Three Phase Seven Level SVPWM Inverter Topology with Symmetrical DC-Voltage Sources with Fuzzy Controller

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Abstract - The least complex system received is parallel or series connection of conventional inverters to frame the multilevel inverter. More complex structures include embeddings inverter inside inverter to frame a multilevel inverter. Whatever approach is picked, the ensuing voltage or current rating of the multilevel inverter turns into a several of the individual switches thus that the power rating of the inverter can surpass the point of confinement forced by the individual switching devices. Pulse Width Modulation (PWM) of multilevel inverter is normally an expansion of two level inverters. The multilevel inverter enhances the AC power quality by playing out the power transformation in little voltage steps prompting lower harmonics. This work proposes a three phase seven level SVPWM inverter topology with symmetrical dc-voltage sources with fuzzy controller.

Keywords - Multi Level Inverter, DC Sources, Fuzzy Controller.

I. INTRODUCTION

Three phase voltage-fed PWM inverters are recently showing growing popularity for multi-megawatt industrial drive applications. The main reasons for this popularity are easy sharing of large voltage between the series devices and the improvement of the harmonic quality at the output as compared to a two level inverter. In the lower end of power, GTO devices are being replaced by IGBTs because of their rapid evolution in voltage and current ratings and higher switching frequency. The Space Vector Pulse Width Modulation of a seven level inverter provides the additional advantage of superior harmonic quality and larger under-modulation range that extends the modulation factor in Sinusoidal Pulse Width Modulation.

An adjustable speed drive (ASD) is a device used to provide continuous range process speed control (as compared to discrete speed control as in gearboxes or multi-speed motors). An ASD is capable of adjusting both speed and torque from an induction or synchronous motor. An electric ASD is an electrical system used to control motor speed. ASDs may be referred to by a variety of names, such as variable speed drives, adjustable frequency drives or variable frequency inverters. The latter two terms will only be used to refer to certain AC systems, as is often the practice, although some DC drives are also based on the principle of adjustable frequency.

Pulse Width Modulation variable speed drives are increasingly applied in many new industrial applications that require superior performance. Recently, developments in power electronics and semiconductor technology have lead improvements in power electronic systems. Hence, different circuit configurations namely multilevel inverters have become popular and considerable interest by researcher are given on them. Variable voltage and frequency supply to drives is invariably obtained from a three-phase voltage source inverter.

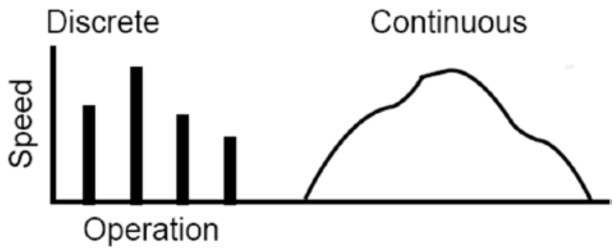

Figure 1.1 Process speed Control range.

A number of Pulse width modulation (PWM) schemes are used to obtain variable voltage and frequency supply. The most widely used PWM schemes for three-phase voltage source inverters are carrier-based sinusoidal PWM and space vector PWM (SVPWM). There is an increasing trend of using space vector PWM (SVPWM) because of their easier digital realization and better dc bus utilization.

II. SYSTEM MODEL

The basic structure of a multilevel power converter is formed by small discrete DC-voltage sources. The modulation strategies can be divided into two parts: Fundamental switching frequency and high switching frequency PWM. The latter part is the main focus in this chapter, because this is the part that is relevant for high voltage conversion.

Different PWM - approaches have the same goal: To reduce the THD of the current. Increasing the switching frequency reduces the lower-harmonics, which contributes to a lower THD, achieving the goal of a voltage output waveform with the requested rms values and frequency and a sinusoidal waveform resemblance.

Turning the switches ON and OFF creates pulses with the same amplitude but with different width. These pulses are generated in the output to replace the sinusoidal waveform [20]. The easiest way of creating this is by using a intersection method, ie comparison with a sawtooth/triangle waveform (carrier wave). When the reference wave (sinus) is larger than the triangular waveform, the PWM signal is switched ON (value: 1) and when it is smaller it is switched OFF (value: 0). (SVPWM) generates the appropriate gate drive waveform for each PWM cycle. The inverter is treated as one single unit and can combine different switching states (number of switching states depends on levels). The SVPWM provides unique switching time calculations for each of these states [6]. This technique can easily be changed to higher levels and works with all kinds of multilevel inverters (cascaded, capacitor clamped, diode clamped).

SVPWM also have good utilization of the DC link voltage, low current ripple and relative easy hardware implementation. Compared to the SPWM, the SVPWM has a 15% higher utilization ratio of the voltage [22][24]. This features makes it suitable for high voltage high power applications, such as renewable power generation. As the number of level increase the redundant switching states increases and also the complexity of selection of the switching states [7]. So, deciding which level is right for a certain application it is important to find a balance between losses and specification of the positioning of the reference vector.

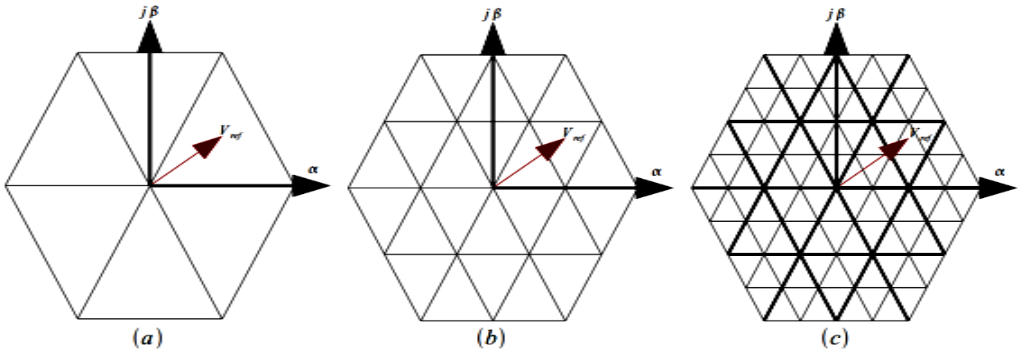

Figure 2.1 Space Vector diagram of a (a) two-level inverter (b) three-level inverter (c) five- level inverter.

III. PROPOSED MODEL

The Model of 7 level inverter is designed similarly as the five level and three level inverter model. The different here is the quantity of number of carrier signals. Here in this work for carrier signal has been taken. Two of them are connected over the positive half cycle of the modulation signal, staying two of them are connected over the negative half cycle of the modulation signal. From these signals eight PWM signals are produces and afterward given to the eight switches of a leg.

Fig. 3.1 Shows the block diagram of the system which consists main parts of the proposed system like suppy grid, transformer proposed methodology for system improvement which is 7-level SVPWM with frequency control.

Fig. 3.2 Shows the equivalent simulink model of the system shows in the block diagram of Fig. 3.1. It shows the each and every block of the simulation model which has been prepared using different parameters to acheive higher stability of the system. The 7-level controlling approach is connected in parallel to the transmission line. The proposed methodology circuit is shown in the Fig. 3.3.

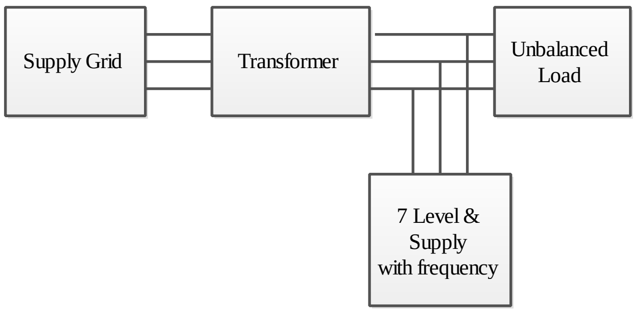

Fig. 3.1 Block Diagram of The Proposed System

Additionally the pulses are produced for remaining phases. The main contrast is that the modulating signal is phase shift by 120 degrees. Figure 3.3 demonstrates the model of a 7-level cascaded inverter. Which is being operated with the help of fuzzy logic controller and the reference is taken as dc voltage which will better to take compensate the unwanted changes in the system. The 7-level inverter circuit has the higher number of operation levels than the previous 3-level approach and this able to sense variations higher than the previous model and approach.

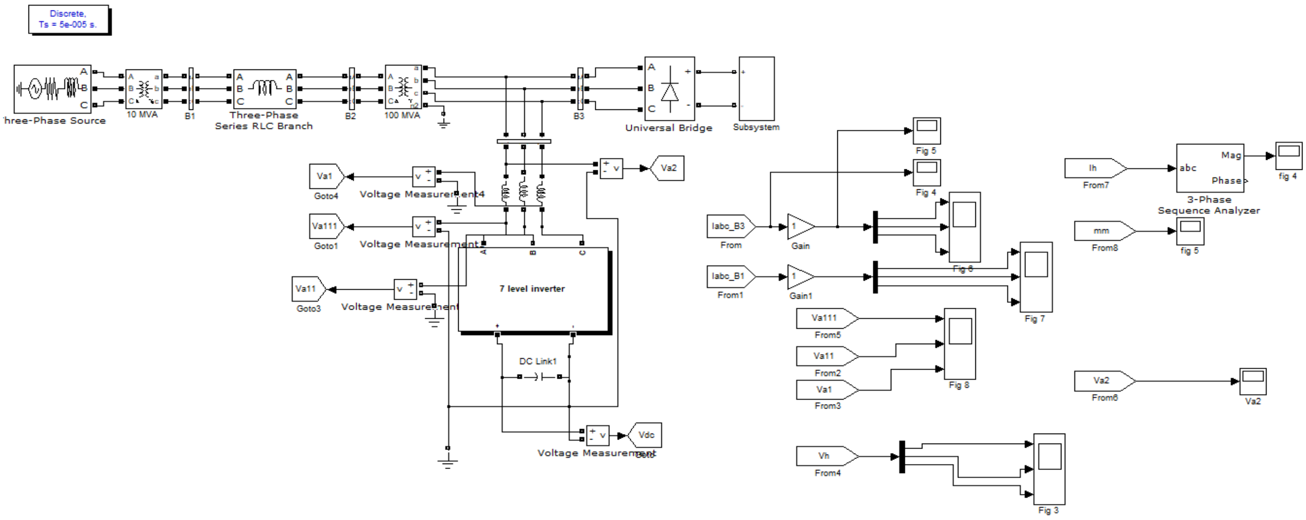

Figure 3.2 Proposed Simulink Model of Proposed System.

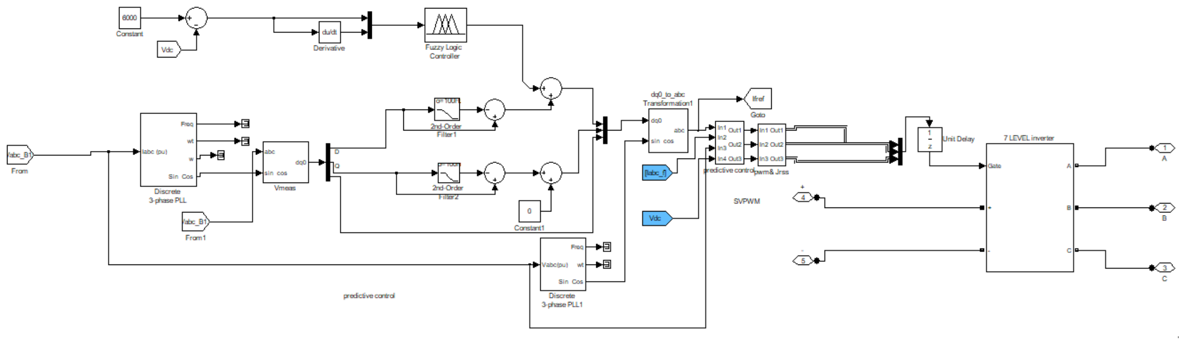

Figure 3.3 Proposed 7 Level Multilevel Inverter.

IV. SIMULATION OUTCOMES

The SVPWM Inverter model for seven level inverter is implemented on a Matlab Simulink simulation tool. The experiment outcome are shown for different modulation index covering diffeent layers of operation of seven level Symmetrical DC-Voltage Sources with Fuzzy Controller. Phase Voltage of the Proposed System has presented in figure 4.1 and Line Voltage of the Proposed Fuzzy Based Seven Level SVPWM System has been illustrated in figure 4.2.The waveform of load current has given in figure 4.3 Load Current of the Proposed Fuzzy Based Seven Level SVPWM System. Fig. 4.4 represents a Grid Current of the Proposed Fuzzy Based Seven Level SVPWM System. Fig. 4.5 represents the final outcome of Proposed Seven Level SVPWM Waveforms. The total harmonic distortion evaluated in proposed work is about to 3%. Total Harmonic Distortion is 3% of the Proposed Fuzzy Based Seven Level SVPWM System.

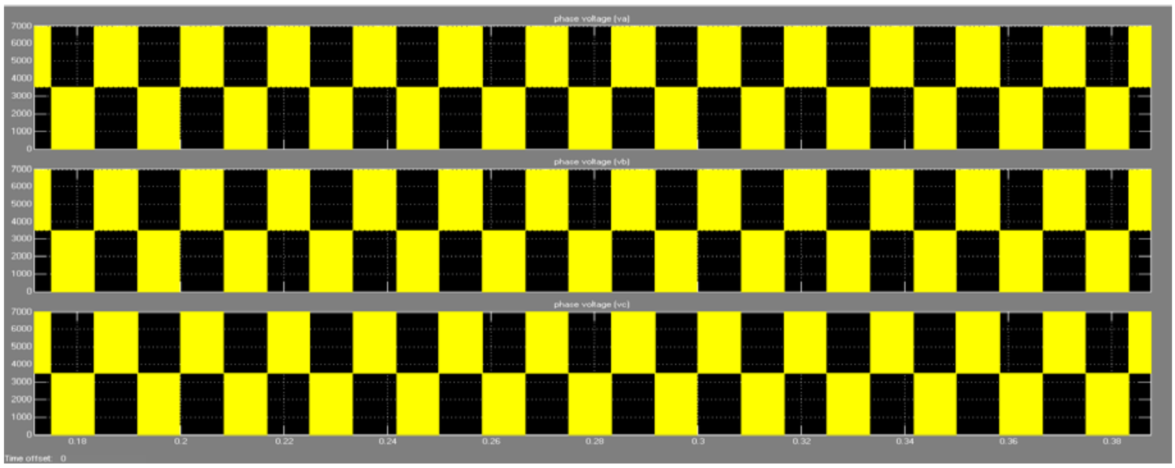

Fig.4.1 Phase Voltage of the Proposed System

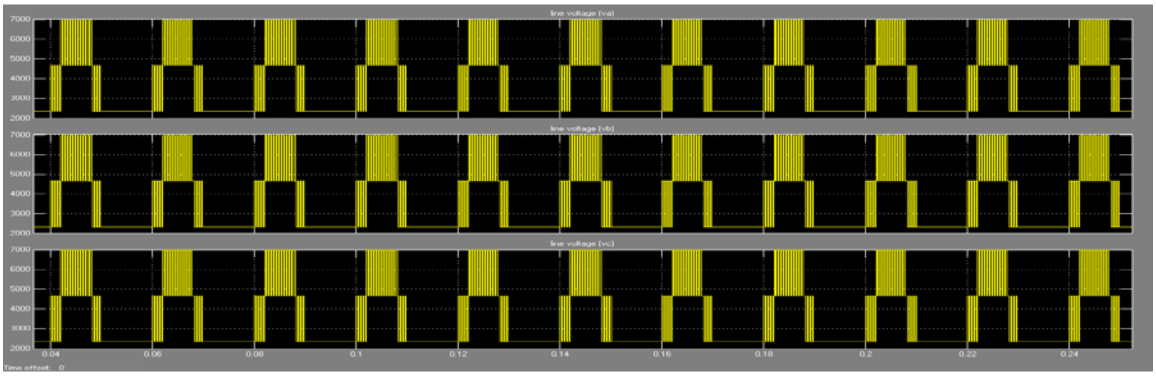

Fig. 4.2 Line Voltage of the Proposed Fuzzy Based Seven Level SVPWM System.

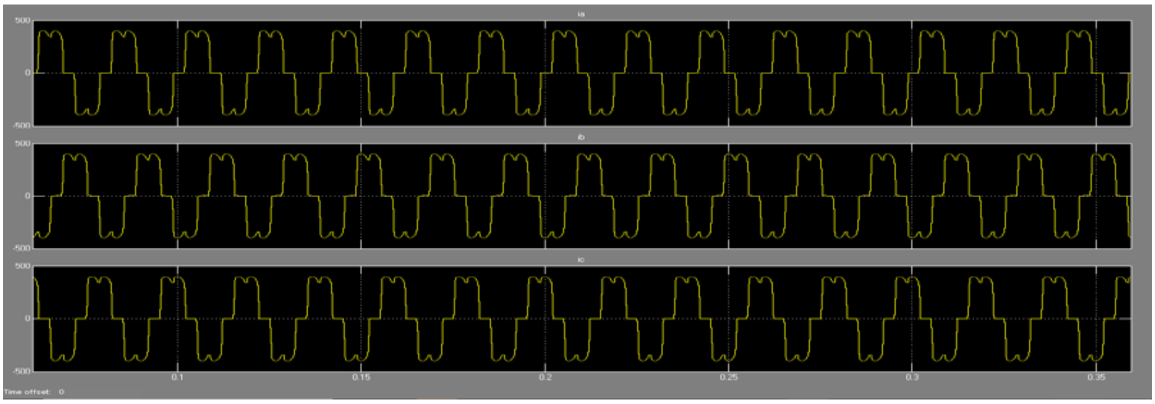

Fig.4.3 Load Current of the Proposed Fuzzy Based Seven Level SVPWM System.

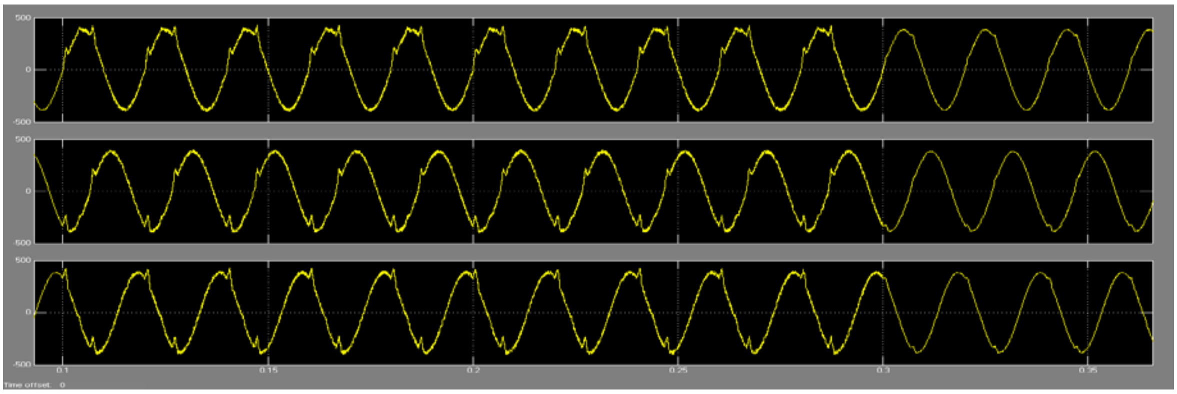

Fig. 4.4 Grid Current of the Proposed Fuzzy Based Seven Level SVPWM System.

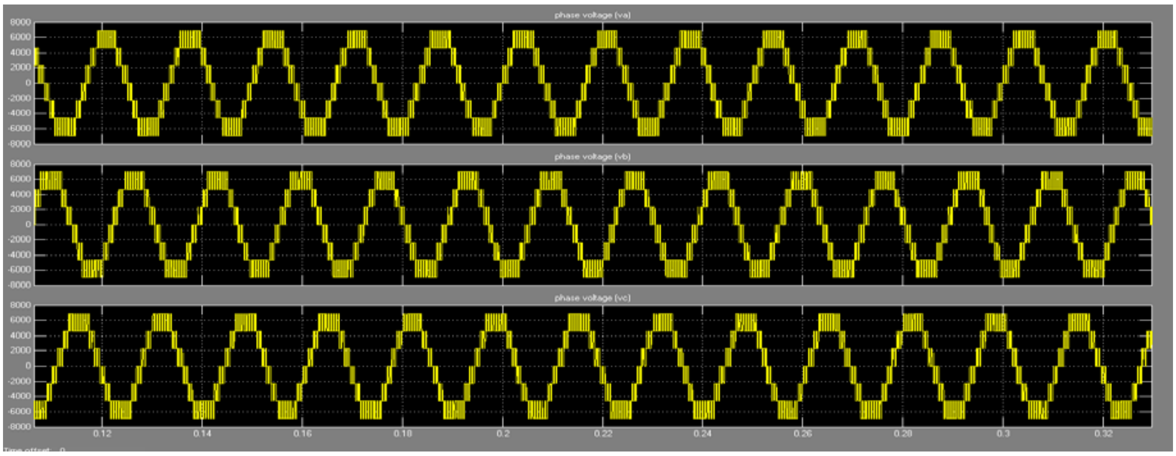

Fig. 4.5 Proposed Seven Level SVPWM Waveforms.

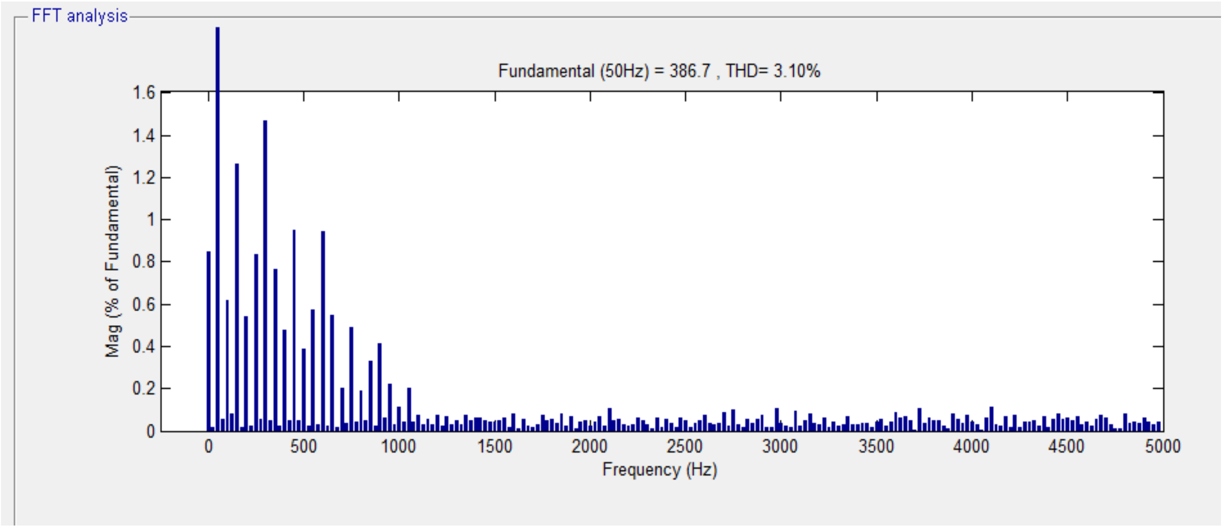

Fig. 4.6 Total Harmonic Distortion is 3% of the Proposed Fuzzy Based Seven Level SVPWM System.

V. CONCLUSION AND FUTURE SCOPES

The Pulse width modulation (PWM) techniques are progressively utilized today in inverter control for ac drives. PWM procedures are utilized to control both extent and frequency of the voltage connected to motors. Different PWM methods, control procedures for inverter, and execution of these systems are considered. PWM systems are utilized to decrease the harmonic substance and switching losses, the principle goal of PWM is to limit harmonics and acquire most extreme power. SVPWM Inverter Topology with Symmetrical DC-Voltage Sources with Fuzzy Controller technique for inverter provides a better result with the inverter as compared to the conventional SPWM. There is THD Total Harmonic Distortion is 3% of the Proposed Fuzzy Based Seven Level SVPWM System. In future there are lots of scope to Implementation of proposed work SVPWM using microcontroller for other control algorithm for motor control and industrial automation application.

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