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ON-OFF Control of Dual Three Phase Induction Motor on Priority base by using Five-leg Converter

Miss. Ayesha Pachghare¹, Prof. A. P. Kinge², Prof. Dr. S. G. Kanade³.

Dept. of Electrical Engineering, TSSM's Bhivrabai Sawant College of Engineering and Research, Narhe, Pune, India¹

Dept. of Electrical Engineering, TSSM's Bhivrabai Sawant College of Engineering and Research, Narhe, Pune, India²

Dept. of Electrical Engineering, TSSM's Bhivrabai Sawant College of Engineering and Research, Narhe, Pune, India³

ABSTRACT: In this paper we proposed new concept that is, Switching of Two Induction Motor of Half HP is controlled by Five Leg Voltage source Inverter. Generally to run Two Induction Motor of Three phase, a six leg Inverter is required. But in this a five leg Voltage source is developed to run Two Induction Motor of three phases. One leg from six legs treated as common leg so that five leg inverter is Developed. Also one new modification is that, Two Induction motor can be run at the same time, and also can be run on Priority control signal. Also speed of Induction motor In RPM can be controlled.

I. INTRODUCTION

Induction motors are the starting point to design an electrical drive system which is widely used In many industrial applications. In modern control theory, different mathematical models describe induction motor according to the employed control methods. Vector control strategy can be applied to this electrical motor type in symmetrical three phase version or in unsymmetrical two phase version [1],[3]. An AC Motor Drives played important role in all field, mostly in industrial application they are mostly used in blower, Pumps, Industrial Fan, Machine tools, Electric Vehicles, etc. In order to operate several motors used in one inverter multilevel drives have been suggested, five leg inverter system [1].

Since multimotored drives are configured with reduces switches as compare with convectional motor drives. They have advantages in terms of size, capital cost, and switching losses.

The five leg voltage source (FLVSI) is one of the examples of multilevel drives that operated dual three phase induction motor name as IM1 and IM2. It has total 6 leg, but we make two leg combine hence it has five leg. It required total ten switches for operating dual induction motor which is comparably less with three level voltage source inverter. Controlling o two motor independently by using FLVSI. (MPC) [7], [8], [9]. [10].

This project is focused on to run Two Induction Motor at a time. Also that Two Induction Motor Can be run separately according to Priority Base. (By using Operation of Three Switches).

II. LITERATURE SURVEY

According to the authors Miss. Ayesha Pachghare¹, Prof. A. P. Kinge², Prof. Dr. S. G. Kanade³ presented in published paper of “**Design and Development of Five-leg Converter for Three Phase Induction Motor**” described that introduction of Five-leg inverter is employed to feed dual induction motors for the cost-down of power devices and hardware circuits. In order to realize independent fast control for both IM', a model predictive control (MPC) strategy is developed in this paper. By using this strategy, the following state is predicted by using discrete-time models of the five-leg inverter and two IM's. The switching state, which minimizes the cost function, is selected to be applied in the following sampling period. Simulation results show that the dual induction motor drive system has extremely good static and dynamic performances

According to the authors Dongho Choi , Student Member, IEEE, June-Seok Lee , Senior Member, IEEE, Young-Seol Lim, Member, IEEE, and Kyo-Beum Lee , Senior Member, IEEE presented in published paper of “**Priority-Based Model Predictive Control Method for Driving Dual Induction Motors Fed by Five-Leg Inverter**” described



that introduction of priority-based model predictive control (PMPC) method for a five-leg voltage source inverter (FLVSI) that independently drives dual three-phase induction motors (IMs). In a FLVSI operated by a MPC method, selecting an optimal future voltage vector among all 32 candidate switching states causes a high computational burden.

According to authors, M. Stender, O. Wallscheid, Member, IEEE, and J. Böcker, Senior Member, IEEE presented in published paper of “**Accurate Torque Control for Induction Motors by Utilizing a Globally Optimized Flux Observer**” described that introduction of High-precision torque estimation and control of induction motor drives is an important research field due to the extensive use of these motors in torque-controlled applications, for example in electric vehicles. The open-loop torque control performance depends strongly on the accuracy of both the motor model and the flux estimation. To address this appropriately, an adaptive Kalman filter with offline parameter and observer design optimization is proposed in this paper

According to the authors Sunku Kwon, Student Member, IEEE, and Jung-Ik Ha, Fellow, IEEE, presented in published paper of “**Fault-Tolerant Operation under Single-Phase Open in Mono Inverter Dual Parallel SMPMSM with Single Shaft**” described that introduction of fault-tolerant operation for dual three-phase surface-mounted permanent magnet machines (SPMSMs) that were both electrically connected on three winding phases and mechanically connected on one shaft

According to authors Yaman B. Zbede, Shady M. Gadoue, and David J. Atkinson, presented in published paper of “**Model Predictive MRAS Estimator for Sensor less Induction Motor Drives**” described that introduction of The proposed estimator is based on the finite control set model predictive control (FCS-MPC) principle. The rotor position is calculated using a search-based optimization algorithm which ensures a minimum speed tuning error signal at each sampling period. This eliminates the need for a proportional integral (PI) controller which is conventionally employed in the adaption mechanism of MRAS estimators.

According to authors Sunku Kwon, Student Member, IEEE, and Jung-Ik Ha, Fellow, IEEE, presented in published paper of “**Fault-Tolerant Operation under Single-Phase Open in Mono Inverter Dual Parallel SMPMSM with Single Shaft**” described that introduction of fault-tolerant operation for dual three-phase surface-mounted permanent magnet machines (SPMSMs) that were both electrically connected on three winding phases and mechanically connected on one shaft. Authors

According to the authors Enrique Ledezma, Brendan McGrath, Alfredo Muñoz, Member, IEEE, and Thomas A. Lipo, Fellow, IEEE, presented in published paper of “**Dual AC-Drive System With a Reduced Switch Count**” described that introduction of A dual current-regulated pulse width-modulated voltage-source inverter based on multiple two-phase PWM inverters, also called a B4 topology, requiring a dual ac-drive system with reduced switch count is proposed. The drive utilizes a total of only eight switches to produce two sets of three-phase or two-phase sinusoidal output currents that can be employed to feed three-phase or two-phase induction motors

According to authors Philippe Delarue, Alain Bouscayrol, Member, IEEE, and Eric Semail, Member, IEEE, presented in published paper of “**Generic Control Method of Multileg Voltage-Source-Converters for Fast Practical Implementation**” described that introduction of A generic and simple control method is suggested for any multileg voltage-source-converter. A specific coding yields an inversion table allowing a fast practical implementation. Phase-to-phase voltage references have to be defined for such a table. This original control strategy is validated by experimental results for two-leg, three-leg, four-leg, and five-leg structures supplying balanced and unbalanced multiphase loads.

According to the authors authors Young-Seol Lim, Student Member, IEEE, June-Seok Lee, Member, IEEE, and Kyo-Beum Lee, Senior Member, IEEE, presented in published paper of “**Advanced Speed Control for Five-Leg Inverter Driving a Dual-Induction Motor System**” described that introduction of advanced speed control for a five-leg voltage source inverter (FLVSI) Stability analysis of the two controllers under advanced speed control is implemented, and the whole performance of the advanced speed control for FLVSI fed the dual-motor drive system

According to the authors Chee Shen Lim, Student Member, IEEE, Nasrudin Abd. Rahim, Senior Member, IEEE, Wooi Ping Hew, and Emil Levi, Fellow, IEEE, presented in published paper of “**Model Predictive Control of a Two-Motor Drive With Five-Leg-Inverter Supply**” described that introduction of Model predictive control (MPC) for a two-motordrive, supplied from a five-leg inverter, is presented in this paper. As an alternative to existing methods, use of MPC in multimachine drives has the advantages of independent fast current control of the machines, elimination of the closed-loop system’s cascaded structure, and a reduced number of microcontrollers. A vector control algorithm is

required, necessitating state-space modeling, with each machine's direct- and quadrature-axis currents chosen as state variables.

According to the authors Saverio Bolognani, Student Member, IEEE, Silverio Bolognani, Member, IEEE, Luca Peretti, Student Member, IEEE, and Mauro Zigliotto, Member, IEEE, presented in published paper of "**Design and Implementation of Model Predictive Control for Electrical Motor Drives**" described that introduction of Speed and current controllers are combined together, including all of the state variables of the system, instead of keeping the conventional cascade structure. In this way, the controller enforces both the current and the voltage limits. Both simulation and experimental results point out the validity of the design procedure and the potentials of the MPC in the electrical drive field.

According to the authors Hernán Miranda, Student Member, IEEE, Patricio Cortés, Member, IEEE, Juan I. Yuz, Member, IEEE, and José Rodríguez, Senior Member, IEEE, presented in published paper of "**Predictive Torque Control of Induction Machines Based on State-Space Models**" described that introduction of predictive control algorithm that uses a state-space model. Based on classical control theory, an exact discrete-time model of an induction machine with time-varying components is developed improving the accuracy of state prediction.

According to the authors Samir Kouro, Member, IEEE, Patricio Cortés, Member, IEEE, René Vargas, Student Member, IEEE, Ulrich Ammann, Member, IEEE, and José Rodríguez, Senior Member, IEEE, presented in published paper of "**Model Predictive Control—A Simple and Powerful Method to Control Power Converters**" described that introduction of Finite Control Set Model Predictive Control (FCS-MPC) applied to power converters. Several key aspects related to this methodology are, in depth, presented and compared with traditional power converter control techniques, such as linear controllers with pulse width-modulation-based methods.

According to the authors, Yasser Abdel-Rady Ibrahim Mohamed, Member, IEEE, presented in published paper of "**Adaptive Self-Tuning Speed Control for Permanent-Magnet Synchronous Motor Drive With Dead Time**" described that introduction of an adaptive self-tuning speed control for a permanent-magnet synchronous motor (PMSM) drive with dead time is proposed. Firstly, to equivalently place the dead time element outside the closed-loop speed control, a dead time compensator (DTC), based on the Smith predictor and a self-tuning proportional-integral model-following controller (ST-PI-MFC) is proposed.

According to the authors, Slobodan N. Vukosavic Martin Jones, Drazen Dujic, Emil Levi, IEEE, presented in published paper of "**An Improved PWM Method for a Five-Leg Inverter Supplying Two Three-Phase Motors**" described that introduction of Many PWM modulation methods have been suggested for such a drive system. However, they all suffer from serious drawbacks that impact negatively on the overall drive performance. This paper presents a new PWM modulation method that overcomes many of the issues experienced using the existing methods. The method effectively utilizes standard three-phase modulators in conjunction with additional logic to generate modulation signals for all five legs of the inverter and enables an arbitrary distribution of the available DC bus voltage between the two machines.

According to the authors, Tsutomu Kominami, Yasutaka Fujimoto, presented in published paper of "**A Novel Nine-Switch Inverter for Independent Control of Two Three-phase Loads**" described that introduction of Two methods exist for controlling PM motors providing an inverter to control each motor, and connecting the motors in parallel and driving them with a single inverter. The first method makes an experimental apparatus complex and expensive; the second does not allow independent control of each motor because of differences in rotor angle between the two motors.

According to the authors, GUOXIU JING^{1,2}, (Student Member, IEEE), AND CHANGPAN ZHOU¹, (Member, IEEE), presented in published paper of "**Control Strategy for a Five-Leg Inverter Supplying Dual Three-Phase PMSM**" described that introduction of control strategy for a five-leg inverter-fed dual three-phase permanent-magnet synchronous motor (DT-PMSM) system. Three different five-leg inverter topologies (operating modes) can be reconfigured by choosing a pair of phases for sharing the common leg. The five-leg inverter operation mode with 150° phase difference can achieve full torque output, but the utilization of DC bus voltage is low. The operation mode with 30° phase difference has higher DC bus voltage utilization but lower output torque.



According to the authors, Yang Mei, Zichen Yi, Zhengxi Li, presented in published paper of “A Model Predictive Control Strategy for Dual Induction Motor Drive System Fed by Five-leg Inverter” described that introduction of Five-leg inverter is employed to feed dual induction motors for the cost-down of power devices and hardware circuits. In order to realize independent fast control for both induction motors, a model predictive control (MPC) strategy is developed in this paper utilization but lower output torque.

According to the authors, Chee-Shen Lim, Student Member, IEEE, Emil Levi, Fellow, IEEE, Martin Jones, Nasrudin Abd. Rahim, Senior Member, IEEE, and Wooi-Ping Hew, Member, IEEE, presented in published paper of “A Comparative Study of Synchronous Current Control Schemes Based on FCS-MPC and PI-PWM for a Two-Motor Three-Phase Drive” described that introduction of A two-motor drive, supplied by a five-leg inverter, is considered in this paper. The independent control of machines with full dc-bus voltage utilization is typically achieved using an existing pulsewidth modulation (PWM) technique in conjunction with field-oriented control, based on PI current control. However, model predictive control (MPC), based on a finite number of control inputs [finite-control-set MPC (FCS-MPC)], does not utilize a pulsewidth modulator. This paper introduces three FCS-MPC schemes for synchronous current control in this drive system.

Problem Statement	How to overcome
Basically three phase induction motor is run on three leg inverter. So that to run two induction motor of three phase, six leg inverter is required. Also only one Motor can run at a time on five leg converter. Therefore switching losses increases and cost of model also get increases.	To overcome this problem, instead of six leg inverter, we used five leg inverter. Means to make one common phase from six phase motor. So that there are five phases which can run on five leg inverter. The one leg from six phase induction motor is treated as shared leg. Therefore Two Induction Motor Can Run at a time Also they can run on Priority Base. And Speed Control of IMs can be Possible

III. METHODOLOGY AND WORKING

In this, Priority Based MPC (PMPC) method following Cases are Achieved.

1. Case I
2. Case II
3. Case III
4. Case IV

In this there are Two Induction motors of half HP (IM 1, IM 2). The main focus of this converter is to run two induction motors at a time. Also they can be run on priority base, with speed controlled. For the Operation of this Induction Motors, Three Switches are provided.

Example in Hospital

1. Both IM1 & IM2 is OFF
2. IM 1 is for Cooling purpose – Case II (Priority motor 1)
3. IM 2 is for Fire Extinguisher purpose – Case III (Priority motor 2)
4. IM1 & IM2 (Cooling purpose + Extinguisher purpose) – Case IV (Priority motor 1 & Motor 2)

Case – I

In Initial stage Both Induction Motor 1 & Induction 2 is in OFF state because there is no load

Case – II

In case I Priority is selected for Induction Motor 1, this is work for cooling purpose of Hospital. Once the Switch one pressed controller received signal , and the Induction Motor 1 get operated. Speed of this IM can be controller, so that speed of cooling also can be controlled. [1],[2]

Case – III

In case II Priority is selected for Induction Motor 2, this is work for Fire extinguisher purpose in Hospital. If suddenly fire catches in hospital, it needs to extinguish on priority base. For that Switch two is pressed, controller received signal and the Induction Motor 2 get operated. Can be controller, and Fire can be controlled.[1],[2]

Case – IV

In case III Priority is selected for both Induction Motors IM1 & IM2, IM1 work for cooling purpose of Hospital and Induction Motor 2 work for Fire extinguisher purpose in Hospital. When there is a requirement of both situation both



induction motor should be operate. Once the Switch three is pressed controller received signal and the Induction Motor 1 & Induction Motor 2 get operated.

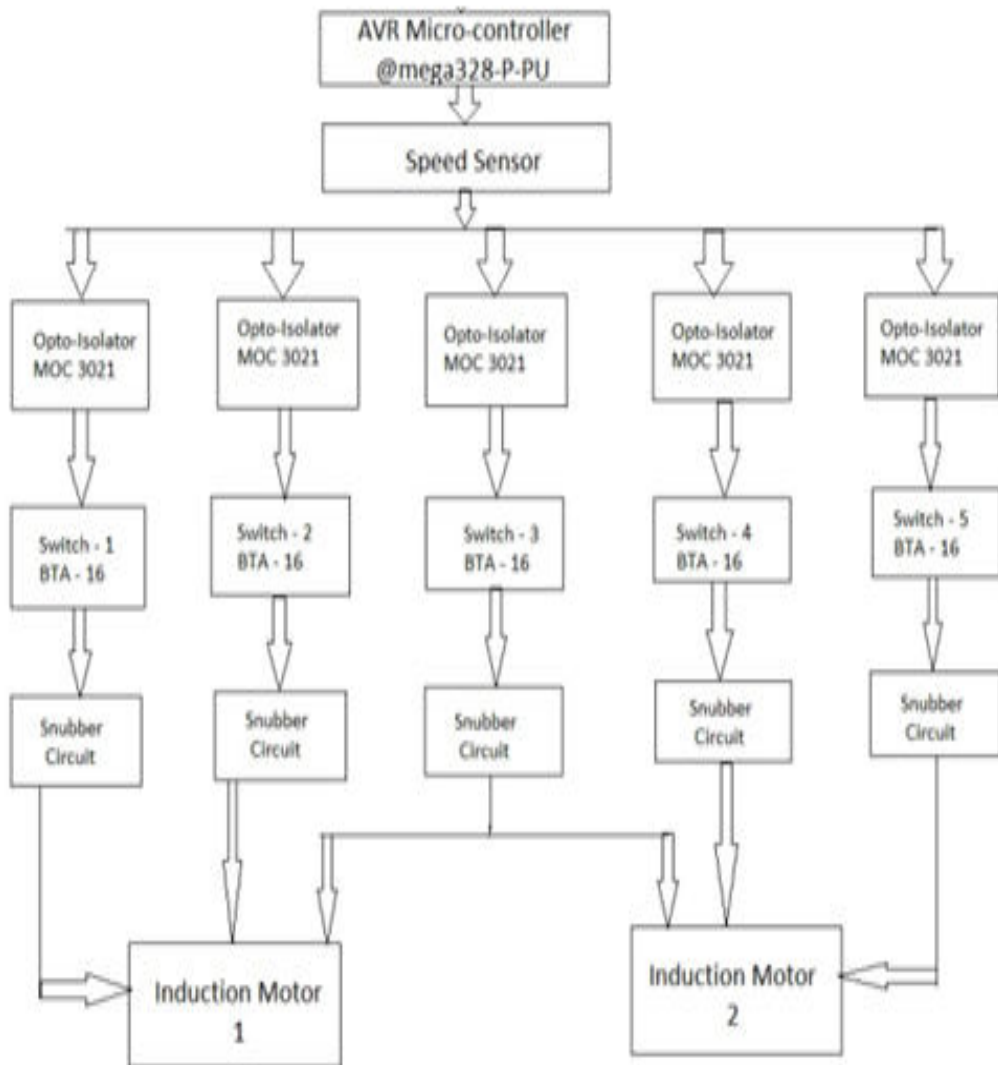


FIGURE 1: Block Diagram

IV. HARDWARE DISCRPTION AND SIMULATION



FIGURE 2: Hardware of two three phase IM with 5 leg inverter

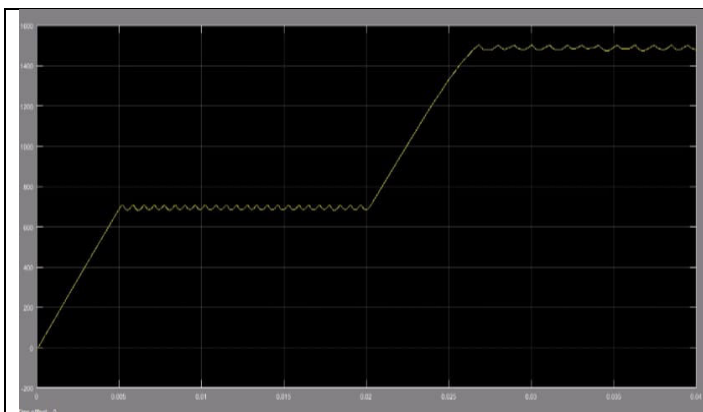


FIGURE 3: Result Graph of Speed

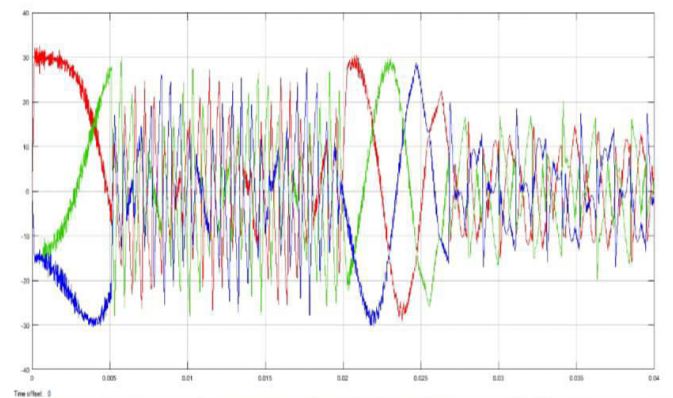


FIGURE 4: Motor Current

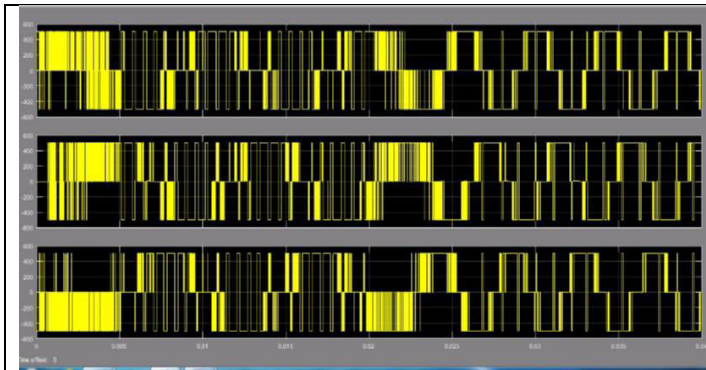


FIGURE 5: Result Motor Voltage

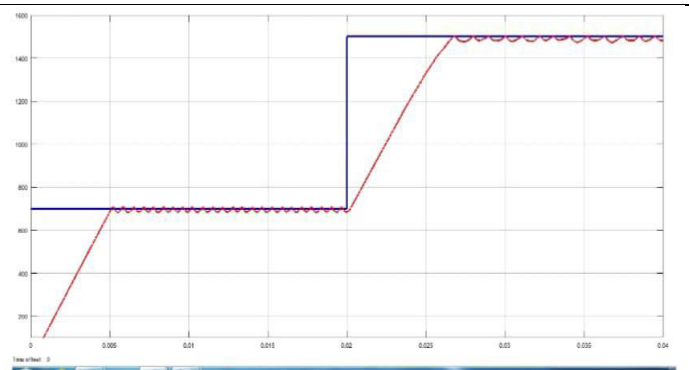


FIGURE 6: Actual speed VS getted speed

In Above figure shows the hardware of two three phase Induction Motor with common Five leg inverter with the priority based operation. Following are the list of parts used in hardware.

1. Three phase induction motor of half HP – 2 Nos
2. Switch BTA-16
3. AVR Microcontroller @mega328-p-PU
4. Speed Sensor
5. Potential Transformer
6. Snubber Circuit
7. Crystal 16 MHz

1. Three phase induction motor of half HP – Two, Three phase Induction motor of Half HP is used as a load.
2. Switch BTA-16 – BTA-16 is a TRIAC which is act as switch. It is provided for ON & OFF operation of Induction Motors.
3. AVR Microcontroller @mega328-p-PU – It is micro controller. This IC will generated five phase pulse width modulation signal to drive the two motors.
4. Speed Sensor – It is used to control speed of induction motors.
5. Potential Transformer- Potential Transformer is used to step-down voltage from 230V to 12V
6. Snubber Circuit- Snubber Circuit is used as a protective device. It is essential for switching circuit. It can save equipment from over voltage, Harmonics, and transient spikes.

Crystal 16 MHz – It is provided the clock to controller as per set speed from mobile

V. CONCLUSION

In this paper PMPC method to drive dual induction motors using the FLVSI. Two Induction motor can run at a time on this five leg voltage source inverter. Also this two induction motors are run on priority basis, as per requirements. Hence numbers of switches get reduces; hence switching losses also get minimized and also compact circuit id form.

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