IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 11, November 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

Alpha Cut Based Intelligent Method Controller Sensorless Speed Control Of An Induction Motor.

Uchegbu C.E[2],Ekulibe James[2],Ilo F.U[1]

[1] Department of electrical and Electronic Engineering, Enugu State University of Science and Technology
[2] Department of Electrical/Electronic Engineering, Abia state polynitechnic umuahia(Abiapoly).

ABSTRACT

This paper focuses on an intelligent controller sensorless speed control of induction motor using alpha cut based, he development of non linear model of induction machine was the major contribution to this paper which take into consideration, the error in flux estimation and the use of PI controller for flux regulation with simulations, the stability of the control system was demonstrated and this has an easier constructional advantage over the conventional drive that requires shift mounted speed sensor or other control method that exhibits much heat acquisition. The model was simplified for speed regulation with the use of (high gain) P.I controllers that regulate the Q-axis current.

INTRODUCTION

The induction motor for many years has been regarded as the workhorse in industrial application. In the last few decode, induction motor has evolved from being a constant speed motor to a variable speed, variably torque machine. [1] For high power and torque application, induction motor remains more efficient to use with the invention of variable voltage, variable frequency drives [2]. The main major reason to shift from DC machine to AC machine induction machine is known reasons such as robots design, size, cost and efficiency. The D.C machine requires periodic maintenance due to mechanical commentator which also limits the over speeding and over loading capacity [3]. To implement conventional control, the model of the controlled system must be known. The usual method of computation of mathematical model of a system is difficult. When there are system parameter variations or environmental disturbance, the behavior of the system is not satisfactory. An advanced control based on artificial intelligent techniques is called intelligent control, which means every system with artificial intelligent is self organized system. D.C machines are best solutions for special cases where high dynamic and four quadrant operation is required. Generally, wide operating drives for induction motor requires both wide operating range of speed and fast torque response regardless of load variation. Making A.C machine sensorless is a part of making structure of A.C drive close to D.C drive and increases the robustness of whole system. the proposed intelligent controller sensorless speed control of induction motor using alpha cut based for both low speed and very low speed range is to be considered using fuzzy logic field oriented control that is stator terminal voltages and current estimate to checkmate the poor angular speed, slip angular speed and rotor flux.

Methodology

In industries, motors must satisfy very strict characteristics requirement, with respect to range and smoothness of control and also with respect to economical operation. The speed of an induction motor is given by:

$$N = \frac{120F}{P}(1+S) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (1)$$

F = frequency

e = Number of poles and slip T on which the speed of an induction motor depends. From the torque equation of the induction machine given.

$$T = \frac{\mathrm{KSR}V^2}{\mathrm{R}_2^2 + (SX_2)^2} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

We can see that the torque depends on the square of the applied voltage. Hence, if n is n is the speed of the speed of the rotor in radians.

$$n = \frac{fi}{\mathrm{pi}} + (1 - S_1) = \pm \frac{S_1 f_1}{\mathrm{P}_2} (1 - S_2) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

Giving the rotor output of the first machine to the stator of the second.

$$n = \frac{fi}{P_1 P_2} \; or\; n = \frac{f_1}{\mathrm{P}_{1-\mathrm{P}_2}} (S_2\, negligible) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Then considering the rotor side circuit power dissipation pe phase.

$SE_1\ 1_2 \cos\phi_2 = 1_2 R_2 + P^2$ ……………………………………………………... (5)

The value of S can be changed by the value of Pr for Pr = 0. It might be seen mathematically as follows. If E is the voltage across the magnetizing branch and F is the frequency of excitation, then, E = KF where K is the constant proportionality. If $\omega = 2\pi F$. The developed torque is given.

$$T\frac{E}{F} = \frac{\mathrm{k}^2\mathrm{F}^2}{(R_r^1) + (\omega L_2^1)^2} = \frac{R_r^1}{\mathrm{S}\omega} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

The maximum torque is obtained by substituting into equation 6

$$\frac{Te}{F} = \frac{\mathrm{k}^2\mathrm{F}^2}{8\pi^2 L_r^1} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (7)$$

Calculate the reference torque from and speed relation of an induction motor.

$$T_{ref} = \frac{2\mathrm{J}\omega_{ref-\omega_r}}{P \quad T} B\omega_r \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (8)$$

Where
'J' motor inertia
'B' biscous coefficient
'P' pole number
'T' sampling period

When $T_{ref} \geq T_{maxs}$ maximum torque operation is required. When $T_{ref} < T_{max}$, maximum torque operation is not required. In order to obtain good dynamic response, I^*_{ds} should be determined according to the operating point and I^*_{qs} is given as follows:

$$I *_{qs} = \frac{T_{re}}{\frac{3\mathrm{P}L_m^2}{4L_r}} \mathrm{I} *_{\mathrm{ds}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (9)$$

Then for the final stage, input voltages V^*_{ds} and V^*_{ds} can be obtained from the motor model.

4.0 Data collection and implementations

The description of the reference machine parameters used in this paper is stipulated below which shows that the sensorless vector control for induction machine is designed in steps. The machine chosen in this paper is ABB premium efficiency induction motor (M4BP160 MLB) with its technical data and parameter description given in the table below.

Table 1 M4BP 160 MLB Technical Data and Test motors

property	data	property	data
Machine type	Induction motor	Nominal power factor	0.84
Number of pole pairs	4	Nominal speed	17848.3 (rpm)
slip	**0.287**	Maximum torque slip	0.178
Nominal voltage	415(v)	Nominal frequency	50(Hz)
Rated Torque	81.49(Nm)	Nominal power	15(kwatts)
Stator current	4.08[A]	Nominal power	25(hz)

Table 1. Showing M4BP 160 MLB Technical Data and Test motors.

Table 2.

parameters	value	parameter	value
Stator resistance,rs	0.106	Rotor resistance	0.0764
Leakage inductance l	5.31(mh)	Magnetizing inductance,l	56.02
Stator leakage inductance x	5834	Rotor inertia, j	2.8kg,m2

Table 2 showing M4Bp 160 MlB parameter description (test motor) at room temperature. The load machine used is an ABBs induction motors. The speed controller ACSM-1(load drive) are proportional gain kp=10, integration time $T_{i=}$0.75secs.

CONCLUSION

In this paper of intelligent controller sensorless speed control induction motor using alpha cut based method is also known as vector control because it controls both magnitude and phase of Ac quantities. It was also observed that by increasing the injection of the frequency, the effect of the injected current on the rotor flux can be neglected. This shows that if the current controllers are slow, at higher injection frequencies, they will not be able to follow the current references precisely and this will lead to wrong result. The measuring method was also depending on the motor parameters.

REFERENCES

Ah-choy liew,lipo T.Asng E.K.K,(1998)new observer based DFO scheme for speed sensorless field oriented drives for low zero speed operation IEEE trans power electron ,volume 13,no.5,pp.959-968.

Attainanesse c,pertepp A,marongun l,(2000) An observer for speed sensorless induction motor drive Estimating rotor ressistance variation''proc .of oct 19994 IEEE IAs Conf .

BarutM;S.Bogosyan,and M.Gokasan (2008) experimental evaluation of braided EKF for sensorless control of induction motor'',IEEE trans .Ind.Electron.,vol.55no2pp.620-632

Caruana ,C.asher G.M and Clare j.,(2003) sensorless vector control at low and zero frequency considering zero frequency current in delta connected cadge induction motor'',in IEEE 29th ann.conf of Ind.electron.soc IECON'03 pp1460-165 vol2

Fernando Briz,Alberto Diez,Micheal N.deger dynamic operation of carrier signal injection based sensorless Direct field oriented AC Drive I IEEE trans .ind Appl.,Vol.36 no3,797-804.

Consoli, G. Scarcella, and A. Testa, (2000), "A new zero frequency flux position detection approach for direct field oriented control drives", IEEE Trans. Ind. Appl., VOL. 36, no. 3, pp. 797 – 804..

Fernando Briz, Alberto Diez, Micheal N. Degner: "Dynamic Direct Field –Oriented AC Drives" in IEEE Trans. Ind. Appl., Vol. 36, No 5, PP 1360 – 1368, Sep. Oct. 2000.

Gupta J.b., (2007), "Theory and Performance of Electirical machines", Nai Sarak, Delhi, S. K. Katara & Sons.

H. XU, Z. Zhang and L. Heilman, "Sensoreless direct filed oriented control of three phase induction motors based on 'sliding mode' for washing machine drive application" in conf rec, IEEE IAS Annu meeting, 2005, Vol. 1, pp 77.

J. Holtz, " The Representation of AC Machine Dynamics by Complex Signal Flow Graphs", IEEE Transactions on Industrial Electronics, Vol. 42, No. 3, June 1995, pp. 263 – 291.

Jung – IK Ha, Seung-Ki Sul, Kozo Ide, Ikuma Murokita, Kolijiro Sa wa m ura: "Physical Understanding of High Frequency Injection Method to Sensorless Drives of an Induction Machine" in Proceedings of IEEE Industry Appl. Society, Annual Meetings, Rome, Italy October 8 – 12, 2000.

Kubota H. K. Matsuse, " Speed Sensorless Field Oriented Control of Induction Motor with Rotor Resistance Adaptation", Proc. Of IEEE IAS Conf 1994.

Min-Huel Kim, James C. Hung, "Vector Control System for Induction Motor without Speed Sensor at Very Low Speed" Tran. Of IEEE performance Ac Drives", IEEEIAS Tutorial Course. Vol. 3, pp5 – 12.

Peter VAS, "Vector Control of AC Machine" Clarondon Press, 1990.