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Closed Loop Speed Control of Bldc Motor with Design and Modelling Using Fuzzy Logic Controller

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Abstract— Brushless Less DC motors have certain features such as large initial twisting speed, efficiency and long life and are also referred to as a compatible magnetic motor. Due to the making of similar motor for censorious application it is majorly applied in the industrial area. By analysing the BLDC motor with the normal induction motor and the DC motor has so many advantages such as longevity and no necessity for machine replacement. To stabilize the machine in this paper we have used the Proportional Integral Derivative controller and the sensible controller. In BLDC Motor by providing the gate signal a theta angle value is given. Using MATLAB Simulation features of BLDC vehicles such as rear EMM, speed, current limit.

Keywords— BLDC motor, Fuzzy logic controller, PID controller, Inverter circuit model.

I. INTRODUCTION

The DC motor main problem is maintenance and also the brushes are the main issue.In recent trends the brushless DC motor is the load utilised as it has high efficiency and reliability of the machine leads towards less maintenance [1-4]. The brushless DC motor is activated by electronically commutated method by means of voltage source inverter by modifying the frequency based on load. The rotor position modified by maintaining the electronic switches with stator winding properly energised in correct way so as to get continuous rotating emf on motor. In this way the electromagnetic interference sparking and friction can be eliminated.

By controlling the size and quantity of stator power the motion of the Brushless DC motor is balanced and the ratio of stator power to frequency is always maintained. Compared to a standard regulator the paper can examine high in different explanations [5]. The crossover Fuzzy drive regulator is utilized that changes the regulator to make it work better with a Brushless DC vehicle. Using the PWM process the switching process is generated according to overshoot, oscillation and other conflicting losses [6][11][12]. With the Xilinx FPGA Software 400E processor the incomprehensible control model is used in real time. Under

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various burden conditions the speed to be kept up is constantly introduced [7][8][9][10]. The various car ratings the proposed system makes for free offset monitoring, ignoring dynamic response and normal frequency.

II. BRUSH LESS DIRECT CURRENT MOTOR

In a Brushless DC motor the vehicle will be continuously rotated by changing the solid state thyristor ON on the motor winding will be enabled [8-16]. Figure 1 shows a basic Brushless DC driver that you drive with a semiconductor switch such as MOSFET. The Brushless DC car works both in three-phase operation and one-phase operation.

The equation regarding the torque and emf equation was given in 2.1-2.3.

$$Vab = R(ia - ib) + L\, d/dt\, (ia - ib) + (ea - eb) \quad - (2.1)$$

$$Vca = R(ic - ia) + L\, d/dt\, (ic - ia) + (ec - ea) \quad - (2.2)$$

$$Vbc = R(ib - ic) + L\, d/dt\, (ib - ic) + (eb - ec) \quad - (2.3)$$

Formula of movement is given as,

$$Ta = BWm + J\ d/dtWm + TL \quad - (2.4)$$

The voltage equations becomes,

$$Vab = R(ia - ib) + L\, d/dt\, (ia - ib) + (ea - eb) \quad - (2.5)$$

$$Vbc = R(ib - 2\,ib) + Ld/dt(ib - 2\,ib) + (eb - ec) \quad -(2.6)$$

BLDC motors have hall Effect sensors as position regulator . Contingent upon the need the vehicle speed can be constrained by the MOSFT Gate driver circuit.. With precise speed control acquired by PID and incomprehensible controller. The four-wheel drive BLDC drive produces optimal performance for a variety of speed conditions.

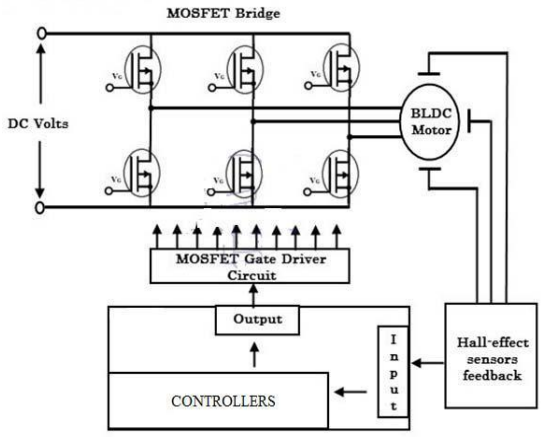

Fig.1 Circuit for brush less DC drive

III. CONTROLLERS

A. PID CONTROLLER

- Inference mechanism: The mapping is done between the input and output values by using the

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fuzzification method and it is allowed by interference mechanism [2]. The Mamdani and the Sugeno method is the most commom methods used for interference mechanism, in this method we are using the Mamdani method.

- Defuzzification: The required Crisp Value is converted from the fuzzy reasoning Mechanism is done by using the Defuzzification method.
  Transfer function of PID controller: KP+ K_1/S+ Kd S

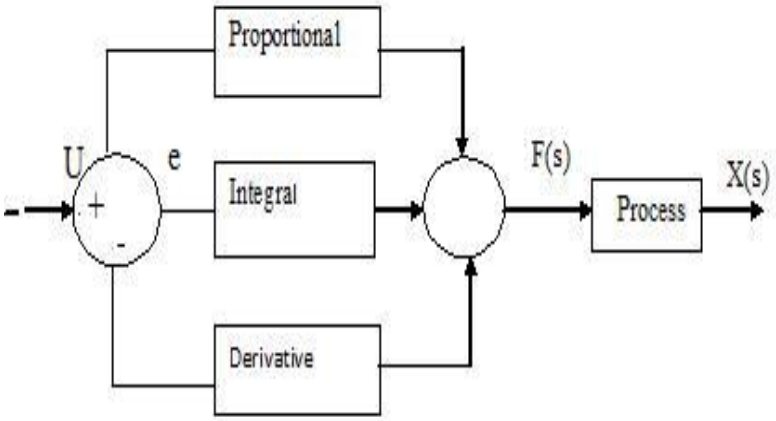

Fig 2PID Controller. Block diagram

B. FUZZY LOGIC CONTROLLERS

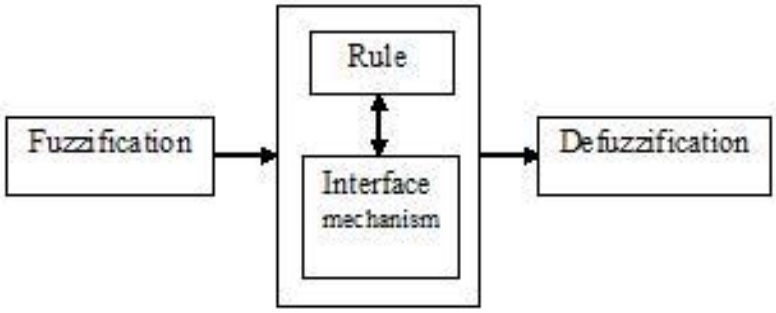

Fig 3 Controller interfacing the system (Fuzzy Logic)

- Fuzzification: By using the predefined membership function the values for fuzzification is choosed. The exponential, sinusoidal, trapezoidal and triangular are the other membership functions are used for fuzzification.
- Rule Matrix: The fuzzy operators and fuzzy set is explained by Rule matrix and is explained in standard state
- Mamdani and the Sugeno method is the most commom methods used for interference mechanism, in this method we are using the Mamdani method.
- Defuzzification: The required Crisp Value is converted from the fuzzy reasoning Mechanism is done by using the Defuzzification method.

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IV. SIMULATION MODEL OF SPEED CONTROL OF BLDC MOTOR USING MATLAB

A. CIRCUIT DIAGRAM OF Brushless DC motor.

The Fig 4 explains the capacity circuit for Brushless DC engine speed control by utilizing proficient regulator are fluffy and PID regulator.

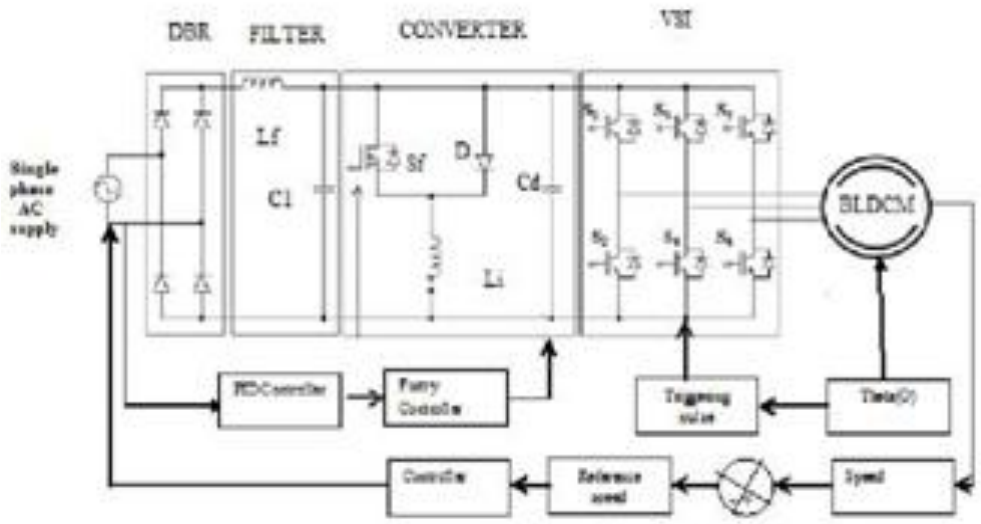

Fig.4.Functional circuit for BLDC motor

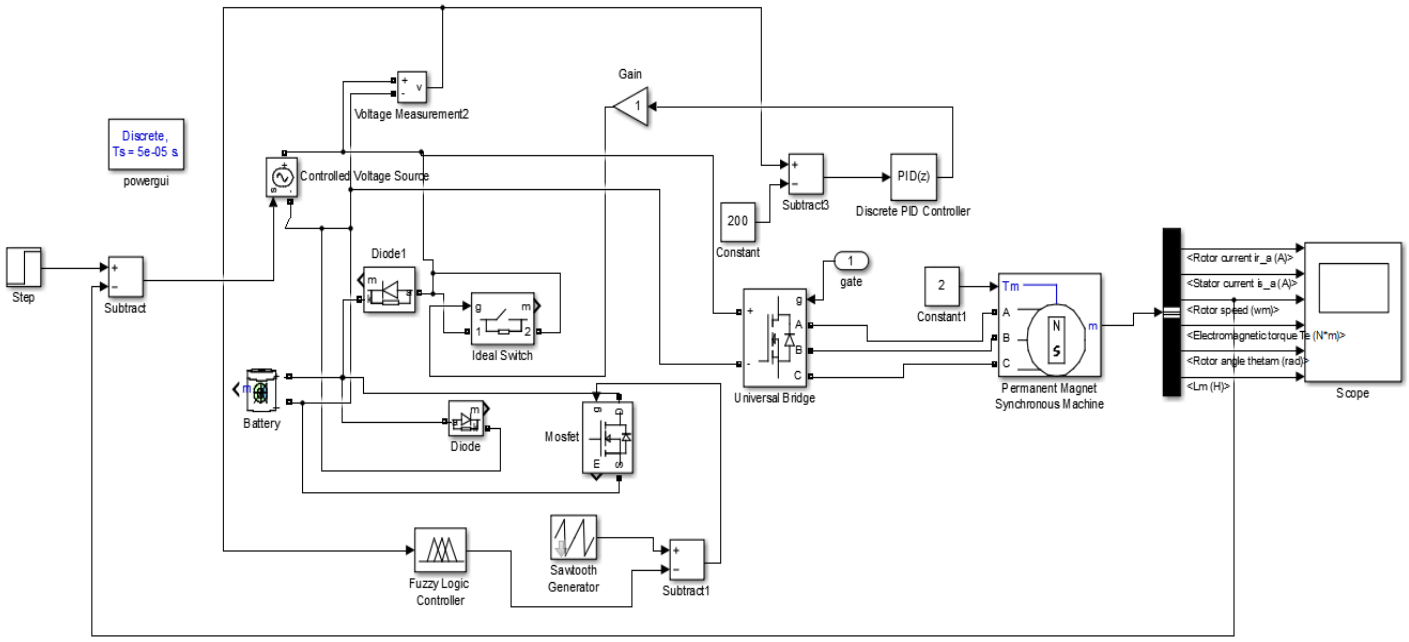

Fig 5 Brushless DC motor simulation model

The working reliability of BLDC Motor is explained by means of simulink. The duty cycle of the semiconductor device such as MOSFET is controlled by Fuzzy and PI controllers. Stator of the BLDC Fig 6 Brushless DC motor simulation model

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The major blocks of BLDC model block are Inverter circuit block, Controller block and Subsystem 1.In this paper, fuzzy merged with PID controller was activated Figure 7 shows the proposed system of the three phase brushless DC motor.

V.WAVEFORM ANALYSIS OF CIRCUIT PARAMETERS

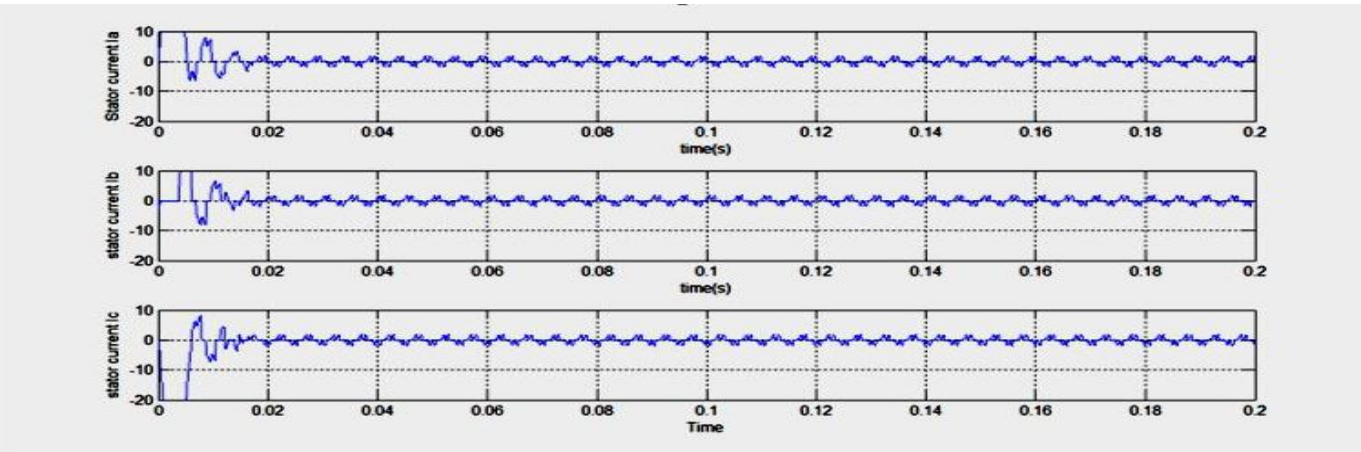

Fig 6 waveforms of Stator Current

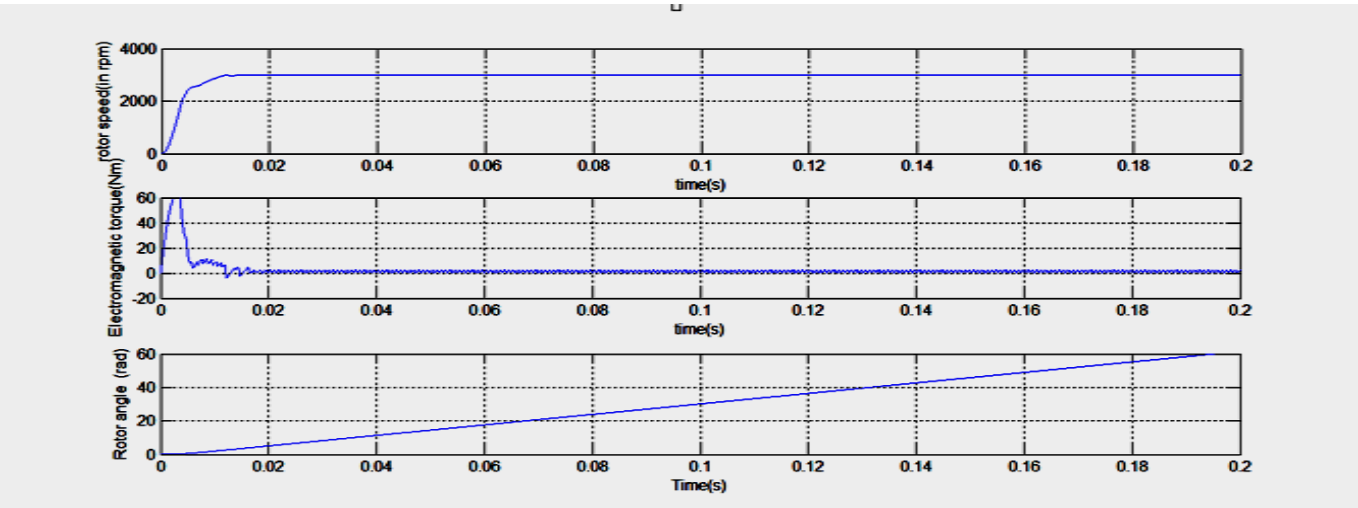

Fig 7 Speed, Torque and Rotor angle waveforms

Speed/Time table

Speed Vs Time for closed Loop

Reference speed(rpm)	**Reference time(s)**
1800	0.01
1600	0.02
1400	0.03

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1200	0.04

Table1 Speed Vs Time for closed loop

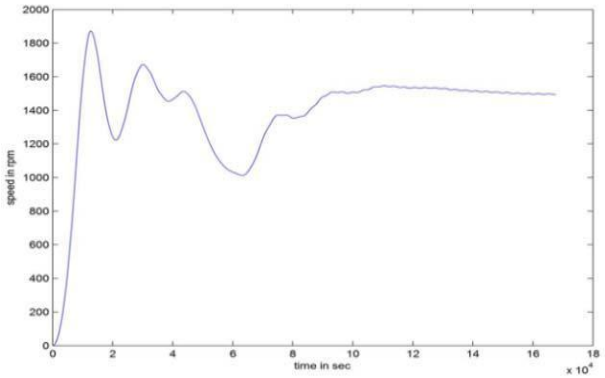

Fig 8 Speed Vs Time

Figure 8 shows the curve for speed in BLDC Motor at no heap condition where reference is set at 1500 rpm. Time to attain the rated speed of motor is 0.04s at 1500 rpm.

VI. CONCLUSION

By using an unobtrusive sensor and a PID controller on a BLDC motor the speed is controlled under various load conditions. By the output voltage from the inverter is used to control the motor speed. In a different loading mode the gate signal is generated. Using the MATLAB SIMULATION software various features such as current load, output speed and background EMM are analyzed under different load conditions. Vehicle performance is improved at a wider range of load on the proposed system.

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