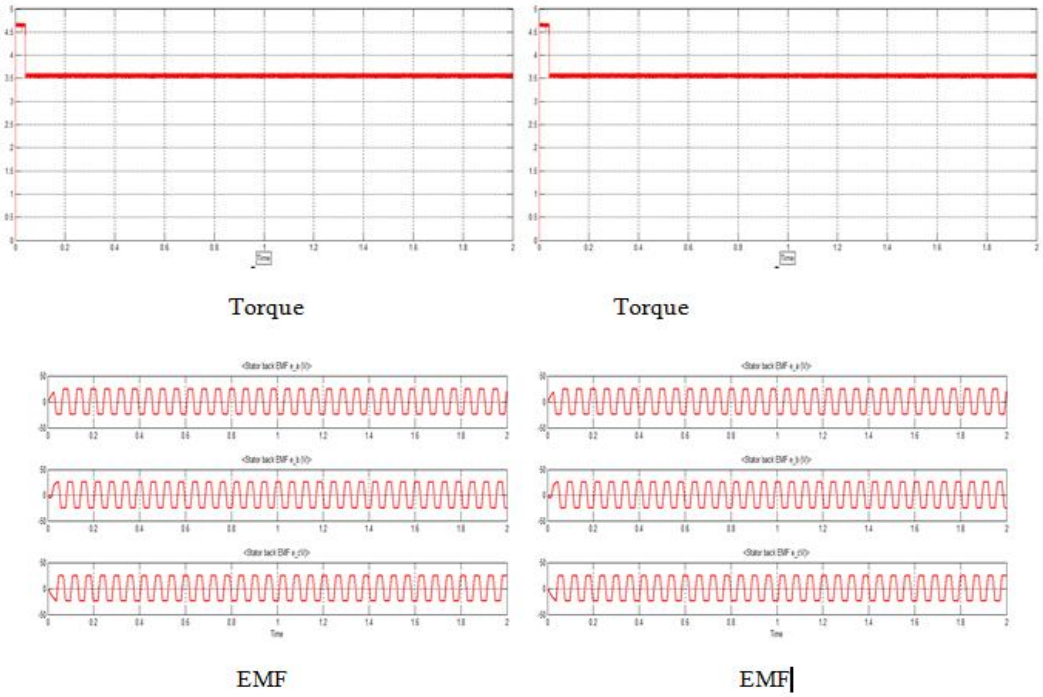
Speed



Current



Current




(a) With Conventional Controller (b) With ANFIS Controller

## References

[1] Pragasan Pillay and R. Krishnan,"Modeling Simulation and Analysis of Permanent Magnet Motor Drives, Part II: The Brushless DC Motor Drives", in IEEE Trans. on Industrial Applications, vol. 25, no. 2, pp. 274-279, MarchiApril 1989.

[2] Pragasan Pillay and R. Krishnan,"Modeling of Permanent Magnet Motor Drives", in IEEE Trans. On Industrial Electronics, vol. 35, no. 4, pp. 537-541, November 1988.

[3] R. Krishna, “electric motor drives” (modeling, analysis and control), low price Edition.

[4] A. Halvaei Niasar, A. Vahedi, H. Moghbelli "Speed Control of a Brushless DC Motor Drive via Adaptive Neuro-Fuzzy Controller Based on Emotional Learning Algorithm," International Conference on Electrical Machines and Systems (ICEMS), vol. 3, pp 230-234, 2005.

[5] Chung-Jin Kwon, Woo-Yong Han, Sung-Joong Kim and Chang-Goo Lee "Speed Controller with Adaptive Fuzzy Tuning For BLDC Motor Drive Under Load Variations" at SICE Annual Conference in Fukui, pp 311S-3121,2003.

[6] Chang Liang Xia, *Permanent Magnet Brushless DC Motor Drives and Controls*, Wiley Press, Beijing, 2012

[7] . Moreno, M. E. Ortuzar and J.W. Dixon, "Energy-management system for a hybrid electric vehicle, using ultracapacitors and neural networks," *IEEE Trans. Ind. Electron.*, vol.53, no.2, pp. 614- 623, April 2006.

[8] A. Rubai, A. Ofoli, and M. Castro, dSPACE DSP-Based Rapid Prototyping of Fuzzy PID Controls for High Performance Brushless Servo Drives, *IEEE Industry* Applications Conference, 41st IAS Annual Meeting, page(s):1360–1364, 2006.