MICROPROCESSOR BASED SPEED CONTROL OF DOUBLY FED INDUCTION MOTOR

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ABSTRACT

A wide range of solid state power modulation techniques are available for speed control of induction motor. The entire spectrum of these techniques can be classified as Variable Voltage Fixed Frequency (VVFF) or Variable Voltage Variable Frequency (VVVF) type. While VVFF modulators provide a narrow range of speed control, the VVVF modulators provide wide range of speed control, but are expensive and bulky for higher ratings of machines. To overcome these limitations, efforts are being made for utilising doubly fed induction motors.

This thesis deals with design, and fabrication of a doubly fed induction motor (IM) drive, using a current source inverter (CSI) for rotor power control. Such an arrangement provides a wide range of speed control from near zero to twice the synchronous speed.

To achieve smooth operation of the doubly fed IM drive, for a range of twice the synchronous speed, it is necessary to have a signal generator to ensure slip frequency operation of CSI. In the past electromechanical devices have been used for implementing the signal generator. In this thesis, an IC based signal generator has been developed to meet the requirements of the drive. Design details of signal generator consists of generation of reference frequency pulses from supply, actual speed pulses from motor shaft, and their further processing to get the desired frequency pulses which are used for triggering the inverter thyristors.

The reported applications of doubly fed IM drives have been based on the use of cascaded PI speed and current controllers. Such

schemes are not entirely satisfactory for high performance requirements. For better performance state feedback controllers provide a solution.

In the past no attempt has been made in the literature for deriving a state space model of doubly fed IM drive and for its utilization in the design and implementation of state feedback controller. In the work reported in this thesis, a state space model of doubly fed IM along with CSI in the rotor circuit has been proposed and further utilized for developing a state feedback speed controller.

In the first stage, a generalised nonlinear d-q axes model of the doubly fed IM along with CSI in rotor circuit is developed. Digital simulation studies of the model are carried out. The simulated responses are further validated by a comparison with experimentally obtained responses. Linearisation of the validated generalised model has been carried out at various operating points of the drive. Simulation studies revealed that change of operating point has minimal effect on the system response. As a result a state space model linearised at a central point has been selected for controller design.

Both simulation and experimental studies have been made with parameter optimised PI speed feedback controller. Use of PI speed controller improves the system dynamics. In order to affect a further improvement in performance, use of state feedback controller has been investigated. Design of state feedback speed controller has been done on the basis of shifting eigenvalues of drive model to desired locations. Simulation studies carried out with state feedback speed controller confirm their superiority in terms of fast rise time, less overshoot and settling time.

The designed state controller has been implemented on an 8-bit 8085 A microprocessor augmented with Am 9511 arithmetic processor. A fast method of digital speed measurement is developed to feed in the actual speed data to the microprocessor based speed controller. Details of interfacing for speed reference, rotor side d.c. current, and current controller output are presented in the thesis. The output of state feedback controller has been used as reference input to current controller for trigger angle control of controlled rectifier.

The final chapter contains a summary of the principal results establishing a procedure for developing a doubly fed IM drive having a microprocessor based state feedback controller.

Various appendices contain the associated theory, equipment parameters and listing of microprocessor data acquisition and controller subroutines.

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