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Fuzzy Based Real Time Control of Induction Motor Drive

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Abstract

Due to advancement in power electronics and micro computing, the control of the induction machines has considerable development that lead to the possibility of high performance real time implementation. The most popular algorithm for the control of a three-phase induction motor is the v/f control approach using a natural Pulse-Width Modulation PWM) technique to drive a Voltage Source Inverter (VSI). But the performance of electric drives requires decoupled torque and flux control. The most widely used controllers in industrial applications are PI controllers because of their simple structure and good performance in a wide range of operating conditions. PI and Fuzzy Logic controllers have been designed and developed using MATLAB/SIMULINK. Prototype model is developed to validate the effectiveness of the PI and Fuzzy control of induction motor drive using dSPACE DS1104 controller. The performance of the SVPWM based induction motor in open loop and closed loop is presented with simulation. Fuzzy Logic (FL) and Conventional PI controllers have been practically implemented using SVPWM based VSI fed induction motor in open loop mode. The real time performance of Fuzzy based induction motor is presented by validating simulation results with the hardware results.

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*Keywords:*PI Controller, SVPWM, Fuzzy Logic Controller, dSPACE Controller

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1. Introduction

Over the last two decades, commercially available computer has become both increasingly powerful and affordable. This, in turn, has led to the emerging of highly sophisticated simulation software applications that not only enable high-fidelity simulation of dynamic systems and related controls, but also automatic code generation for implementation in industrial controllers [1-6]. This paper presents the speed control scheme of scalar controlled induction motor drive in open loop and closed loop mode, involves decoupling of the speed and reference speed into torque and flux producing components. PI and Fuzzy logic based control schemes have been simulated. The performance of fuzzy logic controller is compared with that of the conventional proportional integral controller in open loop and closed loop. The dynamic performance of the Induction motor drive has been analyzed for No load, Const Load and Speed change command. To validate the effectiveness of proposed fuzzy controller, an experiment is conducted on low power prototype of three-phase VSI fed induction motor using dSPACE controller. The real time performance of fuzzy based induction motor is presented by validating simulation results with the hardware results[1-2].

2. Dynamic Modelling & Simulation of Induction Motor

The induction motors dynamic behavior can be expressed by voltage and torque which are time varying. The differential equations that belong to dynamic analysis of induction motor are so sophisticated, that with the change of variables the complexity of these equations decrease converting poly phase winding to two phase winding (q-d). In other words, the stator and rotor variables like voltage, current and flux linkages of an induction machine are transferred to another reference model which remains stationary [1-6]. Stator inductance is the sum of the stator leakage inductance and magnetizing inductance ($L_{ls} = L_s + L_m$), and the rotor inductance is the sum of the rotor leakage inductance and magnetizing inductance ($L_{lr} = L_r + L_m$). From the equivalent circuit shown in in Fig.2.1 of the induction motor in dq frame, the model equations are derived. The dynamic model of an induction motor is developed by using equations given in Appendix A.

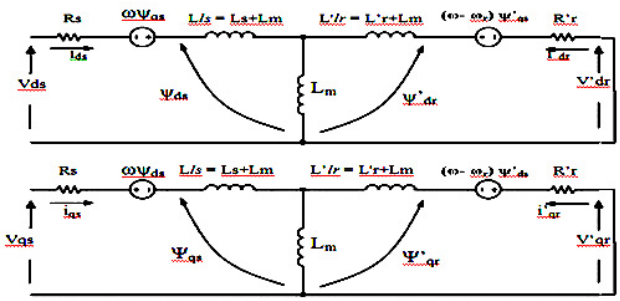

Fig.2.1 d q model of Induction Motor.

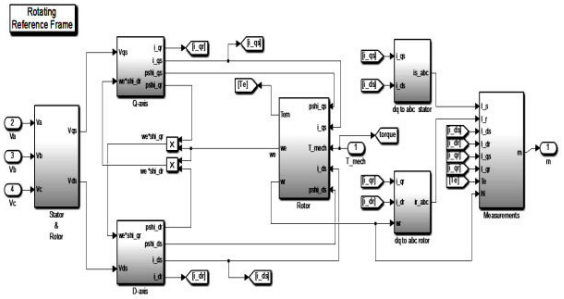

Fig. 2.2 Simulated Induction Motor model in Conventional Model

The model constructed according to the equations has been simulated by using MATLAB/SIMULINK as shown in Fig.2.2 in open loop and closed loop mode with PI controller as operation of induction motor. The block-diagram of induction motor and its drive that are simulated in MATLAB/SIMULINK is shown in Fig.2.2.

3. Control Approaches Of Induction Motor Drive

Fig. 3.1 shows proposed control scheme for induction motor drive system in open loop and closed loop with artificial intelligent controller under implementation.

3.1 PI Controller

The gain equation for PI Controller is given by