A Performance Investigation of a FSTP Inverter-FED IM Drives at Low Speeds Using Fuzzy Logic Controllers

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***Abstract-* Three phase induction motors have been considered one of the most commonly used electric machines in industrial applications due to their low cost, simple and robust construction. Existed six-switch three-phase inverters have been widely used in different industrial applications. These inverters have some drawbacks in low power range applications, which involve extra cost, the six switches losses, and complicated control schemes. The main objective of research work to design new power converters for minimizing losses and costs have been proposed. The project objective describes a speed controller using a fuzzy-logic controller for indirect field oriented control of induction motor drives fed by a four-switch three-phase inverter. The proposed FLC improves dynamic responses and, it is also designed with reduced computation burden.**

Index Terms- FLC; Total Harmonic distortion; FSTP inverter, parameters variation, IFOC.

I. INTRODUCTION

Three-phase induction motors have been considered one of the most commonly used electric machines in industrial applications due to their low cost, simple and robust construction. Three-phase inverters are considered an essential part in the variable speed AC motor drives. Previously, the traditional six-switch three-phase (SSTP) inverters have been widely used in different industrial applications. These inverters have some drawbacks in low power range applications, which involve extra cost. The six switches losses, and complicated control schemes. Moreover, they require building interface circuits to produce six PWM pulses. The development of low-cost motor drive systems is an important topic, particularly for a low-power range.

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II. FOUR SWITCH THREE PHASE INVERTER

This inverter is configured with four switches: Q1, Q2, Q3, and Q4, respectively, as shown in Figure 1. Two output phases are taken from the inverter legs directly where the third output is taken from the midpoint of the two capacitors. The inverter converts the DC voltage to a balanced three-phase output with adjustable voltage and frequency. In the analysis, the inverter switches are considered to be ideal power switches, and it is assumed that the conduction state of the power switches is associated with binary variables Q1 to Q4. Therefore, a binary "1" will indicate a closed state, while "0" will indicate the open state. Pairs Q1 to Q3 and Q2 to Q4 are complementary and, as a sequence, (Q1 =1-Q3, Q4 =1-Q2). Two control possibilities exist to control the four- switch bridge inverter, i.e., two-level current control to force the two controlled phases currents to sinusoidal or using pulse width modulation (PWM) to control the voltages applied to the three-phase quasi-sinusoidal. The two-level current control of the four-switch bridge inverter is used to control the load current by forcing it to follow a reference one. This is achieved by the switching action of the inverter to keep the current within the hysteresis band.

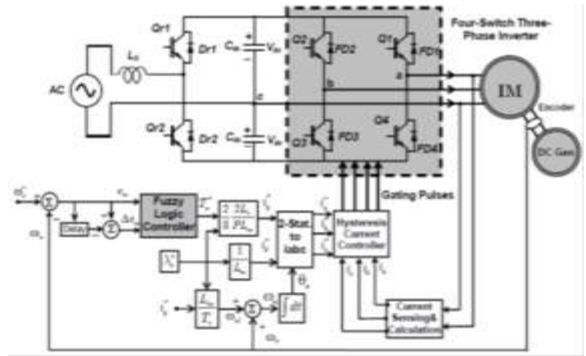

Fig 1. Block diagram of the proposed FLC-based IFOC scheme of IM drive fed by FSTP voltage source inverter

III. PROPOSED SYSTEM

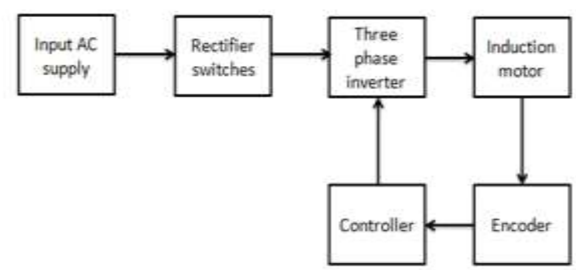

Fig 2. Block Diagram

This block diagram is composed from two sides. The first side is a half-wave voltage doublers fed from single-phase AC power supply. The frequency of the input ac voltage is fixed; this voltage is rectified using rectifier two switches. The rectifier circuit is utilized to charge the capacitor bank in the DC-link. The second side is the FSTP-VSI. The FSTP inverter utilizes four switches. The FSTP inverter uses four isolated gates bipolar transistors (IGBTs) and four freewheeling diodes to get the two line-to-line voltages. The inputs to FLC controller block are the deviation between the reference and actual motor speeds (speed error) and speed error derivative. A controller generates PWM signal controls the induction motor efficiently.

IV. MATLAB SIMULATION

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment. A proprietary programming language developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python.

Simulink provides a graphical editor, customizable block libraries, and solvers for modeling and simulating dynamic systems. It is integrated with MATLAB, enabling you to incorporate MATLAB algorithms into models and export simulation results to MATLAB for further analysis.

V. RESULTS

The results from the MATLAB Simulation is getting from the Simulink module, the new fuzzy logic model is created and then getting the results of speed, current, torque and THD values are getting from the simulation results

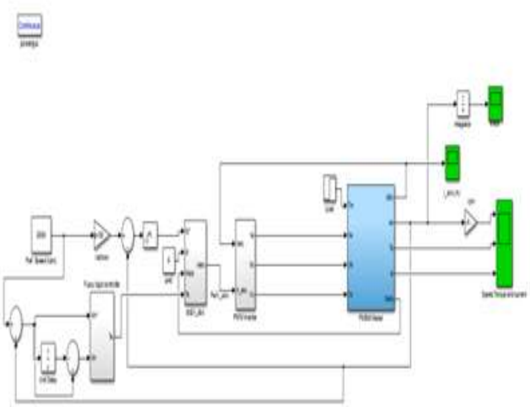

Fig 3. MATLAB Simulink Model

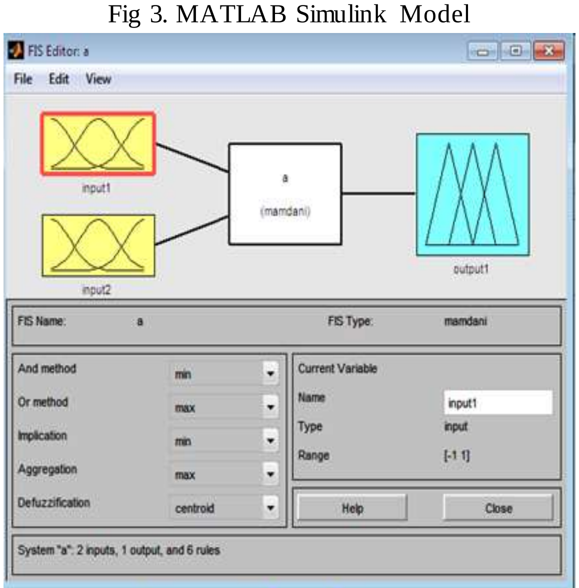

Fig 4. Fuzzy rules file

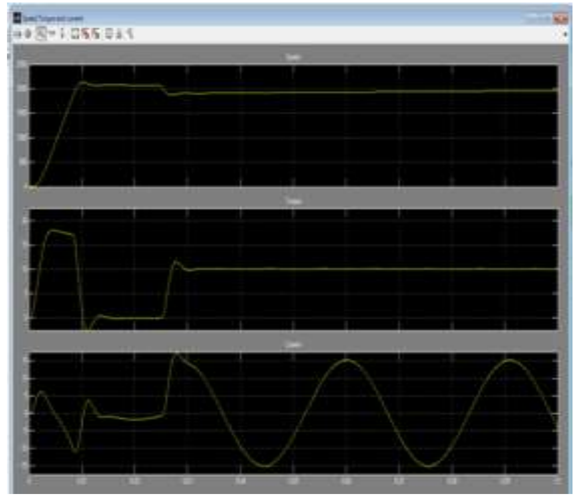

Fig 5. Results-Speed, Torque, Current

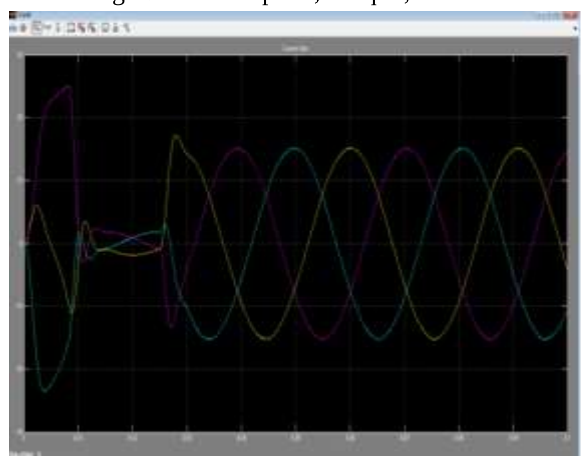

Fig 6. Result-Current

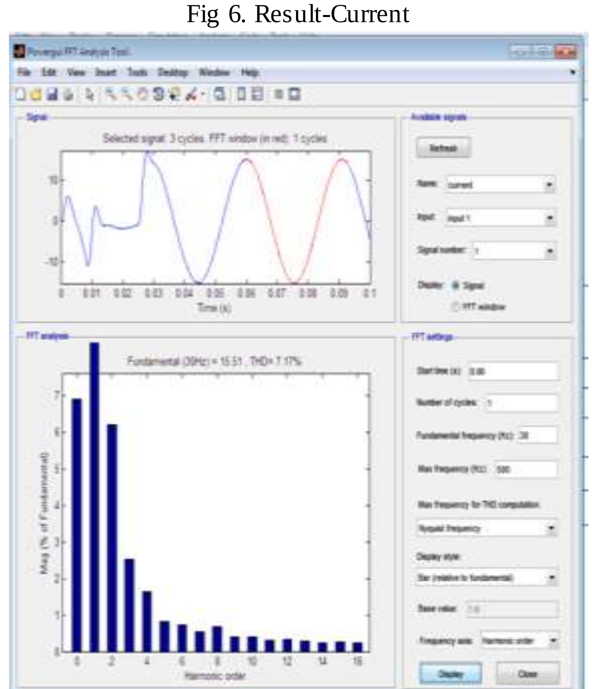

Fig 7. Results –THD

VI. CONCLUSION

The proposed FLC-based IFOC for an IM drive fed by FSTP inverter has been effectively simulated by MATLAB –SIMULINK. The dynamic speed response of the IM drive at low speeds is improved using the FLC which is designed with low computation burden to be appropriate for real-time applications. The proposed IM drive system is also suitable for cost-effective low power industrial applications. Over the years induction motor (IM) has been utilized as a workhorse in the industry due to its easy build, high robustness, and generally satisfactory efficiency. In future work we can modify the controller model or change the circuit to enhance the performance of three phase induction motor and reduce the Total harmonic distortion.

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