ABSTRACT

Three phase induction motors are the most sought after machines in industry as they are relatively less costly and rugged due to the absence of commutators. They are the driving mechanism for majority of operations in industries, agriculture, commercial complexes etc.

Separately excited DC machines are the most versatile machines from the control point of view. This is mainly because of the reason that the torque and flux components of current are orthogonal to each other and hence there is no mutual influence between them. However, in an induction motor, the stator current has to meet with both torque and flux requirements. Therefore, torque producing component of current and the flux component of current are interdependent and hence it is not possible to change one without influencing the other. This makes the motor control very complex. Researchers have started working on reducing the complexity of induction motor control right from mid 1980’s leading to various techniques for separating the torque component of current and flux component of current. This revolutionized the induction motor control and today induction motors are dominating the drive market and have substituted the DC motor in high performance applications where variable speed and torque control is needed. The most widely adapted methods of speed control today are Scalar Control, Direct Torque Control(DTC) , Field Oriented Control(FOC) and Adaptive Control.

Direct Torque Control, which is basically a kind of vector control scheme, is used when fast torque control is required. Conventional DTC scheme use hysteresis controllers in the torque and flux loops which can not
consider magnitude and change of errors. Better torque and flux responses are possible if the magnitude and change in errors are taken into account. A fuzzy controller with different types and levels of multilevel inverters are used in this work to replace hysteresis controllers, which decide the switching states of inverters depending on the error and the change in error. The main contributions of the present investigation include,

a) Carried out simulation studies with cascaded H bridge inverter and diode clamped inverters up to seven levels and analyzed the performance of drive with regard to torque ripple minimization.

b) Developed a hardware setup for Direct Torque Control scheme with conventional PI controller replacing the hysteresis controller along with three-level diode clamped inverter and analyzed the performance.

c) Carried out simulation study in Direct Torque Control scheme with fuzzy torque controller and analyzed the performance.

Accordingly, the thesis consists of seven chapters. The chapter one presents the problem under investigation, the objectives of the present work along with the related literature survey. Chapter two discusses the performance analysis of cascaded multilevel inverter fed induction motor drive to check the suitability of this type of inverter for the proposed work. Chapter three discusses the performance analysis of diode clamped multilevel inverter fed induction motor drive employing multi-carrier sinusoidal PWM method with a view to identify the most suitable multilevel inverter for the proposed work. Chapter four explains the modelling and simulation of a three-level diode clamped DTC of induction motor for closed loop system using MATLAB software. Chapter five discusses the experimental setup for a three
level diode clamped DTC of induction motor for closed loop system. Chapter six deals with the direct torque control with fuzzy logic controller to minimize the torque ripple in induction motor. Chapter seven gives the summary of work done along with its merits, the conclusions and the directions for further research.

Fast torque response and minimum torque ripple are the most preferred characteristic features of an induction motor control strategy. DTC, even though is the most preferred control scheme by industry, has the major drawback that it produces large amount of torque ripple. The proposed study is carried out to propose the most suitable strategy, when DTC is applied, which gives minimum torque ripple. Various types and levels of multilevel inverters are studied using PSIM software to find the most suitable level of inverter which gives less THD. It is concluded from the study that the amount of THD reduces as the level of inverter increases. However, as the cost and complexity also increases as the level of inverter increases, the analysis is limited to DTC with a three level inverter. With an aim to propose a scheme with a low level multilevel inverter, the performance of a TLDCI DTC -SVM induction motor with conventional PI controller is carried out using MATLAB simulation software and the torque ripple is calculated for two machines of ratings 3kW and 0.75kW. The results of simulation are validated by an experimental set up for 0.75kW motor drive. Further, the study is repeated with a fuzzy controller replacing the conventional PI controller. The results obtained are very satisfactory and hence it can be concluded that the torque ripple in DTC scheme can be reduced to a very low level with a help of a multilevel inverter with fuzzy logic controller.

Thus, the proposed methodologies are viable solutions for reducing the torque ripple in DTC scheme as applied to three phase induction motors.