

Direct Torque and Indirect Flux Control of BLDC Motor Controller by Using Fuzzy Logic Controller

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Abstract: In the present scenario, utilization of BLDC drives are increasing rapidly, as a result of more efficiency, more power density, normal to control and great inertia torque ratio. This rag proposes a concept of sensorless control of drive using Fuzzy based DTC system. An indirect flux control proposed in this rag is similar to the direct torque controller for controlling of BLDC motor by the reference signals from the direct axis currents. A fuzzy regulator also proposed in this rag for better controlling of brushless DC drive. Simulink/Matlab is used to test the proposed DTC-Fuzzy based BLDC drive

Keywords : BLDC Motor, Fuzzy Controller, DTC technique and PWM controller

I. Introduction

BLDC motor plays a key role in the present scenario, due to its high accuracy, good performance and high efficiency. BLDC vehicles are interior-out of commonplace dc vehicles and they showcase the equal N-T curves. BLDC motor doesn't require brushes, the commutation principle for BLDC motor is electrically commutated. With the help of role sensors, the commutation identifies the rotor positions [1-2].

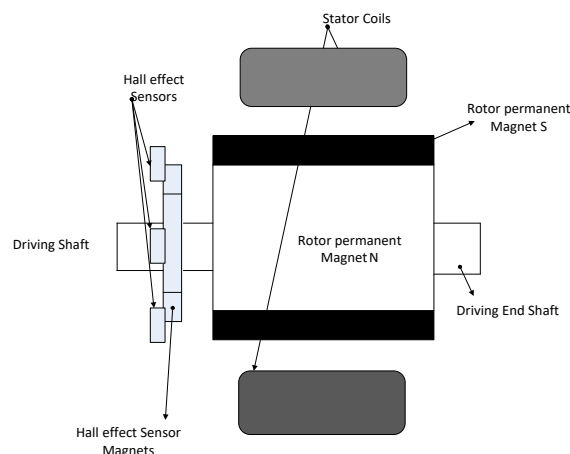


Fig. 1. Structure of Brushless DC Drive

II. Designing of BLDC Motor

Brushless motor is one of the part in PMSM family [3-4]. As its name shows as SM the magnetic area created with the aid of the usage of every the rotor revolves by the identical frequency. So BLDC motors do now not revel in any "slip". The main parts in BLDC motor is wound stator poles and rotor is permanent magnet type. The brushes and mechanical commutator are used in BLDC for proper commutation. The Hall Effect sensors that are located a hundred and twenty electric tiers away from each other detects the rotor location that allows you to mark right commutation collection [5-8].

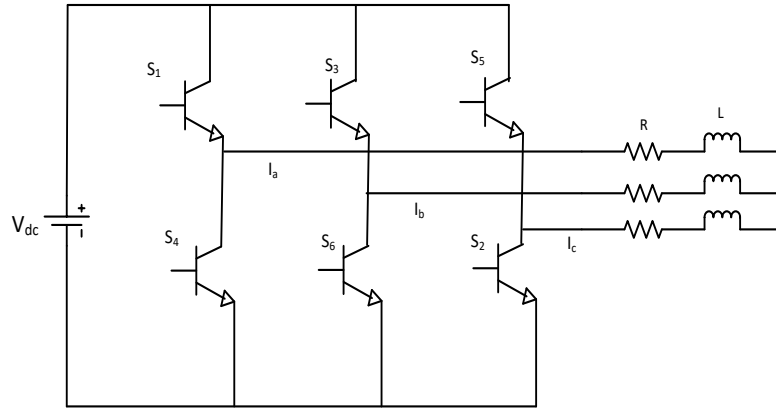


Fig. 2. Equivalent Circuit for BLDC

Apply the principle of KVL to obtain the mathematical differential equations for BLDC Drive.

$$V_1 = i_1 r_1 + L \frac{di_1}{dt} + e_1$$

$$V_2 = i_2 r_2 + L \frac{di_2}{dt} + e_2$$

$$V_3 = i_3 r_3 + L \frac{di_3}{dt} + e_3$$

Apply Park's transformation analysis for converting three phase system to two phase system (i.e dq transformation).

$$\begin{bmatrix} V_{ab} \\ V_{ca} \end{bmatrix} = \begin{bmatrix} -\frac{1}{3} & -\frac{1}{3} \\ \frac{\sqrt{3}}{3} & -\frac{\sqrt{3}}{3} \end{bmatrix} \begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix}$$

The leakage flux linkages for BLDC drive, in the form of two phase rotational frame axis is expressed in two phase and voltage and currents as shown below.

$$\psi_\alpha = \frac{1}{L_\alpha} (V_\alpha - i_\alpha r_\alpha)$$

$$\psi_{\beta} = \frac{1}{L_{\beta}} (V_{\beta} - i_{\beta} r_{\beta})$$

The Expression for Phase angle is expressed as,

$$\psi_1 = \psi_{\alpha} + j\psi_{\beta}$$

$$\theta = \tan^{-1}(\psi_{\beta} / \psi_{\alpha})$$

Torque developed by the BLDC motor is

$$T_e = \frac{e_1 i_1 + e_2 i_2 + e_3 i_3}{\omega_e}$$

III. Fuzzy Inference System

Generally, Fuzzy Controller is widely used in machine control. The input and output variables in a fuzzy control system are mapped by sets of variables called as membership functions or also called as fuzzy sets [9].

The process of Fuzzy system is explained under three stages namely:

1. Fuzzification
2. Inference Engine
3. Defuzzifier.

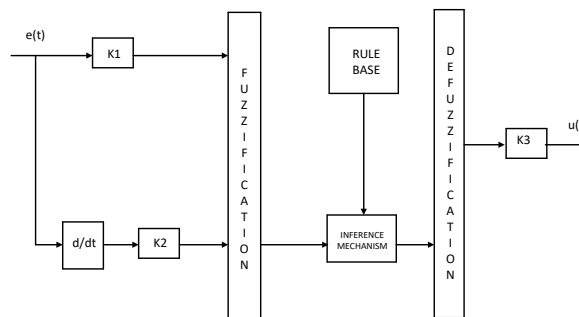


Fig.3. Fuzzy Inference System

Fuzzy systems are simple in concept. It consists of 3 stages called as source layer, hidden layer and sink layer. The input stage identify the input variables and converted into fuzzy sets. The processing stage is used to get the output by using rule base formation

IV. Principle of Operation BLDC Control Diagram

The fundamental control block diagram indicates the implementation of the DTC-SVM model is as shown in figure 4. Park's transformation principle is applied to this system for converting three phase system to two phase orthogonal coordinates. PI Controller are used to control the system current errors. An SVPWM controlled is introduced in this paper to generate the gate signals required for BLDC drive [10-12]. In this An DTC based control structure is proposed for generating state vectors.

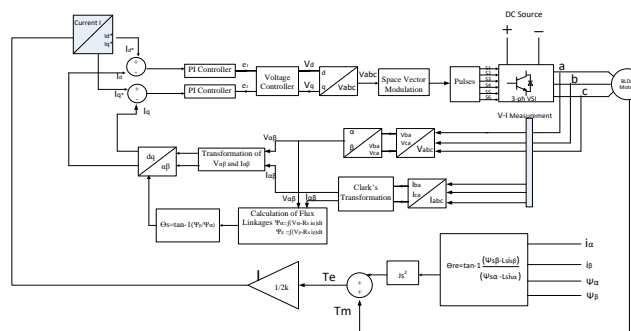


Fig. 4. Fuzzy based DTC-SVM Control circuit for BLDC Drive

V. Simulation Experiments and Results

The proposed Fuzzy based DTC-SVM BLDC drive is proposed and implemented using Simulink. The experiment setup (Simulink) is verified under two control techniques called Conventional PI & Fuzzy Control techniques. The results for BLDC motor is shown below.

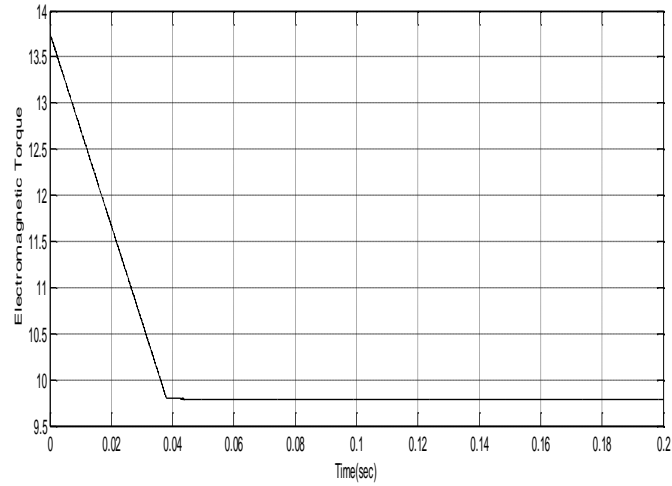


Fig. 5. Experimental Waveform for Electromagnetic Torque

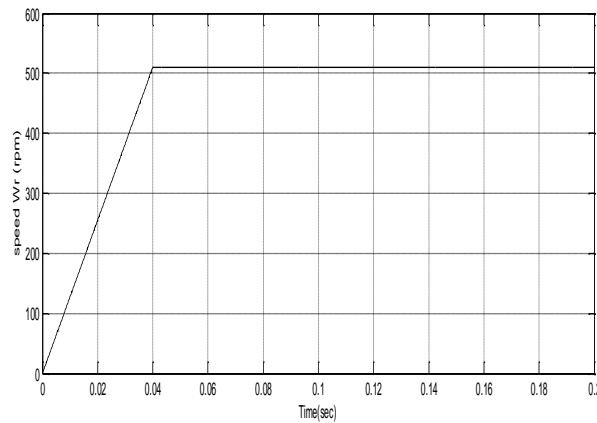


Fig. 6. Experimental Waveform for BLDC Speed

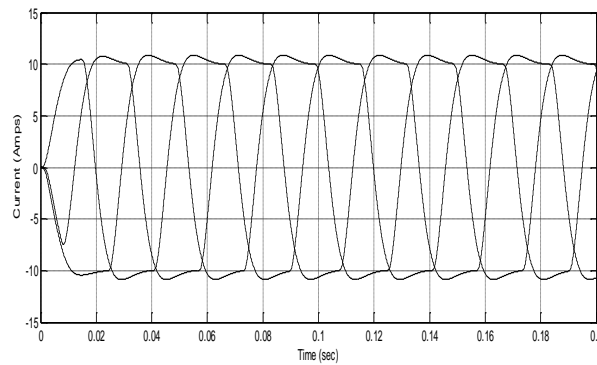


Fig. 7. Experimental Waveform for Stator Currents

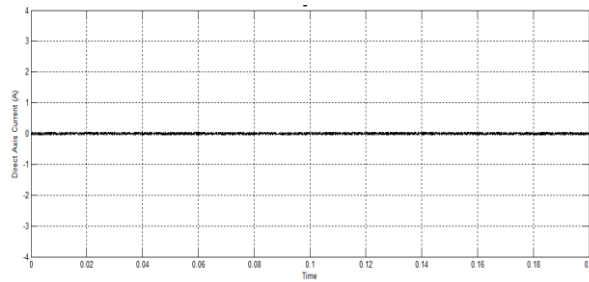


Fig 8. Experimental Waveform for Stator I_d

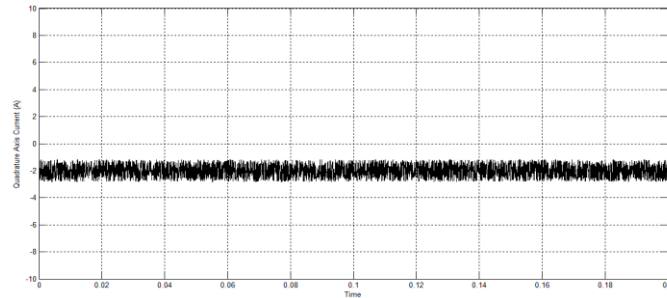


Fig. 9. Experimental Waveform for I_q

VI. Conclusion

This paper has provided a thought of Fuzzy based DTC for brushless dc drive machine. Pertaining to adjusting an alternating current turns essential DTC techniques stay labeled in varieties: i. e. the first hysteresis-based totally transferring desk DTC, then a few other you are regular switching consistency sample working with space vector modulation approach. Away of those techniques we chosen a DTC based Fuzzy method as it has the ability to improve overall performance of power with the useful resource of decreasing the disorders in the τ and ψ . From the simulation results, DTC based Fuzzy System provides good result as compared to conventional controllers.

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