May-June 2020
ISSN: 0193-4120 Page No. 6174 - 6177

Investigations on Brushless DC Motor Drive to Control Speed Using Single Input Fuzzy Logic and PID Controller

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Article Info
Volume 83
Page Number: 6174 - 6177
Publication Issue:
May-June 2020

Article History
Article Received: *19 November 2019*
Revised: *27 January 2020*
Accepted: *24 February 2020*
Publication: *18 May 2020*

Abstract:
This paper symphasizes on the investigations on BLDC motor speed control using SIFPIDC as a velocity controller. SIFPIDC is more advantageous that it has tuning procedure and also has an exceptional reaction for instances of huge disturbance of sign. The BLDC motor force is fed up with the aid of three phase inverter having 2 closed loops where the current loop is the inner and speed loop is the outer which is used to control the current and to govern the rate of the motor respectively. The Simulation result is determined through velocity reaction below numerous situations. The overall output of SIFPIDC is compared with the PI controller and Fuzzy PI controller. Thus the result obtained from SIFPIC is implemented in hardware.

Keywords: *Brushless DC motor (BLDC), Single Input Fuzzy PID Controller (SIFPIDC), fuzzy controller, PI controller.*

I. INTRODUCTION

The BLDC motor is extensively used in diverse programs for domestic and industrial purposes. The BLDC motor is similar to PMSM motor except the rotor flux produces is of trapezoidal emf. The two types of approaches are using the controller to measure the current and speed and other parameters whereas the other type is of sensorless control where the back emf is lowered in the non moving coil. To encounter the rotor function encoder is used. Many control technique has been introduced for the PWM generation. However the conventional technique is to manage the loop of the controller. The main aim to overcome the harmonic distortion produces in the motor which affects the performance drastically.

II. EXISTING SYSTEM

The existing system consists of PI controller which is broadly utilized in fields of electric powered pressure due to its speedy and efficient response. The PI controller is a linear controller that proportionally integrates the values of the feedback component and is implemented to reduce error signal for the system. It is complicated to improve the performance using PI controller in a non linear system. Thus a new improved technique has been implemented and the result has been compared.

III. PROPOSED SYSTEM

In this proposed model the Pi is replaced by the SIFPIDC to enhance the performance of the BLDC motor. By varying the DC link voltage of VSI the speed is controlled. This reduces the switch losses of

VSI and eliminates the need of current sensors for PWM-based current management of BLDC motor for speed control. Thus the system will be able to handle non-linear load responses and react instantly so that desired speed is attained without any delay

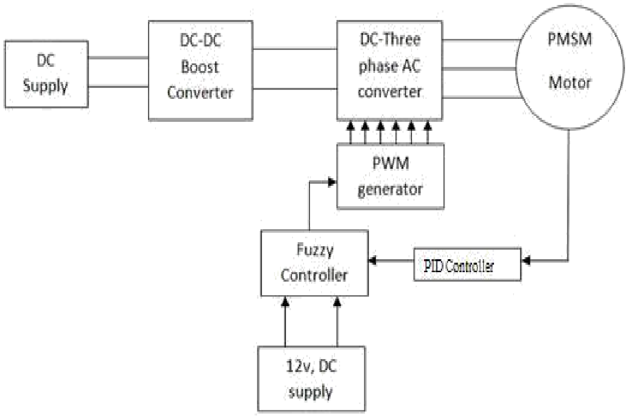

Fig 1 Block diagram of BLDC motor using SIFPID Controller to control speed

IV. SIMULATION MODEL

The block diagram shown in Fig 2 consists of boost converter, driver circuit, closed loop controller that consists of Fuzzy and PID controllers and other necessary blocks. The boost converter gives the boosted voltage required to drive the driver circuit which in turn is used to drive the motor. The actual speed from the motor is taken as feedback to the controller circuit which gets compared with the desired speed set by the user and the error signal generated alters the pulse width given to the driver circuit. Thus pulse width controls the speed of the motor by fuzzy action defined inside the fuzzy block.

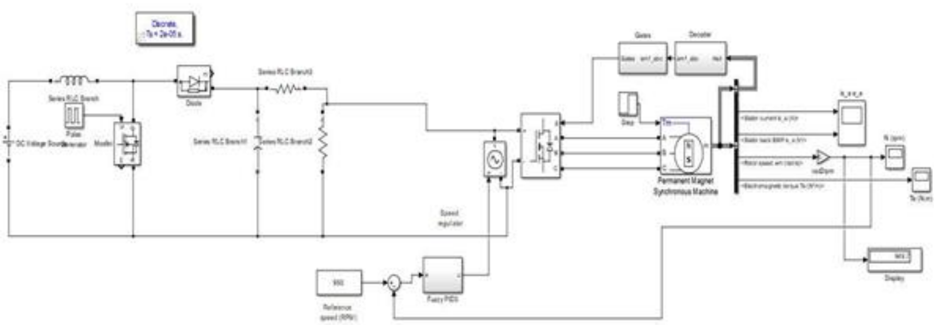

Fig 2.Simulation of Brushless DC Motor Speed Control using SIFPID Controller

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4.1 Fuzzy-PID Block

The fuzzy block shown in Fig 3 is provided with two inputs and produces three outputs. The inputs are the actual speed signal and its delayed response. The outputs are -1,0,1. These outputs are given as corresponding inputs to the P, I & D Controller expression blocks where they get manipulated and combined to produce a certain constant as the output. This output is fed to PWM circuit as the reference signal.

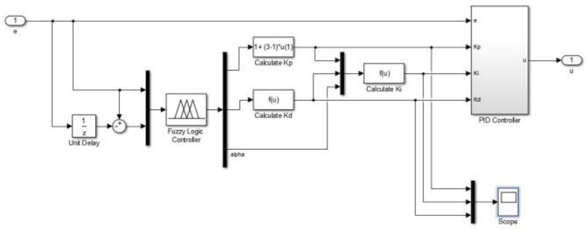

Fig 3 Simulation of Fuzzy PID Controller

4.2 Membership Functions

Membership functions characterize fuzziness whether the elements in fuzzy sets are discrete or continuous. Here the membership function input variables are the actual speed and it's delayed response. The membership function output variables are constants for P, I, D which are generated by the rules written which is shown in Fig 4.

Fig 4. Membership Function

V. RESULTS AND DISCUSSION

The three outputs from the fuzzy-pid controller set is combined to form a constant and this constant is given to the PWM circuit as the reference signal is shown in fig 5.

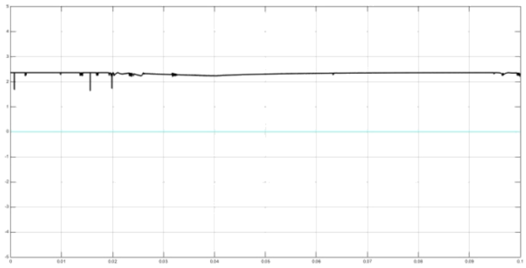

Fig 5 Output of PID controller

Once the desired speed is set, the motor first rotates at its rated speed and then after a few milli seconds, the desired speed is obtained and its value retains forever without any distortion. The delay is due to the delay set in the feedback controller. The desired output is shown in Fig 6.

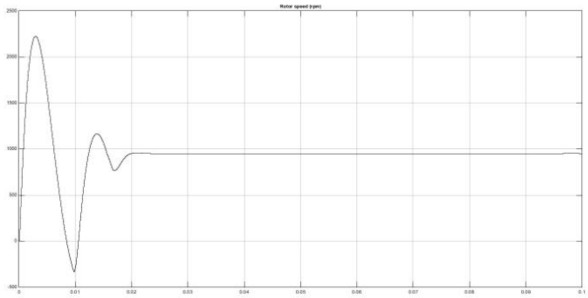

Fig 6 Output of BLDC Motor Drive

Reference speed = 950 rpm
Actual speed = 949.7 rpm
Percentage Error = ((950-949.7)/950)*100
= 0.03
Accuracy in percentage = 100-0.03
= 99.97%

The Hardware Setup is shown Fig 7 which consists of 4 transformer circuits of which 3 transformers are of 12v/500mA and they are used to energize the driver circuit. The other transformer has the rating of 18V/1A which is used to drive the dc-ac converter part. The other components present are Driver Circuit, Boost Converter, LCD Display and Inverter Circuit. The BLDC motor along with the hall sensor is taken as input to the PIC microcontroller. From the inputs taken from the

BLDC motor, the PIC microcontroller drives the driver circuit which produces the required PWM which in turn the desired speed is attained.

The output attained met the desired speed with 99% accuracy.

Reference speed = 720 rpm

Actual speed = 718 rpm

Percentage Error = ((720-718)/720)*100

=0.27 %

Accuracy in percentage = 100-0.27

=99.73 %

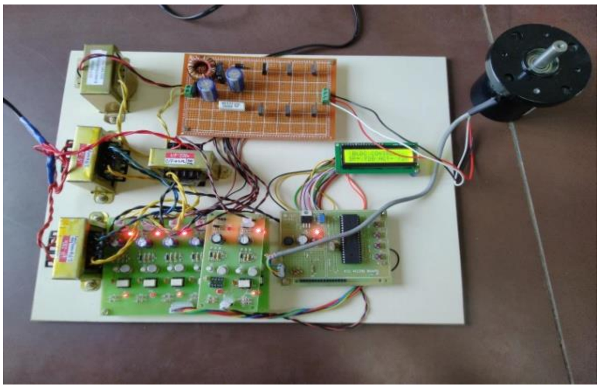

Fig 7 Snapshot of Hardware Implementation

VI. CONCLUSION

Thus the Speed Control of Brushless DC Motor using Single Input Fuzzy Logic and PID Controller aims to control the actual speed of the motor by getting reference speed from the user. From the result obtained it is proved that the reduced error and accuracy is more when compared with conventional system.The hardware is also successfully implemented with fuzzy rules embed on the PIC microcontroller which drives the driver circuit with variations in the pulse width which is generated by PIC controller by taking inputs from the hall sensor.

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