A Performance Investigation of Three Phase Inverter Fed IM Drives using Fuzzy Logic & Arduino Controller

Dr. R. Sureshkumar[1] A. Senthil Kumar[2] B. Saravanakumar[3]
[1]Assistant Professor [2,3]PG Scholar
[1,2,3]Department of Electrical & Electronics Engineering
[1,2,3]Anna University Regional Campus, Coimbatore, India

Abstract— Speed control Motor is the most common and very impotent application for industries. This project work is based on investigating the performance of 4-switch 3- phase inverters fed Induction Motor (IM) driven by Fuzzy Logic Controller (FLC). And the controller of this inverter is arduino Microcontroller. However, neither rotor nor magnetizing inductances were investigated. Instead, the variation in stator resistance and load inertia - which have less effect on the orientation algorithm- are demonstrated. The FLC is simply used as speed controller, which is well addressed by most of the literature in this field. With identical tests, two main errors have been found. First, the reported speed which is in RPM should be in rad/sec. Second, the motor speed response to increasing inertia is opposite. The obtained results from the evaluation model confirm the claimed issues which impact the interpretation of commented.

Key words: 4-Switch 3- Phase Inverters Fed Induction Motor, Fuzzy Logic Controller, Arduino Microcontroller

I. INTRODUCTION

A three phase induction motor is basically a constant speed motor so it's somewhat difficult to control its speed. In project work to control the Induction Motor (IM) to use the Arduino Microcontroller in compare to the electrical drives the microcontrollers are low cost and fast response in the controller are used to generate the pulse because the IM are connected to the Four-Switch Three Phase inverter so the controller generate the pulse for to convert the DC-AC for the IM power supply. If control the supply voltage of the motor is automatically control the speed of the IM. And mainly input of the motor will take from the PV system. So output of the PV Voltage will boosted using Boost converter and the Boosted DC Supply will go to the Four-Switch Three Phase inverter.

II. EXISTING METHOD

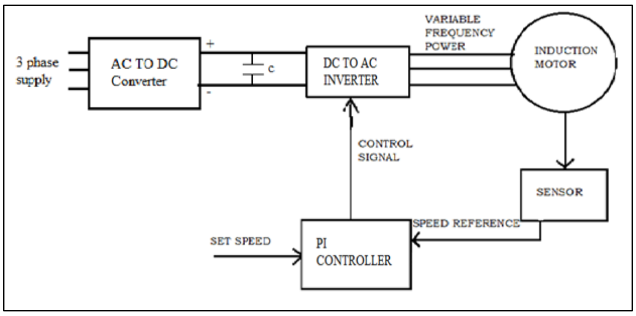

Fig. 1: Speed control of IM using PI Controller

In existing method the IM motor will connect to the DC-AC inverter and the input supply is directly given to the 3 phase supply and the here PI controller was used and most of the place to control the IM to use Variable Frequency Drive are used and normally used 3 Phase starters to control the speed but the starters are used to starting of the motor safely. Fig.1 shows the model of the Speed control of IM using PI Controller. In three phase supply will go to the AC-DC converter will convert the DC supply and the DC will Boosted using Boost converter and the DC to AC converter will convert the Boosted DC to AC supply based on the Firing Pulse will give to the PI controller. PI controller will generate the Firing Pulse Based on the set speed and speed measured from the motor. So the IM is constant speed drive so we set the speed in the PI controller will compare the actual speed and the set speed to produce the error signal in the comparator and based on the error signal the PI controller will produce the Firing Pulse to the generated and the inverter will invert the supply voltage based on the firing pulse will give to the controller so the supply of the motor will controlled so the speed of the motor will controlled.

III. PROPOSED SYSTEM

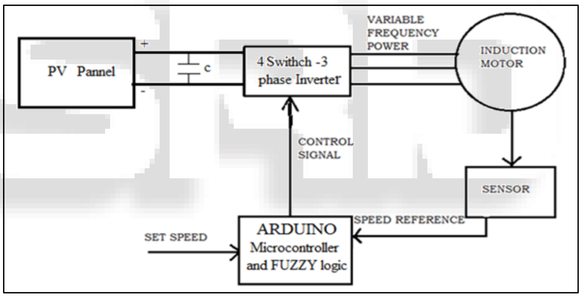

Fig. 2: speed control of IM using Arduino Micro controller and FUZZY logic

Fig.2 shows speed control of IM using Arduino Micro controller and FUZZY logic model. In the proposed work the supply voltage is take from PV panel and the solar energy is used. So the PV dc output is Boosted in the Boost converter and the dc voltage will convert into the 3 phase ac voltage using the 4 switch 3 phase inverter and the inverter will controller by Arduino Microcontroller and Fuzzy logic in the work. The controller will give the firing angle based on the set voltage and the actual speed of the IM.

IV. FOUR SWITCH THREE PHASE INVERTER

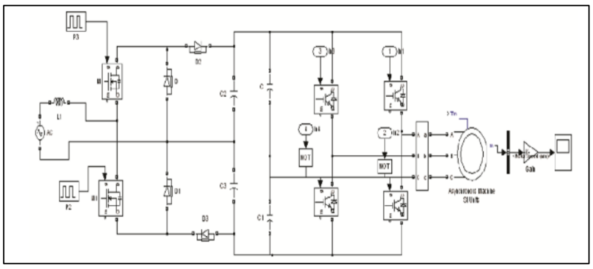

Fig. 3: Four Switch Three Phase Inverter Fed Induction Motor System with Half Bridge Doubler Boost Converter

In the half bridge circuit the output voltage will be twice the value of the input voltage. Thus, for a nominal 230V input voltage range, the output voltage will be greater than 760V. Thus a high voltage rated semiconductor components are required to meet the desired design. For a nominal 110V input voltage range, the output voltage range will be greater than 370V. This voltage level is acceptable and adopted in boost PFC circuits. Thus, the half bridge topology is proposed in this chapter as a good choice for the 110 V input voltage system.

The half bridge doubler boost topology is shown in Fig.3. The voltage across each semiconductor device is equal to V_o and the voltage ripple across capacitors C_2 and C_3 is reduced. The control circuit employed in this topology is rather simple, since the same gate signal can be applied to mains witches S_1 and S_2. By considering boost PFC circuit and assuming sinusoidal input current at unity power factor

P_{in} = input power = $V_s I_s$

P_{loss} = Conduction loss in bridge rectifier==$2V_F(I_S/kf)$

Where V_S is rms input voltage, I_S is rms input current and V_F is diode forward voltage drop.

Bridge efficiency= $(p_{in}-p_{loss})/p_{in}$

From the above equation, the reduction in efficiency at higher V_F values suggests that by reducing number of devices in series the total conduction voltage drop in the semiconductor devices and significantly improves the overall efficiency of the PFC circuit. The main advantage of this topology is that at any time there is only one semiconductor on stage voltage drop which may be expected to result in high operating efficiencies.

V. FUZZY CONTROL SYSTEM & ARUDINO MICRO CONTROLLER

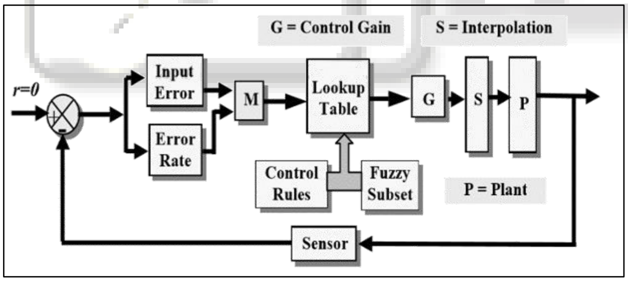

Fig. 4: Block diagram of Fuzzy logic controller

Fig.4 shows the block diagram of Fuzzy logic controller. Fuzzy controllers are very simple conceptually. They consist of an input stage, a processing stage, and an output stage. The input stage maps sensor or other inputs, such as switches, thumbwheels, and so on, to the appropriate membership functions and truth values. The processing stage invokes each appropriate rule and generates a result for each, then combines the results of the rules. Finally, the output stage converts the combined result back into a specific control output value.

The most common shape of membership functions is triangular, although trapezoidal and bell curves are also used, but the shape is generally less important than the number of curves and their placement. From three to seven curves are generally appropriate to cover the required range of an input value, or the "universe of discourse" in fuzzy jargon.

As discussed earlier, the processing stage is based on a collection of logic rules in the form of IF-THEN statements, where the IF part is called the "antecedent" and the THEN part is called the "consequent". Typical fuzzy control systems have dozens of rules.

Fig. 5: Arudino Microcontrollers

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources.

Fig.5 shows the hardware diagram arudino microcontroller. The Uno is one of the most popular Arduinos available based on the Atmel ATmega328 microcontroller, 14 I/O pins USB & power connectors, 16MHz clock speed, 8-bit AVR RISC-based microcontroller, 32KB program flash memory, 1KB EEPROM , 2KB SRAM , 20MHz max clock frequency , 23 GPIO pins, 32 general purpose registers , 3 timers/counters, Internal & external interrupts, USUART, 2-wire serial interface, SPI port, 6-channel 10-bit A2D.

VI. SIMULATION AND RESULTS

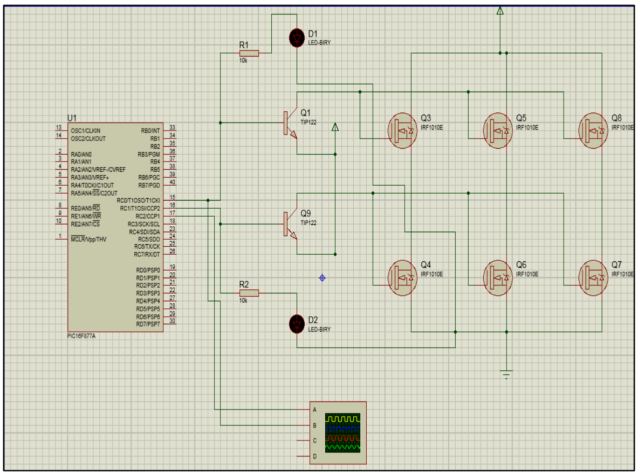

Fig. 6: Simulation of the Speed control of 4 Switch 3phase Inverter connected IM using Arudino Microcontroller and Fuzzy logic

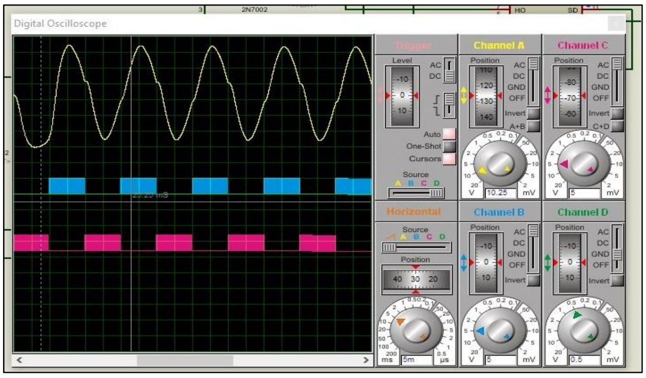

Fig. 7: Simulation output for controlling the IM

In Fig.6 shows the Simulation of the Speed control of 4 Switch 3phase Inverter connected IM using Arudino Microcontroller and Fuzzy logic to controlled in the various operating conditions, and the Fig.7 shows the control output of the IM.

VII. CONCLUSION

In the project work it is the one of the method to speed control of three phase induction motor using 4 switch 3 phase inverter, Arudino Microcontroller, FUZZY logic. And input supply of PV is too used. And showing the simulation output in various conditions and the output shows the measuring the speed and the controlling of speed using Arudino controller, Fuzzy logic are shown.

REFERENCE

[1] LijunDiao, JingTang, PohChiangLoh, ,ShaoboYin,LeiWang, “An Efficient DSP-FPGA Based Implementation of Hybrid PWM for Electric Rail Traction Induction Motor Control”, IEEE Transactions on Power Electronics, 2017.

[2] Zicheng Liu, Zedong Zheng, Yongdong. Li, “Enhancing Fault-tolerant Ability of a Ninephase Induction Motor Drive System Using Fuzzy Logic Current Controllers”, IEEE Transactions on Energy Conversion, 2017.

[3] E. E. EL-Kholy, “Robust Active Disturbance Rejection Control of Induction Motor Systems Based on Additional Sliding Mode Component”, IEEE Transactions on Industrial Electronics, 2017.

[4] Z. M. Elbarbary, Hany A. Hamed, “Comment on ‘A Performance Investigation of a Four-Switch Three-Phase Inverter-Fed IM Drives at Low Speeds Using Fuzzy Logic and PI Controllers”, IEEE Transactions on Power Electronics, 2017.

[5] Mario Bermudez, Ignacio Gonzalez-Prieto, Federico Barrero, “Open-Phase Fault-Tolerant Direct Torque Control Technique for Five-Phase Induction Motor Drives”, IEEE Transactions on Industrial Electronics 2016.

[6] Ignacio González-Prieto1, Mario. J. Duran, Federico J. Barrero, “Fault-tolerant Control of Six-phase Induction Motor Drives with Variable Current Injection”, IEEE Transactions on Power Electronics, 2016.

[7] Md. Habibullah, Dylan Dah-Chuan Lu, Dan Xiao, John E. Fletcher, Senior Member, and Muhammed Fazlur Rahman, Fellow, “Predictive Torque Control of Induction Motor Sensorless Drive Fed by a 3L-NPC Inverter”, IEEE Transactions on Industrial Informatics, 2016.

[8] Jay K. Pandit, Mohan V. Aware, Ronak Nemade, Emil Levi, Fellow, “Direct Torque Control Scheme for a Six-Phase Induction Motor with Reduced Torque Ripple”, IEEE Transactions on Power Electronics, 2016.

[9] K. Zeb, Z. Ali, K. Saleem, W. Uddin, M. A. Javed, N. Christofides, “Indirect field-oriented control of induction motor drive based on adaptive fuzzy logic controller”, IEEE Transactions on Industrial Informatics, 2015.

