COMPARATIVE STUDY OF VARIOUS SPEED CONTROL METHODS FOR BLDC MOTOR

Pravina K. Rajput[1], Dhaval M Patel[2], Nilesh D. Rabara[3]
[1]M.E (4th Sem), [2]Asst. Professor
[1,2,3]Electrical Engineering Department
[1,2]Merchant Engineering College, Basna, [3]L. D. Engineering College, Ahmedabad.

Abstract: This paper including the details of the BLDC motor structural overview. You can see the different type of speed control methods & comparative study for BLDC motor like PI, PID, Fuzzy, Neural Network etc. From these method PI & PID are Conventional speed control method but these methods don't give the accurate result of speed control and response. Remains Fuzzy control and Neural Network control system gives better output then conventional methods. In this paper we compare the different method of speed control. Proposed the Neuro-Fuzzy method for BLDC motor speed control.
Keywords: Introduction, Operation Principle of the BLDC motor, Comparison of the various Speed control methods, Limitation of PI & PID methods, Advantage of Fuzzy and Neural Network, Proposed methods, Conclusion.

I. INTRODUCTION

Permanent magnet Brushless DC (BLDC) motors are becoming very popular rapidly in industries such as automotive, aerospace, consumer, medical, industrial automation equipment and instrumentation because of their high efficiency, high power factor, silent operation, compact form, reliability, and low maintenance[1]. As the name suggests i.e. it does not require any type of brushes for commutation purpose. It requires electronic switches. Moreover it has better Speed-Torque Characteristics compared to other motors. It require sensing elements to sense the rotor position of the motor, however we can use hall sensor for sensing. It offers long operating life, noiseless operation, high efficiency & high dynamic response.

A. STATOR

The stator consists of stacked steel laminations. It has stator windings connecting in star phase. One or more coils are placed in the slots and they are interconnected to make a winding.

B. ROTOR

The rotor is made of permanent magnet & can vary from two to eight pole pairs with north & south poles. Ferrite magnets are used to make a permanent magnet. The rotor & hall sensor of the motor is shown below,

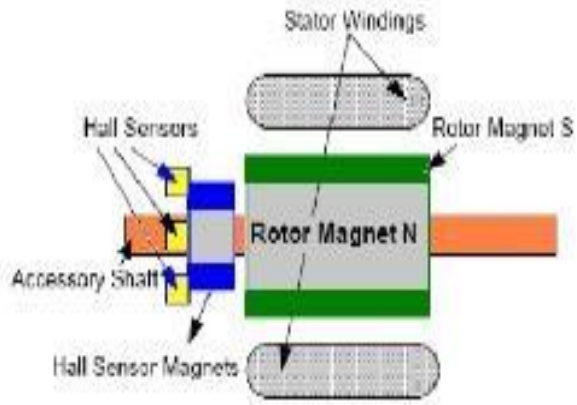

Fig.1 BLDC motor construction [1].

II. BLDC MOTOR OPERATION PRINCIPLE

Brushless dc motor defined as permanent magnet synchronous motor. It is generally controlled with three phase Semiconductor Bridge. BLDC motor works according to six states and in every state two phase working principle is similar. The motor require sensor for rotor position. The equivalent circuit of BLDC motor is shown below,

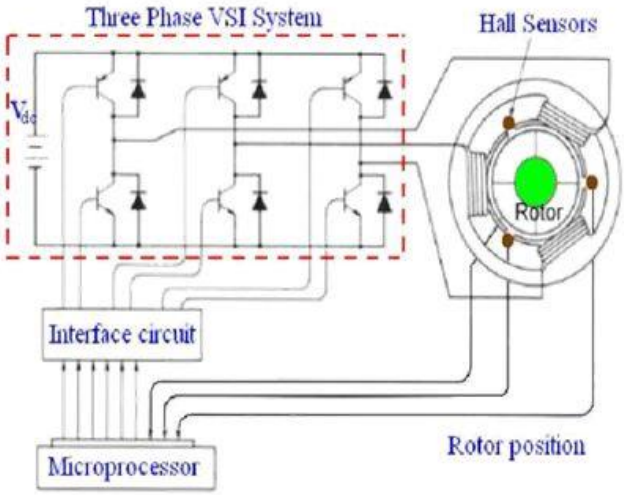

Fig. 2 Circuit of BLDC motor with switches [1]

In this circuit three phase VSI system is connected with the rotor of the BLDC motor & also we use hall sensor for sense the rotor position. The trapezoidal back emf of three phase BLDC motor is shown below.

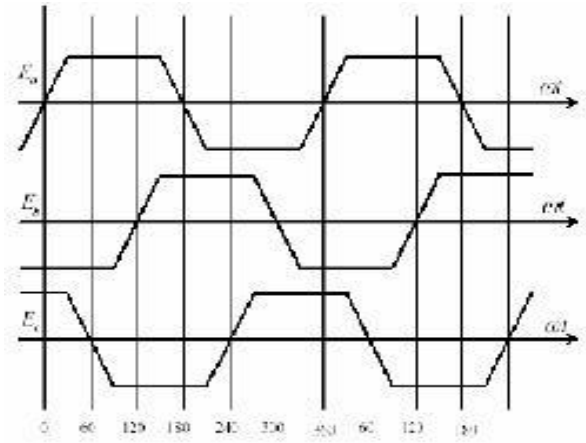

Fig. 3 Back EMF Wave form [3].

III. COMPARISON OF THE VARIOUS SPEED CONTROL METHODS FOR BLDC MOTOR

A. Using PI Controller

The speed of the motor using pi controller is shown below, for this speed is obtained through MATLAB Simulink.

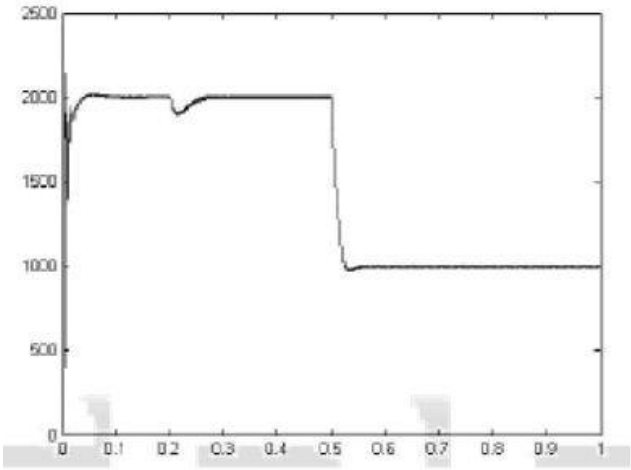

Fig. 4 speed of motor using pi controller

In this diagram the overshoot is described, so we could not opt the linear graph for speed. That's why this is one of the reason why it is not used in recent.

B. Using PID controller

The diagram for PID control is shown below,

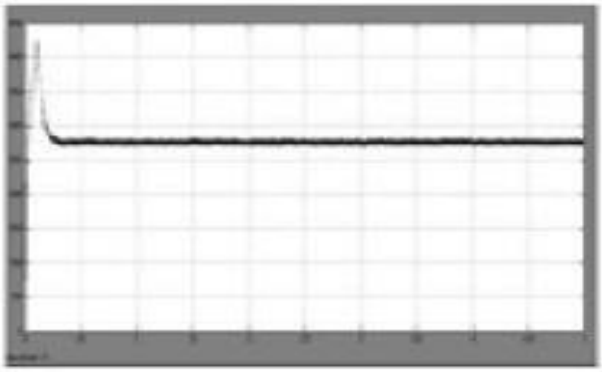

Fig. 5 speed for PID controller

With PID control the program tends to complicated because a special algorithm is necessary as compensation on the reduction of current sensor. With
PID control we don't get accurate result of speed.

C. Using fuzzy logic controller

In this diagram, we can see a small starting overshoot. Therefore the same is to be considered as nearly linear graph and this way it provides good result compared to above methods.

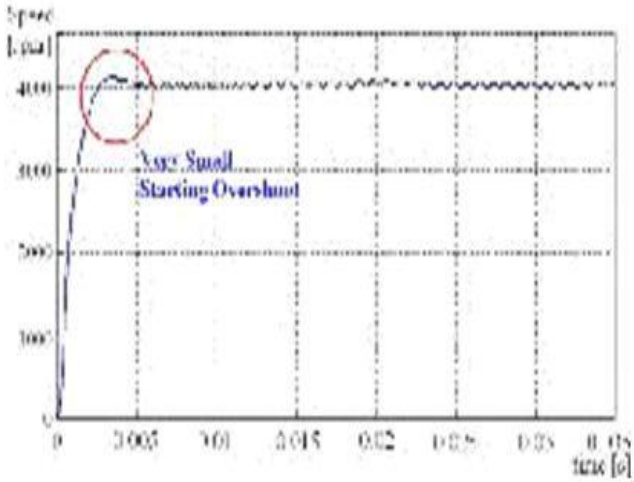

Fig. 6 Speed for fuzzy logic [1].

D. Using Neural Network base controller

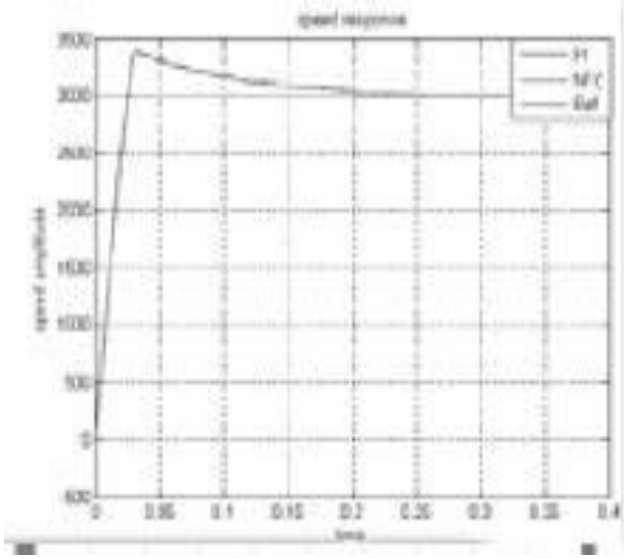

Fig. 7 speed for Neural Network method

From the figure Neural network control give the better result than other methods. It gives lower overshoot & shorter settling time.

PI	**PID**	**Fuzzy**	**Neural**
It does not increase the speed of response	It used for dealing with high capacitive process.	Fuzzy is used to increase the speed of response	It is used for training algorithm
We don't used for higher order terms.	We don't get accurate result.	We get nearly accurate result.	We get good result of speed

Table 1. Comparison Table for various Speed control Methods

IV. LIMITATIONS OF PI & PID METHODS

PI control does not increase the speed of response & don't give accurate result. PID control is used for dealing with higher order capacitive process. In this type of controller first we convert nonlinear system to linear system & then we perform. With PID control the program tends to complicated because a special algorithm is necessary as compensation on the reduction of current sensor. With PID control we don't get accurate result of speed. So we required another method for accurate answer. PI controller does not have means to predict what will happen with the error in near future. PI controllers are very often used in industry, especially when speed of the response is not an issue. In PID controller we required tuning methods, which has many disadvantages, that's why we don't use conventional controller (PI, PID) for control the speed.

V. ADVANTAGE OF FUZZY CONTROL AND NEURAL NETWORK CONTROL METHODS

Intelligent control, act better than conventional adaptive controls. Artificial intelligent techniques divide two groups: hard computation and soft computation. Expert system belongs to hard computation which has been the first artificial intelligent technique. In recent two decades, soft computation is used widely in electrical drives. They are, [4]

- Fuzzy Logic Control
- Neural Network based Control

A) Fuzzy Logic Control

In the first concept, the controller is represented as a set of rules, which accepts/gives the inputs/outputs in the form of linguistic variables. The main advantages of such a controller are: [4]

- Approximate knowledge of plant is required
- Knowledge representation and inference is simple.
- Implementation is fairly easy.

B) Neural Network based Control

In the second concept, the controller is represented as a nonlinear map between the inputs and outputs. Depending on a specific plant, the map (in the form of a network) can be trained to implement any kind of control strategy. A neuro controller (neural networks based control system) performs a specific form of the adaptive control with the controller taking the form of a multi layer network and the adaptable parameters being defined as the adjustable weights. The main its advantages are: [4]

- Parallel architecture
- Any kind of nonlinear mapping is possible
- Training is possible for various operating conditions,

VI. PROPOSED METHODS FOR BLDC MOTOR

We can use ANFIS architectures for implementation of adaptive NFC. The ANFIS implements fuzzy inference system with NN architecture. The proposed controller integrates ideas of the FLC and NN structure into an intelligent control system. The nodes in the hidden layers perform as membership functions and fuzzy rules. Initially, the proposed controller is constructed from the fuzzy IFTHEN rules, which are based on a simple engineering Knowledge regarding the controlled BLDC drive system. To learning for the proposed NFC, instead of the traditional EBP through system method, the supervisory learning procedure is used. The proposed controller is used for speed and torque control of a BLDC motor drive. The performance of the designed controller is demonstrated by MATLAB/SIMULINK simulation results.

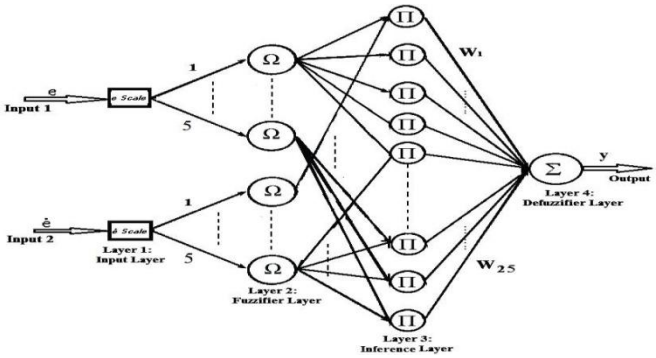

Fig 8 Fuzzy – Neuro network structure [6].

VII. CONCLUSION

By this way paper can be concluded that Neuro-Fuzzy Control System is much better to PI, PID, FUZZY Control & Neural network based Control. Moreover it gives better speed response, lower overshoot & that's why, it is used for any type of non linear system. We can opt comparatively good result for the same method. Recently, particularly this method is useful for controlling purpose, because it is a combination of both neural network & fuzzy logic. Both these techniques are belongs to artificial intelligence.

REFERANCE

[1] Tan Chee Siong , Baharuddin Ismail, Siti Fatimah Siraj , Mohd Fayzul Mohammed "Fuzzy Logic Controller for BLDC Permanent Magnet Motor Drives" International Journal of Electrical & Computer Sciences IJECS-IJENS Vol : 11 No: 02,april 2011.

[2] T. S. Radwan, M.M. Gouda "Intelligent Speed control of permanent Magnet synchronous Motor Drive based - On Neuro - fuzzy Approach." 0-7803-9296-5/05/$20.00 © 2005 IEEE

[3] G.R.P. Laxmi, S. Paramasivam "Speed Control of Brushless Dc Motor Using Fuzzy Controller" IJAR, Research paper Volume: 3|Issue 11|Nov 2013|ISSN – 2249 – 555X.

[4] K. Naga Sujatha, Dr. K Vaisakh, Anand G. "Artificial Intelligent based Speed control of BLDC motor" 978-1-4244-6551-4/10/$26.00 ©2010 IEEE.

[5] M. V. Ramesh, J. Amarnath, S. Kamakshaiah and G. S. Rao ." Speed Control of Brushless DC Motor by using Fuzzy Logic PI Controller". ARPN Journals Vol. 6, No. 9, September 2011.

[6] Mohammad-Reza MOSAVI, Abdoreza RAHMATI, Alireza KHOSHSAADAT "Design of Efficient Adaptive Neuro-Fuzzy Controller Based on Supervisory Learning Capable for Speed and Torque Control of BLDC Motor" Iran University of Science and Technology,2012.

[7] S. Rambabu, " Thesis on modelling and control of brushless DC motor" Master of technology in power control and drives, Department of electrical engineering, National institute of technology. Rourkela, 2007.

