

Speed Control of BLDC Motor using Fuzzy Logic Controller

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Abstract— in this paper the detail of bldc motor is shown. Conventional methods like pi, pid don't give better result for speed control. These methods don't increase the speed of response. But fuzzy control gives better output then these methods .we make rule table for different value of speed & get accurate answer for the control of speed. We use mamdani methods for fuzzy control & centroid method for defuzzification. Then we use matlab software for fuzzy set & get the simulation.

Index Terms—introduction, speed control, comparison of controllers, fuzzy logic, simulation.

I. INTRODUCTION

Bldc motor is widely used in many type of applications like industry, home appliances , electronics equipments etc. it has many advantages than other motors like dc motor and induction motor. It does not require any type of brushes for commutation. It require electronic switches. It has better speed torque characteristics than other motors.it require sensing elements for sense the rotor position of the motor .but we 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.

C. Principle operation of bldc motor

Brushless dc motor defined as permanent magnet synchronous motor.it is generally controlled with three phase semiconductor bridge. The motor require sensor for rotor position. The circuit of bldc motor with switches is shown below.

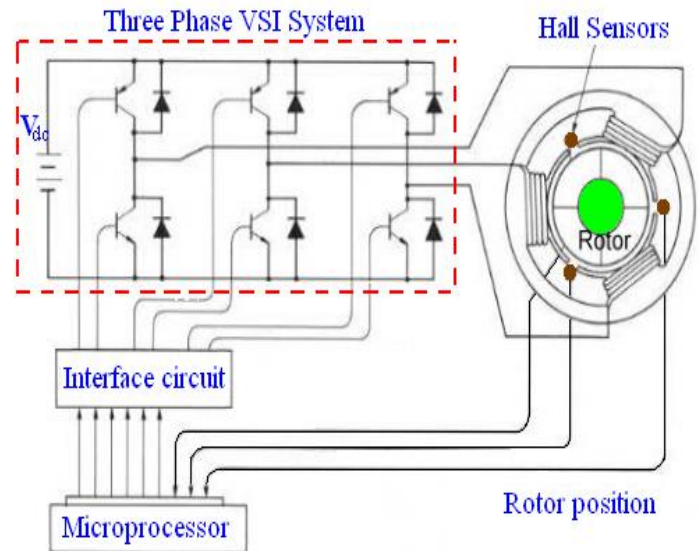


Figure 1 circuit of bldc motor with switches

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.

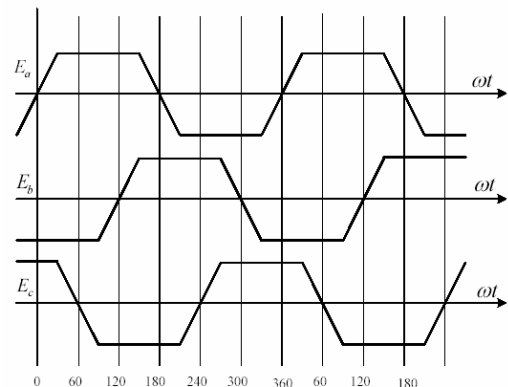


Figure 2

II. DISADVANTAGES OF PI & PID CONTROLLER

Pi control does not increase the speed of response & this control don't give accurate result .pid control is used for dealing with higher order capacitive process. in these type of controller first we convert nonlinear system to linear system & then we perform.

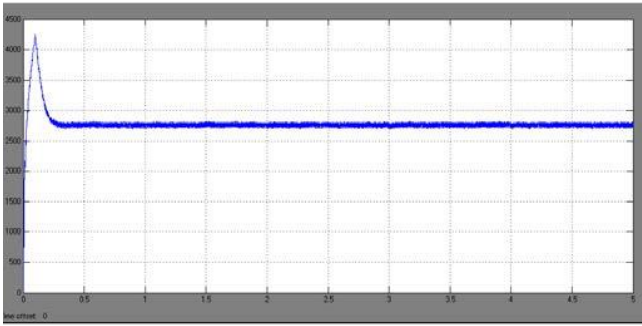


Figure 3

Speed characteristic of bldc motor using pid control

With pid control the program tends to be 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.

III. FUZZY LOGIC

Fuzzy logic has many advantages than conventional controller. it used many type of application, like camera ,camcoder , washing machine,& microwave. It is used in industry also. With it aid complex requirement so may be implemented in amazingly simple, easily minted and inexpensive controllers. many decision-making and problem solving tasks are too complex to be understand quantitatively however ,people succeed by using knowledge that is imprecise rather than precise.

Fuzzy logic is all about the relative importance of precision .fuzzy logic has two different meanings. in narrow sense, it is a logical system which is a extension of multi value logic, & in wider sense ,it is synonymous with the theory of fuzzy set. Fuzzy set theory is originally introduced by Lotfi Zadeh in the 1960.

Fuzzy Logic Control gives superior results with respect to conventional control algorithms thus, in industrial electronics the FLC control has become an attractive solution in controlling the electrical motor drives. With by this logic we can get accurate answer than other methods. fuzzy logic techniques have gained much interest in the application of control system. They have a real time basis as a human type operator, which makes decision on its own basis. the structure of this system is shown below,

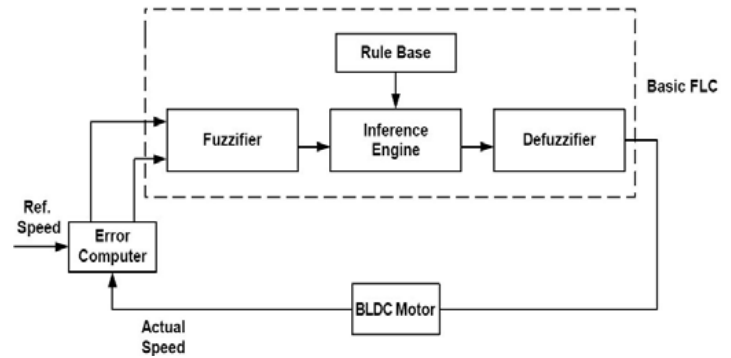


Figure 4 Block diagram of fuzzy logic

It has three main components,

1. fuzzifier
2. Inference engine.
3. defuzzifier.

By this structure, first we convert crisp value into fuzzy value .it is called fuzzification , & last we convert fuzzy value into crisp value, called defuzzification. Between this two block we do decision making process, in this process we make rule base & get the accurate result.

Fuzzy logic terms are expressed in the form of logical implication. Such as if- then rules. It is called member ship function. which are shown below,

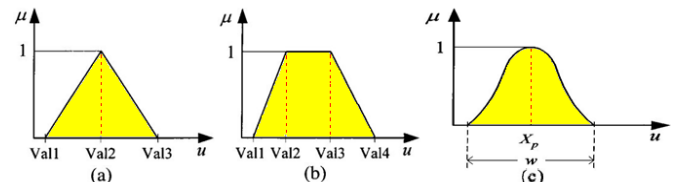


Figure 5 a.triangular function b.trapezoidal function c.bell shape function

IV. DEFUZZIFICATION

It converts fuzzy value into crisp value there are three methods for defuzzification,

- A. **The max criterion method** - It produce a point at which membership function reaches maximum value.
- B. **The height method** - the centroid of each membership function for each rule is first evaluated. The final output is then calculated as the average of the individual centroids .
- C. **Centroid method** - It generate the center of gravity of the area by membership function.

There are seven clusters in the membership functions, with seven linguistic variables defined as: Negative Big (NB),Negative (N), Negative Small (NS), Zero (Z),Positive Small (PS), Positive (P), and Positive Big(PB). Which are shown in below fig,

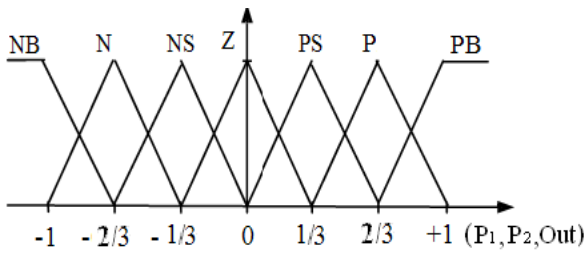


Figure 6 are seven clusters in the membership functions A sliding mode rule-base, used in the fuzzy logic controller is given in Table 1. The fuzzy inference operation is implemented by using the 49 rules. The min-max compositional rule of inference and the center of gravity method have been used in the “defuzzification” process.

If p_1 is NB and p_2 is NB Then out is PB,
 If p_1 is NB and p_2 is N Then out is PB,
 If p_1 is NB and p_2 is NS Then out is P,
 If p_1 is NB and p_2 is Z Then out is P,

Table 1

Input p1	Input p2						
	NB	N	NS	Z	PS	P	PB
NB	PB	PB	P	P	PS	PS	Z
N	PB	P	P	PS	PS	Z	NS
NS	P	P	PS	PS	Z	NS	NS
Z	P	PS	PS	Z	NS	NS	N
PS	PS	PS	Z	NS	NS	N	N
P	PS	Z	NS	NS	N	N	NB
PB	Z	NS	NS	N	N	NB	NB

This is the rule table for fuzzy logic.

V. SIMULATION

We use matlab software for speed control; the matlab simulation diagram for fuzzy logic is shown below,

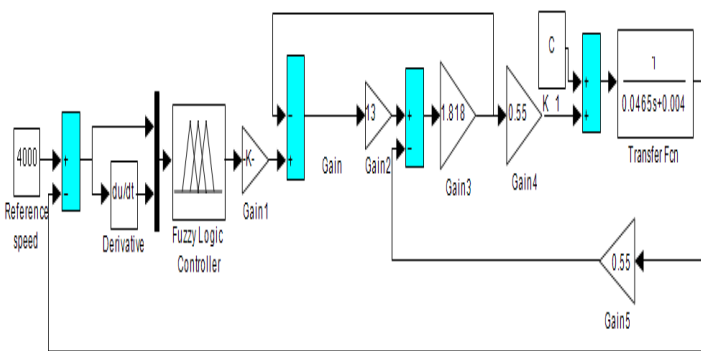


Figure 7 matlab simulation diagram

This model is use to observe speed, torque & phase current of the motor.

VI. RESULT

Figure 8 shows the speed responsefor the Fuzzy logic developed in matlab.

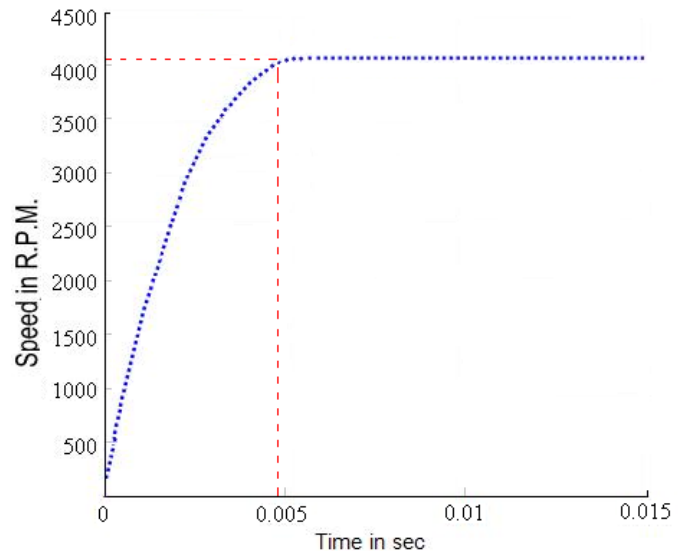


Figure 8 the speed response for the Fuzzy logic
 Figure 9 shows the speed response of fuzzy logic on load change.

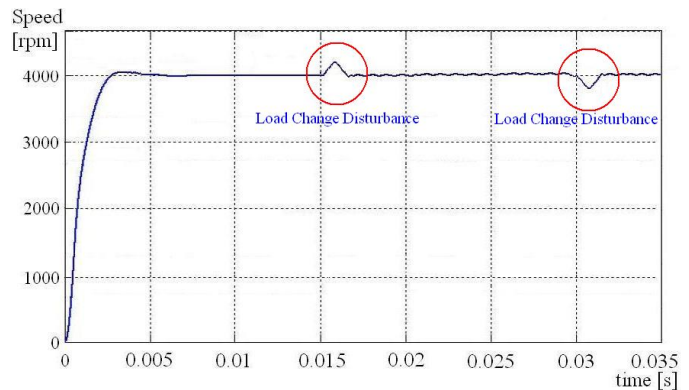


Figure 9 the speed response of fuzzy logic

VII. CONCLUSION

We have to conclude that speed is control by fuzzy logic is nearly accurate than conventional control. Pi& pid controller (conventional) don't give accurate answer. We get good dynamic response of speed by fuzzy logic. the speed is detect by hall sensor ic's is very good than complicated encoder system. The matlab software is good for fuzzy logic control. & it is easy to get result from matlab software.in future artificial intelligence used anywhere.

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