International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Prediction Technique for Reduction of Current Ripples in Induction Motor

***Kurava Govind* [a], *M. Sekhar* [b]**

[a] *M. Tech, Student Electrical Power System, CRIT College Anantapur, Andhra Pradesh, India*
[b] *Asst. Prof., Electrical Power System, CRIT College Anantapur, Andhra Pradesh, India*

A B S T R A C T

Direct torque control (DTC) is one of the most excellent control strategies of torque control in induction machine. It is considered as an alternative to the field oriented control (FOC) or vector control technique. These two control strategies are different on the operation principle but their objectives are the same. They aim to control effectively the torque and flux. Torque control of an induction machine based on DTC strategy has been developed and a comprehensive study is present in this project.

In the paper, a novel technique for the direct torque control (DTC) of an induction motor is proposed, which overcomes the trouble of high torque ripple afflicting the conventional DTC technique. With the novel technique, the inverter voltage vector selected from the switching table is applied for the time interval needed by the torque to reach the upper (or the lower) limit of the band, where the time interval is calculated from a suitable modeling of the torque dynamic

By this approach, the control system emulates the operation of a torque hysteresis controller of analog type since the application time of the inverter voltage vector is dictated by the allowed torque excursion and not by the sampling period

Keywords: DTC,

INTRODUCTION

1.1 BACKGROUND:

Currently the main types of electric motors are still the same DC, AC Asynchronous and Synchronous motors. But, since its invention, the AC asynchronous motor, also named induction motor, has become the most widespread electrical motor in use today. Induction machine (IM) has been the work-horse of industry due to its robustness, low cost, and less maintenance. The main advantage is that induction motors do not require any electrical connection between stationary and rotating parts of the motor. Therefore, they do not need any mechanical commutator (brushes), leading to the fact that they are maintenance free motors. Induction motors also have low weight and inertia, high efficiency and high over load capability. Furthermore, the motor can work in explosive environments, because no sparks are produced.

On the other hand DC motors has been widely used during the last century in applications where variable speed operation was needed, because its flux and torque can be controlled easily by means of changing the field and the armature currents respectively. Furthermore, operation in the four quadrants of the torque-speed plane including the temporary standstill was achieved. However, DC motors have basically three drawbacks. They are:

- High speed limitation because of the commutators
- Poor reliability and need for regular maintenance
- Expensive

Taking into account all the comparisons outlined above, induction motors must be considered the perfect electrical to mechanical energy converter. The only effective way of producing an infinitely variable speed induction motor drive is to supply the induction motor with three phase voltages of variable frequency and variable amplitude. A variable frequency is required because the rotor speed depends on the rotating magnetic field provided by the stator. A variable voltage is required because the motor impedance reduces at low frequencies and consequently the current has to be limited by means of reducing the supply voltages.

To overcome the drawbacks of DC Motors, AC motors are being used. Among them IM has proven to be the best due to its lower cost, better reliability, lower weight and reduced maintenance requirement. It has become the workhorse in the industry for variable-speed applications in a wide power range that covers from fractional horsepower to multi-megawatts. These applications include pumps, fans, paper and textile mills and in locomotive applications.

The control of IM is considerably more complex than those of DC drives and this complexity increases substantially if high performances are required. The control is possible now-a-days due to the introduction of micro-controllers and high switching frequency semiconductor devices with the use of these devices the frequency, phase, magnitude of the input to the IM can be controlled and hence the motor's speed and torque can be controlled. Various control techniques for the control of IM have been proposed. The main objective of a control technique is to obtain good dynamic performance and reliability under all load conditions.

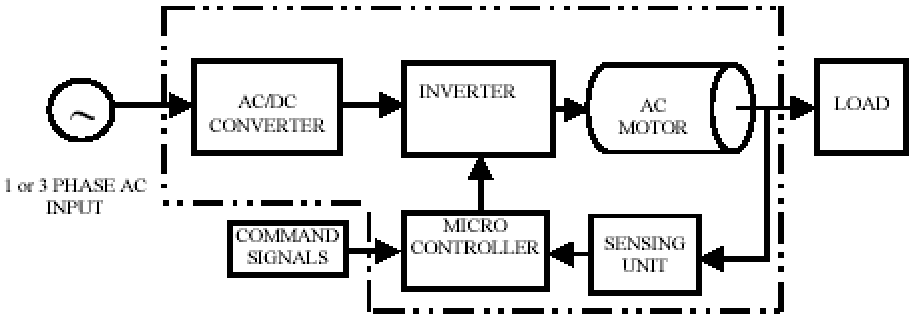


Figure 1.1:- Block diagram of AC motor drive

The basic block diagram of IM drive is shown in figure 1.1. A single-phase or three-phase AC power supply and AC/DC converter provide a DC input to an inverter. A micro-controller decides the switching states for the inverter to control the motors torque or speed. A sensing unit feeds back terminal values such as motor speed, voltage and current to the micro-controller as needed for the closed-loop control of the motor.

With enormous advances made in semiconductor technology during the last 20 years, the required conditions, for developing a proper induction motor drive, are present.

These conditions can be divided mainly in to two groups.

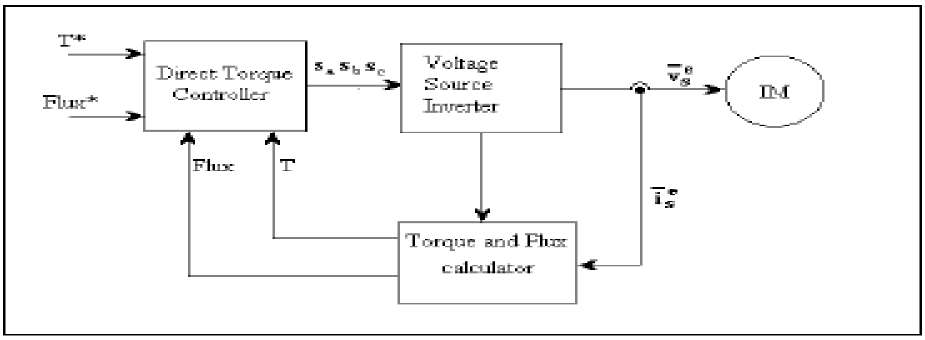
- The decreasing cost and improved performance in power electronic switching devices.
- The possibility of implementing complex algorithms in the new micro processors. Historically, several general controllers has been developed

Most of the industrial motor applications use AC induction motors. The reasons for this include high robustness, reliability, low price and high efficiency. Industries have many applications, where variable operating speed is a prime requirement. Principal benefits of variable speed drives in industrial applications are that they allow the drive speed and torque to be adjusted to suit the process requirements.

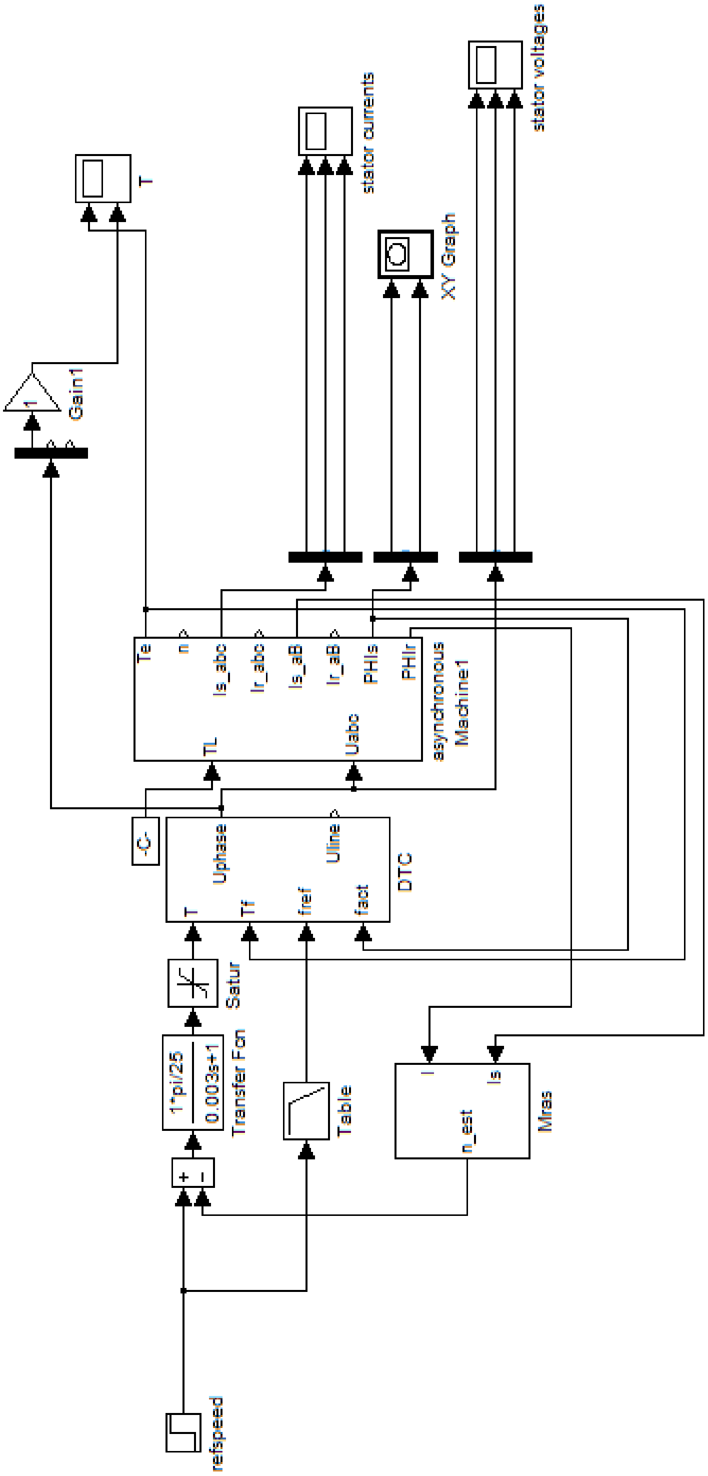
DIRECT TORQUE CONTROL OF INDUCTION MACHINE

3.1 PRINCIPLE OF DTC:

In a Direct Torque Controlled (DTC) induction motor drive, supplied by a voltage source inverter, it is possible to control directly the stator flux linkage (or rotor flux linkage, or magnetizing flux linkage) and the electromagnetic torque by the selection of optimum inverter switching modes. This selection is made to restrict the flux and torque errors within respective flux and torque hysteresis bands, to obtain fast torque response, low inverter switching frequency, and low harmonic losses.



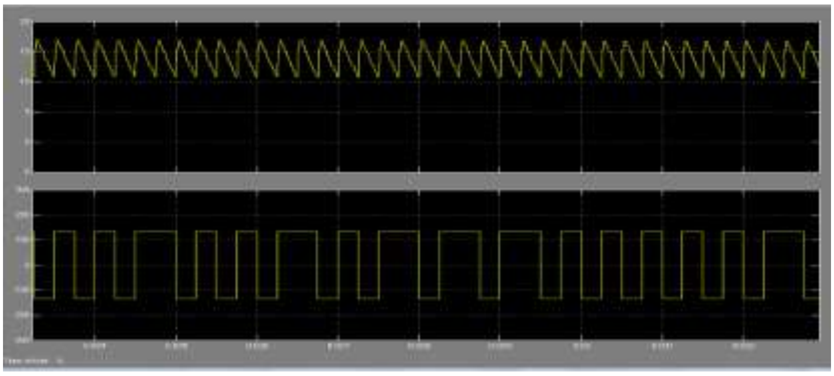
SIMULATION DIAGRAM



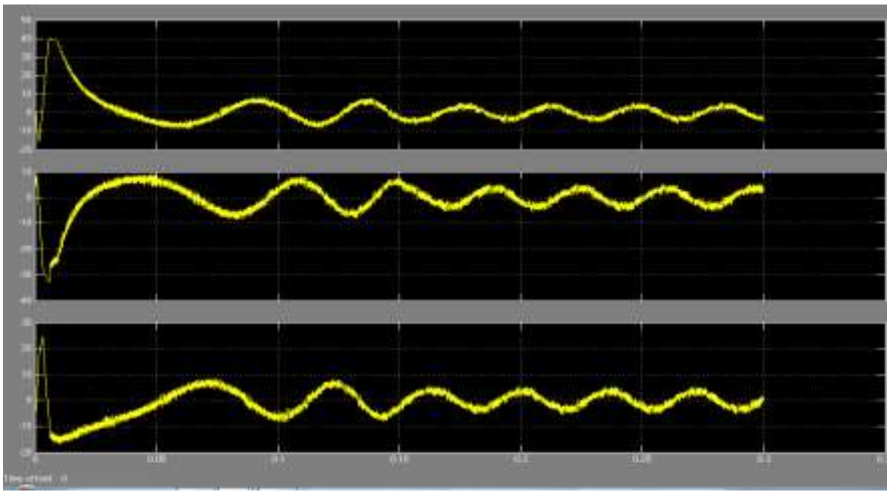
5.1 Simulation diagram of conventional DTC Technique as shown in above figure

IMULATION RESULTS

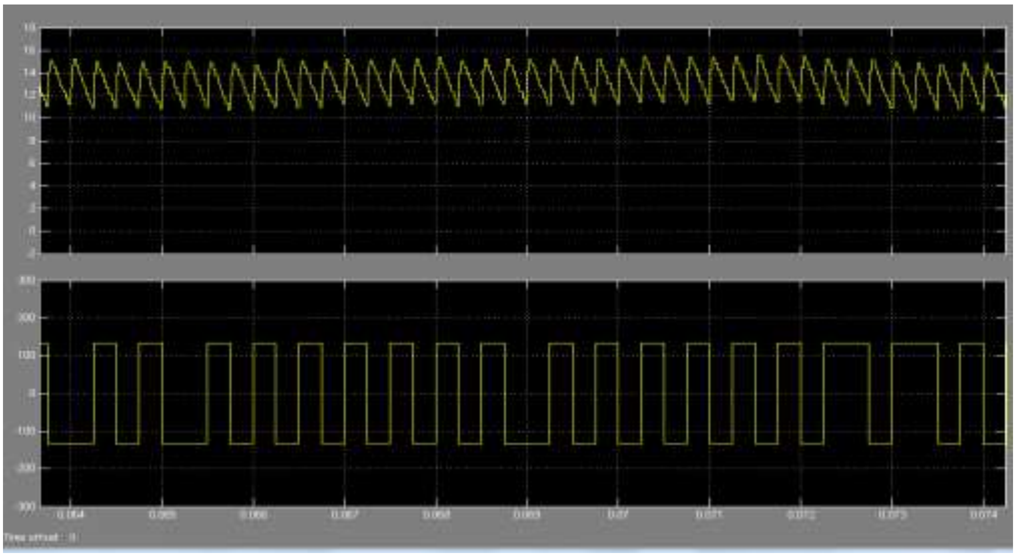
5.1.1Graphs for constrained technique of DTC at 20%W_n as shown in below figures:



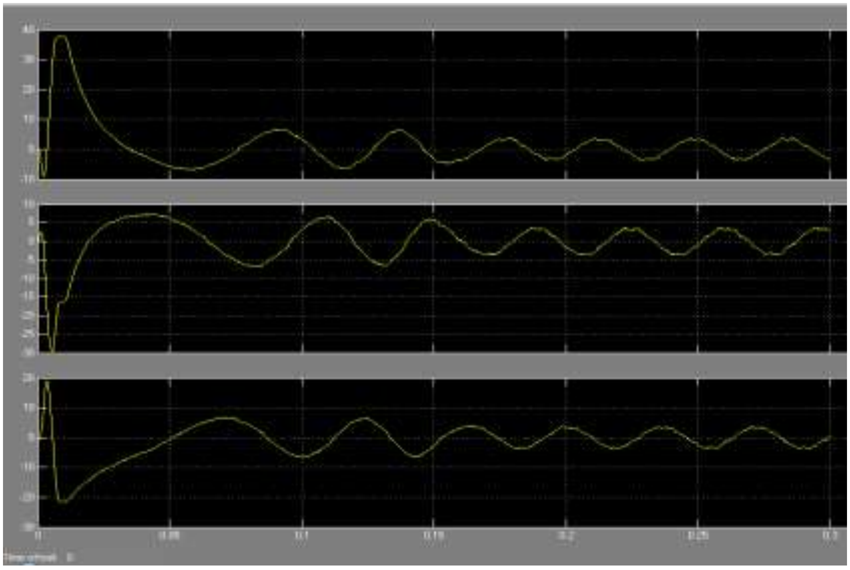
Graph for torque vs time and load voltage vs time



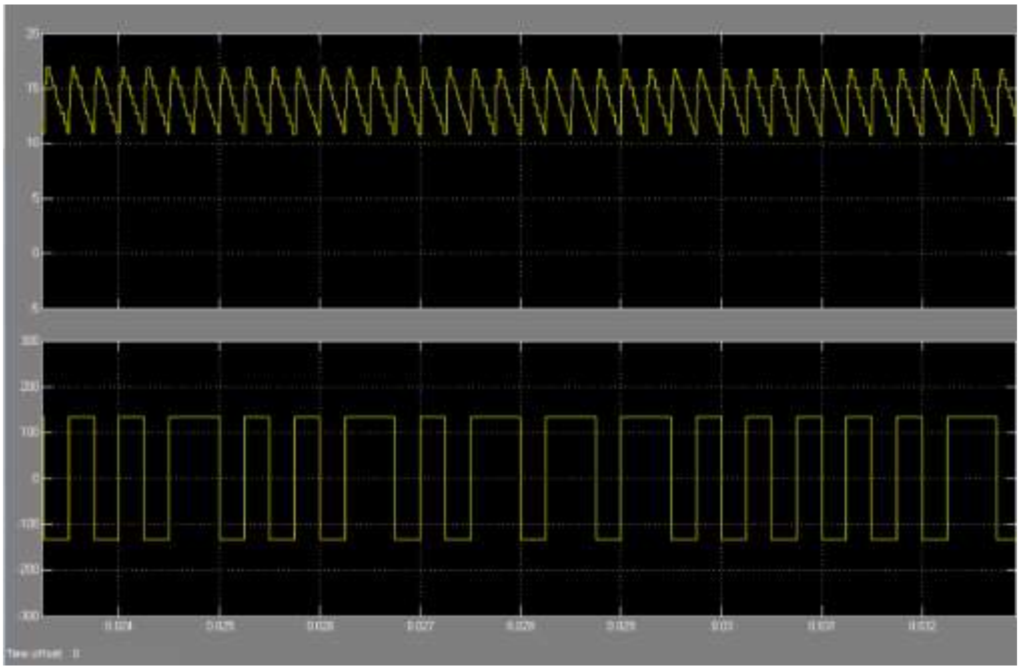
Graph for stator currents vs time



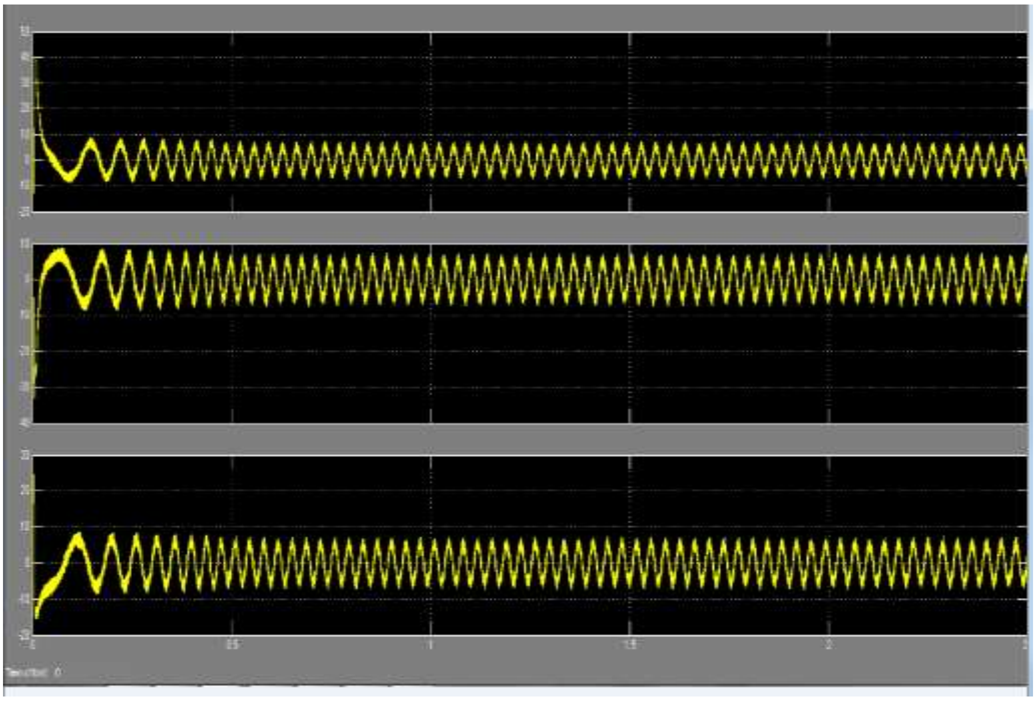
Graph for motor torque vs time and voltage vs time



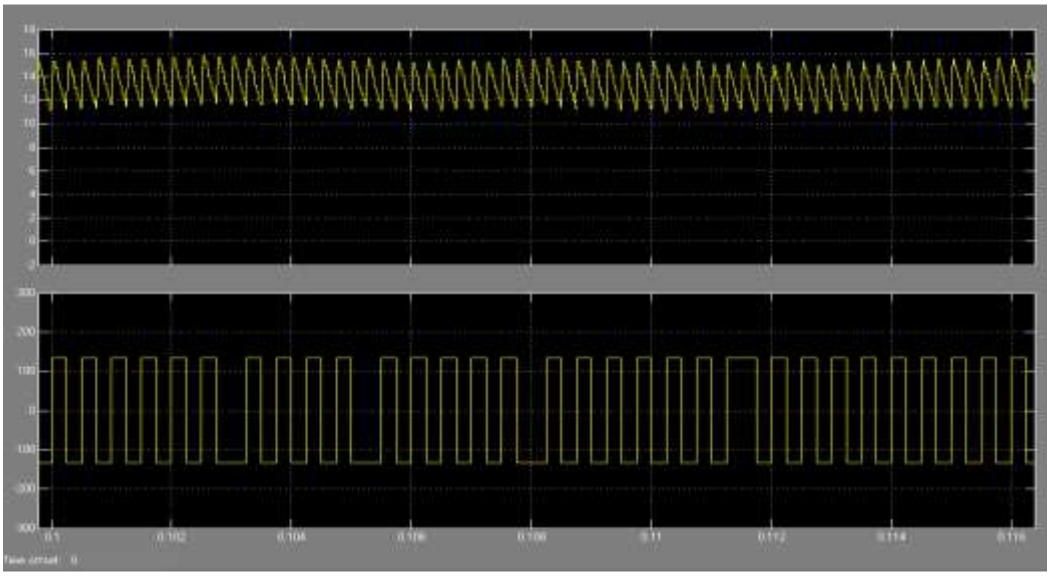
Graph for stator currents vs time



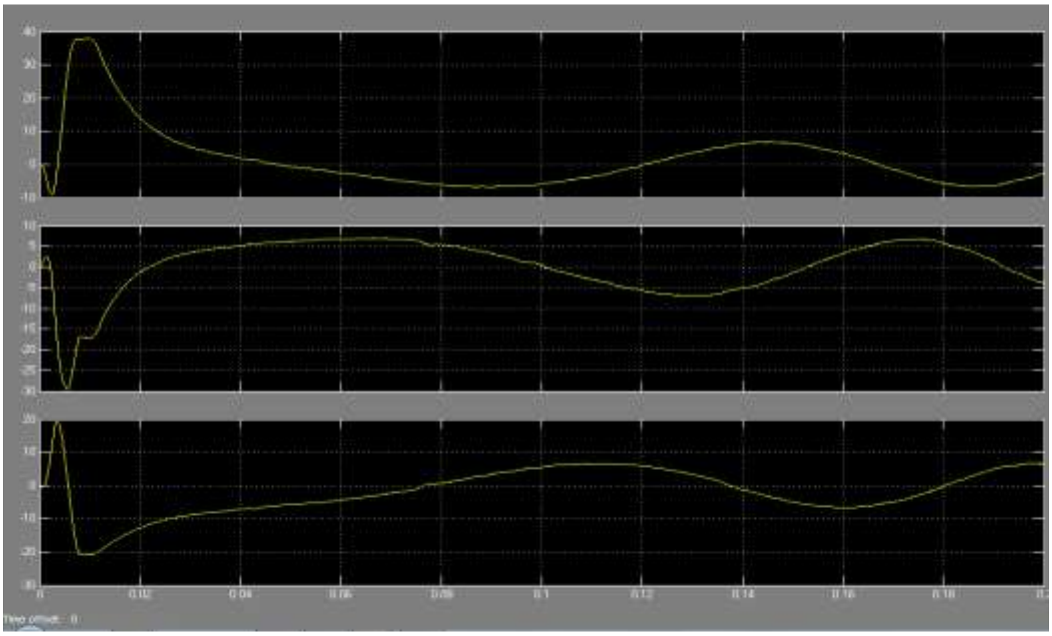
Graph for motor torque vs time and applied inverter voltage vectors vs time



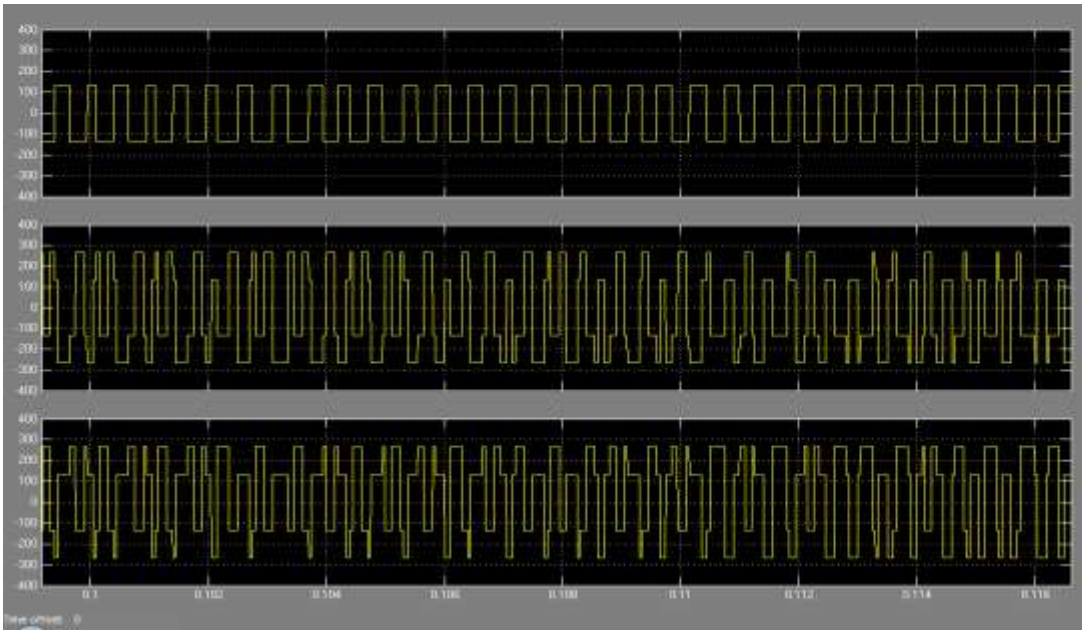
Graph for stator currents vs time



Graph for motor torque vs time and applied inverter voltage vectors vs time



Graph for stator currents vs time



CONCLUSION

This project has presented a direct induction machine torque control method based on predictive control of the torque and flux. By estimating the synchronous speed and the voltage behind the transient reactance, the change in torque and flux over the switching period is calculated.

The principle of the novel technique consists in applying the inverter voltage vector selected from the switching table for the time interval needed by the torque to reach the upper (or the lower) band limit. It has been demonstrated that the accomplishment of this principle considerably reduces the torque ripple and the enforcement of the principle by predicting the motor torque one sampling period ahead so as to compensate for the delay introduced by the discrete-time control algorithm constrains the torque ripple within the customary value used for the hysteresis band of the torque controller.

For narrow or even zero bands, the technique has been readily extended by introducing fictitious band limits. The benefits of the proposed technique compared to the conventional one have been evaluated by measuring the average torque error, the rms values of the torque ripple, and the inverter switching frequency for different operating conditions..

REFERENCES

[1] Barak Ozpineci.and Leon M. Tolbert, “Simulink Implementation of Induction .Machine Model”, IEEE

[2] B.K.Bose “Modern Power Electronics and AC Drives”, Prentice Hall, 2002

[3] M.Riaz, “Simulation of Electrical Machine and Drive Systems Using Mat lab and Simulink”.

[4] Nuno.M. Silva, Antonio P. Martins, .Adriano S. Carvalho “Torque and Speed Modes Simulation of a DTC Controlled Induction Motor”, IEEE

[5] Paul.C.Krause,.Oleg.Wasynczuk,.Scott.D.Sudhoff.“Analysis of Electric Machinery and Drive systems.

[6] P.Vas,. “Sensor.less.Vector.and.Direct.Torque.Control”,.Oxford.UniversityPress,

1998

[7] R.Krishnan,.“Electric.motors.and.Drives.Modeling,.Analysis.&.Control”,.Prentice Hall.

[8]S.S.Murthy,.Department.of.Electrical.Engineering,.Indian.Institute.ofTechnology“A.Generalized.Operational.Equivalent.Circuit.Of.Induction.Machines.For.Transient or Dynamic Studies Under Different Operating Conditions”,.

[9] Zhenyn.Yu..Arefeen.Mohammed.Issa.Panahi,. “.A.Review.of.Three.PWMTechniques”, IEEE

[10]. The Math Works Inc. “Using Simulink”.

www.ieeeexplore.ieee.org

www.ece.osu.edu/ems