ISSN: 2321-7782 (Online)
Volume 2, Issue 2, February 2014
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Paper / Case Study
Available online at: www.ijarcsms.com

A Survey on Induction Motor Drive using DTFC & Fuzzy Logic Control

Charu Prabha. V[1]
PG Scholar
M.E. Power Electronics and Drives
The Kavery Engineering College
Salem – India

Karthick. S[2]
Assistant Professor
Department of EEE
The Kavery Engineering College
Salem – India

Abstract: This paper presents the direct control techniques which are used to control the electric drives (ED). The direct control strategy that has been used in this paper is (DTFC) Direct Torque and Flux Control. DTC is a direct method of controlling the stator side or the rotor side flux and torque. In this paper DTC is implied on a three phase Induction Mo-tor drive (IMD).This approach has been examined with the help of PI controller and (FLC) Fuzzy Logic Controller. This proposed method has been simulated with the help of MATLAB software.

Keywords: ED-Electric Drives, DTC-Direct flux and torque control, IMD-Induction motor drive, FLC-Fuzzy logic controller, PI-Proportional integral controller.

I. INTRODUCTION

The electric drives are generally used in various industries in order to perform its desired operations and control applications. These motors are driven under various conditions depending upon its different areas of location. The electric drives used in any industry should meet its desired output. Hence for each individual application the controlling method varies widely.

II. VARIABLE FREQUENCY CONTROL

These control methods are of various types and they are utilized for specific purposes. General control techniques for induction motor drives are classified into two as,

- Scalar control method and
- Vector control method.

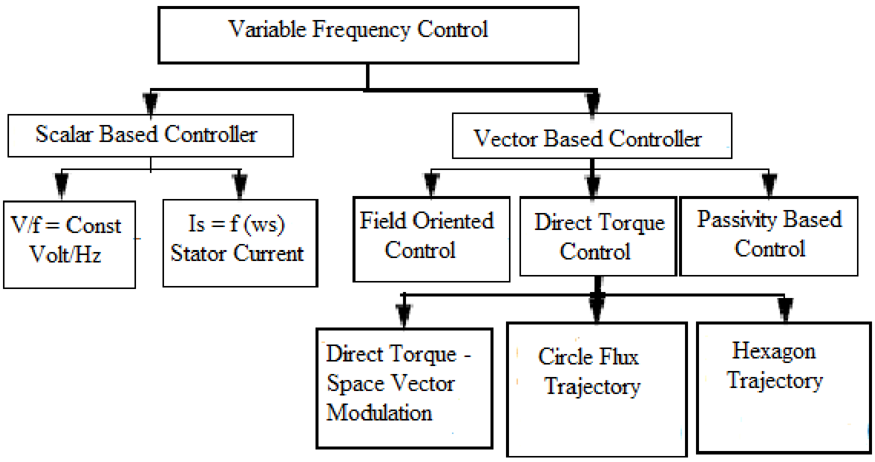

Fig. 1 Control methods of induction motor

The broad classification of Variable frequency control is shown in the following figure.1 and the proposed control scheme is indicated with thick lines as shown in the figure. The various types under variable frequency control are discussed below.

A. Scalar control

The scalar control is a type of variable frequency control. This scalar control is used to control the angular speed of current, voltage, and flux linkage in space vectors. The scalar control operates in steady state and it is not capable of operating in transient state.

B. Vector control

The vector control can operate in all dynamic states. It controls not only the angular speed and magnitude but also the instantaneous position of current, voltage, and flux linkage are also controlled. This vector based control is further classified as,

- Field Oriented Control(FOC)
- Direct Flux and Torque Control (DTC)
    a) Direct Torque Space Vector Modulation(DTC-SVM)
    b) Circle Flux Trajectory
    c) Hexagon Flux Trajectory
- Passivity Based Control

1. Field Oriented Control (FOC):

In the vector control, one of the most popular control method for induction motor drives, known as Field Oriented Control (FOC).

The FOC gives high performance, and high efficiency for industrial applications. In this FOC, the motor equations are transformed into a coordinate system that rotates in synchronism with the rotor flux vector control.

This drawback was eliminated using the new strategies for torque and flux ripple control of IMD using DTC.

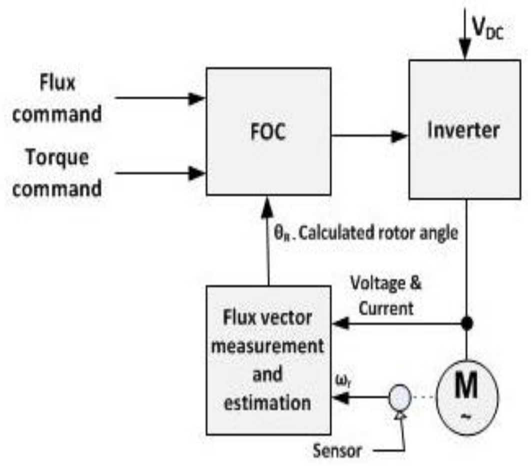

Fig. 2 Control Scheme for Field Oriented Control.

The FOC is good in high dynamic performance, low stator flux and torque ripples, switching frequency, and maximum fundamental component of stator current, but FOC method has some drawbacks, such as requirement of two co-ordinate transformations, current controllers, and high machine parameter sensitivity.

The control scheme for a field oriented control (FOC) approach differs in that the current loop occurs de-referenced from the motor's rotation; there are two actual current loops, one for the torque Q, and the other one for the torque D. The torque loop Q is driven with the torque that is given by the user from the servo controller.

The loop D is driven with an input command zero that is used to minimize the unwanted direct torque component. This work is done with the help of mathematical transformations that convert the vector phase angle to the de-referenced D and Q reference frame.

These transformations are known earlier and their practical implementation in brushless DC and AC Induction drives is now relatively acquires commonplace due to the availability of less cost, good performance in microprocessor's.

2. *Conventional direct torque and flux control (DTC):*

3. The drawbacks in the field oriented control can be eliminated by using this DTC technique. Compared with the field oriented control DTC has very simple control scheme and computational requirements such as the current controllers and coordinate transformations are not required. The DTC is simplified scheme with less time consumption. The DTC technique is also abbreviated as direct flux and torque control (DFTC).

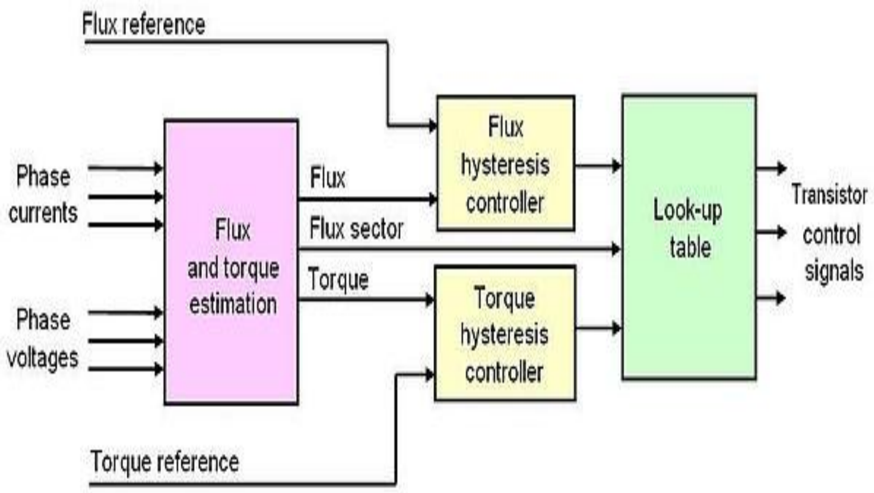

Fig. 3 Basic blocks of DTC Scheme

This control proposes motor linearization and decoupling through mathematical coordinate transformations using torque and flux hysteresis controllers, and hence said to be DTC method.

The main drawbacks in this control method are given below as,

- High torque ripples
- Slow transient response during start-up condition.
- Variable switching frequency and
- Low speed operating conditions.

To overcome this, the DTC control method is used along with the artificial intelligence technique such as Fuzzy logic. With the Fuzzy logic all the disadvantages especially the torque ripples and transient response of the system can be improved significantly.

The following are some of the properties of DTC, by changing the reference values the values of torque and flux can be changed. Since transistors are switched only when nits needed to keep the torque and flux within the heir hysteresis band it reduces the losses and improves the efficiency. Hence proper reference values provide better performance of the drive. The average switching frequency can be maintained constant by controlling the width of the tolerance bands.

This keeps the current and torque ripples small. Thus compared with the vector controlled drives with the same switching frequency here the torque and current ripple are of the same magnitude. There are no peaks in the current spectrum which means that the noise of the machine is low. In higher speeds the method is not sensitive to any motor parameters but at low speeds error in stator resistance becomes critical.

Another drawback is the flux and torque distortion which is caused by stator flux vector which is changing with the sector position and the Induction motor drive speed also changes in accordance with the states of transient and dynamic operating conditions.

4. *Proposed Direct Torque and Flux Control (DTC):*

The proposed direct torque and flux control is mostly employed for fast dynamic motors.DTC has been robustly used for its fast torque and flux control. The changes in the rotor flux linkages is compared with the changes in the stator flux linkages, since the rotor time constant of an induction machine is large.

Rapid changes can be made to the electromagnetic torque by rotating the stator flux in the required direction by providing the proper torque command. The stator flux can be increased or decreased by giving proper stator, thus providing the effective control.

In this proposed method PI controller is used which regulates the speed of the Induction motor drive and the fuzzy logic controller is used to reduce the stator flux and torque ripples.

Two independent torque and flux controlling hysteresis bands are employed in this proposed DTC technique.

The independent hysteresis bands of torque and flux are used in order to control the limits of torque and flux. Finally the effectiveness of the induction motor drive is examined for its low stator flux and torque ripples and provides good speed regulation.

5. *Direct Flux and Torque-Space Vector Modulation (DTC-SVM):*

The most convenient control scheme for voltage source inverter fed Induction motor drive is obtained with the direct flux and torque controlled with space vector modulation.In SVM technique instead of using separate modulators for each of the three phases the reference voltage is given by the space voltage vectors and the output voltage of the inverter is considered as space vectors.

The implementation of DTC using SVM requires computation of vector switching states through a feedback current loop of torque and flux without usage of the inner current loop. The flux loop has two levels of digital output and the torque loop has three levels of digital output.

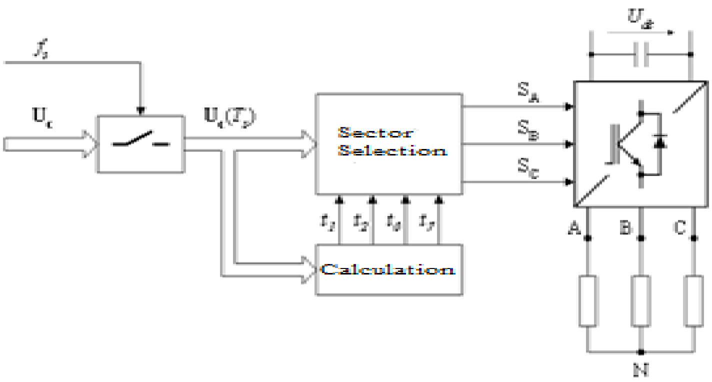

Fig. 4 Block diagram of Space vector modulation

Totally there are eight possible voltage space vectors. In that (U_1-U_6) are six active space vectors and (U_7-U8) and the remaining two are zero vectors which is shown in figure5.

In those eight possible switches if U_0 and U_7 are selected then the flux rotation stops and there will be a derease in torque and therefore the amplitude of flux remains constant.By this kind of torque and flux hysteresis comparator the voltage flux is maintained within circular zigzag path.

The required switching table is formed with its torque and flux reference values and its compared with the actual values and finally the speed is improved.

In this proposed method PI controller is used which regulates the speed of the Induction motor drive and the fuzzy logic controller is used to reduce the stator flux and torque ripples. Two independent torque and flux controlling hysteresis bands are employed in this proposed DTC technique.

The independent hysteresis bands of torque and flux are used in order to control the limits of torque and flux. Finally the effectiveness of the induction motor drive is examined for its low stator flux and torque ripples and provides good speed regulation

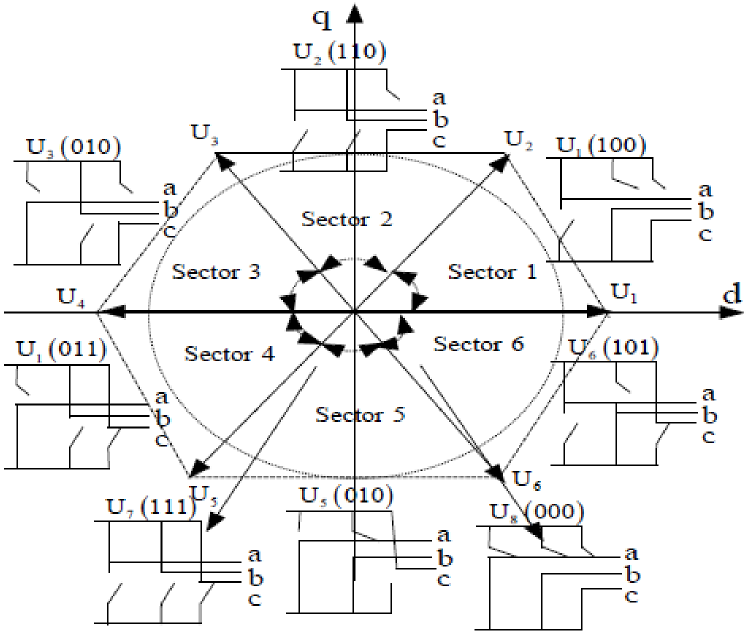

Fig. 5 Eight possible switching configuration of the voltage source inverter

The advantages of this DTC-SVM method are as follows,

- The number of dynamic equations can be reduced.
- Possibility of analysis at any supply voltage waveform,
- Equations can be represented in rectangular coordinate systems.

III. Conclusion

This paper has introduced a survey on Induction motor speed control. Three phase induction motor is controlled with an efficient technique called DTC. The DTC helps in controlling the torque and flux and provides better speed regulation. Hence by using this DTFC technique along with the Fuzzy logic control strategy has improved the motor performance and efficiency and speed control of the Induction motor is obtained in an accurate manner.

References

1. Blaschke F (1988), the principle of field-orientation as applied to the transvector closed-loop control system for rotating-field machines, Siemens Rev., vol.34, pp.135-147.
2. Suresh Mikkili, A.K. Panda (2011), PI and Fuzzy Logic Controller based 3- phase 4-wire Shunt active filter for mitigation of Current harmonics with Id-Iq Control Strategy, Journal of power Electronics (JPE), vol.11, No. 6
3. Tang L, Zhong L, Rahman M.F, Hu Y (2004),A novel direct torque controlled interior permanent magnet synchronous machine drive with low ripple in flux and torque and fixed switching frequency, IEEE Transactions on Power Electronics, 19(2), p.346-354.
4. Uddin M.N, T. S. Radwan, and M. A. Rahman (2002), Performance of fuzzy logic- based indirect vector control for induction motor drive, IEEE Trans. Ind. Appl. Vol.38, no. 5, PP. 1219-1225.
5. G.S. Buja, M.P.Kazmierkowski, “DTC of pwm inverter-fed AC motors – A Survey”, IEEE Trans. on Ind. Elec., volume 54, no. 4, 2004.

6. I. Takahashi and T.Noguchi, "A new quick response and high efficiency control strategy of an induction motor", IEEE Trans. Ind. Appl., vol. 22, no. 5, pp. 820-827, 1986.
7. M. Dependrock, "Direct self control (DSC) of inverter-fed induction machine", IEEE Trans. on Power Electronics, volume 22, no. 5, pp. 820- 827, September/October 1986.
8. B.K.Bose, "Modern Power Electronics and AC Drives", Prentice Hall Indic, 2006.
9. C. F. Hu, R. B. Hong, and C. H. Liu, "Stability analysis and PI controller tuning for a speed –sensorless vector-controlled induction motor drive", 30th Annual Conference of IEEE Inds. Elec.,Society, 2004, IECON, vol. 1, 2-6 Nov. 2004, pp. 877-882, 2004.
10. I. Takahashi and Y. Ohmori, "High-performance direct torque control of induction motor", IEEE Trans. Ind. Appl., vol. 25, no. 2, pp. 257-264, 1989.
11. P. Vas, Sensorless vector and direct torque control, Oxford University Press, 1998.

AUTHOR(S) PROFILE

V.Charu Prabha, student of The Kavery Engineering College, Pursuing M.E (PED). She has received her B.E (EEE) Degree from Karpagam Institute of Technology, Coimbatore, in 2012. Her research area is flux and torque control of an Induction motor.

S. Karthick, obtained his Master Degree in Applied Electronics, from Anna University, Chennai. He has 7 years of teaching experience and 6 years in industries. He has presented 14 research papers in International / national Conference. His main area of research is image processing.