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Fuzzy Based Field Oriented Control of Induction Motor for Torque and Ripple Reduction

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Extended Abstract

Industry applications necessitate faster, effective and stable control of induction motors. Furthermore, competition in the global world, companies inevitably leads to a detailed cost analysis. Therefore, the speed control of induction motor at a low cost and fewer sensors, more effective solutions are required.

Different control techniques are developed in order guarantee robust operation for the squirrel-cage 3 phase asynchronous induction motor with rotor of short circuit in various speeds. In particular induction motors used in looms, thread winding machines, printing machines need sensitive speed and precise moment control.

Vector control method for reducing torque ripple and harmonics should be used so as to produce desired torque, increase the reliability of control system, maintain a high lifespan for the motor, decrease harmonics which affects other devices of the same system with the motor, and reduce mechanical vibrations and resulting noise (Bertoluzzo M., Buja G.,2006).

The current-controlled direct vector control method will be used in this study. In this method, A Luenberger observer is composed using the asynchronous motor parameters (Cherifi et al., 2013). α-β axes set was used in the observer. First, the observer was used to calculate rotor flux amplitude, conversion angle from d-q to a-b-c axis set and torque, which are not measurable, by using the measured current and voltage values to compare with reference flux and torque values.

Then, to eliminate the error, PI controller was employed. The reference value of stator d axis current is obtained with the signal from PI controller that shall eliminate flux error and the reference value of stator q axis current is obtained with the signal from the PI controller that shall eliminate the torque error. Both torque and flux error shall occur when the torque and the flux reference value obtained from the observer are compared. Reference currents creating flux and torque on the d-q axis, vector control of induction motor is provided by the desired PWM inverter pulses are obtained as a result of comparison of the obtained reference currents with the phase currents from the motor in the hysteresis comparator (Sarioglu et al., 2003). All control system is realized in Matlab/Simulink. When the control model runs the flux and the torque value sit in a band about 0.7 Wb and 9.2 Nm. Time of simulation is 1 second. There are deviation and error in flux value about 12% and in torque value about %8 and there are oscillations around these values.

Here, conventional PI controllers are insufficient to calculate the desired reference current value in d-q axis set and cause excess-drop and more ripple . This is much evident especially in speed and load changes. Fuzzy logic controller can be used to minimize the deviation and ripple. Structure of Fuzzy Logic controllers, which have adaptive features, provides the desired outputs in control of uncertainties, variable parameters and systems with load distribution (Elmas et al., 2007). Flux and torque error values entered into fuzzy logic controller inputs as in the PI controller. Reference current values are found in the d-q axis according to the error from generated fuzzy rule table. Obtained results are satisfactory. After the fuzzy based method, Flux and torque value sit in a band about 0.75 Wb and 9.6 Nm, respectively.

The amount of error in the flux and torque is reduced about %58 and %50 respectively with fuzzy based FOC method.

As a result in this study, Fuzzy Based Field Oriented Control method is compared to conventional Field Oriented Control method. The FOC and the Fuzzy based FOC method are simulated and the comparison of their performances is presented. The Fuzzy based method is observed to give slightly better results.

***Keywords**:* Induction Motor, Field Orient Control, Fuzzy Logic, Luenberger Observer, Torque & Flux Ripple.

The parameters of the three-phase Induction motor,employed for simulation purpose, in SI units are Pmek=3000W, Rr=1.93Ω, Rs=1.45Ω, Ls=12.2.10-3h, Lr= 0.19734h Rr=1.45Ω, Lm=0.1878h F= 0.03 Nm sec/rad, , p=2, J=0.03 Kgm^2, Tr=Lr/Rr.

Reference moment and flux were used 10Nm , 0.8 Wb respectively. Load is applied 10 Nm $0 < t < 0.5$ range, -5Nm $0.5 < t < 1$ range.

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