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HYSTERESIS CURRENT CONTROL INDUCTION MACHINE DRIVE THROUGH MODELING AND SIMULATION

Parth velani[1]

Electrical department

Abstract— ***Field oriented control is inherently used for controlling the induction motor drives. Indirect field oriented scheme with various topologies like SPWM, HCC have been widely used. This paper synthesizes and develops indirect field oriented control of induction motor based on hysteresis current control. Comparison of HCC and scalar control is also carried out. Comparison shows that HCC fed induction motor drive is a more stable over entire control range.***

Keywords— ***Indirect field-oriented control, hysteresis current control, electric drives, scalar control, induction machines, controller parameters.***

I. INTRODUCTION

The basic operating principle of vector controlled drive is to separate flux producing component & torque producing component of stator current; which are direct axis & quadrature axis current components respectively. Now we can independently control torque generated by motor by controlling quadrature axis current without affecting the flux as direct axis current is maintained constant. Similarly decoupled flux control can be achieved by varying direct axis current only. Thus current control is of prime significance in vector control of induction motor [2].

This paper describes an approach of indirect field oriented control of induction machine with hysteresis current control. Section II presents a model of induction motor. In section III simulation model with control strategies is designed. Simulation results are present and discussed in Section IV.

II. MODEL OF INDUCTION MOTOR

The equations convenient for simulating the induction machine in arbitrary reference frame can be seen as,

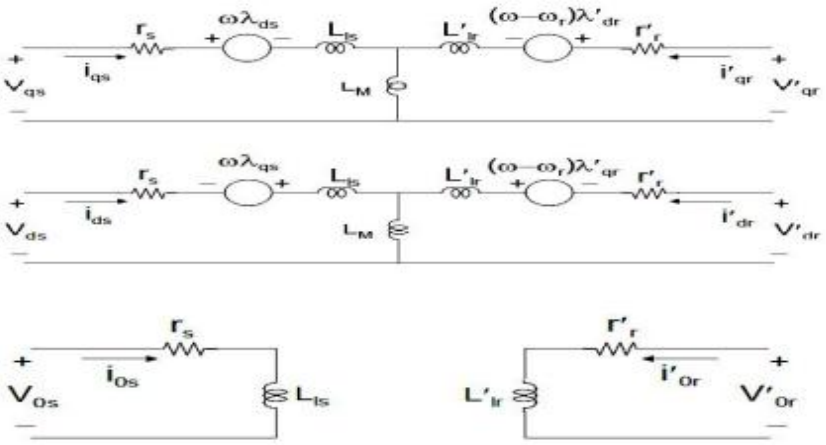

Figure 4.1 Equivalent circuits of a three phase, symmetrical Induction motor with rotating d-q axis at rated speed.

$$i_{qs}=\frac{1}{X_{ls}}(\psi_{qs}-\psi_{mq}) \quad (1) \qquad i_{ds}=\frac{1}{X_{ls}}(\psi_{ds}-\psi_{md}) \quad (2)$$

$$i_{0s}=\frac{1}{X_{ls}}(\psi_{0s}) \quad (3) \qquad i'_{qr}=\frac{1}{X'_{lr}}(\psi'_{qr}-\psi_{mq}) \quad (4)$$

$$i'_{dr}=\frac{1}{X'_{lr}}(\psi'_{dr}-\psi_{md}) \quad (5) \qquad i'_{0r}=\frac{1}{X'_{lr}}(\psi'_{0r}) \quad (6)$$

When ψ_{mq} *and* ψ_{md} ,which are useful when representing saturation , are defined as

$$\psi_{mq} = X_M\left(i_{qs}+i'_{qr}\right) \quad (7) \qquad \psi_{md} = X_M\left(i_{qs}+i'_{dr}\right) \quad (8)$$

if the resulting voltage equations are solved for the flux linkages per second, following integral equations can be seen:

$$\psi_{qs} = \frac{\omega_b}{p}\left[v_{qs}-\frac{\omega}{\omega_b}\psi_{ds}+\frac{r_s}{X_{ls}}(\psi_{mq}-\psi_{qs})\right] \quad (9) \qquad \psi_{ds} = \frac{\omega_b}{p}\Big[v_{ds}-\frac{\omega}{\omega_b}\psi_{qs}+\frac{r_s}{X_{ls}}(\psi_{md} -$$

ψds *(10)*

$$\psi_{0s} = \frac{\omega_b}{p}\left[v_{0s}-\frac{r_s}{X_{ls}}(\psi_{0s})\right] \quad (11) \qquad \psi'_{qr} = \frac{\omega_b}{p}\Big[v'_{qr}-\frac{(\omega-\omega_r)}{\omega_b}\psi'_{qr} +$$

$rr'Xlr'\psi mq-\psi qr'$ *(12)*

$$\psi'_{dr} = \frac{\omega_b}{p}\left[v'_{dr}-\frac{(\omega-\omega_r)}{\omega_b}\psi'_{dr}+\frac{r'_r}{X'_{lr}}(\psi_{md}-\psi'_{dr})\right] \quad (13)$$

$$\psi'_{0r} = \frac{\omega_b}{p}\left[v'_{0r}-\frac{r'_r}{X'_{lr}}(\psi'_{0r})\right] \quad (14)$$

Equations (7) and (8) are now expressed as

$$\psi_{mq} = X_{aq}\left(\frac{\psi_{qs}}{X_{ls}}+\frac{\psi'_{qr}}{X'_{lr}}\right) \quad (15) \qquad \psi_{md} = X_{ad}\left(\frac{\psi_{ds}}{X_{ls}}+\frac{\psi'_{dr}}{X'_{lr}}\right) \quad (16)$$

$$X_{aq} = X_{ad} = \left(\frac{1}{X_M}+\frac{1}{X_{ls}}+\frac{1}{X'_{lr}}\right) \quad (17)$$

III. SIMULATION MODEL

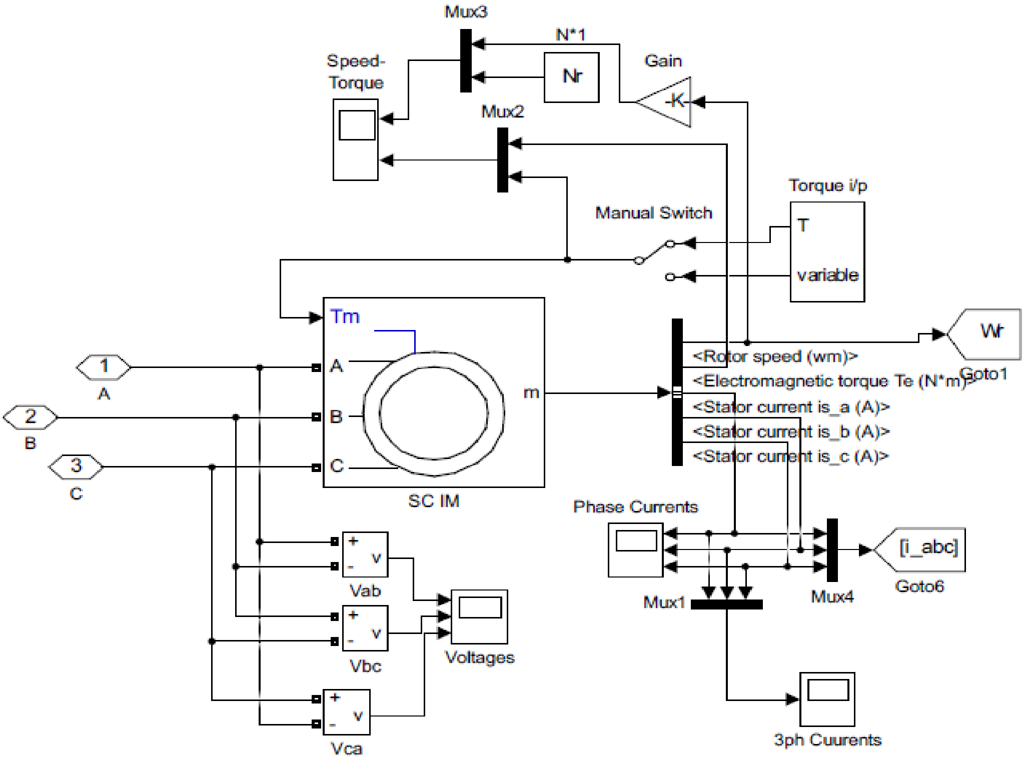

Fig. 1 induction motor and measurements block

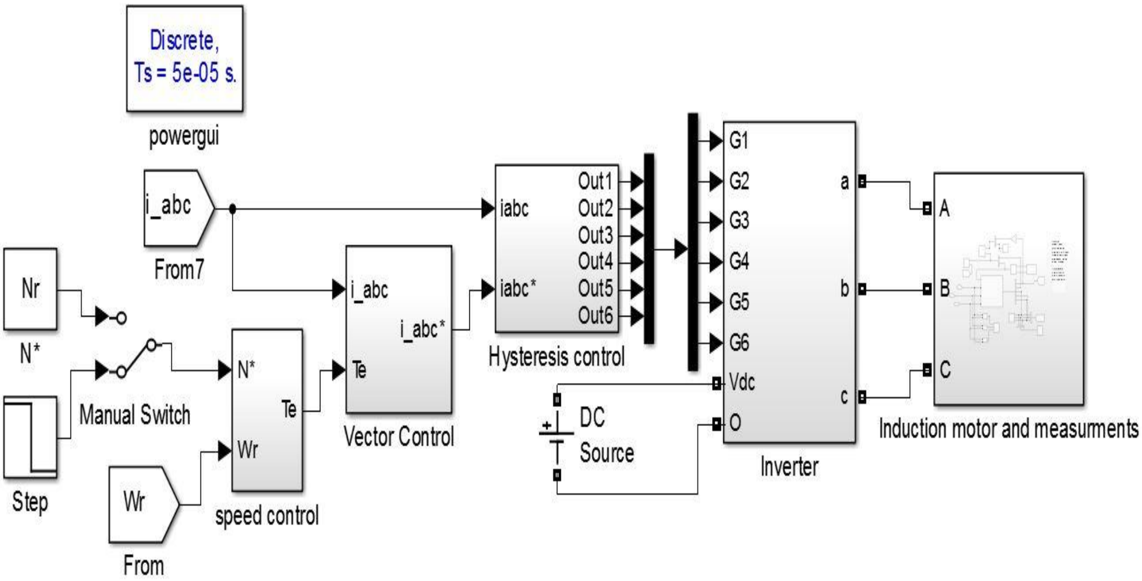

Fig. 2 Complete drive Simulink model

IV. SIMULATION RESULTS

When Step change in torque (T_s =50 usec.) At t=1sec T_L=13.36N-m, At t=2sec T_L=26.72N-m, and Command speed=1400rpm

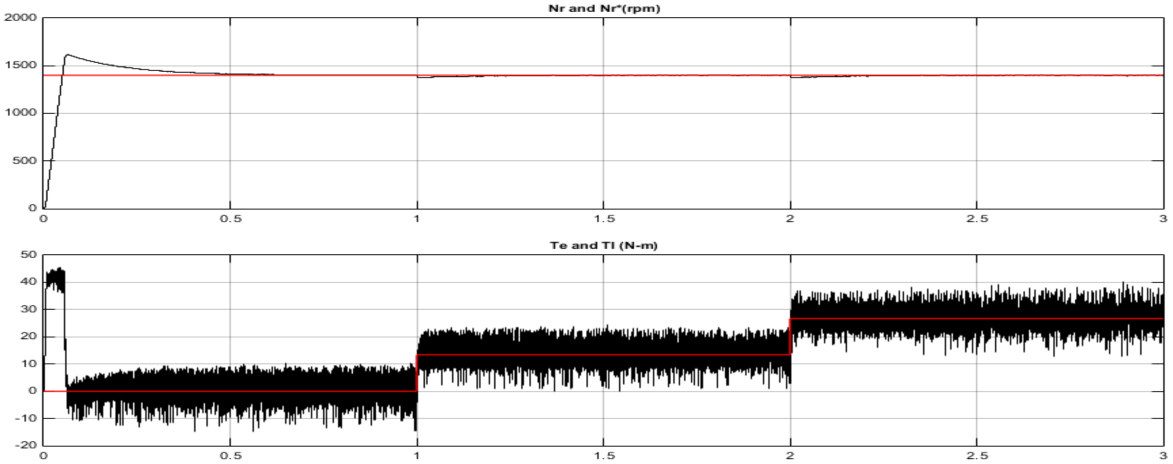

Fig. 3 Speed and torque(T_e) response under load variation

When Step change in torque (T_s =2 usec.) At t=1sec T_L=13.36N-m, At t=2sec T_L=26.72N-m, and Command speed=1400rpm

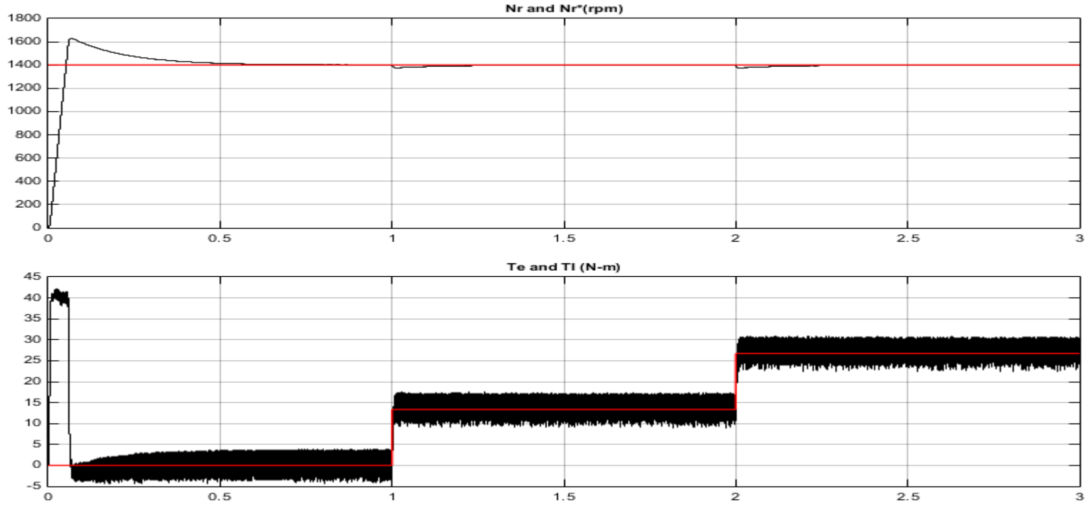

Fig. 4 Speed and torque(T_e) response under load variation

When Step change in torque Settling time for speed Waveform ~ **0.5 sec at T_L=26.72 N-m**

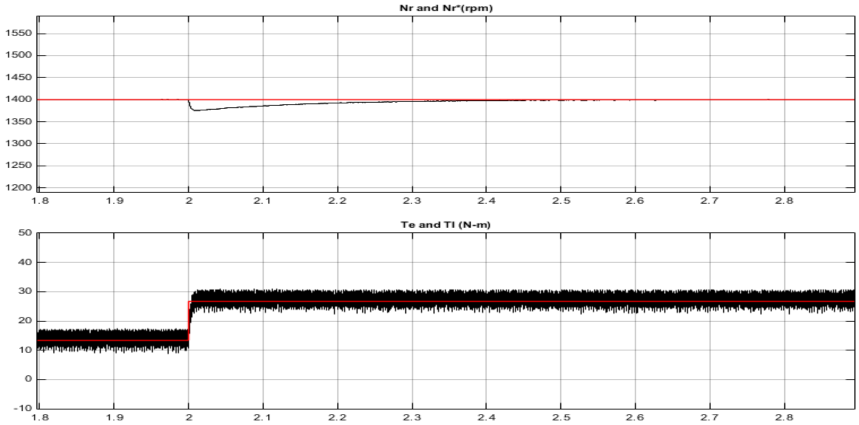

Fig. 5 Speed and torque(T_e) response (t=1.9 to 2.5 sec)

Decoupling Characteristic (Varying torque and constant flux):

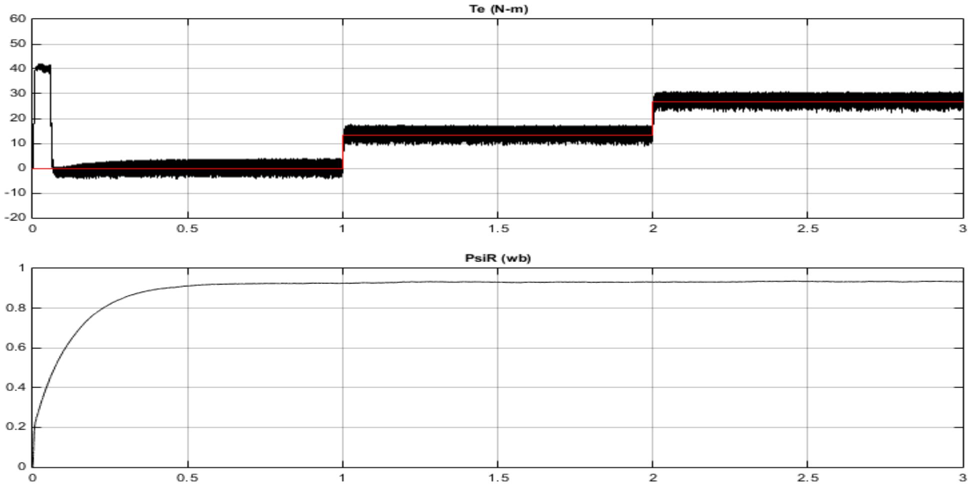

Fig. 23 Torque and flux response

When Step change in speed at t=1; Nr*=500 rpm and T_L=26.72 Nm results are as follow

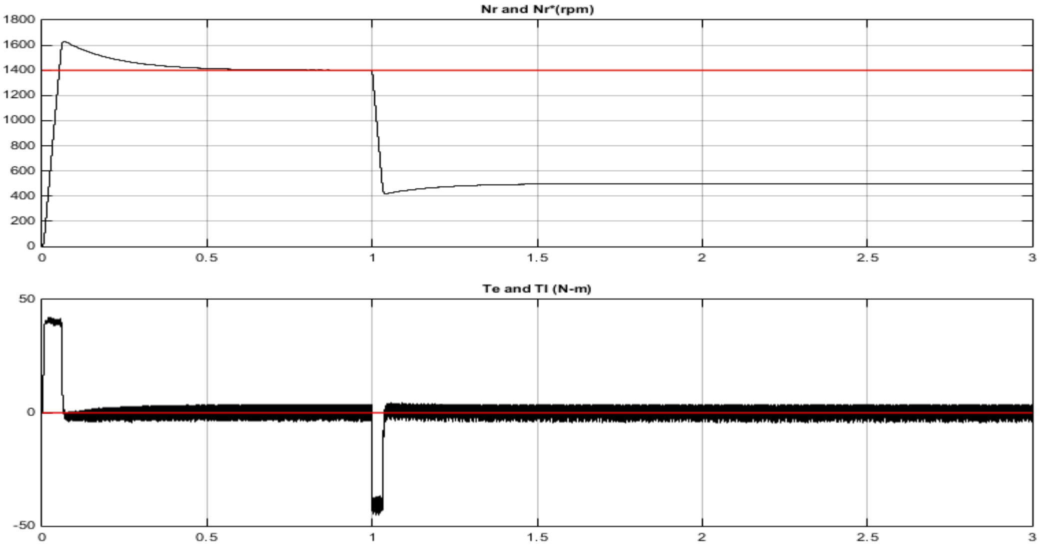

Fig. 24 Speed and torque(T_e) response under speed variation

Table-II
Comparison between “HCC & Scalar control

Hysteresis current control	Scalar control
Dynamic response (Speed-Torque) is fast.	Dynamic response is slower than that of HCC and has more oscillations before it comes to steady state
% THD (Harmonics generation) is less	%THD is higher than SVPWM
Torque ripple are less	Torque ripple are higher
Efficient for speed regulation near to zero	In lower speed region Current controller saturates due to high switching frequency
Complex implementation, requires powerful controller (driver)	Easy to implement
Inverter treated as a single unit	Independent phase control

V. CONCLUSIONS

In this paper Indirect Field Oriented control method (IFOC) with Hysteresis current control technique is illustrated. Comparative analysis between HCC current control and scalar control shows that HCC fed Induction motor drawn less harmonic current compare to scalar control fed Induction motor drive. Less Total harmonics distortion (THD) can be achieved. Therefore, it gives better performance. Smoother speed control with low torque pulsations can be achieved with HCC fed induction motor drive.

REFERENCES

[1] Rajneesh Mishra, S. P. Singh, Deependra Singh, B. Singh, and Dinesh Kumar "Investigation of Transient Performance of VSI-Fed IM Drives using Volts/Hz and Vector Control Techniques",2012 2nd International Conference on Power, Control and Embedded Systems IEEE

[2] Mehdi Mohammadzadeh Rostami ,"Analysis of Indirect Rotor Field Oriented Vector Control for squirrel Cage Induction Motor Drives" , 2012 IEEE International Power Engineering and Optimization Conference (PEOCO).

[3] JW Finch, DJ Atkinson & PP Acarnleg, "Scalar to vector: General principles of modern induction motor control", IEEE Fourth International Conference on Power Electronics and Variable-Speed Drives, 1991, London.,Pp. 364 – 369

[4] Jurifa Mat Lazi1, Zulkifilie Ibrahim, Marizan Sulaiman, Irma Wani Jamaludin, Musa Yusuf Lada "Performance Comparison of SVPWM and Hysteresis Current Control for Dual Motor Drives" 2011 IEEE Applied Power Electronics Colloquium (IAPEC)

[5] A. MILOUDI, A. DRAOU "Robust Controller Design for Speed Control of an Indirect Field Oriented Induction Machine Drive" Leonardo Electronic Journal of Practices and Technologies ISSN 1583-1078 Issue 6, January-June 2005 p. 1-16

[6] R.Arulmozhiyal, K.Baskaran, R.Manikandan "An Intelligent Speed Controller for Indirect Vector Controlled Induction Motor Drive" 2010 IEEE

[7] "Indirect Vector Control of a Variable Frequency Induction Motor Drive (VCIMD)" Khalaf Salloum Gaeid 1, Hew Wooi Ping1, Haider A.F.Mohamed2, BME 2009 Proceedings,IEEE

[8] "Indirect vector control with simplified rotor resistance adaptation for induction machines", Jingbo Kan, Kai Zhang, Ze Wang, State Key Laboratory of Advanced Electromagnetic Engineering and Technology, Huazhong University of Science and Technology, Wuhan, HuBei, People's Republic of China,IET Journals 2014

[9] Modern Power Electronics and AC Drives By B.K.Bose.