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STUDY ON A NEW AND EFFECTIVE SPEED SENSORLESS CONTROLLER FOR 3-PHASE INDUCTION MOTORS BY APPLYING DE-COUPLING METHODOLOGY

Abstract:

The 3-phase induction Motors (3pIM) are widely used in energy technologies as well as other industries. There have been many studies, which help to increase performance of the 3pIM, however, there are still many problems remaining, such as separation of the current that makes flux and the current that make moment is not completed; the control systems could not be fully digitalized to ensure high quality. To overcome these disadvantages, this study uses a new approach to design a new and effective controller for the 3pIM by applying Direct-Decoupling Methodology based on Exact Linearization Algorithm and Adaptive Backstepping Technology together with Kalman filter for constructing an observer for rotor flux. 3pIM are expressed by a system of non-linear equations for currents and flux in the d-q coordinate system, and moment and motion. Then State feedback controller with pole assignment from predefined poles is used for deriving a linearized model or the de-coupling structure of the 3pIM. After adding integral component to reduce static errors, non-linear oscillating noises to take into account oscillations of stator angular frequency, rotor flux, stator voltage and motor's and choosing a Lyapunov control function, Kalman filter for observing rotor flux, the Adaptive Backstepping Controller of the 3pIM has the structure as shown in the Image 1. Several simulations and experiments (with speed changed from 1500 to -1500 rpm and from -1500 to 500 rpm) have been carried out using Simulink/Matlab, where state feedback controller, controller for currents, controllers for speed and rotor flux provided by the Simulink. Besides, programs for state vector modulation and Kalman filter were written in C language and installed in Simulink throug S-Function.

Simulations and experiment results show clearly that the rotor flux can be well estimated in all operating conditions and performance of the 3pIM under all dynamic modes can be improved by using the new developed controller. In any speed intervals the designed system has excellent responses, speed's overshoots were always less then 7 rpm, and response times were very short (less than 200 ms). Direct-decoupling methodology has been effectively applied to construct a new adaptive backstepping controller for the 3pIM, and a Kalman filter has been also successfully used for observation of rotor flux. In order to prove the application of the new method in practical aspects, designing of a controller without adaptation of rotor time constant will be studied and published in the near future.

Keywords:

3-Phase Induction Motors, Adaptive Back-stepping, Decoupling Control Methodology

JEL Classification: C63, L69, O30