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Analysis of SVPWM for Inverter Fed DTC of Induction Motor Drive

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Abstract

Various aspects related to the control of induction motors are investigated. The Direct Torque Control (DTC) strategy is extensively studied and its relationship to Vector Vector Modulation (SVM) underlined. driven by induction motor. The main objective of this work is the analysis of the induction motor with SVPWM inverter and the harmonic analysis of voltages and currents. To control the number of IM pulse width modulation schemes (PWM schemes) are used for the variable voltage and frequency power supply. The most commonly used PWM schemes for three-phase voltage source (VSI) inverters are PWM sinusoidal PWM motors (SPWM) and PWM space vectors (SVPWM). There is a growing trend for using Spatial Vector PWM (SVPWM) as it reduces the harmonic content in the voltage and increases the base output voltage of instant messages. The performance of the inverter-driven SVPWM drive is therefore modeled and simulated using the MATLAB / SIMULINK software. The results of the SVPWM-based induction motor drive speed control will be similar to those of the Modulator Driven Induction Motor (IM) motor drive and Direct Induction Motor (DTC) induction.

Keywords: SPWM, SVPWM, Three phase Inverter, Three phase Induction Motor,THD,Direct Torque Control(DTC),Induction Motor(I.M)

INTRODUCTION

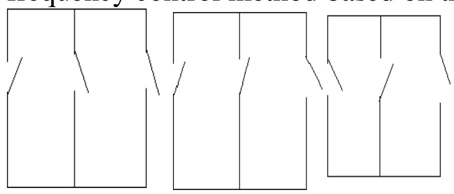
The induction machine (IM) is widely used in the industry because of its relatively low cost, low maintenance and high reliability [1]. The control of frequency converters IM [2], [3] often requires the control of the currents of the machine obtained with the voltage source inverter (VSI). In conventional error codes, the electromagnetic torque and the electromagnetic flux are independently controlled by selecting the optimal switching modes of the inverter. The purpose of selecting the optimal switching modes of the inverter is to limit torque and electromagnetic flow errors within the torque and flux hysteresis bands. The basic DTC scheme includes two fixed bandwidth comparators, a switch table, a voltage source inverter, a flow, and a torque estimation block. Like any control method, the DTC method has advantages and disadvantages. Some

The advantages are less dependent on the parameters, which makes the system more robust and easier to handle, and the disadvantages are that the flow and torque at low speed, the current and torque distortion during the change of sector, the frequency Variable switching and a high sampling frequency are required are difficult to control when implementing digital hysteresis, with high torque ripple. Torque ripple generates noise and vibration, causes errors in sensorless motor drives, and associated current ripples are again responsible for electromagnetic compatibility. The reason for the high current and torque ripple in the DTC is the presence of hysteresis comparators as well as the limited number of voltage vectors available. If a number of voltage vectors greater than that used in conventional DTCs is used, favorable motor control can be obtained. Due to the complexity of the power and control circuits, this approach is unsatisfactory for low and medium power applications. Another solution for minimizing the torque ripple is the spatial vector modulated DTC.

SPACE VECTOR PWM (SVPWM)

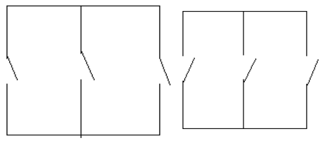
Space vector modulation (SVM) was originally developed as a vector approach for pulse width modulation (PWM) of three-phase inverters. It is an advanced technique for generating a sine wave that provides the motor with a higher voltage with less overall harmonic distortion. The main goal of any modulation technique is to obtain a variable output with a maximum fundamental component with minimum harmonics .

The space vector PWM technique is used to generate the switching control signals to be applied to the three-phase inverter. The SVPWM inverter offers 15% higher DC link voltage utilization and lower harmonic distortion than conventional PWM sine wave inverters. The control strategy of the SVPWM inverter is the voltage / frequency control method based on the space

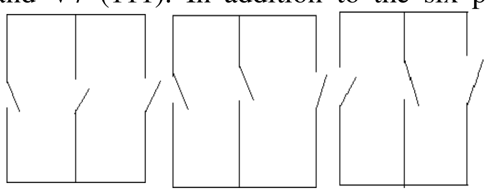


vector modulation technique.

The basic difference between SVPWM and SPWM is



the existence of two additional zero voltage states V0 (000) and V7 (111). In addition to the six possible



voltage vectors associated with the VSI, there are two zero voltage states associated with the activation of the three positive pole switches or the three negative pole switches. This fact allows a higher output voltage since the third harmonic component is present. Therefore, SVPWM is often considered to be an eight state operation.

BASE AND INVERTER SWITCH STATUS

The circuit model of a typical three-phase source bridge inverter is shown in the figure. S1 to S6 are the six power switches that form the output controlled by switches s1, s4 for phase A, s3, s2 for phase B and s5, s6 for phase C. When a top switch is activated, c that is, when s1, s3 and s5 are equal to 1, the corresponding lower switches are deactivated, i.e. the corresponding s2, s4 and s6 are 0. The eight available digits (b) represent various switching states of the three-phase inverter. It should be noted that all the terminals of the machine are electrically connected and that no effective voltage is applied to the machine when the zero vectors are represented by the states (000) and (111).

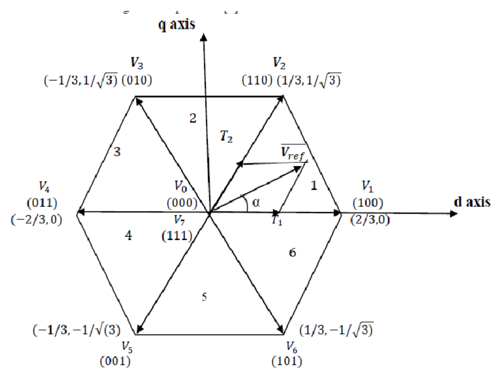


Figure 1: Space Vector

state1(100) state2(110) state3 (010)

State4(100) state5(001) state6(101)

State7(111) state8 (000)

Figure 2: Switching positions of inverter in states S_1-S_8

For a PWM operation, a state of eight is required so that the average output voltage is sinusoidal. States 1, 2, 3, 4, 5 and 6 generate a non-zero output voltage, these states being on the spatial vector. The state phase 010 B is Vdc, in phase 011 the phases B, C are in Vdc, in the state phase 001.

It is at V_{DC}, at state 101 the phases A and C are at V_{DC}. By combining all pole voltages, it is a hexagon whose radius is equal to the space vector, as shown in the following figure. In (c), the six active voltage vectors are equal along the radii of the hexagon. The maximum radius of the space vector is Vdc. Here, the reference space vector Vref rotates at a uniform speed.

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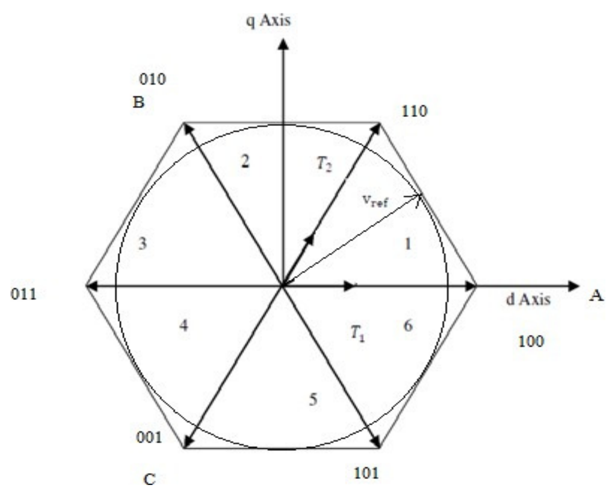

Figure 3: Space Vector

SIMULATION MODEL OF SVPWM AND PROPORTIONAL INTEGRAL CONTROL

The simulation results are given for the induction motor for the following specification:

Number of poles [P] = 4, Frequency [F] = 50 Hz, Number of phases = 3, Stator resistance [Rs] = 6 ohms, Rotor resistance [Rr] = 10 ohms, Stator inductance [Ls] = 450 mH, Mutual inductance [Lm] = 390 mH, Moment of inertia [J] = 0.00388 Kg-m/sec.

RESULTS AND CONSLUSION:

The following figures show the comparison of the results obtained by DTC simulation with PI controller, DTC with PWM and DTC with SVPWM. Figures 13 and 14 illustrate the torque waveform of pwm and svpwm, respectively. Fig. 15 shows the improvement of the waveform of the svpwm pair. Figure 17 shows the speed comparison of pwm and svpwm. 18 and 19 show the phase voltages Va and Vb, respectively.

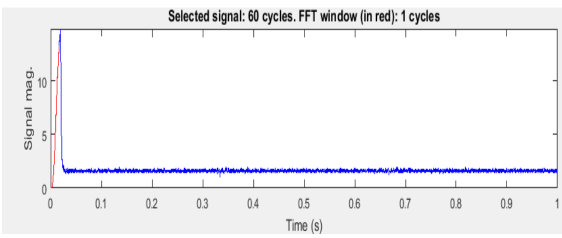

Figure 13: torque waveform of pwm

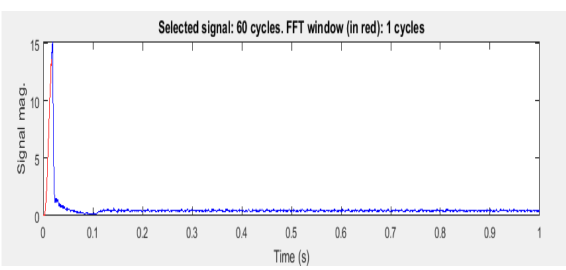

Figure 14: torque waveform of svpwm

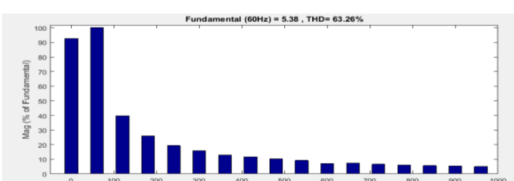

Figure 15: FFT of Torque(svpwm)

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