IF : 3.62 | IC Value 70.36

Volume-5, Issue-10, October - 2016 • ISSN No 2277 - 8160

Original Research Paper

Engineering

Speed Control of Induction Motor Using Vector Control Method

Satish Chand Modi M.Tech (Power System) Ph.D. Pursuing Sunrise University

Dr. Rajeev K. Chaturvedi B.E.,M.E.,Ph.D. Director Nagaji Institute of Technology & Management - Gwalior (M.P.)

ABSTRACT *Now a day in most of the industrial automation applications, the induction motors is widely used represent the starting point when an electrical automation drive system is to be designed. In modern control system, the motor is described by different mathematical modelling theory's, according to that control system method. In this symmetrical 3 phase version or in the unsymmetrical 2 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 give summarize the existing control models and to develop new control models, in order to obtain a unified approach on modelling of the induction machines for vector control purposes. Starting from vector control principles, the work suggests the p-q axes unified approach for all types of the induction motors. However, the space vector analysis is presented as a strong tool in modelling of the symmetrical induction machines. When an electrical induction motor is viewed as a mathematical control system, with inputs and outputs, it can be analysed and described in multiple ways, considering different reference frames and state-space variables. All the mathematical possible models are illustrated in this paper.*

KEYWORDS : Control Theory, Motor, Electrical Power, Mathematical Modelling

INTRODUCTION

Poly phase induction motors are today a standard for industrial electrical drives. Cost, reliability, robustness roughness and maintenance free operation are among the reasons these machines are replacing dc drive systems. The development of power electronics and signal processing systems has eliminated one of the greatest disadvantages of such ac systems, which is the issue of control. With modern techniques of field oriented vector control, the task of variable speed control of induction machines is no longer a disadvantage. Vector control is discussed in detail and sensor less vector control is explained.

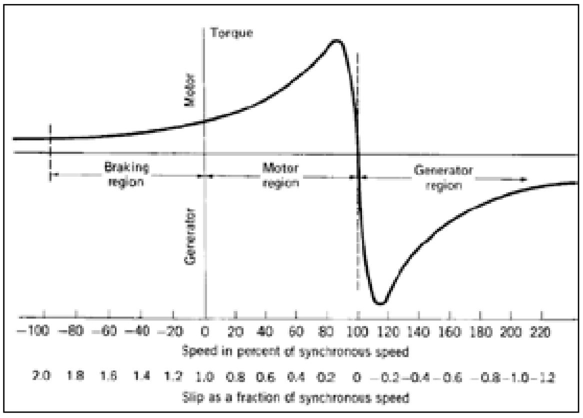

Figure1typical speed-torque curve of induction motor

Controlling a DC machine is much easier because of the fact that the main flux and the armature current distribution are fixed in space and can be controlled independently while with an AC machine these quantities are strongly interacting and move with respect to the stator as well as the rotor. They are, in a complex way determined by the amplitudes, frequency and phases of the stator currents. The three stator currents can be reduced to two independent control variables. And Field oriented control can be achieved.

Vector control

The control and estimation of ac drives is complex than those of dc drives. The main reason for this complexity is the need for variable frequency. Now-a-days the vector control overcomes the drawbacks of scalar control improving the transient performance of motor and hence ac induction motor is the winner in industry. Application of induction motors in continuous duty variable speed drives calls for static inverters of adequate power, generating three phase voltages of variable amplitude and frequency. In that case, indirect frequency conversion methods are appropriate. The indirect frequency changer consists of rectification and inversion. There is a large variety of solution for the inverter and control problem.

In vector or field oriented control both the magnitude and phase alignment of vector variables are controlled. The invention of vector control in the beginning of 1970s and the demonstration that an induction motor can be controlled like a separately excited dc motor brought renaissance in the high performance of control of ac drives. Because of dc like performance vector control is also known as "decoupling" orthogonal or trans-vector control.

Field orientation is a technique that provides a method of decoupling the two components of stator current: one producing the air-gap flux and the other producing the torque. The principle of field orientation originated in the former West Germany through the work of Blaschke and Hasse (Blaschke 1972; Hasse 1969). A variety of implementation methods have now been developed but these techniques can be broadly classified into two groups: direct control and indirect control.

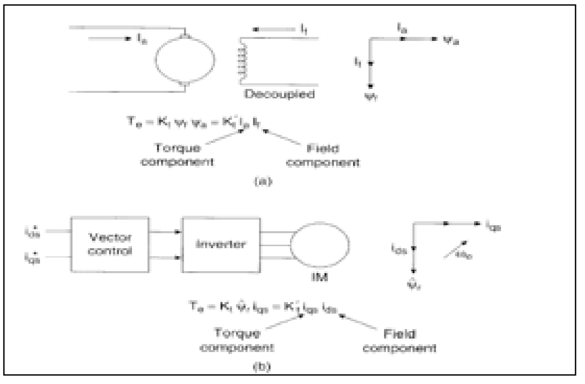

Figure 2 Principle of field oriented control

Here analogy of three phase induction motor with separately excited dc motor is shown. For field oriented control, three phase induction motor is run like a separately excited dc motor. For this a p-q axis model of induction motor is must. **1**

In vector or field oriented control both the magnitude and phase alignment of vector variables are controlled. Induction motor can be controlled like a separately excited dc motor. Because of dc like performance vector control is also known as "decoupling" or Vector control is the most popular control technique of AC induction motors. In special reference frames, the expression for the electromagnetic torque of the smooth-air-gap machine is similar to the expression for the torque of the separately excited DC machine.

In the case of induction motor, the control is usually performed in the reference frame d-q (d- direct axis, q- quadrature axis) attached to the rotor flux space vector. That's why the implementation of vector control requires information on the modulus and the space angle (position) of the rotor flux space vector. The stator currents of the induction machine are separated into flux- and torque-producing components by utilizing transformation to the d-q coordinate system, whose direct axis (*d*) is aligned with the rotor flux space vector. Orthogonal or Trans - vector control.

4.2.1Sensor less vector control

AC drives often need mechanical sensors (tachometers, position encoders) for field orientation. In many applications these sensors reduce robustness and increase costs of a drive considerably. Sensor-less control schemes using motor terminal voltages and currents, works very well at high speeds of operation.

Consequently, this has opened a new interesting area for research and during the last few years a variety of different solutions has reached the market. Neural networks, artificial intelligence and sensor less control are names that might sound familiar. The last one is a method that consists, as indicated by the name, of different ways of controlling the induction motor without using a speed sensor. Even though the induction motor is cheap and simple in its construction, this is not the case when it comes to its mathematics. The machine is represented by a nonlinear model with unknown variables and external inputs, which with its complexity makes sensor less control a challenging theoretical problem.

Sensorless vector control of an induction motor drive essentially means vector control without any speed sensor. An incremental shaft-mounted speed encoder (usually an optical type) is required for close loop speed or position control in both vector- and scalar-controlled drives. A speed signal is also required in indirect vector control in the whole speed range and in direct vector control for low speed range, including the zero speed start up operation.

A speed encoder is undesirable in a drive because it adds cost and reliability

problems, besides the need for shaft extension and mounting arrangement. It is possible to estimate the speed signal from machine terminal voltages and currents with the help of DSP (Digital Signal Processor).

Reference

1. Modern Power Electronics and AC Drives by Bimal K. Bose, Prentice Hall, USA. ISBN 0-13-016743-6, Printed in 2002.
2. Electric Motor drives- Modeling, Analysis and control By R. Krishnan, Prentice Hall of India Private Limited, New Delhi, India, ISBN-81-203-2168-5, Printed in 2002.
3. DSP based Electromechanical motion control by Hamid A. Toliyat and Steven G. Campbell, (Chemical Rubber Company) CRC Press, Taylor and Francis Group. ISBN:9780849319181, Printed in 2003.
4. A course in Electrical Machine Design- A. K. Sawhney, Dhanpat Rai & Co.(P) Ltd. New Delhi, 5th Edition - Reprint 2005.
5. Fundamentals of Electrical Drives by G.K.Dubey, Narosa Publishing House, New Delhi, Second Edition 2001, Reprint 2002.