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Multimode Drive System for Electrical Vehicle

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ABSTRACT

The induction motor finds its place amongst more than 85% of industrial motors as well as in its single-phase form in various domestic usages. Markedly a constant-speed motor with shunt characteristic, speed drops only by a few percent from no-load to full load. Hence, in the past, induction motors have been used primarily in constant speed applications. Traditional methodologies employing speed control have either been high-priced or very inefficient, unlike the dc motor. Nonetheless, the presence of commutator and brushes in the latter, which require recurrent maintenance make dc motor drives improper for use in hazardous and polluted environments. On the other hand, owing to the simple, rugged, cheaper, smaller and subsequently lighter build of induction motor drives (particularly squirrel-cage type), they are designed for fans, blowers, cranes, traction, conveyers, etc. in spite of finding stiff competition from dc drives for such applications.

I. INTRODUCTION

This project presents design and implementation of hybrid-space vector pulse width modulation (SVPWM) inverter for induction motor drive.In recent years, the field oriented control of induction motor drive is widely used in high performance drive system. It is due to its unique characteristicslike high efficiency, good power factor and extremely rugged construction. This scheme is able to adjusts the speed of the motor by controlling the frequency and amplitude of the stator voltage i.e. the ratio of stator voltage and frequency should be kept constant. The main objective of this project is speed control of induction motor with minimization of harmonics in voltages and line current. For speed control of induction motor number of Pulse Width Modulation (PWM) schemes are used with variable voltage and frequency supply. Using flux control it is possible to control both frequency and magnitude of the voltage applied to induction motor drive. As result PWM inverter fed induction motor drives are reliable and offer a wide range of speed. Also it gives better efficiency and higher performance as compared to fixed frequency induction motor drives. The energy delivered by the PWM inverter to the induction motor is controlled by PWM signals applied to the gates of the power switches at different time of intervals. Most widely used PWM techniques for three-phase VSI are Sine PWM (SPWM) and hybrid SVPWM. By using hybrid space vector approach inverter generate desired output voltage waveform, minimize harmonic content, minimize torque ripple. So hybrid SVPWM is better than Sine-PWM.

II. PROPOSED SYSTEM

As the name indicates, direct torque control (DTC) directly controls the torque and the flux of the motor by alternative chose the voltage space vector of the power converter through a look-up table. The main advantage of DTCs is their simple construction, as no coordinate transformations, current regulators, and modulations are required.

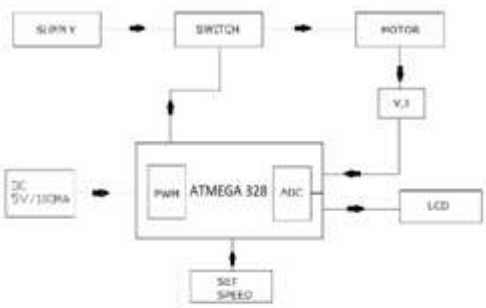

Fig.1:Block diagram of proposed system

The fundamental principle of Direct Torque Control is to select the stator voltage vector dependent on torque and flux errors directly (the inconsistency between the reference torque and the stator flux and its estimated value). This is a sensor less method. The first base is the power converter (this is a fixed inverter circuit). You control this converter through a microcontroller. Set the speed to this speed and generate the PWM. After supplying power, it can be 3-phase or 1-phase. As shipped, the switch is activated by the PWM depending on the speed set. PWM changes according to the set speed.

This output is checked at actual speed by measuring the flow rate. Induction motors give feedback through an inductive load. From this feedback, we determine the inter-correlated torque and flux by measuring the torque and flux. It is called sensor less because it checks accuracy and does not measure speed.

The implemented DTC consists of a rectifier, a voltage source inverter, a driver protection circuit, an operational amplifier used as a current sensor, and a voltage divider used as a DC bus voltage sensor. Some of these hardware components00 reside on the AVR controller.

The other part is the software design to realize the DTC algorithm. This function is implemented through the motor control board. Additionally, ADC and DAC conversions are implemented using the C programming language and the Code-C compiler. I also ran the AVR controller live to get better results without using float variables. The variables used in this implementation are called integer quotient (IQ) variables. These variables are useful for motor control applications. All control algorithms in the suite operate on a per system (PU) basis based on the calculated IQ variable. For controlling the speed of IM, the stator flux estimator is used. This estimation is based on his two approaches, IM's current model and voltage model.

III. METHODOLOGY

Direct Torque Control integrate FOC theory, direct self-control theory, application-specific integrated circuit (ASIC), and advanced digital signal processing (DSP) technology to realize "sensor less" variable speed drive. It is based on the error in between the calculated flux, torque, and the reference, by reducing the flux and torque errors in a specific range directly we can control the state of the inverter. The dissimilar DTC, FOC has no need of a current controller, coordinate modification, or PWM modulator (hence the timer).Despite their simplicity, DTCs provide excellent torque control in stationary and mysterious conditions. FIG.shows the basic DTC circuit.

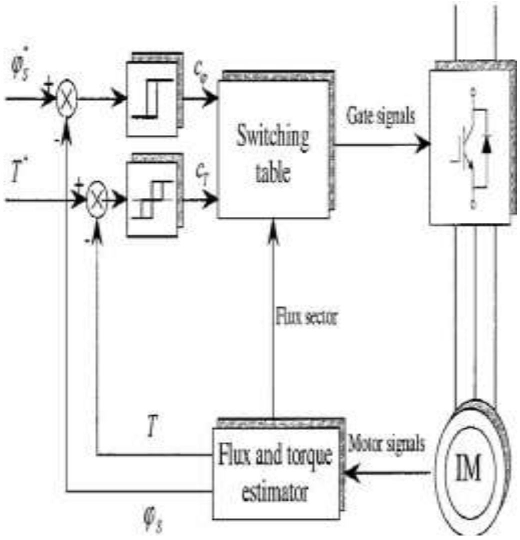

Fig. 2:Basic Direct Torque Control

According to Fig.the three-level hysteresis comparator's input determines the accuracy between the reference stator flux and the estimated stator flux (S) as well as the difference between the reference torque (T*) and estimated torque (T).
(ϕS*) is an input, Selection of a suitable voltage vector for a two-stage hysteretic comparator is based on switch table

Sector		1	2	3	4	5	6
$c_\varphi = -1$	$c_T = -1$	$\overline{V}_2$	$\overline{V}_3$	$\overline{V}_4$	$\overline{V}_5$	$\overline{V}_6$	$\overline{V}_1$
	$c_T = 0$	$\overline{V}_7$	$\overline{V}_0$	$\overline{V}_7$	$\overline{V}_0$	$\overline{V}_7$	$\overline{V}_0$
	$c_T = +1$	$\overline{V}_6$	$\overline{V}_1$	$\overline{V}_2$	$\overline{V}_3$	$\overline{V}_4$	$\overline{V}_5$
$c_\varphi = +1$	$c_T = -1$	$\overline{V}_3$	$\overline{V}_4$	$\overline{V}_5$	$\overline{V}_6$	$\overline{V}_1$	$\overline{V}_2$
	$c_T = 0$	$\overline{V}_0$	$\overline{V}_7$	$\overline{V}_0$	$\overline{V}_7$	$\overline{V}_0$	$\overline{V}_7$
	$c_T = +1$	$\overline{V}_5$	$\overline{V}_6$	$\overline{V}_1$	$\overline{V}_2$	$\overline{V}_3$	$\overline{V}_4$

Tab.1: Switching table for Direct Torque Control (DTC).

In order to properly use the lookup table for optimal switching, we need to know the vector located sectors, and the space vector of stator flux linkage, in order to properly use lookup table for optimal switching. Although, stationary performance is defined by unwanted breaker in current, torque and flux. This is because of lack of

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information about values of rotor speed and the torque in the algorithm of voltage vector selection.

Direct Torquing Control is like FOC, in that it is separate the torques and the currents and controls them separately. However, direct current motors control force directly, without a speed controller, so torque response is quicker than for servo motors.

In the Direct Torque Control, we can use two control curves. First the speed control loop and second is the torque control loop that work with a modern motor model to accurately forecast motor torque and stator flux. Here is how it works:

1 – Two motor phase currents and the DC bus voltage are measured, along with the inverter's switch positions. (Motor voltage is determined from the DC bus voltage and the inverter's switch positions.)

2 – Motor current and voltage are fed to the motor model, which uses advanced mathematical algorithms to produce exact values of the stator flux and motor torque, along with shaft speed, every 25 µs (as fast as 12.5 µs in some drives).

3 – The actual torque and flux values are fed to the torque and flux comparators, which compare them to torque and flux reference values that are provided by the speed control loop.The goals of the comparators are to hold the magnitudes of the torque and flux vectors within a narrow hysteresis band around the reference values. This is a primary factor in DTC's ability to achieve fast torque response without overshoot.

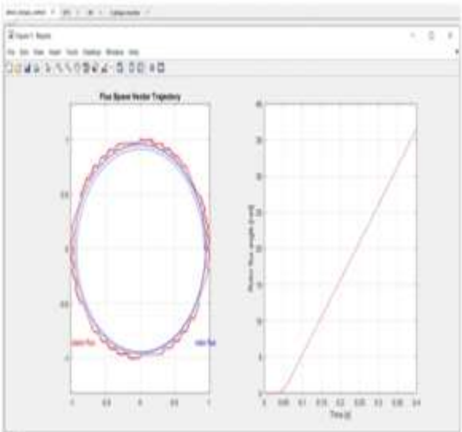
4 – Torque and flux status signals are fed to the optimum pulse selector.

5 – The optimum pulse selector chooses the optimum voltage vector from a lookup table and, based on this, sends pulses to the inverter's semiconductor switching devices to maintain or change the motor torque as required.The lookup table provides the optimum voltage vector based on three parameters: whether torque and stator flux each need to be increased or decreased (or, for torque,held constant), and in which sector (60-degree segment) of the space vector plane the stator flux resides.The semiconductor switching in the inverter again determines motor voltage and current, which determines motor torque and flux, therefore closing the control loop.

6 – The speed control loop contains a speed controller (which consists of a PID controller and an acceleration compensator), a torque reference controller, and a flux reference controller.The output of the speed controller is fed to the torque reference controller, whose output is the internal reference value for the torque comparator in the torque control loop.The fluctuating setpoint authority decide the entire value of stator flux and uses it as inside reference of the flux compare to the torque control curve. The flux inside reference controller it is also where the flux is controlled and change for drive functions such as energy enhance and flux slow down.

IV. RESULT AND DISCUSSION

Fig.3: Flux vector trajectory



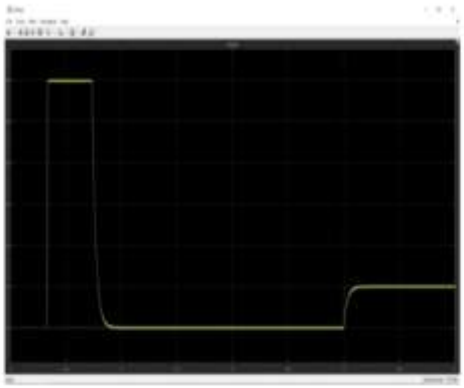


Fig.4: Torque

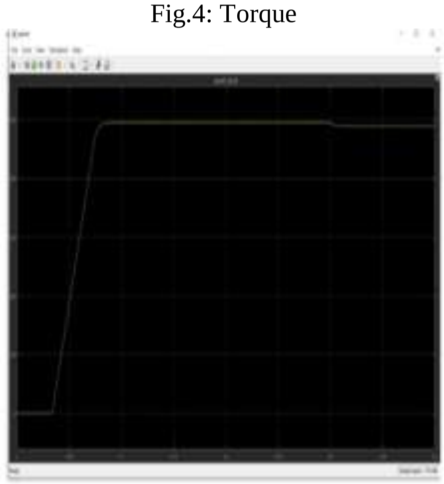


Fig.5: Speed output 500rpm

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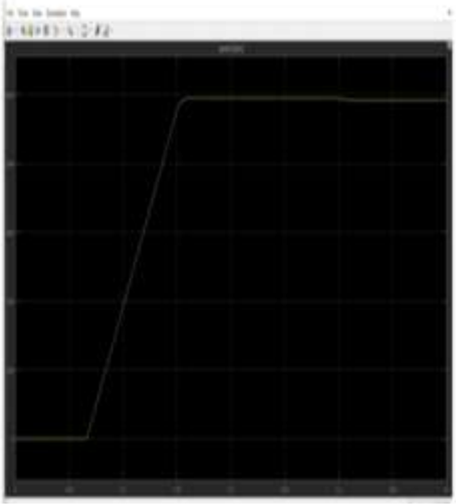


Fig.6: Speed output 1000rpm

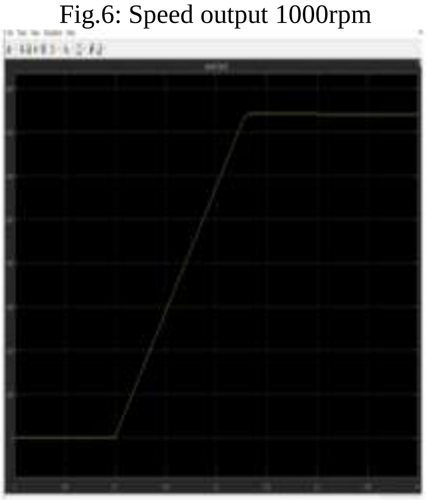


Fig.7 Speed output 1500rpm

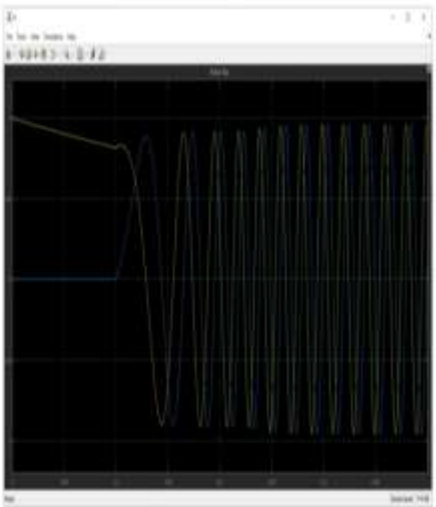


Fig.8: Rotor flux

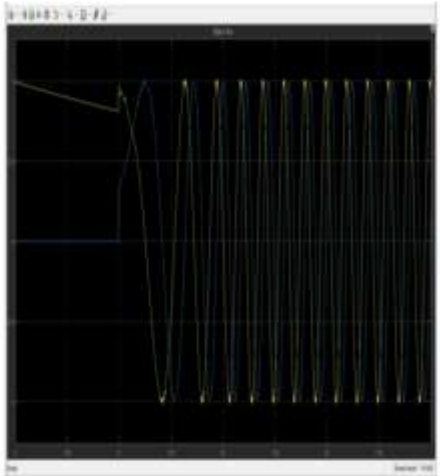
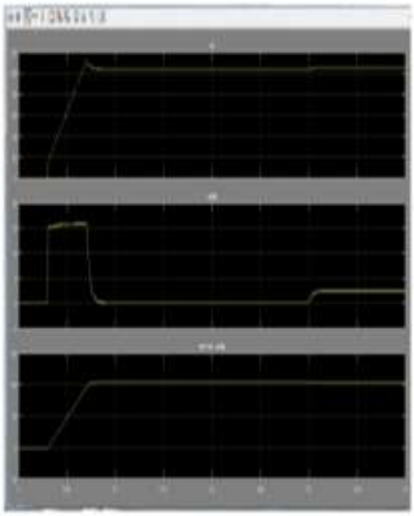


Fig.9:Stator flux



Fig,10: Actual speed, difference between shaft speed and rotor speed

V. CONCLUSION

Improve the performance of DTC controlled of IM is the main purpose of this chapter. The aim of this improvement is to minimize pair ripple and IM flux and to lower the switching frequency of inverter is the aim of this improvement. I began by going over the concepts behind his traditional DTC, space vector modulation, fuzzy DTC, and adaptive fuzzy PI speed controller. The advantages of the SVM-DTC Fuzzy method compared to two strategies';LKJ, the traditional DTC & SVMDTC is revealed by this synthesis of simulation studies. We Find SVM-DTC. fuzzy method to be superior by comparing torque, speed and stator flux characteristics.

It is seen that a ripple of torque is reduced and steady state current is sinusoidal with no ripple. The method is mapped to an adaptive fuzzy pl cruise controller to improve SVM-DTC fuzziness

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and improve performance. The DTC based on induction motor more and more Stable because of this association. At startup response time is greatly reduced. The applied load disturbance is rejected very quickly by velocity control loop. First basic principles of FOC and DTC are carefully compared. In that, checking implementation of intelligent control technique such as Fuzzy logic and neural network are done against his DTC and improvements are analyzed systematically.Implementationof intelligent technology reduces stator Flux and torque ripple are concluded and improve dynamic performance. In this article, the latest direct torque control improvement technique for IM is described.

To minimize the pair ripple and IM flux on the one hand and lower switching frequency of inverter on the other hand is purpose of improvements. A classification and comparison of these strategies in terms of ripple reduction, tracking speed, switching loss, algorithmic complexity and parameter sensitivity are presented. Determining the best solution for improving DTC performance is very difficult. The choice of method depends on the application, cost, hardware availability, system reliability and accuracy. This overview is expected to provide a very useful tool for all industries and researchers working on the control of electrical machines.

VI. FUTURE SCOPE

The scope of project is:

- Here we can see the remarkable improvement in the performance of the motor by changing the look up tables. However, some little improvements should be done.
- We can do some improvements for better performance of motor and also for our car.

REFERENCES

[1] M.Nasir Uddin, T.S.Radwan , M.A.Rahman Performance analysis of four switch 3-phase inverter fed induction motor drives” IEEE conf. Power Eng., pp. 36-40, 2004.
[2] Haitham abu-rub, Jochim holtz Medium-Voltage Multilevel Converters State of Art, Challenges and requirements in industrial applications” IEEE Trans. Ind. Electron., vol57, no.8, pp. 2581-2596, Aug.2010.
[3] Amit Kumar Gupta, Ashwin M. Khambadkone A Space Vector PWM Scheme for Multilevel Inverters Based on Two-Level Space Vector PWM” IEEE Trans.on Ind.Electon., vol53, no.5, pp. 1631-1639, Oct2010.
[4] Pratheesh K. Jagadanand G. and Rijil Ramchand “An Improved Space Vector PWM Method for a three-level inverter with reduced THD” IEEE conf. on Power Electron., pp 167-172,2010.
[5] Irfan Ahmed,Vijay B. Borghate,Amarendra Matsa, Prafullachandra M. Meshram, Hiralal Murlidhar Suryawanshi and Madhuri A. Chaudhari. “Simplified Space Vector Modulation Techniques for multilevel inverters” IEEE Trans. on Power Electron.2016.
[6] Wei Chen, Haiwei Sun, XinGu, and Changliang Xia “Synchronized Space-Vector PWM for three-level VSI With lower harmonic distortion and switching frequency” IEEE Trans. Power Electron., vol.31, no.9, pp.6428-6441, Sept2016.
[7] S. Pavan Kumar Hari member and G. Narayanan Space-Vector-Based Hybrid PWM technique to Reduce Peak-to-Peak Torque Ripple in Induction Motor Drives” IEEE Trans. on Power Electron., vol31, no.9, Sept2016.
[8] Amir Peyghambari, Ali Dastfan, and Alireza Ahmadyfard “Selective Voltage Noise Cancellation in three-phase inverter Using Random SVPWM IEEE Trans. Power Electron., vol31, no.6, June2016.
[9] C,Sasidaran and S. Samaya sanjeevi Harmonics reduction in three phase multilevel inverters using space vector modulation IEEE conf. in ICIES 2015.
[10] Biji Jacob and M.R.Baiju A New Space Vector Modulation Scheme for Multilevel Inverters Which Directly Vector Quantize the Reference Space Vector” IEEE Trans.Power Electron., vol.62, no.1, pp. 88-95, Jan2015.