

IMPROVING SLIDING MODE SPEED CONTROL OF PMSM DRIVES WITH REDUCED HARMONICS

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Abstract — In order to optimizing the speed control of performance in the PMSM systems with their different disturbances and an uncertainties of a nonlinear speed control algorithms for the PMSM servo systems using sliding mode controls and disturbance compensatated technique is developed in this paper. A sliding mode control methods based on one novel SMRL law is presented. This methods can be dynamically adapts to the variations of the controlled systems. This allows chattering reductions on the control input while maintaining the high tracking performance of the controllers. This method results in considerable suppressions of the harmonic currents comparing with the conventional full bridge type PWM inverter and to improve Total Harmonic Distortion. Simulation is an very high effective tools by it can experience with their practical results through the Simulink software. Hence, the Simulink part of the MATLAB is employed.

Index Terms — PMSM Drives, Sliding Mode Speed Control, THD, Neutral point clamped SVPWM

I. INTRODUCTION

The multilevel inverters have introduced by a solution of to increase the

converter operating voltages and above the voltage limits of classical semiconductors. One of the significance advantages of multilevel configurations is the harmonic reductions in the output waveform without the increasing switching frequency or decreasing the inverter power outputs. The output voltage waveforms is a multilevel inverters is composed by the number of levels of voltages, typically obtained from a capacitor voltage source. The multilevel inverter starts from a number of levels reach infinity, the output THD approaches to zero. The number of achieve voltage levels, is limited by voltage level unbalance conditions problem, voltage level clamping requirement circuits layouts, and packaging constraints. Multilevel inverters synthesis of a large number of levels have been a lot of merits such as improved by output waveforms, a smallest filter size, a lower EMI and other advantages. The advantages of using multilevel inverters is the low power harmonic distortions obtains due to the multiple voltage level at the output and reduced their stresses on the switching devices used.

Numerous industrial applications having to require a highest power apparatus in the recent years of a multilevel power converter structures has been introduced as an alternative in high power and medium

voltage situations. To keep the power parts simple and the high efficiency the sub inverters have a non feeding from the net and can only supply reactive powers. But the non supplied intermediate circuit capacitors form unstable systems [1]. A cascaded H bridge multilevel boost inverter designs for EV and HEV applications implements without the use of inductors was proposed. Traditionally, each H bridge needs to a dc power supply.

A fundamental switching scheme method is used to demodulation control and to produces a five phase level voltage. In additions a new promising topologies and to recent advance methods made in a modulation and controls of a multilevel converters are also addressed [2, 3]. Five and seven level HNPC topologies loss balancing features is presented. A three phase five levels ANPC inverter is a prototype is built up and both steady and dynamic experimental results is presented to a verify the validity of this method.

By calculating the average NP current of all key zero sequence voltages, the most appropriate zero sequence voltage is selected to generates the demanded NP current, which can be also limits the switching frequency of the series connected insulated gate bipolar transistor to the fundamental frequency [4, 5]. Also an automatic switching patterns generation for multilevel cascaded H-Bridge inverters with equal dc voltage source based on their Space Vector Pulse Width Modulation (SVPWM) technique [6]. Moreover abundant modulation technique and control paradigms have been developed for as multilevel

converters such as a Sinusoidal Pulse Width Modulation (SPWM), Selective Harmonic Elimination Pulse Width Modulation (SHE - PWM), Space Vector Modulation (SVM).

In addition many multilevel converter applications focused on industrial medium voltage motor drive utility interface for a renewable energy system, flexible AC transmission systems (FACTS), and a traction drive systems. The multilevel converters proposed in this project are based on the cascaded interconnections of a 3L - ANPC converter and individual H-bridge for each phase. The seven bridge level output is obtained from the inverter. Inverter output is step up and given to as an input to the asynchronous machine.

II. EXISTING METHOD OF SPEED CONTROL

In the existing multilevel converters cascaded in interconnection of a 3Level converter and individual H-bridge for each phase have been used. The three levels based neutral point clamped converters are the most widely used in industrial applications. The three levels an active can deal with their uneven distributions of semiconductor loss inherent to the NPC converter. The active switch provide redundant in the zero voltage level switching state that can be selected through the appropriate modulation process.

Hence they are widely used in applications such as motor drives, advanced static compensators, HVDC transmissions, and grid connected photovoltaic system. The hybrid cascaded converters with H bridge

cell have been proposed to eliminate the need for individual dc sources for every converters stage and extend the number of levels. A topology based on the cascaded interconnection of a two level inverters with individual H-bridge cells for each phase is used with selective harmonic eliminations PWM (SHE-PWM) offers the potential for improved waveforms quality compared to the other existing modulation technique but their total harmonic distortion (THD) is more.

The modulation techniques are mostly used the sinusoidal pulse width modulation, selective harmonics elimination and space vector techniques. The multilevel SHE-PWM used in the seven levels converter to eliminate the lower order harmonics and it can be used only for the low power applications. Hence the proposed system the space vector techniques is used to reducing harmonic content in the output load current and voltage waveform. SVPWM also improves the Total Harmonic Distortions (THD).

III. PROPOSED PMSM DRIVE

In order to optimizing the speed control of the permanent magnet synchronous motor (PMSM) systems with a different disturbances and uncertainty, a nonlinear speed control algorithm for the PMSM servo systems using sliding mode control and disturbance mode compensation techniques is developed in this proposed techniques. A sliding mode control method based on one novel Sliding Mode Reaching Law (SMRL) is presented. This SMRL can dynamically adapt to the variations of the

controlled systems allow the chattering reduction control input while maintaining the high tracking performance of the controllers. The main objective of neutral points clamped SVPWM inverter have voltage waveform that results is a considerable suppression of their harmonic currents comparing with the conventional full bridge type of PWM inverters and to improves THD.

The DC input is the converts into the AC outputs using their proposed multilevel converter which is controlled by the using SVPWM techniques to fed PMSM. Simulation is an effective tool by which it can experience the practical result through the simulink software. Therefore process using a number of simulation software's available and the most efficient tool is the PMSM Drive. Hence, the simulink part of the MATLAB is employed.

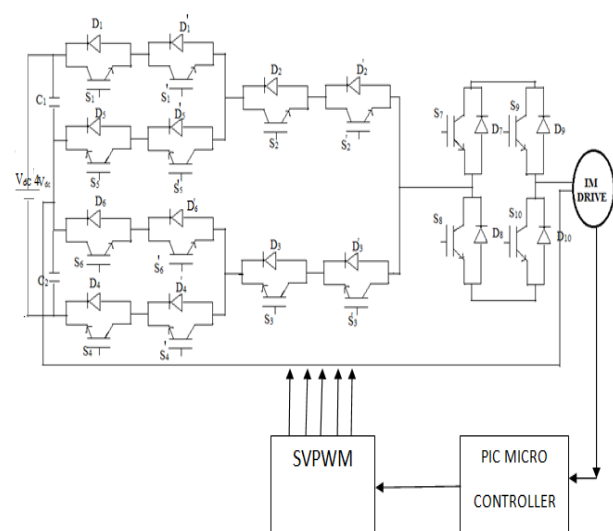


Fig.1 Circuit diagram of proposed motor drive

The block diagram of the proposed system is shown in fig.1. 230V AC supply is given to the step down transformer. The

voltage is stepped down to 12Volts. This is given to the diode rectifier it which converts to the voltage into 12Volts DC pulses. The hybrid cascaded seven level inverter converts to 12V DC supply into 12V AC supply is given to the step up transformer. The regulator regulates the voltage from 12V to 5VDC supply which is given to the microcontroller. The PIC microcontroller helps to give the gate pulses to the inverter. The inverter converts to an AC to DC, which is given to the single phase induction motor.

Bridge rectifier provides the output voltages for both positive negative cycles. The input voltage is applied to across diagonally opposite ends of the bridge and desired load is connected to across the other two ends of the bridges. During the positive half cycles, diodes D_2 and D_4 are forward biased whereas D_1 and D_3 are reverse biased. For negative half cycles D_1 and D_3 conducts. The current through the load flows in the same direction for both positive and negative half cycles, therefore a dc voltage is obtained. The main advantage of Diode bridge rectifier is that it does not requires a centre tapped transformer and the output of rectifier is twice that of centre tapped rectifier.

IV. CONTROL OF SVPWM

The Space vector PWM method is an attractive alternative to the classic multilevel pulse width modulation technique considering as the following aspects, mainly, minimization of voltage and current Total Harmonic Distortion (THD), extension range of linear operations; and least number

of commutations. To solve the problems of computational complexity in multilevel inverters due to the large number of space vectors and redundant switching states, a simple and general space vector PWM algorithm is proposed. Based on these algorithms, the location of the reference voltage vectors can be easily determined and the calculation of swell times becomes a very simple. The typical method of seven-level multilevel inverter is shown in Fig. 3.1, where as a separate dc power supply is used for each Bridge.

Its corresponding space voltage vector diagram is illustrated in Fig.2 in which the vectors for the 3, 5, and 7- level inverters are also illustrated. For the 7-level inverter, there are 216 small triangles and the vertex of each triangle represents a space vector. The hexagonal vectors can be divided into six major triangular sectors (I to VI).

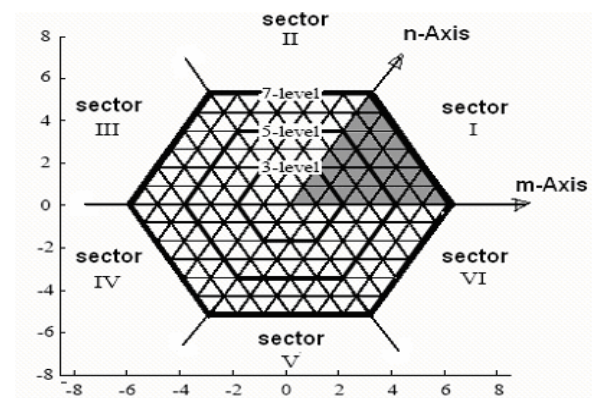


Fig.2 Voltage vectors of 3,5 and 7-level voltage source

V. SIMULATION & RESULTS

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and

programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language.

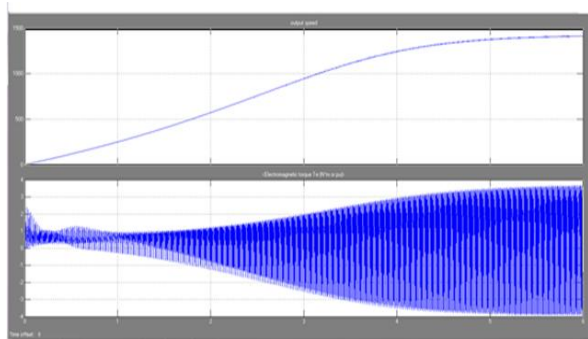


Fig.3 Wave form of speed and torque Characteristics

Simulink is an extension of MATLAB by Math works Inc. It works with to offer modeling, simulating, and analyzing of dynamical systems under a graphical user interface (GUI) environment. The construction of a model is simplified with click-and-drag mouse operations. Simulink includes a comprehensive block library of toolboxes for both linear and nonlinear analyses. Models are hierarchical, which allow using both top-down and bottom-up approaches. As Simulink is an integral part of MATLAB, it is easy to switch back and forth during the analysis process and thus, the user may take full advantage of features offered in both environments. This tutorial presents the basic features of Simulink and

is focused on control systems as it has been written for students in my control

VI. CONCLUSION

This project analyses, a new single phase seven-level inverter topology. The seven level inverter uses the cascaded interconnection of a 3L-ANPC converter and individual H-bridges for each phase with SVPWM is proposed. This method has the advantage of improving the total harmonic distortion over other PWM methods. Also this technique features easy implementation and more importantly, minimum harmonic content in the inverter output voltage and current of the Induction Motor Load.. The MOSFET is used for switching purpose, has the special features of high switching speed, easy drive applications. The optocoupler is used for providing isolation between the PIC microcontroller and inverter circuit and protects microcontroller from reverse voltage from the inverter. Thus the configuration proposed has been analyzed and experimentally verified by running a single phase induction motor.

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