IMPLEMENTATION OF INTELLIGENT CONTROL TECHNIQUES IN DIRECT TORQUE CONTROL TO IMPROVE THREE PHASE INDUCTION MOTOR PERFORMANCE

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DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ABSTRACT

In this thesis, several essential and important improvements of the sensor and sensorless direct torque control space vector modulation DTC-SVM strategy for induction motor drive are presented. The studies comprising of analytical, modeling and experimental implementation clearly indicate the potential of a high-performance direct torque controlled induction motor drive with and without a mechanical encoder. First of all, the classical DTC, modeling of induction motor IM are discussed in detail. Secondly, the stator current is used to estimate the stator voltage in d-q reference frame to reduce the complexity of system by eliminating the park transformation method, as results saving time otherwise consumed in tuning the voltage sensors with digital signal processing DSP. Thirdly, real time estimation of stator resistance (RTESR) based on stator current , and stator voltage is proposed to avoid the mismatch between the stator resistance value used in stator flux estimation and actual machine resistance due to change in temperature of stator resistance of machine in practical. Therefore, it is possible to achieve a more accurate and stable DTC that is based on estimated resistance. Fourthly, the estimation of stator flux based on voltage modeling using pure integration causes DC drift and saturation problems. To overcome these problems, close loop of stator flux estimation based on voltage model, current model, voltage correction, and low pass filter is proposed. The outputs of this work are sinusoidal waveform without distortion, resulting in an optimized torque and flux estimation and improving the performance of system. In addition, one of the main drawbacks namely the high torque and flux ripples are remedied by the proposed PI DTC-SVM based on voltage amplitude and stator flux angle along with previous estimation methods mentioned above. In this method, both the torque and the magnitude of flux are under control. Noting that no decoupling mechanism is required as the flux magnitude and the torque can be regulated by the PI controllers. Also, switching table is replaced by space vector modulation (SVM). In addition, sensorless PI DTC-SVM based on improvement model reference adaptive system IMRAS is proposed to estimate the rotor speed. In this work, IMRAS is based on reference speed, rotor flux, and stator current without a need for PI controller. Fifthly, for fast response of the proposed PI DTC-SVM system, minimizing the starting torque, and reducing stator current, the proposed intelligent DTC-SVM based on proposed particle swarm optimization PSO and adaptive neuro fuzzy inference system ANFIS along with previous estimated methods is presented. In this work, PI speed controller is replaced by certainty based on PSO and PI torque control is replaced by ANFIS. The abovementioned studies show that the problems of the DTC for induction machines namely the high torque and flux ripples, distortion of stator current as well as the variation of stator resistance, and DC drift with problem saturation due to pure integration at low speeds have now been significantly reduced compared to other IM speed control techniques. The simulation and experimental results of proposed intelligent DTC-SVM method show that the system at low speed has a fast response, low torque ripple, low flux ripple, and almost without stator current distortion.

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