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Torque Ripple Reduction in Induction Motor using PWM Techniques

Sheenu.P[1], Athul.G.Nathan[2]

Assistant professor, Dept. of EEE, Mar Baselios College of Engineering and Technology, Trivandrum, Kerala, India[1]

PG Student [PCD],Dept. of EEE, Mar Baselios College of Engineering and Technology, Trivandrum, Kerala, India[2]

ABSTRACT:An induction motor fed from a 2 level voltage source inverter results in a pulsating torque due to application of non-sinusoidal voltages.The pulsating toque or Torque ripple is strongly influenced by the pulse-width modulation (PWM) method adopted. Normally sinusoidal pulse width modulation methods are used for 2 level VSI-fed induction motor. Space vector pulse width modulation is more precise and advanced than conventional sine pwm method. Conventional space vector PWM (CSVPWM) is known to result in less pulsating torque than Sinusoidal PWM. Torque pulsations of a VSI-fed 2 level inverter under sine pwm and space vector pwm methods are evaluated. It is shown that the proposed method reduces the rms torque ripple by about 30% at the rated speed of the motor drive, compared to conventional space vector PWM..

KEYWORDS: PWM (pulse width Modulation, VSI(voltage source inverter), CSVPWM(conventional space vector pulse width modulation).

I.INTRODUCTION

Voltage source inverter fed induction motors are widely used in variable speed applications. For satisfactory operation of the motor drive, the harmonic distortion in the motor phase currents must be low. The harmonic distortion in the current is determined by the switching frequency and the pulse width modulation (PWM) technique employed. The switching frequency is kept within a certain range due to practical limitations. By the design of a good PWM method efforts have been made to reduce the distortion at a given switching frequency. The 2 level voltage source inverter is as shown in figure 1.

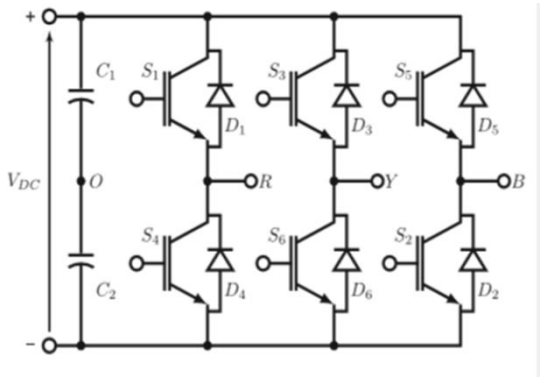

Fig 1: 2 level voltage source inverter using IGBTs

II. LITERATURE SURVEY

Pulse width modulation methods has been extensively used for multilevel inverters driven asynchronous motors. Induction Motor has been used more often due to its torque-speed characteristics [4]. Various PWM techniques like sine PWM, space vector PWM, etc are used more often [5]. A comparative study between sine PWM and space Vector

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PWM has been carried out more often [1-3]. In this paper a comparative study between sine PWM and space vector PWM is done with respect to the torque ripple characteristics obtained from an Induction Motor.

II.PULSE WIDTH MODULATION

Pulse-width modulation utilize a rectangular pulse wave whose width of the pulse is modulated hence resulting in the variation of the average value of the waveform.
A 2 level voltage source inverter that use PWM switching techniques have a DC source input voltage that is usually constant in magnitude. The inverter converts this DC voltage into AC voltage, where the magnitude and frequency can be controlled. There are several different techniques of Pulse Width Modulation (PWM).

A. *Sinusoidal pulse width modulation*

Sinusoidal pulse width modulation (SPWM) is widely used in power electronics to digitize the power so that a sequence of voltage pulses can be generated by the on and off of the power switches. The PWM inverter has been the main choice in power electronic for decades, because of its simple circut and rugged control scheme. SPWM switching technique is commonly used in industrial applications or solar electric vehicle applications.Sinusoidal pulse width modulation is the mostly used method in motor control and inverter application.
The sinusoidal signals are called reference signal and they are 120 degree phase shifted with each other. The frequency of these sinusoidal waves is chosen based on the required inverter output frequency. The carrier triangular wave is usually a high frequency (in several KHz) wave. The switching signal is generated by comparing the sinusoidal waves with the triangular wave. When sine voltage is greater than the triangular voltage the comparator gives out a pulse and this pulse is used to trigger the respective inverter switches.

B. *Space vector pulse width modulation*

Space vector modulation is a PWM control method for multi-phase AC generation where the reference signal is sampled regularly and after each sample the Non-zero active switching vectors adjacent to the referencevector and one or more of the zero switchingvectors are selected for the appropriate fraction of theSampling period in order to synthesize the referencesignal as the average of the used vectors. The topologyof a three-leg voltage source inverter is Because ofthe constraint that the input lines must never beshorted and the output current must always be continuousa voltage source inverter can assume onlyeight distinct topologies. Six out of these eight topologiesproduce a nonzero output voltage and areknown as non-zero switching states and the remainingtwo topologies produce zero output voltage andare known as zero switching states

III.SIMULATION

A. *Sinusoidal pulse width modulation*

A DC link source is applied to the 2 level voltage source inverter. An induction motor is modelled and it is connected to the inverter. Sine PWM method is used to provide control signals to the inverter.

The simulated block is as shown in figure:

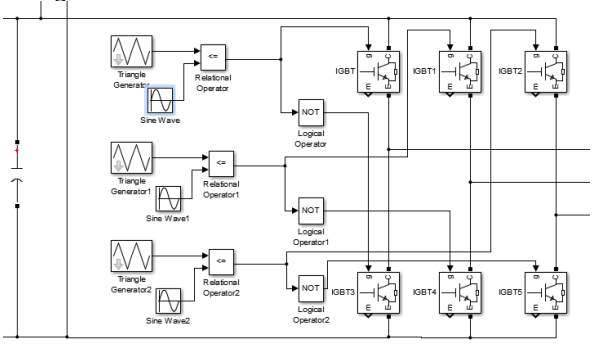

Fig. 2 :2 level voltage source inverter using IGBTs

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B. Space vector pulse width modulation

The induction motor is provided with the same 2 level inverter but the PWM method is changed to space vector pulse width modulation. The same step load is applied at 3 seconds of the motor run. The following figures show the torque output results under sine PWM and space vector PWM methods.

The motor is provided with a step load at 3 seconds. The speed is found to reduce marginally from 1500 rpm at 3 seconds and Torque is found to increase. The torque output is found to be with ripples.

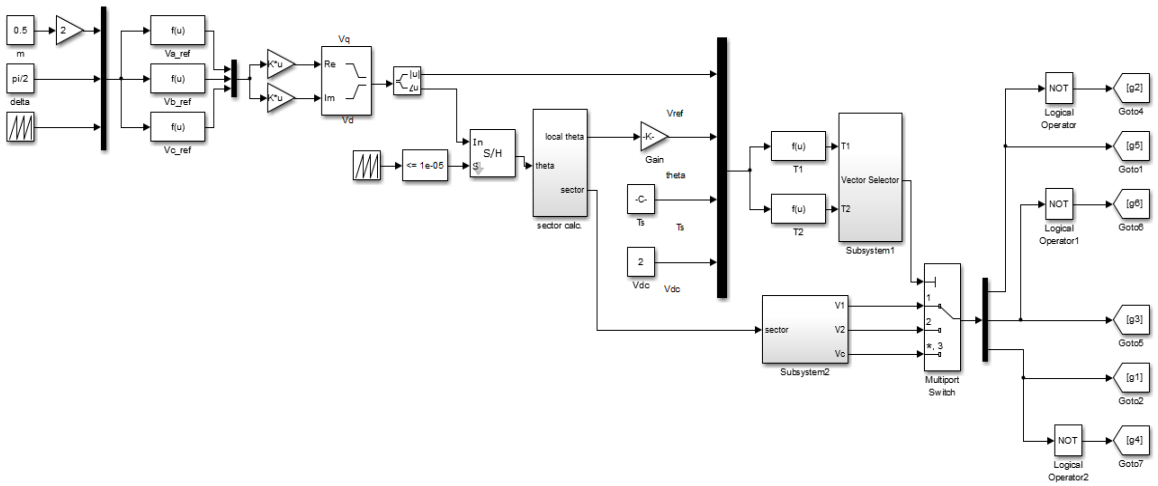
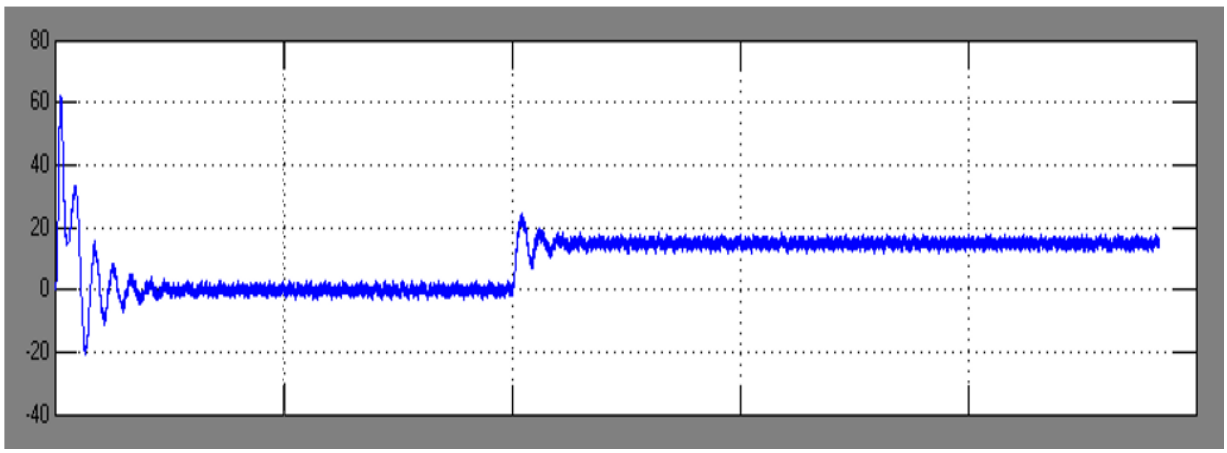


Fig 3: Space Vector PWM Simulink Block.

V. RESULT AND DISCUSSION

From the torque output it has been found that there has been a reduction of 30% ripple using space vector pwm method. The switching losses has been reduced under Space vector PWM compared to Sinusoidal PWM.



(a)

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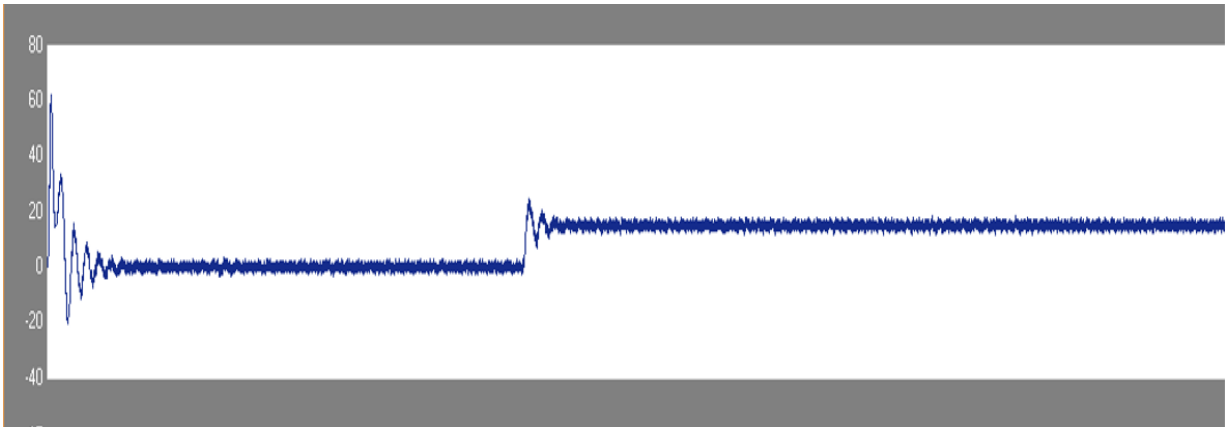

(b)

Fig 4: (a) torque ripple under sine PWM method (b) Torque ripple under space vector PWM method

VI.CONCLUSION

In this paper, Sine PWM and Space Vector PWM techniques have been observed and compared. During the observations, torque ripple phenomenon has been taken inti consideration. The simulation has been done using MATLAB tools. It has been observed that Space Vector PWM has showed superior performances due to less THD, greater PF and less switching losses because SVPWM utilizes advance computational switching technique to reduce THD. Space Vector PWM also reduces the switching losses because of the changing of any one switching state which results in one single phase voltage change every time. At high switching frequencies SVPWM gives better results as compared to SPWM. Thus, based on all the waveforms, we concluded that using SVPWM technique, there has been a reduction of 30% ripple using Space Vector PWM method.

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