Sinusoidal Pulse Width Modulation Based Speed Control of Induction Motor using Fifteen Level Diode Clamped Multilevel Inverter

S.Sumathi, C.Bhavani

Abstract: The main purpose of this work is to use a fifteen-stage diode clamped multi-level inverter that is able to control the speed of an induction motor. To get reduced synchronization and high quality sine curve output voltage. The proposed plan for the diode clamped multilevel inverter is controlled using multicarrier SPWM control. An open circle speed control can be accomplished by utilizing the V/f strategy. This strategy can be executed by changing the recurrence utilized in the three-stage induction motor at the stock voltage and the consistent rate. The proposed system, which results in a poor driver performance, is a useful alternative to the conventional method with high transient losses. Simulation depicts an improved drive performance by reducing the Total Harmonic Distortion resulting from the simulation and effectively controlling the motor speed.

Keyword: This strategy can be executed by changing the recurrence utilized in the three-stage induction motor at the stock voltage and the consistent rate.

I. INTRODUCTION

The main area of work is the industrial motor, where a trigger motor is positioned in the outer part of the station, with the air spaced carefully between the two inside and one rotor. Almost all electrical engines use magnetic rotation to spin their rotors. A single phase induction motor is the type of rotating magnetic because the source of the input source is usually created. DC motors rely on getting into mechanical or electronic steering to create rotating magnetic fields.

There is no direct approach to restoring controlled outputs from ordered entries. So it needs to generate output control data accordingly. This is obtained by a two phase transition tripartite where the current and torque output equal currents are obtained. The machine is valid only in the equilibrium position state. In adjustable speed drives, the device usually An element is formed in a feedback, so its transient behavior is being taken into account. Besides, for such astronauts, the high efficiency of control is based on the dynamic d-k model of the engine. Therefore, we go to the d-Q model for the principle of space biology. Derivative equations can describe the time-machine model, and require mutual inductance: but such a model tends to be more complicated.

Keywords: This strategy can be executed by changing the recurrence utilized in the three-stage induction motor at the stock voltage and the consistent rate.

II. LITERATURE SURVEY

Still, the country faces a huge gap between its energy generation and its needs. About two-thirds of villages are electrified due to geographical and economic factors. Solar PV technology due to the installation costs and losses, eliminating workplace can create the potential for a large through innovation [2] attractive methods of these power quality problems in order to solve an alternative drive system in this paper exercise proposed standard volt / matrix converters with induction motors.

Matrix Converters are a relatively new to develop AC voltage controllers that provide output voltage to control the undesirable power at the input as well as the uncontrolled event while maintaining output [3]. Therefore a heavy DC connection capacitor may otherwise avoid the need for a conventional drive system [4] except that the AC serves as a stand-alone induction motor drive concession for converting the AC to an advanced power-quality drive. This paper has proposed an alternative matrix converter (MC) based driving method so that power quality issues that are associated with conventional VSDs [5] can be solved.

Notwithstanding improving the source side force quality, single stage AC additionally uncovers the upsides of AC transformation, for example, grid converter-driven induction motor drives, dispensing with the requirement for about vitality sparing components, directional and decrease [6].
The hierarchical inverter has 24 sections independently of the load type of batteries. The motor phase on novel, rated DC voltage rates. For constantly shifting stream, and torque transition control (DTFC) [11]. This MPC strategy depends on novel, standard DTFC strategies from the force (three stage inverter) point of view instead of utilizing a solitary voltage vector with control quantifies over a total testing time of the controller.

III. PROPOSED SYSTEM

Multilevel inverters are an alternative to moderate voltage applications. Inverters are symmetric and asymmetric topologies within the kind of time. Asymmetric inverters have different DC voltage values. 3n = 15 positions of different cells (reversed by N = 5) is the most common localization when the cascade arrangement is implemented in DC voltage multiplier without obtaining an AC voltagehis topology yields a low harmonic, at < 3%. However, this is a neglected disadvantage in the presence of some regeneration independently of the load type of inverters, which is high quality voltage. This phenomenon modulation technique (near-level modulation) is the reason this inverter is used. In this work, an asymmetric 15 level inverter is provided. Some of the capacity batteries - from inverter reloading to power flow - are designed to avoid this inverter regeneration problem. This is obtained by obtaining the imaging angles corresponding to the power cells considering a minimum load voltage THD. Finally, a power flow analysis is accomplished and the simulated results show the possibility of this approach.

Figure 1 Proposed system block diagram

The step-by-step inverter module is a three-stage induction motor shown in Fig.1. The whole system consists of two sections; a power circuit and a control circuit. The power section features a power rectifier, filter capacitor, and three-phase diode hierarchical inverter. The motor phase inverter is connected.

The three stage diode connect amends the DC yield voltage over the capacitor channel. A capacitor channel expels the wave substance to display the DC yield voltage. Three-stage inverter with unaludated DC voltage capacitor channel is utilized. The hierarchical inverter has 24 masked switches controlled from the DC input voltage to generate an output AC voltage. The gate drive circuit consists mainly of the control system of the proposed system. Here the Multicarrier PWM technique is used to produce gate pulses for IGBT switches. The output AC voltage step is obtained by controlling both the inverter level and the frequency (V / f open loop control). Controlled output AC voltage induction motor drive. When the power is on the switches, the current reaches the motor DC bus flows. Motor circuits are very comparative in nature; They hold electrical energy in their current form. Since the switches are off, these current requirements must be degraded.

When switching off the switches are associated with diodes throughout to give a path to the current to exit. These dipoles are additionally called uniaxial diodes. The V/f control framework permits the client to control the speed of an induction motor at various rates. For constantly shifting velocity activity, the yield frequency of the various leveled inverter must differ. The voltage to the motor should likewise differ with the direct proportion of the frequency of supply to keep up the motor stream.

Equivalent Circuit

Figure 2 : phase equivalent circuit of induction motor

The various power expressions from the equivalent circuit diagram can be written as follows:

\[ P_{o} = P_{g} - P_{r} \]

\[ P_{r} = \frac{R_{r}}{S} I_{r}^{2} \ldots (2) \]

Since the output power is the product of developed torque \( T_{e} \) and speed \( \omega_{m} \), \( T_{e} \) can be expressed as

\[ T_{e} = \frac{P_{o}}{\omega_{m}} \ldots (3) \]

\[ T_{e} = \frac{3}{2} I_{r}^{2} R_{r} \left( \frac{1 - s}{s} \right) = \frac{3 P_{o}}{2} \frac{I_{r}^{2}}{R_{r} \omega_{m}} \ldots (4) \]
From the equivalent circuit, as shown in FIG. 4, where the core loss resistor $R_m$ has been deleted and the magnetizing inductance $L_m$ has been transferred to the input, an approximate equivalent circuit can be obtained. This approximation is reasonable easy for a full horsepower machine,

$$(R_e + j \omega L_{is}) \ll \omega L_m \quad \ldots (5)$$

The performance prediction by the simplified circuit typically varies within 5 percent.

**Vector control method**

An extremely straightforward and practical strategy for speed control is to change the stator voltage at a consistent force frequency. The three-stage stator voltage at line frequency can be controlled by controlling the switches in the inverter. It tends to be seen from this equation that the created torque is corresponding to the square of the speed.

IV. **RESULT AND DISCUSSION**

MATLAB (Matrix Lab) is a multi-paradigm numerical computing environment. A proprietary programming language developed by Math Works, MATLAB allows matrix operations, functions and data, implements algorithms, creates user interfaces, interfaces with other languages, including C, C++ program plots, they create dynamic Simulink model systems and Based on power electronics model.

![Figure 3 Matlab Simulink for development of sr motor using Neuro Fuzzy logic algorithm](image)

The figure 3 shows the Simulink model of SR motor using fuzzy logic algorithm. The Motor torque ripples are reduced using Instantaneous direct torque control technique.

![Figure 4 Matlab simulink for development of sr motor using Fuzzy logic algorithm](image)

The figure 4 shows the simulink model of SR motor using fuzzy logic algorithm. The Motor torque ripples are reduced using Instantaneous direct torque control technique.

![Figure 5 Matlab simulink for development of sr motor using PI controller](image)

The figure 5 shows the Simulink model of SR motor using PI controller algorithm. The Motor torque ripples are reduced using Instantaneous direct torque control technique.

![Figure 6 Input voltage waveform to the BR converter](image)

Figure 6 shows the input voltage to the BR converter, the 350v is applied to the BR converter. It will convert the DC voltage into AC voltage. This voltage is then fed to the four phase SR motor.
Sinusoidal Pulse Width Modulation Based Speed Control of Induction Motor using Fifteen Level Diode Clamped Multilevel Inverter

![PWM pulses to the BR converter](image1)

**Figure 7** PWM pulses to the BR converter

The figure 7 shows the PWM pulses to the BR converter. The pulses are produced using Direct instantaneous torque control. The switching frequency of the pulses is 25KHz.

![Motor current waveform](image2)

**Figure 8** Motor current waveform

The figure 8 shows the current waveform of the SR motor. The motor initially taking high current due to nature of material. Also its having higher order ripple currents, this causes to produce noise in the torque waveform.

![Motor torque waveform](image3)

**Figure 9** Motor torque waveform

The figure 9 shows the SR motor torque waveform, due to the current ripples in SR motor high torque ripples are produced.

![Motor speed waveform using PI controller](image4)

**Figure 10** Motor speed waveform using PI controller

The figure 10 shows the speed waveform of the SR Motor using PI controller, but the PI controller induces noises in the speed due to maximum peak overshoot problem.

![Motor speed waveform using Neuro fuzzy logic controller](image5)

**Figure 11** Motor speed waveform using Neuro fuzzy logic controller

The figure 11 shows the SR motor speed waveform using Neuro fuzzy logic controller. The neuro fuzzy logic controller reduces the speed oscillation in the motor waveform. Also settling time is very less compared to the PI controller.

![Motor speed and torque waveform using Neuro fuzzy logic controller](image6)

**Figure 12** Motor speed and torque waveform using Neuro fuzzy logic controller

The figure 12 shows the motor torque waveform of the SR motor. The NF controller reduces the torque ripples also. Its coming only 1.7 Nm torque ripples.
A combined or etch ILIPPE. “Comparative analysis of Pulse Width, 2016, “Improved Torque x control of induction motors”, 2016, “Neural Network SVPWM Direct Torque Controlled Space Vector Modulated. Using predictive control, Seron Graham C. Goodwin, “

Retrieval Number: D1902029420

method. This method can be implemented by changing the
loop speed control can be achieved by using the V / ƒ
hierarchical inverter multicarrier SPWM control. An open
curve output voltage. The proposed scheme for the diode is
inverter that is able to control the speed of an induction
work is to use a fifteen stage diode clamped multi level
controller, this PI controller produces oscillation in the speed waveform at both hysteresis as well as IDTC torque control technique. In PI controller its showing 1.8 Nm torque ripples.

Figure 13 Motor speed and torque waveform using PI controller

The figure 13 shows the motor speed and torque waveform using PI controller, this PI controller produces oscillation in the speed waveform at both hysteresis as well as IDTC torque control technique. In PI controller its showing 1.8 Nm torque ripples.

Figure 14 Motor speed and torque waveform using fuzzy logic controller

The 14 shows the motor speed and torque waveform using fuzzy logic controller, this fuzzy logic controller reduce the speed oscillation, because fuzzy is the self-tuning method. In fuzzy the torque ripples comes to 1.75 Nm.

V. CONCLUSION

In this work a diode clamped The main purpose of this work is to use a fifteen-stage diode clamped multi level inverter that is able to control the speed of an induction motor. To get reduced synchronization and high quality sine curve output voltage. The proposed scheme for the diode is hierarchical inverter multicarrier SPWM control. An open loop speed control can be achieved by using the V / f method. This method can be implemented by changing the frequency used in the three-phase induction motor at the supply voltage and the constant rate. The proposed system, which results in a poor driver performance, is a useful alternative to the conventional method with high transient losses. Simulation depicts an improved drive performance by reducing the Total Harmonic Distortion resulting from the simulation and effectively controlling the motor speed. The drive system can be energy-saving boiler feed pump conveyors, rolling mills, printing machines, etc. used in variable torque load applications.

REFERENCES

1. SHUKLA, S., PRAVEEN, H., & SINGH, B. “Flux optimization of PV fed induction motor drive with ANN based current control for water pumping”, IEEMA Engineer Infinite Conference (etch Next). Page s: 1 – 6. 2018
2. MIR, T. N., & BRAT, A. H. “Comparative analysis of Pulse Width Modulated Voltage Source Inverter fed induction motor drive and Matrix Converter fed induction motor drive”, international Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES). Page s: 1 – 6. 2018
3. DAVARI, S. A., & ARAB KHABURLI, D. “Using predictive control and q-ZSI to drive an induction motor supplied by a PV generator”, International Power Electronics, Drive Systems and Technologies Conference. Page s: 61 - 65. 2018
4. AKKARAPAKA, A. K., & SINGH, D. “The IFOC based speed control of induction motor fed by a high performance Z-source inverter”, International Conference on Renewable Energy Research and Application (ICRERA). Page s: 539-543.2018
5. ABDELSALAM A. AHMED, BYUNG KWON KOH, “A Comparison of Finite Control Set and Continuous Control Set Model Predictive Control Schemes for Speed Control of Induction Motors”, IEEE Transactions on Industrial Informatics, Vol. 28, No. 3, April 2018.
6. B. KIRANKUMAR, Y.V. SIVA REDDY, M. VIJAYAKUMAR, “Multilevel inverter with space vector modulation: intelligence direct torque control of induction motor”, IET Power Electron., 2017, Vol. 10 Iss. 10, pp. 1129-1137.
7. ABDEL KARIM AMMAR, AMOR BOUREK, ABDEL HAMID BENAKCHA, “Sensor less Stator Field Oriented-Direct Torque Control with SVM for Induction Motor Based on MRAS and Fuzzy Logic Regulation,” 2017 IEEE
8. VENKATARAMANA融创, N. S. P. SING, “A Two-Level Fuzzy Based DTC Using PLC to Improve the Induction Motor Performance”, 2016 IEEE.
9. RANJITKUMARBINDAL, AND INDERPREET KAUR, “Comparative Analysis of Different Controlling Techniques using Direct Torque Control on Induction Motor”, 2016 IEEE.
10. SIDDHANTGUDHEL, AND B.B. PIMPLE, “Improved Torque Response of induction Motor Drive using Direct Torque Control Technique Applying Fuzzy Logic Control”, 2016 IEEE.
11. RAHUL SADHWANIL AND RAGAVAN, “A Comparative Study of Speed Control Methods for Induction Motor Fed by Three Level Inverter”, 2017 IEEE
12. XINBOCAI ZHENBIN ZHANG, Ralph Kennel, “Deadbeat and Direct Torque-Flux Control of Induction Motor: a Comparison Study”, 2017 IEEE
13. SOUMITRA DAS, HANG GAO, BIN WU, MANISH PANDE, AND DAVID XL, “A Space Vector Modulation Based Direct Torque Control Scheme for a Current Source Inverter fed Induction Motor Drive,” 2018 IEEE.
14. EDUARDO QUINTERO-MANRIQUEZ AND EDGAR N. SANCHEZ, “Real-Time Direct Field-Oriented Control of Induction Motor for Electric Vehicles Applications”, 2014 IEEE
15. SY YI SIM, ZAINALALAMHARON, “Neural Network SVPWM- DTC of Induction Motor for EV Load Model”, 2014 IEEE.
16. MONICA E. ROMERO, Seron Graham C. Goodwin, “A combined model predictive control/space vector modulation (MPC-SVM) strategy for direct torque and flux control of induction motors”, 2016 IEEE.
17. OMAR ELLABBAN, JOERI VAN MIERLO AND PHILIPPE LATAIRE, “Direct Torque Controlled Space Vector Modulated Induction Motor Fed by a Z-source Inverter for Electric Vehicles”, 2016 IEEE.
AUTHORS PROFILE

S.Sumathi, Completed Ph.D In Electrical Engineering From Anna University, Chennai. She Has Completed Master Degree In Power Electronics Drives From Vkmv, Salem. She Has Completed Ug Degree In B.E From Government College Of Engineering, Salem. She Has Published 20 Papers In International And National Journals. She Is A Member In Liste, Ieee. She Has Received Many Awards And Rewards During Her Teaching Career. Currently Working As A Professor In Mahendra Engineering College, Namakkal. Her Research Area Of Interest In Biomedical Engineering, Renewable Energy, Power Electronics And Soft Computing Techniques

C.Bhavani, Pg Student, ME control system, Mahendra Engineering College, Namakkal