SENSORLESS TORQUE CONTROL OF AC INDUCTION MOTORS

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SUMMARY

The nonlinear control method of induction motors (NC) has been introduced to overcome several drawbacks faced using the well-known field oriented control method. NC depends on the nonlinear changes of state variables. The use of this method provides a novel model of the induction motor in which all variables are scalars. This model has been called the multiscalar model (MM). This method makes it possible to present a general control method, which may be used in different variants of induction motor drive systems. This model may be used to linearize the control of induction motors using nonlinear feedback. As a result, the drive system is fully decoupled and two separate mechanical and electromagnetic subsystems can be obtained. This property makes it possible to implement flux weakening without coupling between the mechanical and electromagnetic channels. In addition, the presented nonlinear control method does not contain the complicated transformations from one coordinate system to another.

The main problem during the realization of nonlinear induction motor control systems is the identification of state variables, which are not available for direct measurement. In this paper, a favourable solution to overcome this problem is proposed. One of the solutions is based on the use of voltage and current models and active and reactive power calculation.

The slip PI controller is used to develop stator current frequency. This method makes it possible to avoid the calculation of the rotor angular speed. By this way it is possible to obtain a sensorless control system taking into account the motor dynamics. An additional big advantage of the torque control method is its small sensitivity to the motor parameters. The proposed control system maintains a performance matching that of a system with a speed sensor. This is accomplished using a closed torque loop. The current frequency $\omega_i$ in this paper is developed using a slip frequency PI controller. In this manner the current frequency is commanded correctly in steady states and transients. The torque control system does not include the rotor speed. Therefore, the system is completely closed loop and only requires the stator current and dc-bus voltage measurement. If the motor load changes linearly or nonlinearly with speed then it is possible to exactly identify the rotor speed. The speed calculation may be used only for monitoring and does not take part in the control process.

The voltage source inverter with hysteresis current controllers feeds the induction motor model. The input commands for the hysteresis algorithm are the amplitude and angular frequency of stator current. Thus, this paper introduces a significant innovation in the electrical drive system based on the nonlinear control theory of induction motors. Comprehensive simulation results corroborating the developed theory is presented.