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New Pulse Width Modulation Technique for Three Phase Induction Motor Drive

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***Abstract*— In this paper, various types of speed control methods for the three phase induction motor described. This paper explains speed control of three phase induction motor by means of v/f method. The IGBT (six in number) are used to form inverter to supply a,c .current to the motor. The space vector modulation (SVM) will be utilized as another alternative modulation technique which was known to be better than SPWM technique in certain areas. Space vector pulse width modulation (SVPWM) has become the successful technique to construct three phase sine wave voltage source Inverter (VSI) parallel to control three-phase motor using SVM method. The VSI have six leg for the three-phase induction motor, and eight switching sequence had been simulated in MATLAB/SIMULINK. The simulation result shows the feasibility of proposed modulation technique to drive three-phase induction motor.**

***Index Terms*— Induction Machine, Pulse width modulation (PWM), Sinusoidal PWM, SVM, Voltage Source Inverter.**

I. INTRODUCTION

The inverter is used to converter dc power into ac power at desired output voltage and frequency. The waveform of the output voltage depend on the switching state of the switches used in the inverter. Major limitation and requirement of inverter are harmonic content, the switching frequency and the best utilisation of the dc link voltage. Pulse width modulation (PWM) inverter is studied extensively during the past decades. In this method, a fixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the ON and OFF periods of the inverter component. The sinusoidal pulse-width modulation (SPWM) technique produces a sinusoidal waveform by filtering an output pulse waveform with varying width.[1]

A switching frequency leads to better filtered sinusoidal output waveform. The desired output voltage is achieved by varying the frequency and amplitude of a reference or modulating voltage. The variation in the amplitude and frequency of the reference voltage change the pulse-width patterns of the output voltage but keep the sinusoidal modulation. The most popular PWM technique is the sinusoidal PWM and space vector PWM. With the development of DSPs, space- vector modulation (SVM)become one of the most important PWM methods for three-phase voltage source inverter .In this technique ,space vector concept is used to compute the duty cycle of the switches. It is simply the digital implementation of PWM modulators. The most advance feature of the SVM is digital implementation and wide linear modulation range for output line-to-line voltage.[5]

II. PROPOSED BLOCK DIAGRAM

The main scope of this project is to design the space vector PWM technique for the speed control of induction motor. Model and study of its operation performance using Mat lab Simulink package. The control system for both rectifier and inverter is to be designed. The conventional methods of speed control of an induction motor were either too expensive or too inefficient thus restricting their application to only constant speed drives. However, modern trends and development of speed control methods of an induction motor have increased the use of induction motors in electrical drives extensively.

In this work three phase, 220V 50HZ supply is used as input source which is fed to the three phase controlled rectifier. The rectifier converts three phase AC supply to DC and is fed to three phase inverter. The three phase inverter converts DC supply to AC supply of desired magnitude and frequency and output of converter is used input to the AC motor drive SVM technique used to control the magnitude and frequency as per requirement of AC motor as shown below

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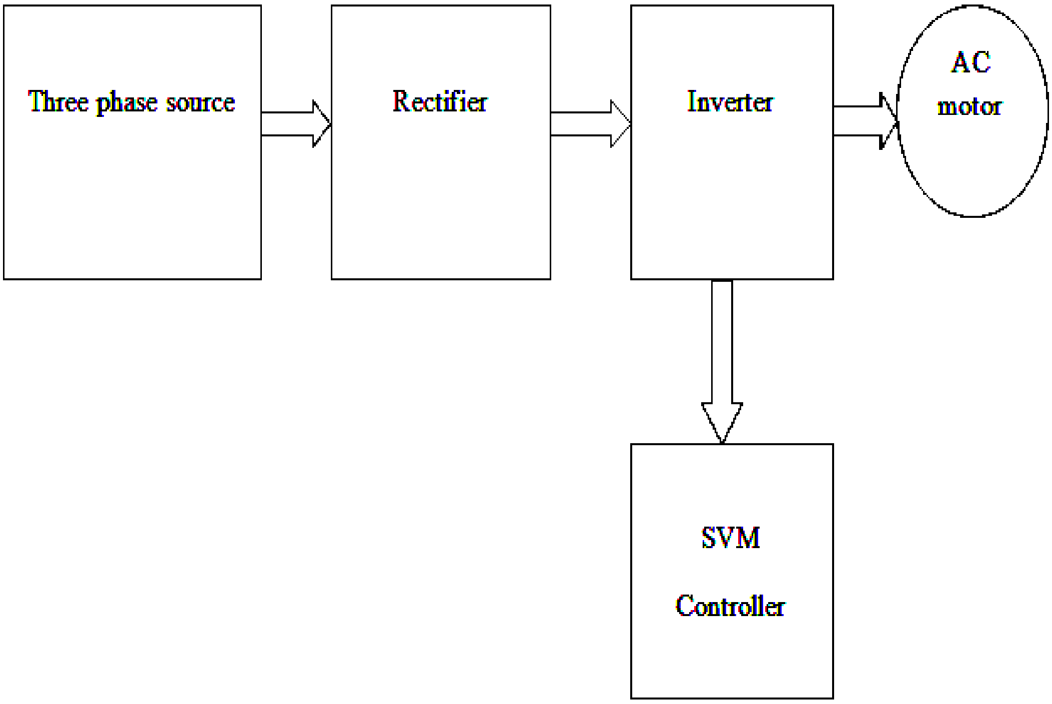

Fig2 General block diagram of SVM technique

This work overcome all the drawbacks on above three cases and ensure reliable and cost effective

III. SINUSOIDAL PULSE WIDTH MODULATION

The sinusoidal pulse-width modulation (SPWM) technique produces a sinusoidal waveform by filtering an output pulse waveform with varying width. A high switching frequency leads to a better filtered sinusoidal output waveform. The desired output voltage is achieved by varying the frequency and amplitude of a reference or modulating voltage. The variations in the amplitude and frequency of the reference voltage change the pulse-width patterns of the output voltage but keep the sinusoidal modulation. As shown in, a low-frequency sinusoidal modulating waveform is compared with a high-frequency triangular waveform, which is called the carrier waveform. The switching state is changed when the sine waveform intersects the triangular waveform.

The crossing positions determine the variable switching times between states. In three-phase SPWM, a triangular voltage waveform (VT) is compared with three sinusoidal control voltages (Va, Vb, and Vc), which are 120 out of phase with each other and the relative levels of the waveforms are used to control the switching of the devices in each phase leg of the inverter. A six-step inverter is composed of six switches S1 through S6 with each phase output connected to the middle of each inverter leg as shown in fig 3. The output of the comparators forms the control signals for the three legs of the inverter. Two switches in each phase make up one leg and open and close in a complementary fashion. That is, when one switch is open, the other is closed and vice-versa. The output pole voltages Vao, Vbo, and Vco of the inverter switch between –Vdc/2 and +Vdc/2 voltage levels where Vdc is the total DC voltage.[2]

The peak of the sine modulating waveform is always less than the peak of the triangle carrier voltage waveform. When the sinusoidal waveform is greater than the triangular waveform, the upper switch is turned on and the lower switch is turned off. Similarly, when the sinusoidal waveform is less than the triangular waveform, the upper switch is off and the lower switch is on. Depending on the switching states, either the positive or negative half DC bus voltage is applied to each phase. The switches are controlled in pairs ((S1; S4), (S3; S6) and (S5; S2)) and the logic for the switch control signals is

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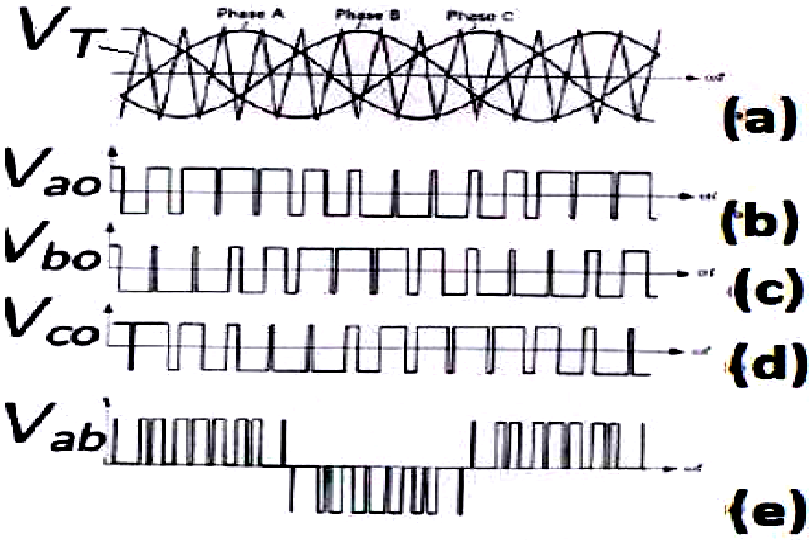

Fig 3 sinusoidal pulse width modulation

IV. SPACE VECTOR MODULATION

In Fig 4(a) the typical power stage of the three phase inverter and the equivalent circuit of a machine are presented. As shown in this figure, the voltages applied to machine is defined as Van,bn,cn and the VaN,bN,cN denote the pole voltages produced in the inverter stage in this paper. And, the available eight different switching states of the three phase inverter are depicted in the Fig 4(b). Note that all the machine terminals are connected to each other electrically and no effective voltages are applied to machine when the zero vectors presented by Vo and V7 are selected.

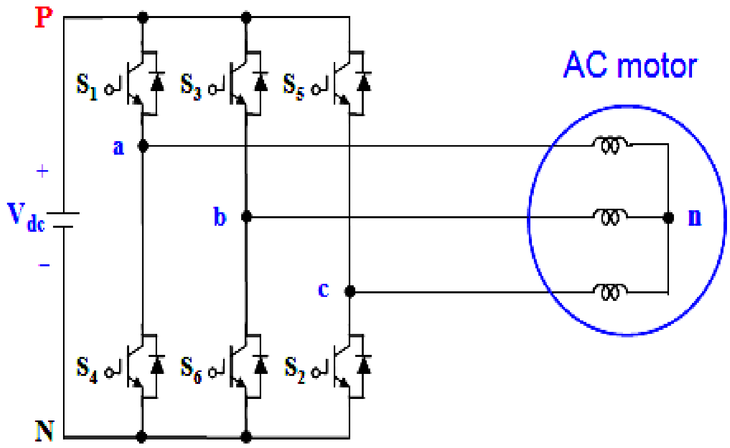

Fig4 (a) three-phase voltage source pwm Inverter

Therefore the six voltage vectors can be selected to apply an "effective voltage" to the machine and these vectors can be located on the vector space represented with the stator fixed d-q reference frame as shown in the fig 4(b). If a constant reference voltage vector V*or Vref is given in one sampling period, this vector can be generated using zero vector (V0 or V7) in combination with only two nearest active vectors (V[n] and V[n+1]). These two active vectors are considered as the effective vectors to generate desired output voltage. From the average voltage concept, the reference vector can be written as followings during one sampling period.

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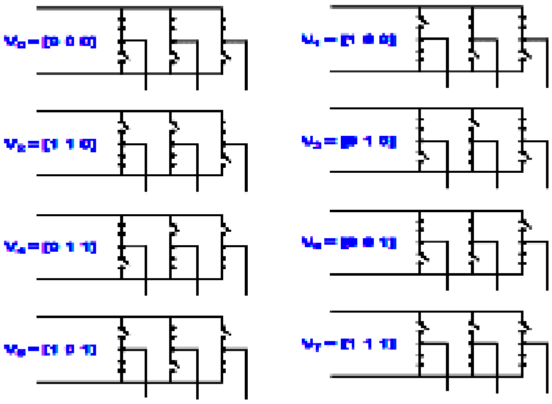


Fig.4.(b) Switching state diagram with Eight switching states

Sector	Upper Switching	Lower Switching
S_1	$S_1=T_1+T_2+T_0/2$ $S_3=T_2+T_0/2$ $S_5=T_0/5$	$S_4=T_0/2$ $S_6=T_1+T_0/2$ $S_2=T_1+T_2+T_0/2$
S_2	$S_1=T_1+T_0/2$ $S_3=T_1+T_2+T_0/2$ $S_5=T_0/2$	$S_4=T_0/2$ $S_6=T_1+T_0/2$ $S_2=T_1+T_2+T_0/2$
S_3	$S_1=T_0/2$ $S_3=T_1+T_2+T_0/2$ $S_5=T_2+T0/2$	$S_4= T_1+T2+T0/2$ $S_6=T_0/2$ $S_2=T_2+T_0/2$
S_4	$S_1=T_0/2$ $S_3=T_1+T_0/2$ $S_5= T_1+T_2+T0/2$	$S_4= T_1+T_2+T_0/2$ $S_6=T_0/2$ $S_2=T_0/2$
S_5	$S_1= T_2+T_0/2$ $S_3=T_0/2$ $S_5= T_1+T_2+T_0/2$	$S_4= T_1+T_0/2$ $S_6=T_1+T_2+T_0/2$ $S_2=T_0/2$
S_6	$S_1=T_1+T_2+T_0/2$ $S_3=T_0/2$ $S_5= T_1+T_0/2$	$S_4=T_0/2$ $S_6=T_1+T_2+T_0/2$ $S_2=T_2+T_0/2$

V* = (T1. Vn+ T2. Vn+1)/T3 ----------------------- (1)
(Where T1, T2 are the applied effective times corresponding to the active vectors.) And, the effective time can be deduced as

$$T1 = \frac{|V^*|.T_3}{V_{DC}.2/3} \cdot \frac{\sin(\pi/3-\alpha)}{\sin(\pi/3)} \quad \text{-------------------- (2)}$$

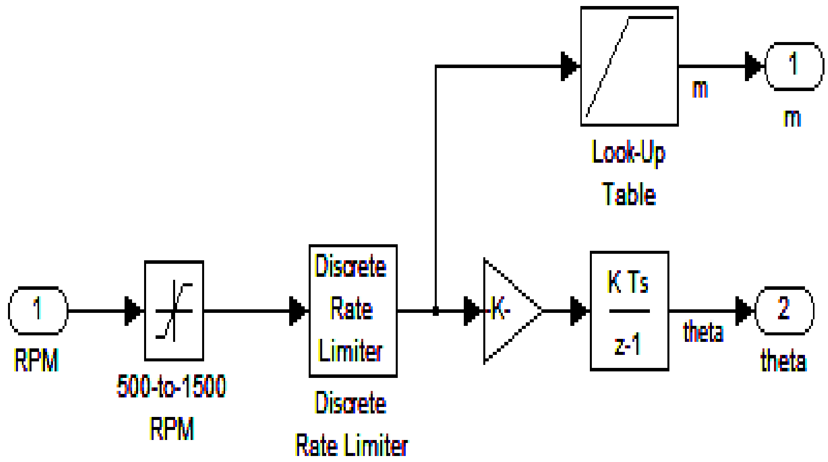
$$T_2 = \frac{|V^*|.T_3}{V_{DC}.2/3} \cdot \frac{\sin(\alpha)}{\sin(\pi/3)} \quad \text{------------------ (3)}$$

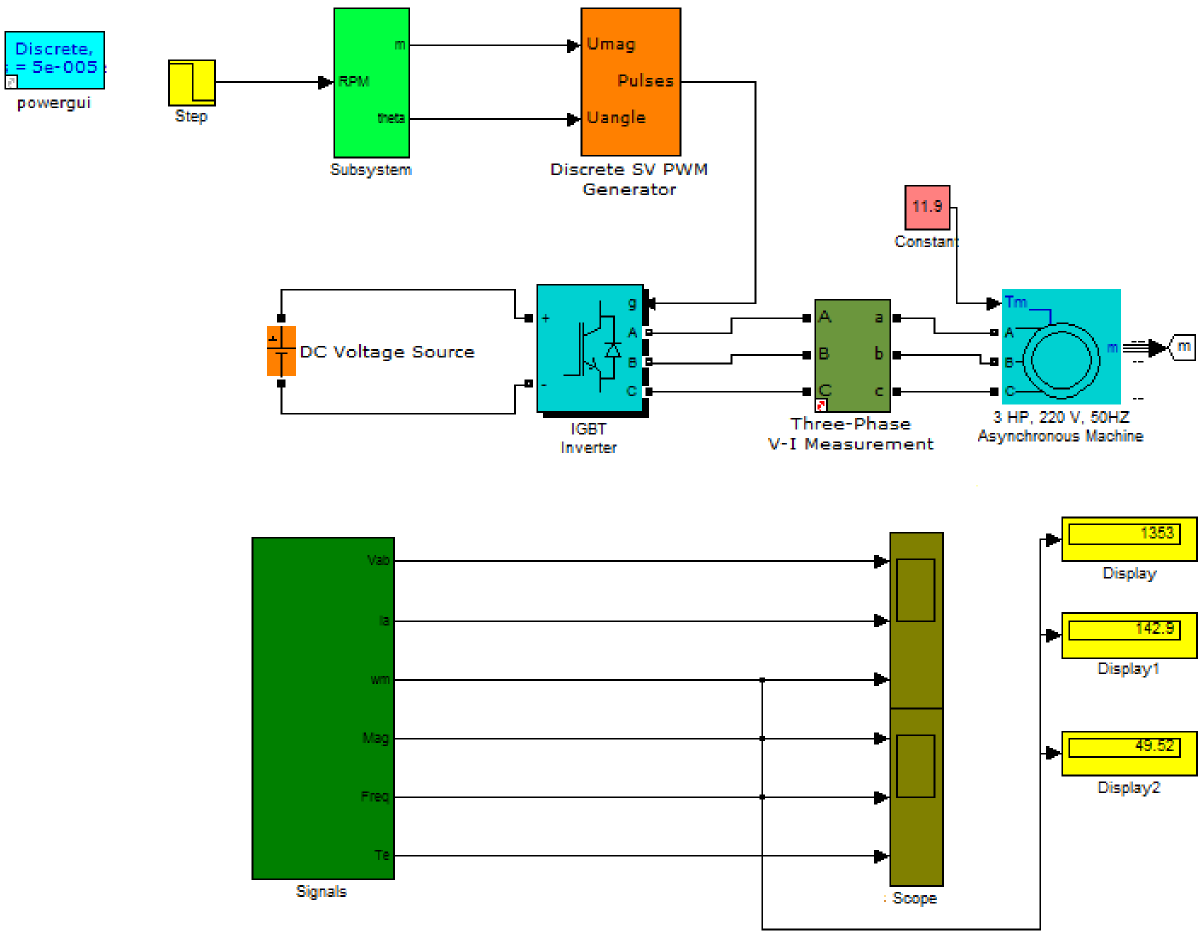
$$T_0 = T_3 - T_1 - T_2 \quad \text{------------------- (4)}$$

Where T0 is the time corresponding to null vector VDC is the DC linkage Voltage and T3 is sampling time.

V. SIMULATION MODEL

Controller design





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VI. RESULTS

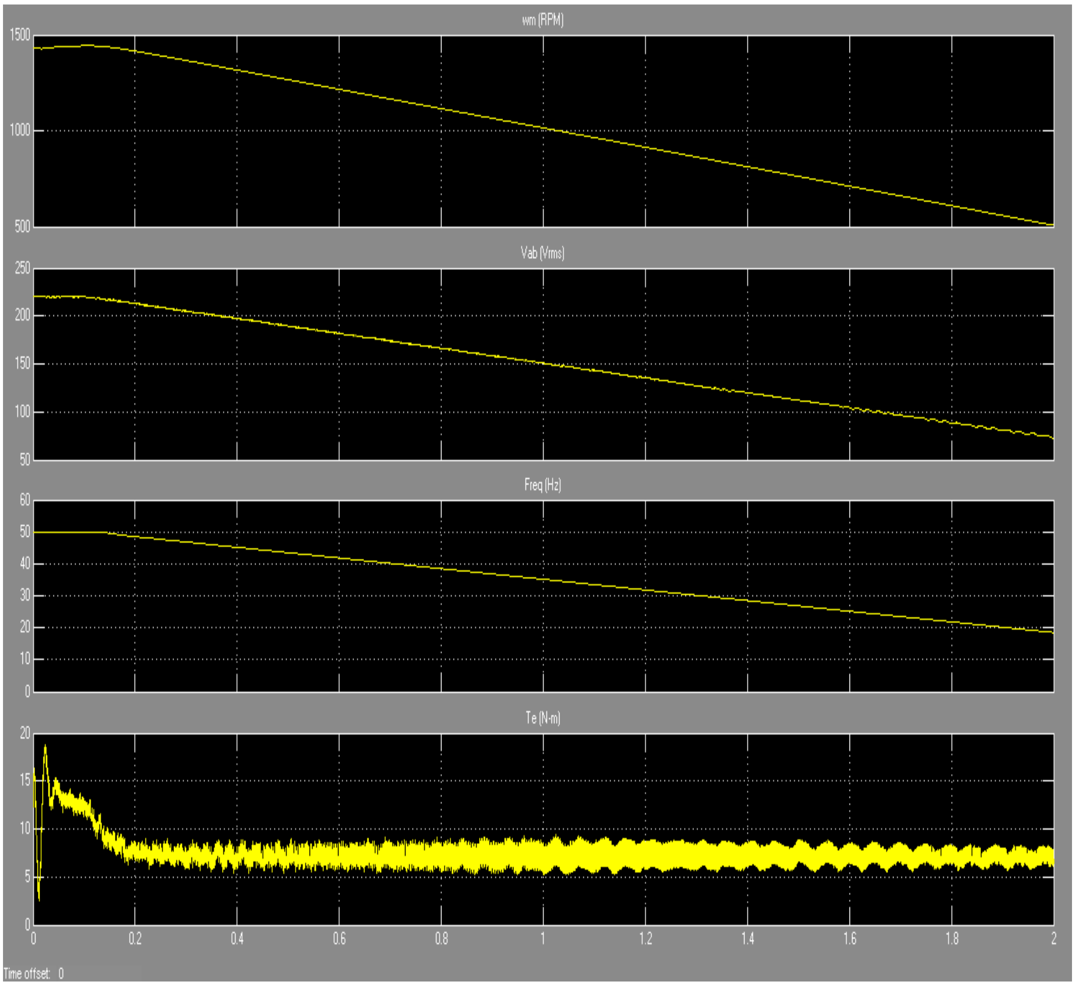

Fig 6.1speed, line voltage, frequency, toque

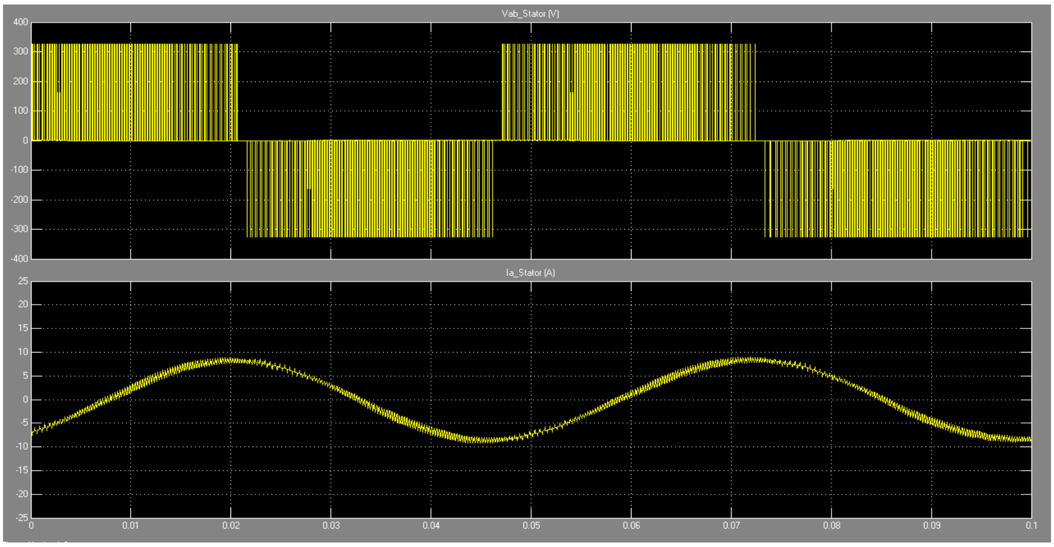

Fig6.2 line voltage, line current

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VII. CONCLUSION

A simple generalized Matlab/Simulink model is presented to implement SVPWM for a three phase VSI. In this work, a three-level inverter using space vector modulation strategy has been modeled and simulated. Through the simulations, it is confirmed that the proposed SVPWM technique, has good drive response to successive changes in speed reference and load torque. The results obtained by simulation show the feasibility of the proposed strategy.

VIII. FUTURE SCOPE

The same work can be carry out using other controllers like Fuzzy, Genetic algorithm etc

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