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A Review on Different Type of Vector Controlled Induction Motor Speed

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Abstract: *Vector control is becoming the industrial standard for induction motor control. Thevector control technique decouples the two components of stator current space vector: one providing the control of flux and the other providing the control of torque. The two components are defined in the synchronously rotating reference frame. With the help of this control technique the induction motor can replace a separately excited dc motor. The DC motor needs time to time maintenance of commentator, brushes and brush holders. The main effort is to replace DC motor by an induction motor and merge the advantages of both the motors together into variable speed brushless motor drive and eliminate the associated problems. The squirrel cage induction motor being simple, rugged, and cheap and requiring less maintenance, has been widely used motor for fixed speed application. So with the implementation of vector control, induction motor replaces the separately excited dc motor. The vector control technique is therefore a better solution so that the control on flux and torque become independent from each other and the induction motor is transformed from a non-linear to linear control plant.*

1. INTRODUCTION

Modern method of static frequency conversion has liberated the induction motor from its historical role as a fixed speed machine. The inherent advantages of adjustable frequency operation cannot be fully realized unless a suitable control technique is employed. The choice of technique is vital in determining the overall characteristics and performance of the drive system. Also the power converter has little excess current capability; during normal operation the control strategy must ensure that motor operation is restricted to the regions of high torque per ampere, thereby matching the inverter ratings and minimizing the system loses. Overload or fault conditions must be handled by sophisticated control rather than over design.Now a days more than 60% of all the electrical energy generated in the world is used by cage induction machines have been mostly used at fixed speed for more than a century. On the other hand, D.C machines have been used for variable speed applications. In DC machines mmf axis is established at 90˚ electrical to the main field axis. The electromagnetic torque is proportional to the product of field flux and armature current. Field flux is proportional to the field current and is unaffected by the armature current because of orthogonal orientation between armature mmf and field mmf .Therefore in a separately excited DC machine , with a constant value of field flux the torque s directly proportional to the armature current. Hence direct control of armature current gives direct control of torque and fast response. Hence they are Widely used in many industrial applications, the induction motors represent the starting point when an electrical drive system has to be designed. In modern control theory, the induction motor is described by different mathematical models, according to the employed control method. In the symmetrical three-phase version or in the unsymmetrical two-phase version, this electrical motor type can be associated with vector control strategy. Through this control method, the induction motor operation can be analysed in a similar way to a DC motor.

The goal of this research is to summarize the existing models and to develop new models, in order to obtain a unified approach on modeling of the induction machines for vector control purposes. Starting from vector control principles, the work suggests the d-q axes unified approach for all types of the induction motors. However, the space vector analysis is presented as a strong tool in modeling of the symmetrical induction machines. When an electrical motor is viewed as a mathematical system, with inputs and outputs, it can be analyzed and described in multiple ways, considering different reference frames and state-space variables. All the mathematical possible models are illustrated in this report. The suggestions for what model is suitable for what application are defined as well. As the practical implementation of the vector control strategies require digital signal processors (DSP), from the continues time domain models are derived the discrete time domain models. The discrete models permit the implementation of the mathematical model of the induction motors, in order to obtain high efficiency sensor less drives. The stability of these various models is analyzed.

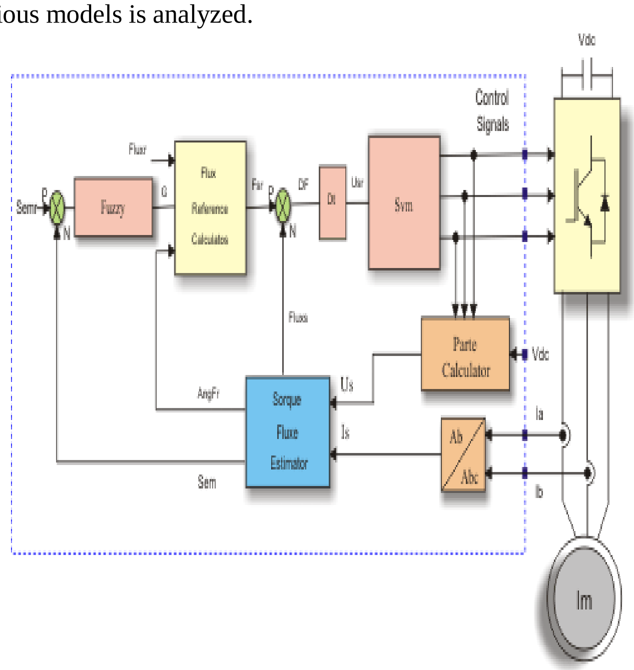

Fig 1: Analogue

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. In practice, intricate control algorithms are involved if ac drives have to match the dynamic performance of dc drives. Due to advancements in microelectronics and power electronics, high performance control of ac motors can now be implemented at a reasonable cost. This technological breakthrough has stimulated in turn the application of sophisticated control algorithms and the widespread use of ac drives in high performance domains.In a Dc machine, a number of coils are distributed around the armature surface and inter connected to form a closed winding. Stationary poles with dc-excited field windings or permanent magnets establish magnetic field in which the armature rotates Current is supplied to the armature through the commentator brushes so that the armature mmf axis is established at 90 degrees electrical to the main field axis.Another classification of the control techniques for the induction machine is made by Holtz (1998) from the point of view of the controlled signal.

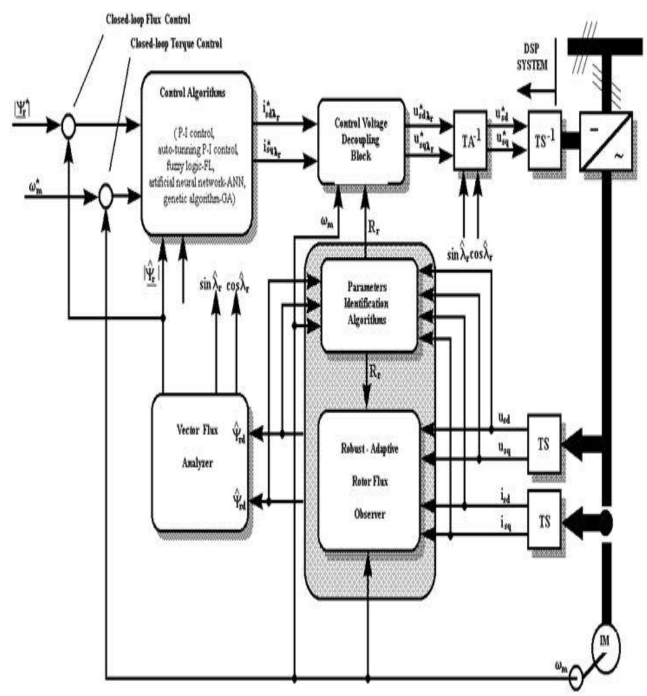

Fig 2: Dc machine Controlling

1) Scalar control:

A. Voltage/frequency (or v/f) control.

B. Stator current control and slip frequency control. These techniques are mainly implemented through direct measurement of the machine parameters.

2) Vector control:

A. Field orientation control (FOC)

A.1. Indirect method;

A.2. Direct method;

B. Direct torque and stator flux vector control.

These techniques are realized both in analogue version (direct measurements) and digital version (estimation techniques) However, in the development of suitable models for control purposes, it is possible to make certain assumptions that considerably simplify the resulting machine model. Nonetheless, these models must incorporate the essential elements of both the electromagnetic and the mechanical systems for both steady state and transient operating conditions (Nowotny and Lipo - 1996). Additionally, since modern electric machines are invariably fed from switching power conversion stages, the developed motor models should be valid for arbitrary applied voltage and current waveforms. This work presents suitable models for use in digital current control of the induction motors. In addition, the limits of the validity of these models are summarized and, in some cases, the models are extended to account for some non-idealities of the machine. Usually, the following assumptions are made (Lorenz et al. 1994):

ASSUPTIONS OF MACHINE CONTROLLING:

- No magnetic saturation, i.e. Machine inductance is not affected by current level.
- No saliency effects i.e. machine inductance are not functions of position.
- Negligible spatial mmf harmonics i.e. stator windings are arranged to produce sinusoidal mmf Distributions.
- The effects of the stator slots may be neglected.
- There is no fringing of the magnetic circuit.
- The magnetic field intensity is constant and radically directed across the air-gap.
- Eddy current and hysteresis effects are negligible.

CONTROLLOING METHOD

The modern control theory for an electrical drive system requires the existence of a real-time, stabile, and precise mathematical model for each component of the system. The analysis and the design of the numerical command for such systems depend on the hardware and software resources. If in communication techniques the real-time response of the system is not always compulsory, in industrial processes the real-time response of the drive systems is essential. The soft numerical command for the electrical drive systems is far more flexible to implement than the hardware version. For the latter, lately there is an intense research effort for implementing ASIC (application specific integrated circuit). The numerical command of the electrical drive Systems are a challenging task mainly due to the DSP (digital signal processing) technology. Now it is possible to realize linear and non-linear techniques for implementing continues and discrete mathematical models of the entire element of an electrical drive system, including the electrical machine (Xu and Nowotny - 1990, 1992).For the AC drives there are several solutions for implementing the command and the control of the system. A quick summary of the existing technologies already out there in the field is given below.

2. CONCLUSION

From the above discussion it can be concluded that the control of induction motor is very necessary as it is the common motor used in industrial motor control systems. Hence a well established induction motor drive which is simple, rugged, low cost and low maintenance can serve the required purpose. Many authors have published several research papers on the vector control techniques of induction motor. And studying vector control techniques it is clear that the indirect vector control technique supersedes the direct vector control and is more used rather than the later one. Hence for the further work the method adopted is the indirect vector control technique.

REFERENCES

[1] Shraddha V. Hule., Sensorless Vector Control of Three Phase Induction Motor. New Delhi, India: Prentice-Hall, 2006, ch 8, pp-333-435.India: Prentice-Hall, 2006, ch. 8, pp. 333–435.

[2] Tien-Chi Chen and Tsong-TerngSheu, "Model Reference Neural Network Controller for Induction Motor Speed Control," IEEE Trans. On Energy Conversion, Vol. 17, No. 2, June 2002.

[3] Gadoue, S.M., Giaouris, D. Finch, J.W., "Stator current model reference adaptive systems speed estimator for regeneratingmodelow-speed operation of sensorless induction motor drives, "Electric Power Applications, IET, vol.7, pp.597-606, Issue.7, Aug. 2013.

[4] Nisha G.K., Lakaparampil Z.V., and Ushakumari S., "Sensorless Vector Control of SVPWM Inverter fed Induction Machine using MRAS-Sliding Mode", 978-1-4673-2636-0/12/2012 IEEE.

[5] G. Pydiraju and M. Daivaasirvadam "Sensorless Speed Control of Induction Motor Using MRAS, "International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-1, Issue-5, November 2012.

[6] Tien-Chi Chen, and Tsong-TerngSheu, "Model Reference Robust Speed Control for Induction-Motor Drive With Time Delay Based on Neural network, "IEEE Transactions On Systems, Man, And Cybernetics—Part A: Systems And Humans, Vol. 31, No. 6, November 2001.

[7] Ashutosh Mishra and Prashant Choudhary., "Speed Control Of An Induction Motor By Using Indirect Vector Control Method", International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 2, Issue 12, December 2012

[8] Rakesh Parekh., 2003. AC Induction Motor Fundamentals. Microchip Technology Inc.

[9] Muljadi, Y. Zhao, T. Liu and T.A. Lipo, "Adjustable ac Capacitor for a Single-phase Induction Motor," IEEE Transactions on Industry Applications, Vol. 29, No. 3,MayIJune 1993, pp. 479-485.

[10] MirceaPopescu," Induction Motor Modelling For Vector Control Purposes," Helsinki University of Technology Department of Electrical and Communications Engineering Laboratory of Electromechanics.

[11] E. R. Collins, Jr., "Torque and slip behavior of single-phase induction motors driven from variable frequency supplies," in IEEE IAS Annual Meeting Conference Record, pp. 61-66, 1990.

[12] A.S.ZEIN EL-DIN and A.E.EL-SABBE," A Novel Speed Control Technique for Single-Phase Induction Motor," IEEE 1999 International Conference on Power Electronics and Drive Systems, PEDS'99, July 1999, Hong Kong

[13] P. C Sen. 2000. Power Electronics, Fifth Edition, TataMC-Graw Hill Publishing Company Limited