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Torque and Flux Ripple Reduction of Three Phase Induction Motor Using DLA

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Abstract: **In this paper, a direct load angle control (DLA) method of a three phase induction machine is proposed to minimize torque ripple and flux ripple while maintaining constant switching frequency. In this comparision between the DLA and DTC. In DLA control drawback of switching frequency is overcome by using SVM. Proposed DLA control method is applied to three level voltage source inverter fed induction motors and result is presented. From the simulation result it is found that the proposed DLA control scheme impressively reduced the torque and flux ripples when compared with conventional DTC.**

Keywords: **Direct torque control, induction motor drives, inverter.**

I. INTRODUCTION

DTC has simple control scheme, less parameter sensitivity, less computational requirements when compared with vector control and also no requirement of current controller and coordinate transformations. Conventional DTC is simple but it produce high ripple in torque due to presence of non-linear hysteresis controllers. Switching frequency of conventional DTC is not constant and also only one voltage space vector is applied for the entire sampling period.The direct torque control (DTC) is one of the actively researched control schemes which is based on the decoupled control of flux and torque. DTC provides a very quick and precise torque response without the complex field-orientation block and the inner current regulation loop [1]–[3]. Direct torque control (DTC) was introduced to give fast and good dynamic torque response. DTC can be considered as an alternative to the field-oriented control (FOC) technique [1], [2]. The DTC scheme as initially proposed in [1] is very simple; in its basic configuration it consists of a pair of hysteresis comparators, torque and flux calculator, a lookup table, and a voltage-source inverter (VSI).the system sampling frequency for the calculations of torque and flux should be very fast in order to provide good tracking performance and limit the errors of torque and flux within the specified bands, respectively. The inverter switching frequency, which varies with speed of drives and the associated error bands, is very low in comparison with the system sampling frequency.

A. Conventional DTC:

The operation of the conventional DTC is simple but it produces high ripple in torque due to the non-linear hysteresis controllers. The switching frequency of conventional DTC is not constant and also only one voltage space vector is applied for the entire sampling period. Hence even when small error exits, the motor torque may exceed the upper/lower torque limit [4]. In order to overcome the problem, the SVM-DTC method was proposed [5]. By applying space vector modulation technique in DTC, the sampling frequency is maintained constantly and the torque ripple is reduced with low switching losses.

The mathematical equations of Induction Motor are as follows

The stator voltage equation:

$\mu es=iesRs+d\psi es/dt+j\omega e\psi es$

The rotor voltage equation:

$0=ierRs+d\psi er/dt+j(\omega e-\omega r)\psi er$

The stator flux equation:

$\Psi es=Lsies+Lmier$

The rotor flux equation:

$\Psi er=Lrier+Lmies$

The electro-mechanical equqtion:

$Te-Tl=Jd\omega r/dt$

$Te=(3p/2)(\psi esdiesq-\psi esqiesd)$

$Te=(3p/2)|\psi s||\psi r|\sin\delta$

Where, $|\psi_s|$ is the stator flux linkage space vector, $|\psi_r|$ is the rotor flux linkage space vector refer to the stator.

In conventional DTC controlled induction motor drive supplied by a three phase voltge source inverter , main aim is to control directly the stator flux linkage or magnetizing flux linkage or rotor flux linkage and electromagnetic torque by the selectiuon of proper inverter switching states [6]. The switching state selection is made to restrict the flux and torque hysteresis bands, to get low inverter switching loss, fast dynamic response and harmonic distortion in stator currents.

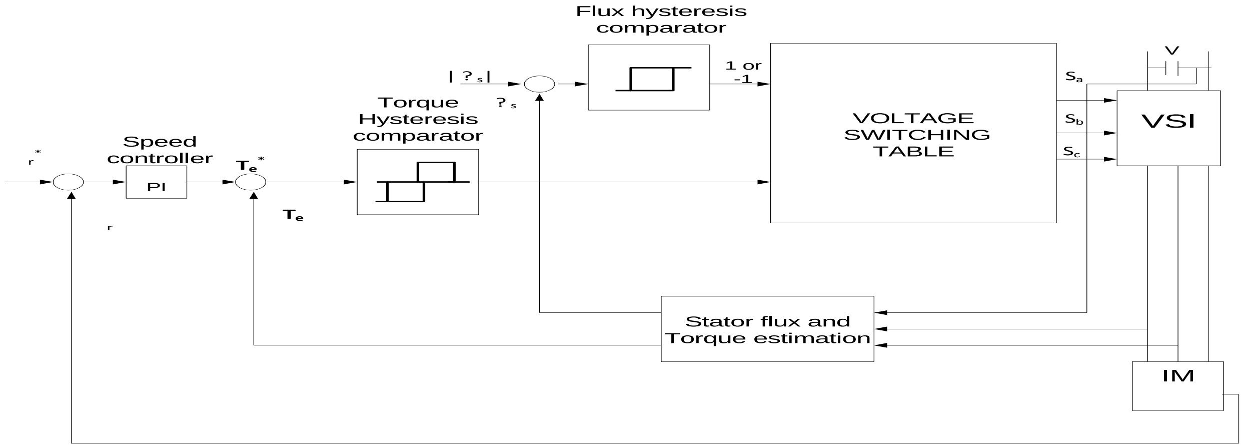

Fig.1. Conventional DTC

B. DLA Control:

The block diagram of the proposed DLA control is shown in Fig. In the proposed control algorithm, stator flux sector number is not required in SVM block to generate the control signals to VSI using time signal calculation The torque control is achieved with the constant amplitude of reference stator flux. From, torque control is directly obtained by controlling torque angle change which is the angle between the stator and the rotor flux vectors and keeps the stator and the rotor flux vectors at constant amplitude.

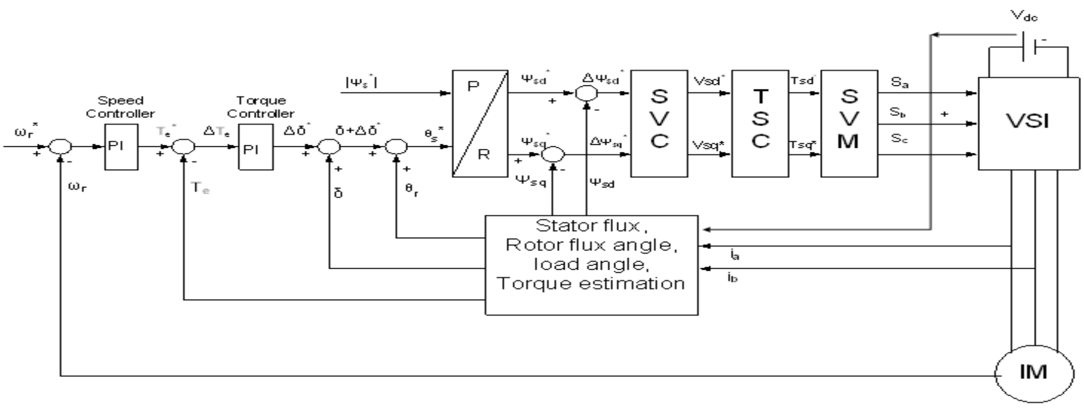

Fig.2. DLA Control

Motor Parameter:

Power	10hp
Stator resistance(Rs)	0.15Ω
Rotor resistance(Rr)	0.17 Ω
Stator inductance(Ls)	0.035H
Rotor inductance(Lr)	0.035H
Mutual inductance(M)	0.04mH
Torque	48N-m
Frequency	50Hz

C. Simulation comparative result of DTC and DLA Method:

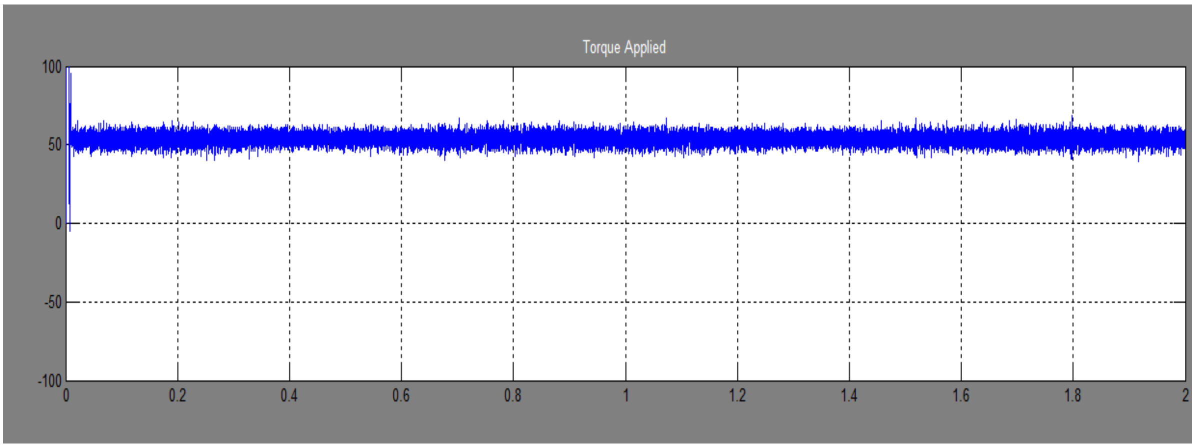

Fig.3. DTC Torque

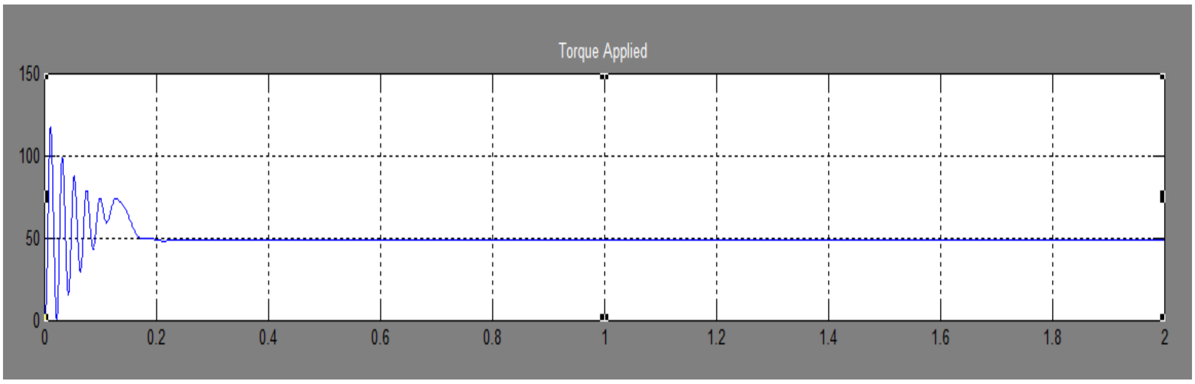

Fig.4. DLA Torque

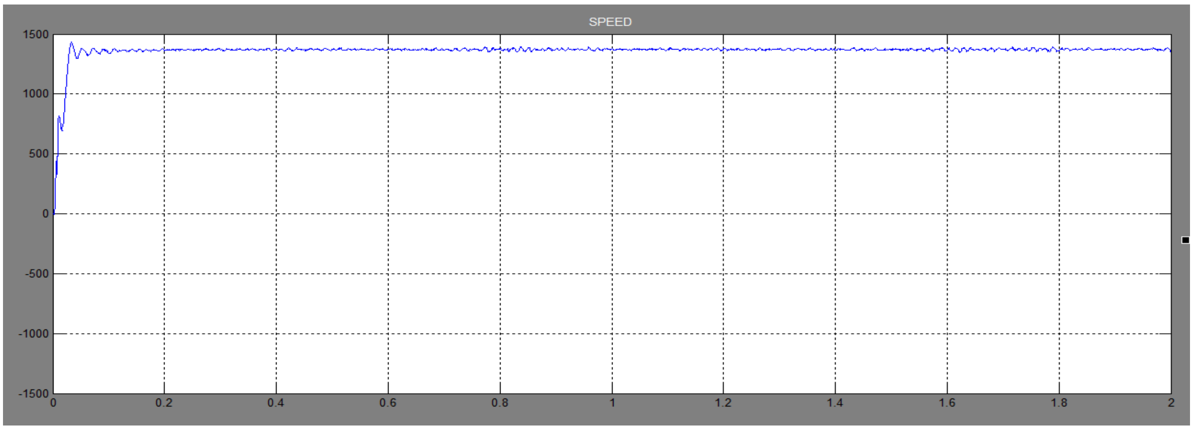

Fig.4. DTC Speed

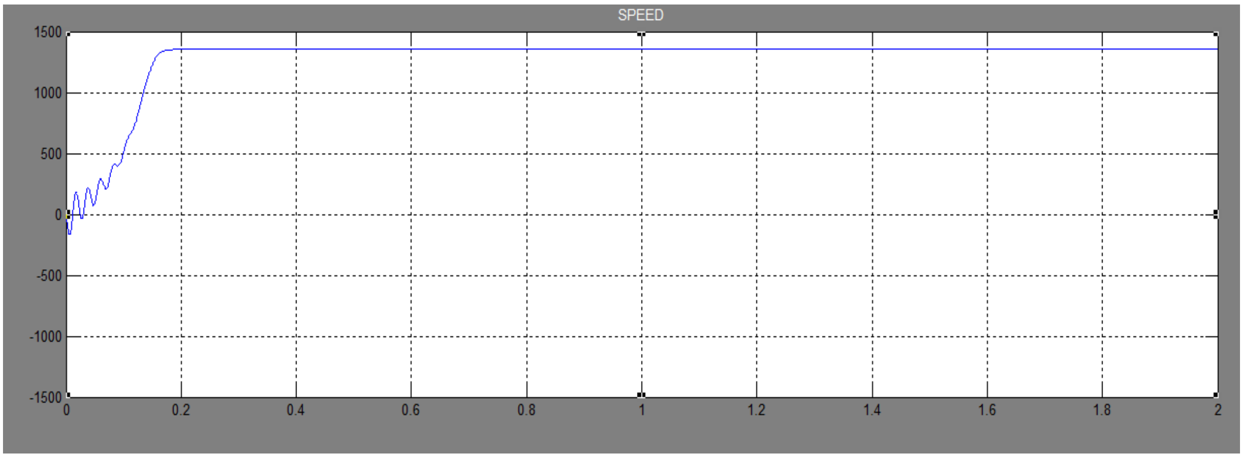

Fig.5.DLA Speed

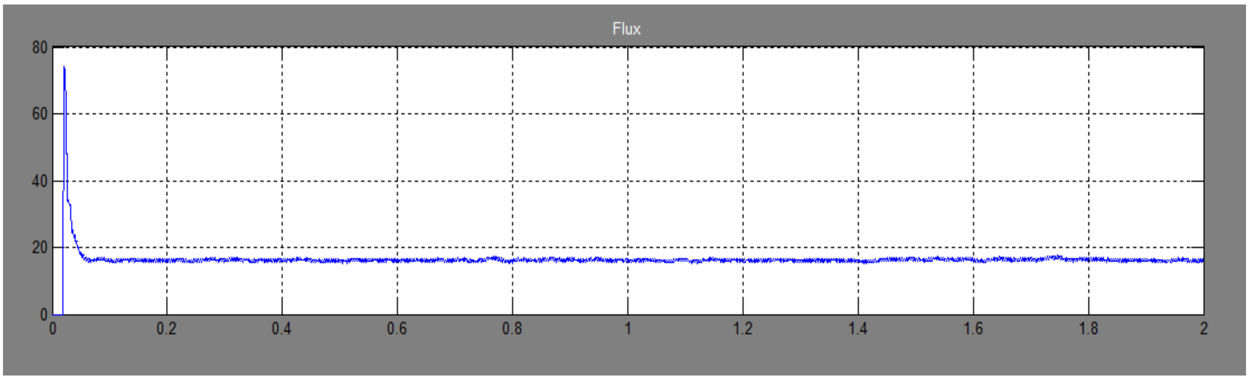

Fig.6. DTC Flux

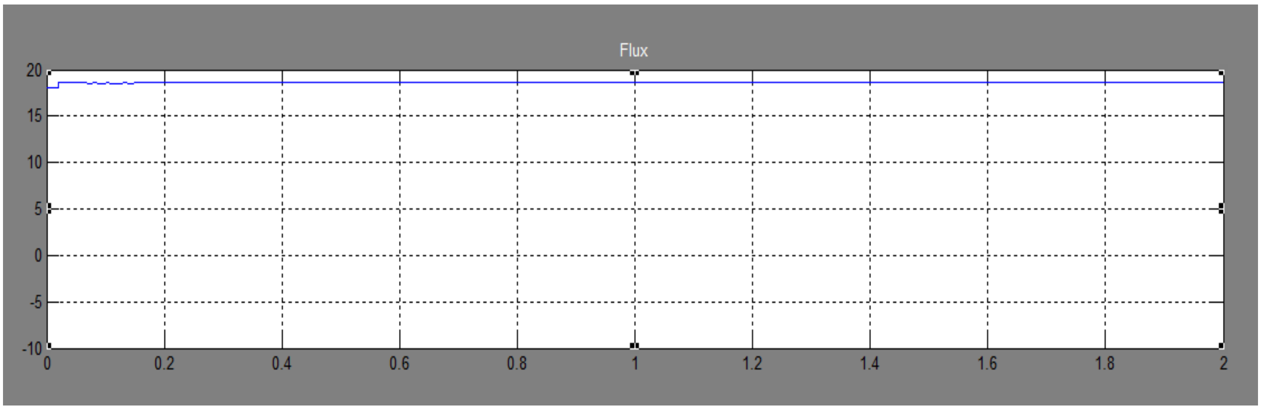

Fig.7. DLA Flux

D. Conclusion:

In this paper, from the simulation result, it is conclude that, the torque ripple and flux ripple are reduced in DLA control technique than the conventional DTC.

REFERENCES

[1] Takashi and T. Noguchi, "A new quick-response and high-efficiency control of an induction motor," IEEE Trans. on Industry Applications, vol. IA-22, no.5, pp. 820-827, 1986.

[2] D. Casadei, F. Profumo, G. Serra, and A. Tani, "FOC and DTC: Two viable schemes for induction motors torque control," IEEE Trans. onPower Electronics, vol. 17, pp. 779–787, Sept 2002.

[3] C. L. Toh, N. R. N. Idris, and A. H. M. Yatim "Constant and high switching frequency torque controller for dtc drives," IEEE power electronics letters, vol. 3, no 2, pp.76-80, Jun 2005.

[4] Yen-Shin Lai, Senior Member, IEEE, Wen-Ke Wang, and Yen-Chang Chen "Novel switching techniques for reducing the speed ripple of ac drives with direct torque control," IEEE, vol. 51, no. 4,pp 768-775, Aug 2004.

[5] J. K. Kang and S. K. Sul, "New direct torque control of induction motor for minimum torque ripple and constant switching frequency," IEEE Trans. on Industry Applications, vol. 35, pp. 1076–1082, Sept./Oct. 1999.

[6] T. G. Habetler, F. Profumo, M. Pastorelli, and L. M. Tolbert, "Direct torque control of induction machines using space vector modulation," IEEE Trans. Ind. Applicat., vol. 28, pp. 1045–1053, Sept./Oct. 1992.

[7] Cristian Lascu, Ion boldea and Frede Blaabjerg "A Modified direct torque control for induction motor sensorless drive," IEEE Trans. On Industry Applications, vol. 36, no.1.Jan/Feb 2000.

[8] Y.-S. Lai and J.-H. Chen, "A new approach to direct torque control of induction motor drives for constant inverter switching frequency and torque ripple reduction," IEEE Transaction on Energy Conversion, vol.16, pp. 220-227, Sept. 2001.

[9] T. Noguchi, M. Yamamoto, S. Kondo, and I. Takahashi, "Enlarging switching frequency in direct torque-controlled inverter by means of dithering," IEEE Trans. Ind. Applicat., vol. 35, pp. 1358–1366, Nov./Dec. 1999.

[10] Nik Rumzi Nik Idris, and Abdul Halim Mohamed Yatim, "Direct torque control of induction machines with constant switching frequency and reduced torque ripple," IEEE Transaction on Industry Applications, vol.51,no.4, Aug 2004.

[11] Hamid A Toliyat, Kumsuwana, Suttichai "Modified direct torque control method for induction motor drives based on amplitude and angle control of stator flux," Electric Power Systems Research, Vol. 78, Issue 10, Pp. 1712-1718, Oct. 2008.

[12] Jun Zhang, Zhuang Xu, Lixin Tang and M. F. Rahman "A Novel direct load angle control for interior permanent magnet synchronous machine drives with space vector modulation," in the proceedings of IEEE PEDS, pp607 - 611, 2005.

[13] Vinay Kumar T. and S.Srinivasa Rao, "Direct Torque Control Method for Induction Motor Drives based on Modified Amplitude and Angle Decoupled Control of Stator Flux," in the proceedings of IEEE PEDES, 2010.