PARAMETER ADAPTATION OF INDUCTION MACHINE DRIVE FOR INDUSTRIAL APPLICATION

Abstract:

This thesis focuses on a few real-life industrial problems of squirrel-cage induction-machine drive with a speed sensor and their solutions for improved steady-state and dynamic performances. The performance of a sensor-based rotor flux-oriented vector control induction machine drive is dependent on the accuracy of the machine parameters, used in the machine model of the controller. A study on the steady-state and dynamic performance of the drive due to the variation of the machine parameter is carried out. A mathematical expression is derived to assess the sensitivity of the models of electromagnetic torque and rotor flux to the possible variation of the machine parameters. The need for online adaptation of the critical machine parameter like rotor time constant is established in the thesis to achieve accurate control over the electromagnetic torque.

This thesis proposes a novel and simple algorithm to estimate and adapt the rotor time constant, online, for a speed sensor-based field-oriented vector control drive. A current-based model is used to compute the rotor flux vector for the torque controller and another voltage-based model is used to estimate the rotor flux vector for the reference. The error between these two rotor flux vectors is minimized using the least-square method. In this process, the rotor time constant gets tuned to its actual value. The thesis also presents a simple technique to estimate the remaining parameters of the induction machine like the stator resistance, the net leakage inductance of the machine, and the initial guess of the rotor time constant in offline mode at standstill.

Results from two practical field studies on industrial drives are presented in this thesis, emphasizing the online adaptation of the rotor time constant and the self-commissioning. Additionally, a synchronous PWM technique and dead-time compensation technique for a two-level inverter are also included in this thesis as they are developed for these industrial studies. In traction drives, during over-modulation, the reduction in the number of switching pulses per fundamental cycle introduces low-frequency sub-harmonics currents. This results in pulsating torque and increased machine losses. This can be improved by adapting the synchronous PWM technique. In this thesis, a simple technique has been proposed to synchronize the carrier signal with the modulating signal using the instantaneous angular position of the traction drive. In this thesis, the effect of dead time has also been demonstrated and a simple dead-time compensation technique has been implemented for the high-power industrial drive.

Keywords: *Induction machine drive, parameter sensitivity, parameter estimation, adaptation of rotor time constant, traction drive, synchronous PWM, dead-time compensation.*