Enhancement of Induction Motor Speed by Using Vector Controlled Method

*** Avinash Singh Rajawat**
**** Anil Kumar**

ABSTRACT

In small scale and large scale applications like automobile industries, domestic appliances such as Refrigerators, washing machine and air conditioning units which use conventional motor technology. These conventional motors have a chacterstics of Low torque, high maintenance and low efficiency. The usage of induction motor enhances various performance factors ranging from higher efficiency, higher torque, high power density, low maintenance and less noise than conventional motors. The main drawback is high cost. In this paper a two leg inverter fed induction motor drive is proposed which uses only four switches and two current sensors compared with six switches, three current sensors in case of three leg inverter fed induction motor drive. Less number of switches and current sensors means less switching loss and low cost. In this paper a two leg inverter fed induction motor drive with two input DC source is proposed. The proposed induction motor drive is modeled and its performance is simulated in MATLAB / SIMULINK. This proposed method is a simple, low cost and enhanced performance of dive is obtained i.e., reduced torque ripple, less voltage stress, Low current THD and fast dynamic performance of induction motor drive.

* Avinash Singh Rajawat, M. Tech Student Dep. of Electrical and Electronics, S.V.C.E., Indore, avi.oist2014@gmail.com

** Anil Kumar, Asst. Professor, Dept. of S.V.C.E.INDORE (M.P.)

I. INTRODUCTION:

Modern methodology of static frequency conversion has liberated the induction motor from its historical role as a hard and fast speed machine. The inherent blessings of adjustable frequency operation cannot be absolutely completed unless an appropriate management technique is utilized. The selection of technique is important in crucial the characteristics and performance of the drive system. Additionally the facility device has very little excess current capability; throughout traditional operation the management strategy should make sure that motor operation is restricted to the regions of high torsion per ampere, thereby matching the electrical converter ratings and minimizing the system loses. Overload or fault conditions should be handled by subtle management instead of over style.

Motor is a permanent magnet synchronous motor which is powered by dc-voltage through the inverter that produces the ac electric signal to drive the motor. The torque-speed characteristics of the BLDC motor are similar to the motor, that’s why the name came. The commutation is done in induction motor is electronically instead of brushes.

It is easily controlled through the rotor position sensors and performs well especially in speed/torque. With these advantages, the motor will spread to more applications. The applications of induction motor are increased and its competing with the induction motors and dc motors. The output voltage and output frequency of the inverter are dependent on the switching state of the inverter. The controlling of the inverter switches is done by using various PWM techniques, among these sine PWM and space PWM methods are mostly used today due to many advantages. SVPWM is easy to digitalize and having lower switching losses and consists lesser harmonics and the better utilization of the dc-bus voltage in comparison with SPWM method.

II. BRIEF THEORY OF VECTOR CONTROL (FIELD ORIENTED CONTROL)

The control of separately-excited dc machines is straightforward due to the inherent decoupled nature between flux and torque. As a consequence, torque linearization can be obtained easily by armature current control with constant field flux .DC motors have been widely used in high performance domains such as robotics, rolling mills and tracking systems where fast dynamic torque control is required. AC machines are always preferable to dc machine due to their simpler and more robust construction; there are no mechanical commentators. However, the electrical structures of ac machines are highly nonlinear and involve multivariable inputs and outputs. Therefore, additional effort is required to decouple and liberalize the control of these machines.

III. SPEED CONTROLLING

Variable speed drive systems are essential in many industrial applications. In the past, DC, are require to high speed synchronous circuit because these improved efficiency of induction motor, since their control flux and armature current of induction motor. Dc motors have certain disadvantage they are totally depends for brushes and large current loss. That is, they have require for large periodicity of torque; they cannot be used in explosive or corrosive environments and they have limited commutator these properties are high speed and higher alternate current and rugged Structure of motor. That is providing high maintainability and good economy.

IV. PERMANENT MAGNET PWM BASED VECTOR CONTROLLED ADVANTAGES

Permanent magnet Brushless direct current (induction) motors have more advantages than any other motors like induction motors, dc motors due to compact size, higher efficiency, noiseless operation , higher dynamic response, longer life, and electronic commutation [1]. induction motor has trapezoidal back EMF and phase current is rectangular waveforms which gives zero torque ripple [2]. The induction motor is controlled using three phase voltage source inverter.

V. ADVANTAGES OF PROPOSED ALGORITHEM

1. The sensors are eliminated.
2. The dynamic performance of the indirect induction control is better than the direct induction control
3. The cost factor is decreased.
4. There is no drift problem as in direct induction control.

VI. PROPOSED METHODE AND ITS DESCRIPTION

6.1 DIRECT vector CONTROL METHOD:

In direct induction control method we have seen that it determines the magnitude and position of the rotor flux induction by direct flux measurement or by a computation based on terminal conditions. It also called flux feedback control is method in which required information regarding the rotor flux is obtained by means of direct flux measurement or estimation. The flux is measured by the sensors like Hall Effect sensor, search coil and this is a part of the disadvantages. Because fixing of number of sensors is a tedious job and this increases the cost factor.

The quantities generated from flux sensors are used in the outer loop of the drive control structure. Alternatively, in place of flux sensors, the flux models can also be used for which the stator currents and voltages become the feedback signals and he rotor flux angle is given as its estimated output.

6.2 IN-DIRECT INDUCTION CONTROL METHOD:

The basic block diagram of induction motor operating in indirect induction control mode. The motor speed is used as feedback signal in the controller. The controller calculates reference values of the two decoupled components of stator current space induction in the SRRF which are iqs* and ids* for the control of torque and flux respectively. [2] The two components of the currents are transformed into three phase currents which are ias *,ibs*,ics* in the stationary reference frame of reference. Now as a balanced load, two of the phase currents are sensed and the third one is calculated from the two sensed currents.

VII.

7.1 SIMULINK MODELLING IN VECTOR CONTROL TECHNIQUE:

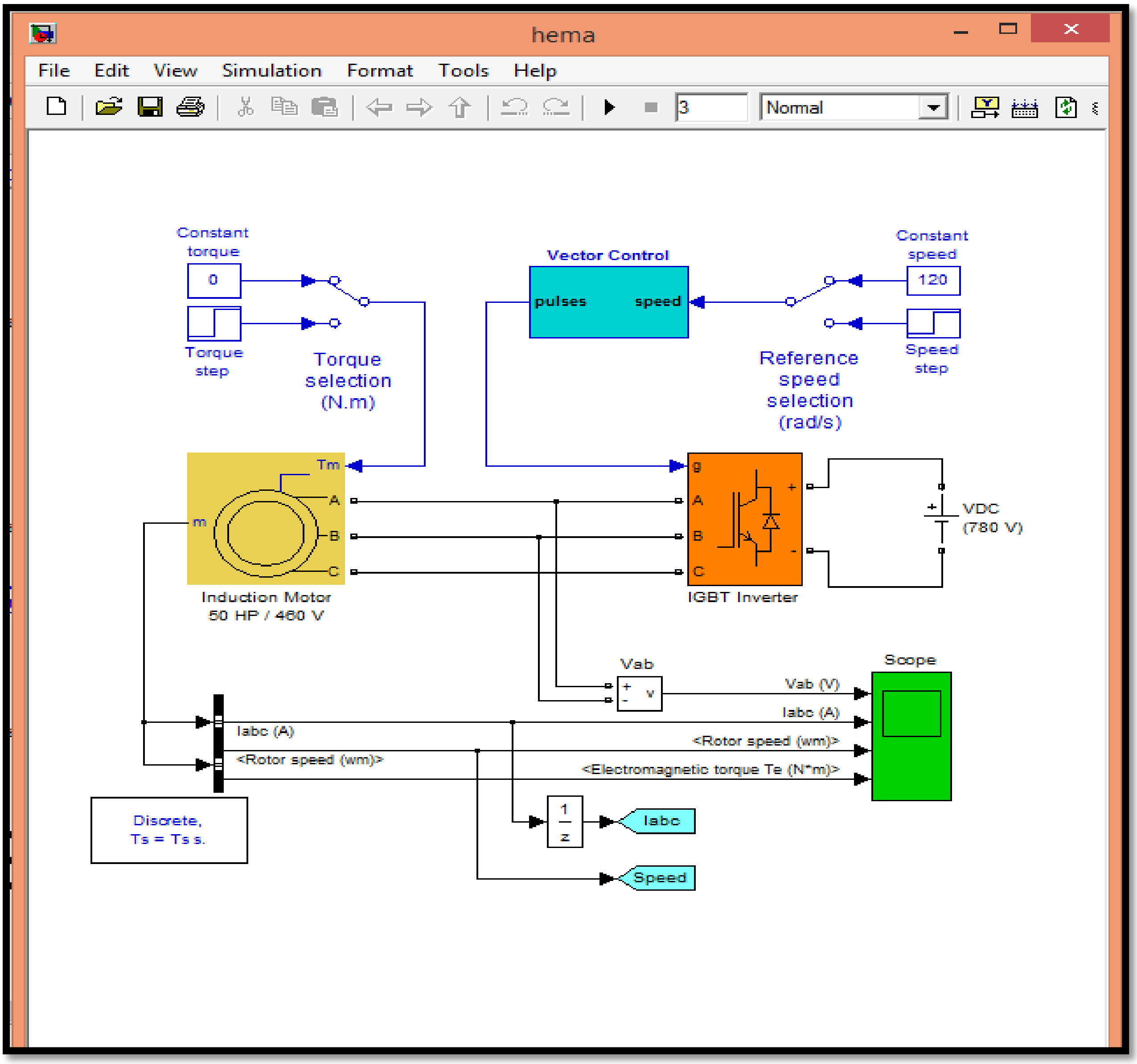

Figure (7.1) Simulink Modeling in Vector controlling induction Motor.

7.2 OUTPUT WAVEFORM IN VECTOR CONTROLING INDUCTION MOTOR:

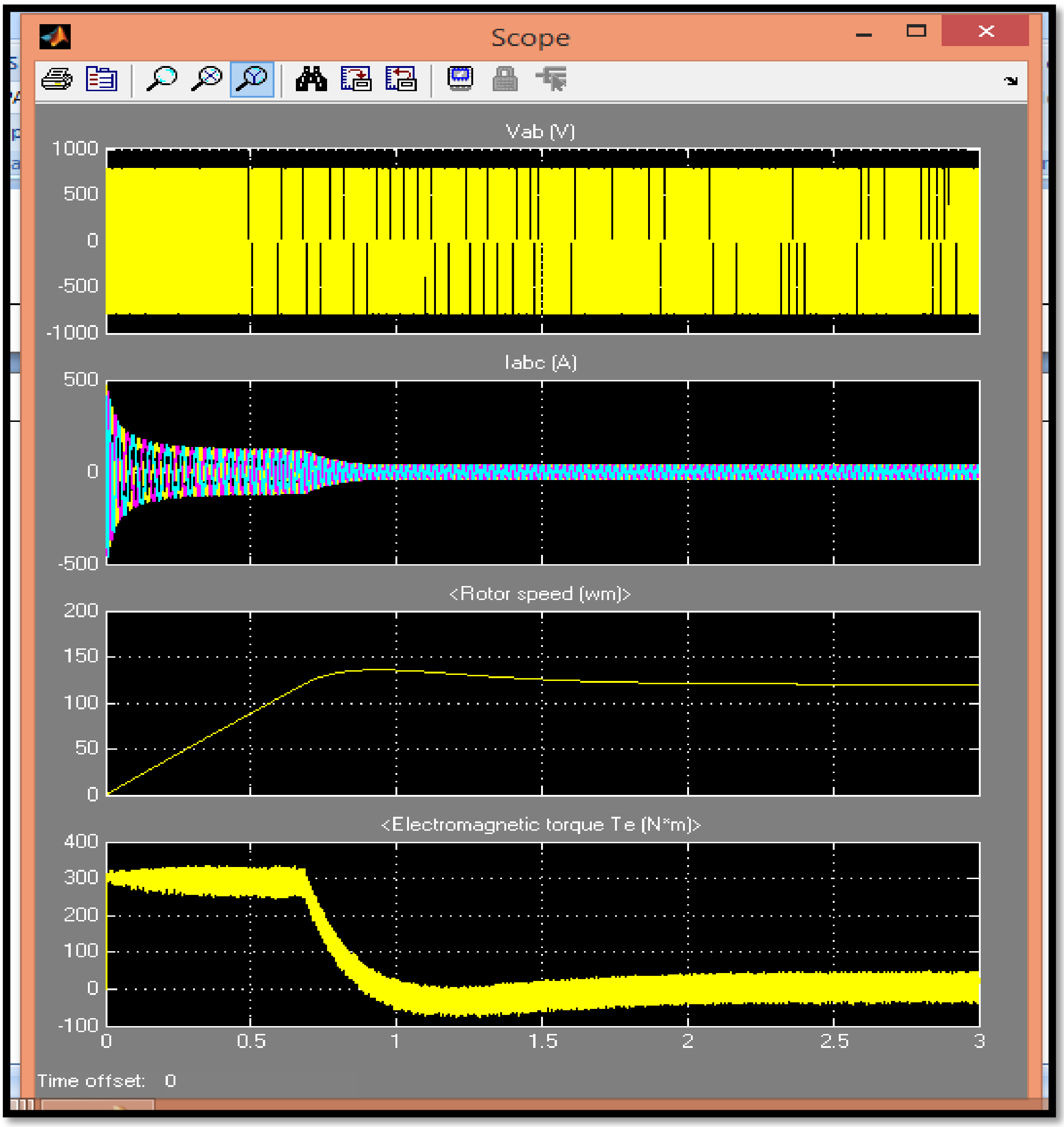

Figure (7.2) V_{ab} PWM output, I_{ab} Current,Rotor speed ,Electromagnetic Torque induced in Induction MOTOR.

7.3 POWER GUI IN PROJCECT:

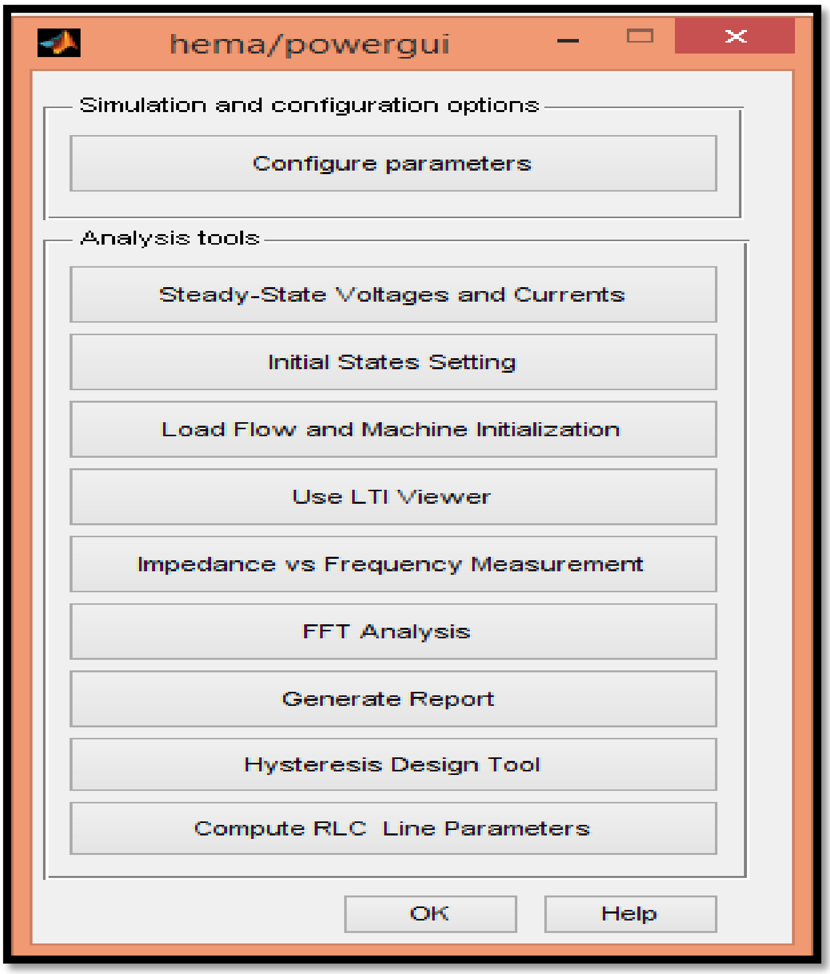

Figure (7.3)

7.4 SINGLE-PHASE ASYNCHRONOUS MACHINE - VECTOR CONTROL:

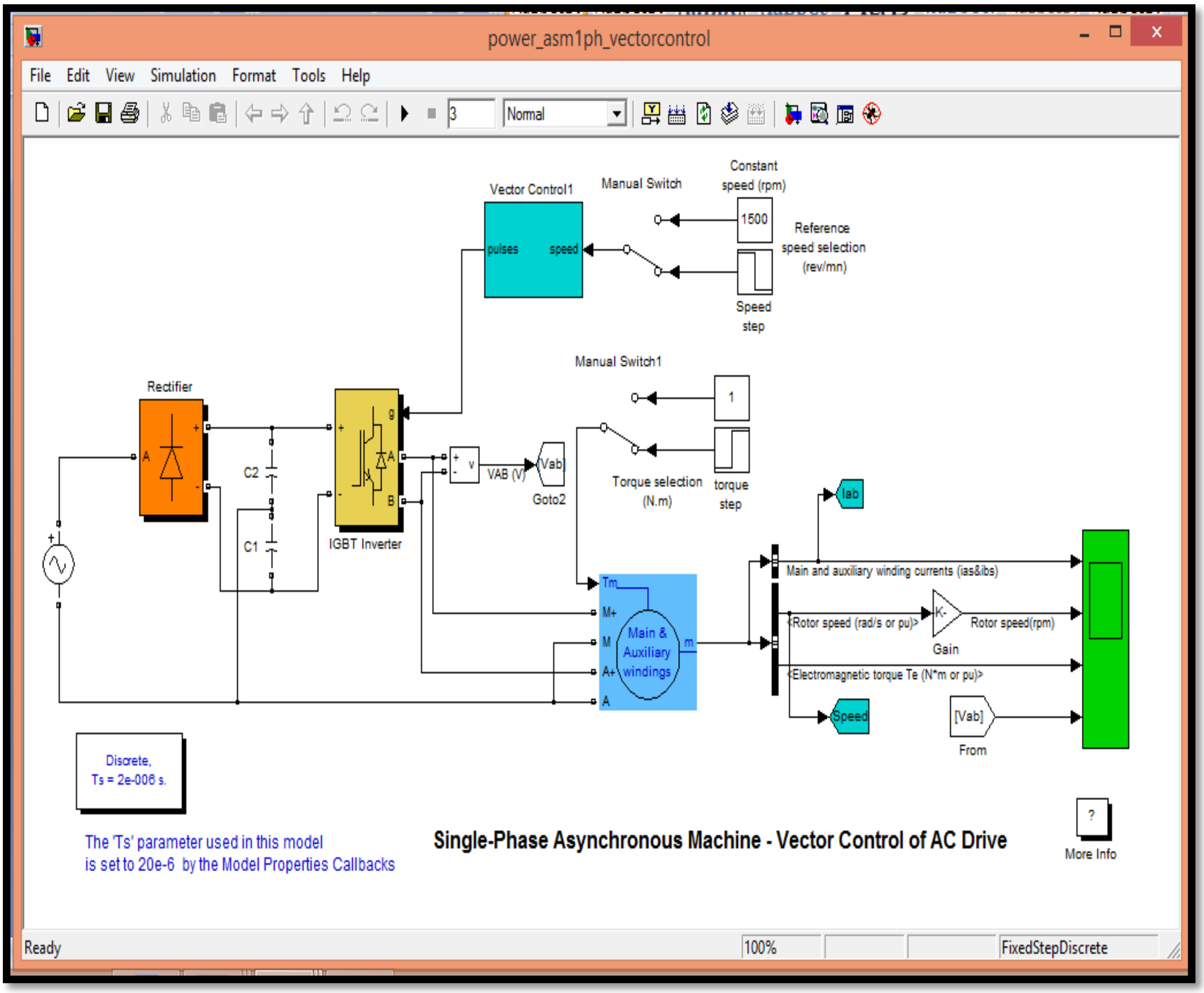

Figure (7.4) Single-phase asynchronous machine

7.5 SINGLE PHASE ASYNCHRONOUS MOTOR:

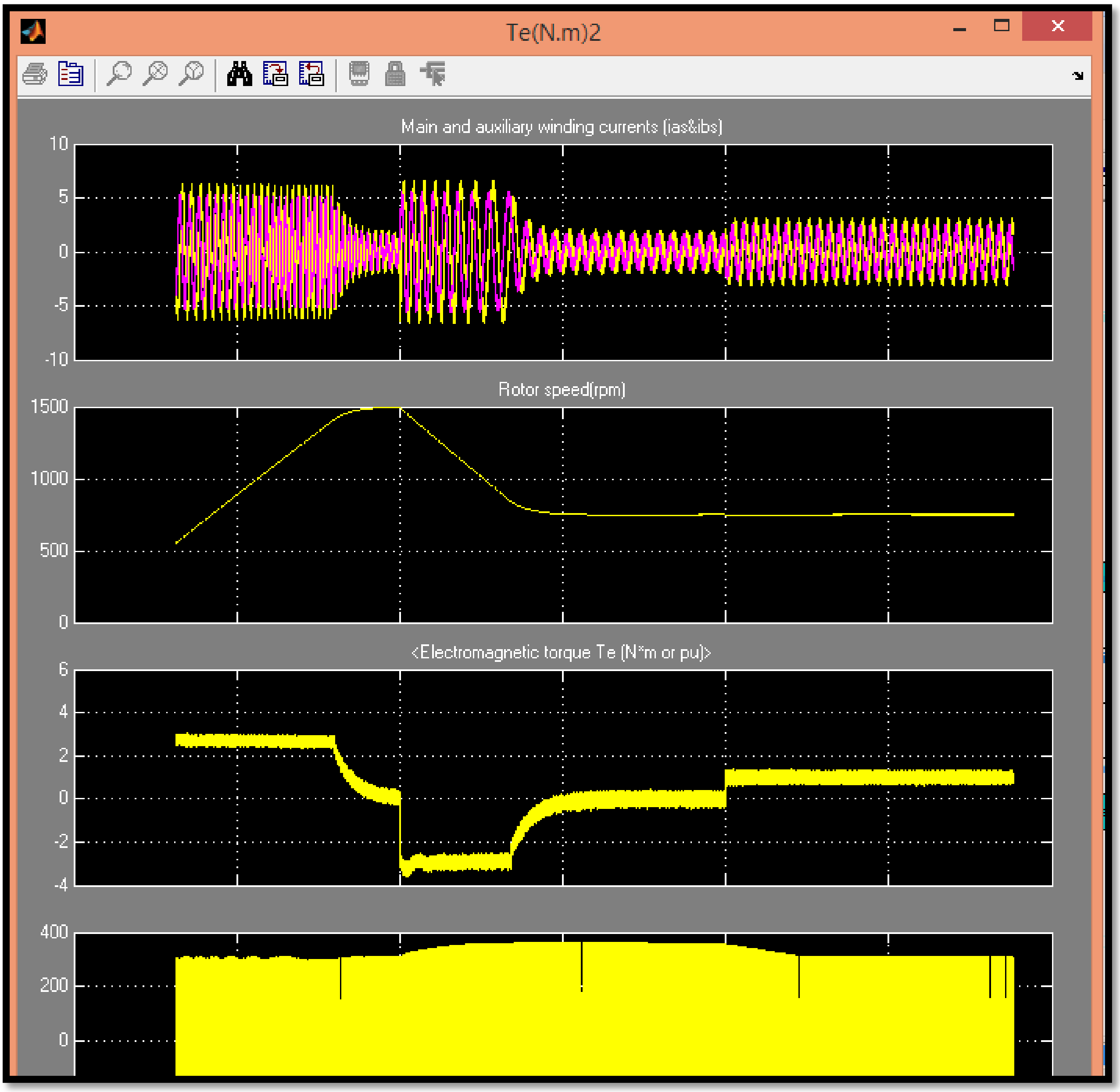

Figure (7.5) Result of Single phase asynchronous Motor.

<u>IMPROVED EFFICIENCY PARAMETER & MY IMPLEMENTATION WORK</u>

1. LOWER TIME CONSUME TO INCRESED LOAD CURRENT AND MOTOR TORQUE:

This figure shows that in the initial state of the Motor , the current signal presents a high value because it is necessary a high torque to increment the rotor speed. In the constant speed region, the motor torque only has to compensate the friction and the load torque and so, the current is lower. Finally, at time *t* = 1 s the current increases because the load torque has been increased.

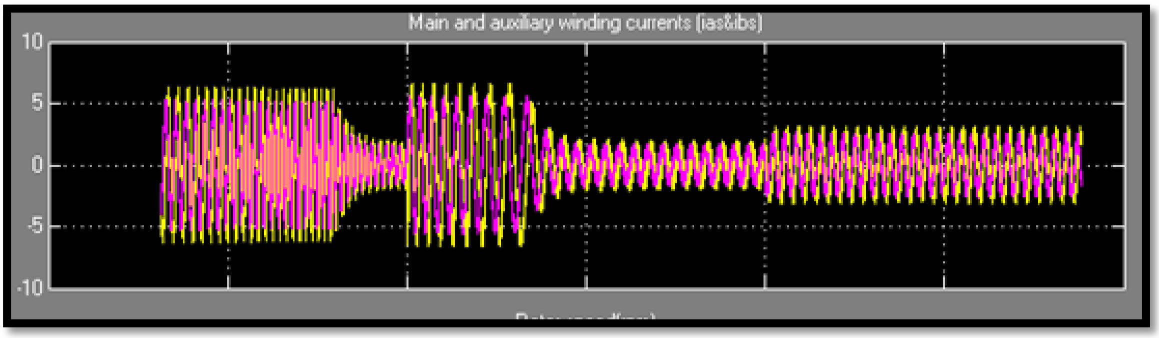

Figure (7.a) Establishment of Winding Current.

2. ENHACEMENT MOTOR TORQUE SAME TIME:

The motor torque as in the case of the current the motor torque has a high initial value speed in the acceleration zone, then the value decreases in a constant region and finally increases due to the load torque increment.

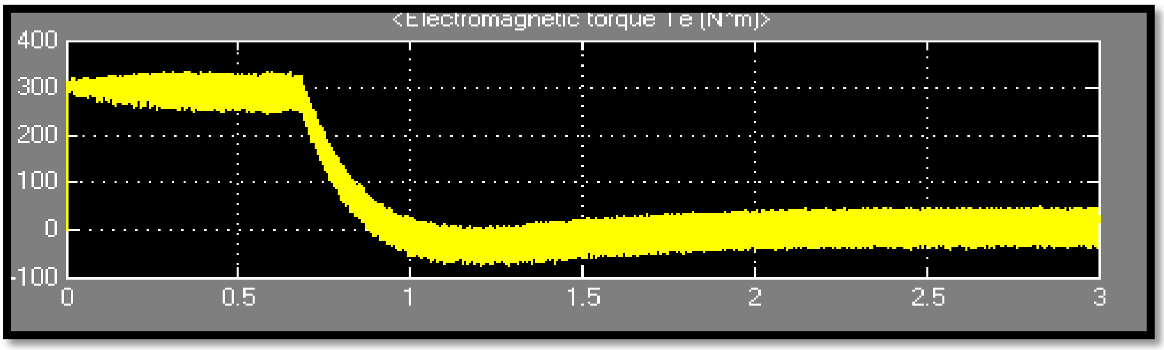

Figure (7.b) Increment of load torque.

VIII. IMPROVED EFFICIENCY PARAMETER & MY IMPLEMENTATION WORK

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3. T=1S HIGHER MECHANICAL INERTIA AND HIGHER FREQUENCY RANGE:

In this figure it may be seen that in the motor torque appears the so-called chattering phenomenon, however, this high frequency changes in the torque will be filtered by the mechanical system inertia.

TABLE-7.1: STEP CHANGE IN REFERENCE SPEED FOR LOW VALUE OF SPEED

TIME SECOND	**0**	**2.5**	**4**
SPEED (RPM)	**1000**	**50**	**20**

TABLE-7.2: STEP CHANGE IN LOAD TORQUE

TIME SECOND	**0**	**3**
SPEED (RPM)	**1000**	**1000**
TORQUE	**0**	**10**

TABLE-7.3: STEP CHANGE IN REFERENCE SPEED

TIME SECOND	**0**	**2.5**	**4**
SPEED (RPM)	**1200**	**800**	**500**

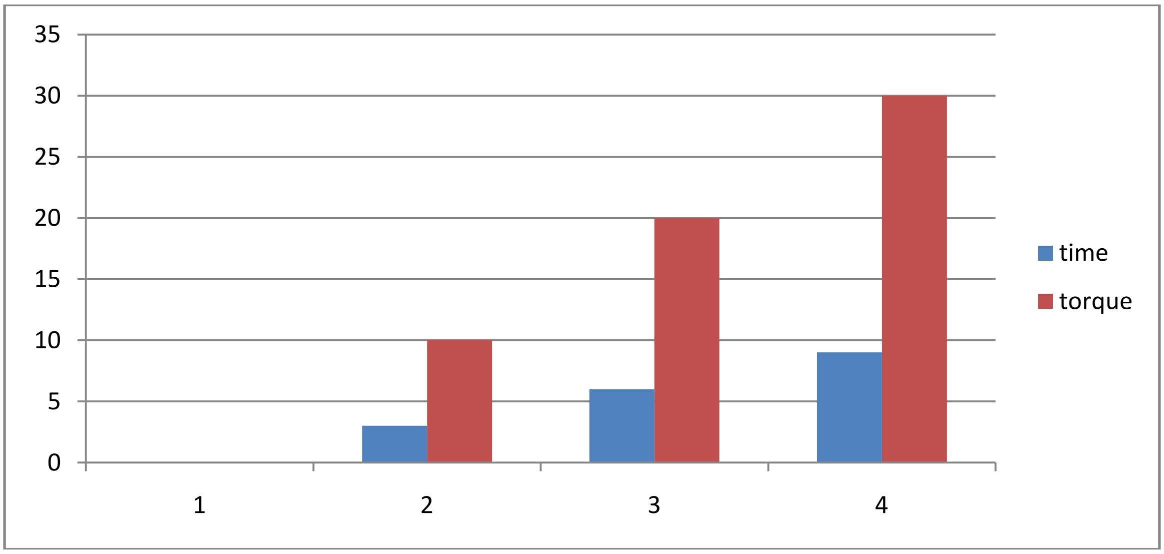

Figure (7.c) Graph between Speed and torque.

IX. CONCLUSIONS AND FUTURE STUDY

Sliding Mode Control (SMC) is a robust control scheme based on the concept of changing the structure of the controller in response to the changing state of the system in order to obtain a desired response. The biggest advantage of this system is stabilizing properties are preserved, even in the presence of large disturbance signals.

The dynamic behavior of the system may be tailored by the particular choice of switching function and the closed-loop response becomes totally insensitive to a particular class of uncertainty. Also, the ability to specify performance directly makes sliding mode control attractive from Design perspective.

REFERENCES

1. Shraddha v. " Sensorless And indirect Torque Control " , Oxford University Press, 1998.
2. Qian cheng lei yuan, Lipo, T.A. , "induction Control And Dynamics Of AC Drives", 1992.
3. Akin acar, A. E. , Kingsley C. , D. Umans Jr. Stephen , " Electric -Hill, 1983
4. Sobha Chandra barik, "Stator Alan Akısı Üzerinden Asenkron Motorun Rotor Akısı Yönlendirmesi _çin Bir Yöntem" ,Doktora Tezi, Fırat Üniversitesi, 1994.
5. Shoeb hussain, "Implementation Of BLDC Control For Induction Motors" , Msc. Thesis, METU, 1999.
6. Vijity kinnares, Tranner, R. and Zwicky, R. "A rotor speed detector for DCutilizing rotor slot harmonics and active three phase injection." in 2nd Proc. Euro. Con$ Power Electronic. App/. induction motor drive. (EPE), Vol. 2, (1987): pp. 599-604.
7. Xingang fu, M. and Naunin, D "A conception for a sensorless speed control of the squirrel cage induction motor." in Proc. Power Electron. Appl. Conf., (1985): pp. 3.51-3.55.
8. Ieroham s. baruch, B. W., Goodfellow, J. K. and Green, T. C. "Sensorless speed measurement of inverter driven squirrel cage induction motors." in Proc. IEEE 4th Int. Con$ Power Electron. Variable Speed Drives, (1987).