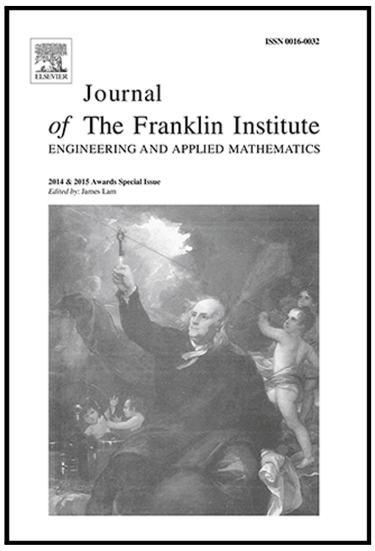

Real Time Implementation of Indirect Rotor Flux Oriented Control of A Five-Phase Induction Motor with Novel Rotor Resistance Adaption Using Sliding Mode Observer

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Abstract: High performance multiphase motor drive requires precise knowledge of the state quantities and the machine parameters. Access to these state quantities is through measurement using sensors whose accuracy is paramount to achieve the performance level required by industrial applications. However, the problems of the parameters variations, inaccessibility to the measurement of some states, no-observability of the machine in some regions, the cost of the sensors and their lack of precision, make this very difficult task. To address these problems, it is necessary to resort to soft sensors through the design of observers and estimators. In multiphase Induction motor drive, the observation problem arises especially for rotor flux that is not accessible for measurement. About the parameters variations, the rotor resistance and the stator resistance are the most critical parameters of the machine because their influence is crucial for the control and observation. The change in the resistances can be as large as 40% to 50% of the rated value, which may affect the control adversely. This paper develops a new structure of an adaptive sliding mode observer based on an online estimation of the rotor resistance value in order to avoid the effect of its variation in the rotor flux oriented control. The results show convergent (the errors in the transient and steady states are 5% and 1%, respectively) behaviour of the drive using the proposed control scheme for large rotor resistance variation under loaded condition. The stability of the drive is proved using Lyapunov criteria. The simulation results are validated using real time implementation.

Key-words: Multiphase Motor, Induction Motor, Sliding Mode Observer, Rotor Flux Oriented Control, Kalman Filter. Voltage source inverter (VSI), Space vector pulse width modulation.

1. Introduction

1.1. Multiphase Motor drive

Multiphase motor drive becoming a serious alternative to the existing three-phase drives and several research results are published in recent years [1]–[6]. Multiphase motor offers: high torque density and reduced torque ripple, high reliability thus the multiphase motor continue to drive even when one or more phases are lost (great fault tolerance), enable to reduce the required electric power per inverter leg and finally the multiphase motor drive permit better noise characteristic and higher degree of freedom [3], [7]–[9]. The multiphase motors are suitable and adequate for many applications such as electric traction, ship propulsion, 'more electric aircrafts' and hybrid vehicles [10]–[15].

The control strategy of multiphase motor is similar to the three-phase motor thus, rotor flux oriented control is still adopted. The control depends upon the rotor flux magnitude that is not possible to measure using a sensor. Hence, make an apparition of the software techniques called estimation or observation based on mathematical approaches. The limitation of the flux estimation in open loop processing can be removed using estimators with feedback state, called observer, to reconstruct the system state.