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SURAPONG SUWANKAWIN: A NOVEL STABILITY ANALYSIS AND DESIGN TECHNIQUE FOR A DECOUPLING CONTROL BASED SPEED-SENSORLESS INDUCTION MOTOR DRIVE. THESIS ADVISOR: DR. SOMBOON SANGWONGWANICH, pp. 211. ISBN 974-17-0025-3.

A new sensorless induction motor drive based on a modified decoupling control and an adaptive full-order observer is proposed in this dissertation. The modified decoupling control is integrated with the adaptive observer to eliminate model redundancy and to reduce the complexity of the whole system. A current control loop is introduced into the decoupling control to improve the performance in the low speed range, and the current controller effectively attenuates the waveform distortion and tracking error of the stator current, which are caused by the dead-time effect, and non-ideal switching devices. Stability of the speed estimation is analyzed using a newly introduced analyzing method, and the necessary and sufficient conditions for the stability of the speed estimation are analytically derived. It is indicated that the adaptive observer can be unstable in the low speed region with regenerative loads. Physical insights into the instability phenomenon are also given from the viewpoint of equivalent circuits. It is revealed that the instability behavior is an inherent property of the adaptive observer, and that the dynamic characteristic of the motor itself together with the direction of the current error, which we observe and use to estimate the rotor speed, are the sources of the instability. A novel feedback gain of the adaptive observer is then proposed to restore the stability for the whole operation especially in the regenerative mode. Stability improvement using the proposed feedback gain is rigorously proven by the method of Lyapunov. In addition, the ramp response characteristic of the speed estimator is proposed as a design guideline for the adaptation PI gain. It is shown that the integral adaptation gain determines the tracking error of the speed estimator during acceleration/deceleration while the sensitivity to current measurement noises depends on the proportional adaptation gain. It is also pointed out that a suitable corner frequency of the adaptation PI gain is required as a design trade-off to avoid an oscillation. The validity of all theoretical results is verified by simulation and experiment.