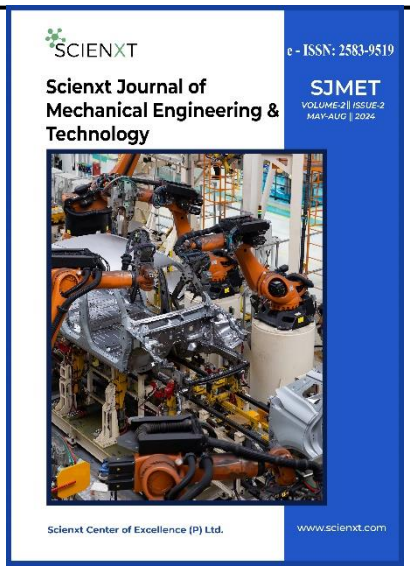

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A Study on fuzzy logic controller-based three phase induction motor speed control"

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Abstract:

For fast response to the speed controlling the dynamic performance of the induction motor must be very high. By applying fuzzy logic in the controlling of the induction motor the dynamic performance can be improved... The advantage of using fuzzy logic control is that it does not require comlex mathematical modelling of the motor. By just knowing the befavior of the motor the control signals is manupulated to obtain the desired response characteristics of the motor. This paper proposes a fuzzy logic technique which is very much simple and can be implemented easily in the actual scenario. Fuzzy logic controller based speed control of a three phase Induction motor uses fuzzy logic to generate the reference current signal for the inverter and curent is being controlled by the inverter... The system is modelled in a MATLAB simulink and the result is being compared with the conventional PI controller. The scheme implements controlling by keeping voltage to frequency ratio to be constant. The controller is designed so as to reduce the error between rotor speed and reference speed as fast as possible. The performance of the induction motor is simulated by changing the reference speed and the dynamic performance of the motor is observed Study shows that there is considerable improvement in dynamic performance of the induction motor. Along with that result shows that the system is not much affected to the disturbance occuring in the system. The induction motor quickly adapts to the system disturbances which proves its robustness.

Keywords:

Three phase induction motor, fuzzy logic controller

1. Introduction:

Power electronics plays an important role in field of electric drives as it increases the energy efficiency and controlling characteristics of the drive. It is important to use the correct drive according to the application. Recently there is tremendous development in the field of power electronics and microcontrollers. Thus the technology of modern drives has changed dramatically and various studies are being carried to design the electric drives to make motor usable for certain application with good efficiency.

The tremendous development of power electronics made us available with the power converters like MOSFET and IGBT having high switching speed and less switching losses to be used in the inverters. Those inverters are quick to response and can adjust the speed of the induction motor very quickly. Another advantage of using these power converters is that they are integrated devices so they are light weight and can reduce the overall weight of the drive tremendously. The current controlling scheme using hysterisis control is proposed. The induction motor is the most widely used motor due to its rugged performance, lower maintenance cost, and simpler construction and economical

There are various methods of speed control in the literature like pole changing method, rotor resistance control, stator voltage control, slip control, constant V/f control, variable V/f control etc. This paper presents survey on a fuzzy logic controller based speed control of Induction motor. The proposed controller is applied to electric drive to control the speed of three-phase induction motor and simulated in MATLAB simulink.

2. Literature review:

2.1. Previous work:

Literature Survey outlines the past research works that have been carried in this context of work. These are essential as they give an over view about the past works done and problems that have been resolved and the areas that have scope for future.

Dr T.Govindaraj et.al, presented speed control of induction motor using fuzzy logic control. In this paper they presented the use of the measurement thresholds generated from the propagation of parametric uncertainty using fuzzy logic to validate the sensor measurements of an induction motor drive by means of fuzzy techniques. If measurements fail the validation check, they are replaced by reconstructed data to maintain the operation.

Reconstruction is performed with fuzzy logic, which also supports the evaluation of the thresholds. The algorithms proposed here have been implemented and tested both in simulation and in real time experiments on a field oriented controlled induction machine.

Shahram Javadi, presented Induction Motor Drive Using Fuzzy Logic. In this paper he presented the use of artificial intelligence for hard and soft computation. It gives us the overview of using artificial intelligence as a controller in nonlinear systems.

Ritita. R. Lavate ET. Al, presented Speed Control of Induction Motor using Fuzzy Logic, in this paper they presented the fuzzy logic control of induction motor using direct torque control. The nonlinear and parametric variation problem of induction motor is solved by using fuzzy logic. Computational demanding is reduced in this method.

V. Chitra et.al, presented Induction Motor Speed Control using Fuzzy Logic Controller. In this paper the fuzzy logic controller is implemented using the Field Oriented Control technique as it provides better control of motor torque with high dynamic performance. The motor model is designed and membership functions are chosen according to the parameters of the motor model. The simulated design is tested using various tool boxes in MATLAB. The result concludes that the efficiency and reliability of the proposed speed controller is good.

D. Archana et.al, presented Efficiency Optimization Control of Induction Motor Using Fuzzy Logic. This paper introduces a smart speed control system for induction motor using fuzzy logic controller. Induction motor is modeled in synchronous reference frame in terms of dq form. The speed control of induction motor is the main issue achieves maximum torque and efficiency. Two speed control techniques, Scalar Control and Indirect Field Oriented Control are used to compare the performance of the control system with fuzzy logic controller. Indirect field oriented control technique with fuzzy logic controller provides better speed control of induction motor especially with high dynamic disturbances. The model is carried out using Mat lab/Simulink computer package. The simulation results show the superiority of the fuzzy logic controller in controlling three-phase induction motor with indirect field oriented control technique.

S.Prakash et.al, Presented Fuzzy Logic Controlled ac Voltage Controller for Speed Control of Induction Motor Drive. In this paper they investigated the effect of membership functions in the fuzzy control (FC) of an ace voltage controller for speed control of induction motor drive. A Sugeno type FC for closed loop control of induction motor drive fed by ac voltage

controller is designed and considered for evaluation. The controller is used to change the firing angle of the ac voltage controller and thereby, the voltage fed to stator of induction motor to regulate the speed. The results of the simulated performances are compared. The triangular membership function shows better performance compared to other membership functions.

Manjunatha M N, presented Comparative Analysis of PI Controller and Fuzzy Logic Controller for Speed Control of Three Phase Induction Motor Drive. Her research incorporates a voltage resource PWM inverter nourished indirect vector manage method connected with induction magnetic motor. The results obtain from PI controller and fuzzy logic controller is compared and concluded that the fuzzy logic controller is superior over PI controller.

Md Shah Faisal et.al, presented Speed Control of Three Phase Squirrel Cage Induction Motor Using Fuzzy Logic Controller. This paper presents the scalar speed control of three phase squirrel cage induction motor. PI and fuzzy logic controller are operated according to speed error to utilize the advantages of both controllers. The control scheme keeps voltage and frequency ratio of induction motor constant. The voltage and frequency input to the induction motor are control in order to obtain desired speed response. This proposed fuzzy controller utilizes the advantages on PI controllers. The simulation results proved that the fuzzy controller performance is superior due to fast response under reference speed and load torque variations. They are comparing in terms of maximum overshoot and settling time with PI and fuzzy controllers.

Nirmala Ashok Dange et.al, presented Position Control of Servo Motor Using Fuzzy Logic Controller. This paper illustrates the benefit of using a PID controller as well as a fuzzy controller. It suggests that the higher demand and time delay structures are more effectively controlled by fuzzy logic controller. It applies the fuzzy logic control in servo system and concluded that control of servo is superior most by using fuzzy controller.

C.Vignesh et.al, presented Direct Torque Control of Induction Motor Using Fuzzy Logic Controller. This paper presents a unique direct torque control (DTC) approach for induction motor (IM) drives fed by using a fuzzy logic controller. It routines the dc current to re-construct the stator currents desired to estimate the motor flux and the electromagnetic torque.

P. Sweety Jose et.al, Presented Performance Enhancement of Direct Torque Control of Induction Motor Using Fuzzy Logic. In this paper they used the direct torque control strategy of selecting proper voltage vector to reduce torque and flux error. For reducing the ripples in the torque the used the fuzzy control along with direct torque controls. Comparison is made with respect to conventional controller and it is concluded that performance of the fuzzy controller is superior.

Jayesh S. Sawai et.al, presented A Review Paper on Closed Loop Control of Bldc Motor Using Fuzzy Logic. In this paper, a fuzzy logic controller for the closed loop control of BLDC motor is used. A single current sensor technique is used for closed loop current control. For closed loop current control of BLDC motor, the motor phase currents are measured using current sensors. The drawbacks and remedies of using multiple sensors are illustrated. An algorithm is presented to obtain the phase current values from the dc link current.

Pritha Agrawal et.al, presented Comparative Study of Fuzzy Logic Based Speed Control of Multilevel Inverter fed Brushless DC Motor Drive. This paper presents a comparative analysis of speed control of brushless DCmotor (BLDC) drive fed with conventional two-level, three and five level diode clamped multilevel inverter (DC-MLI). The performance of the drive system is successfully evaluated using Fuzzy Logic (FL) based speed controller. The control structure of the proposed drive system is described. The speed and torque characteristic of conventional two-level inverter is compared with the three and five-level multilevel inverter (MLI) for various operating conditions.

Mohammad Abdul Mannan et.al, presented Fuzzy-Logic Based Speed Control of Induction Motor Considering Core Loss into Account. This paper proposes a fuzzy logic speed controller of induction motor where flux and torque decoupling strategy is decoupled in terms of magnetizing current instead of stator current to alleviate the effects of core loss. The performances of proposed fuzzy-logic-based controller have been verified by computer simulation. The simulation of speed control of IM using PI and FLC are performed. The simulation study for high-performance control of IM drive shows the superiority of the proposed fuzzy logic controller over the conventional PI controller.

Kamini Devi et.al, presented Speed Control of 3-Phase Induction Motor Using Self-Tuning Fuzzy PID Controller and Conventional PID Controller. This paper presents a rule-based fuzzy logic controller applied to a scalar closed loop Volts/Hz induction motor (IM) control

with slip regulation and compared with conventional PID controller. The IM is model in terms of d-q windings, with synchronous frame associated with the frequency ωs of the stator excitation.

Supriya More et.al, presented Direct Torque Control of Induction Motor Using Fuzzy Logic Controller. In this paper fuzzy logic based direct torque control (DTC) scheme of an induction motor (IM) is modeled and its comparative study using intelligent techniques under varying dynamic conditions are discussed. The high ripples in the torque are reduced by using fuzzy logic controller. Result shows that on using fuzzy logic controller the dynamic performance of the motor is increased.

Safdar Fasal T K et.al, Presented a Comparative Study of Proportional Integral Controller and Fuzzy Logic Controller in Scalar Speed Control of Three Phase Induction Motor. This paper studies the performance of the three phase induction motor in scalar PI control and scalar fuzzy logic control. Speed control is done by varying the supply frequency using the voltage source inverter by keeping the voltage to frequency ratio constant. Result shows the superiority of fuzzy logic control over the PI control.

Girish Kavathekar et.al, Presented Induction Motor Speed Control using Fuzzy Logic Controller. This paper presents the design and implementation technique of speed control of single phase Induction Motor. This scheme is able to adjust the speed of Induction motor by controlling the frequency and amplitude of the stator voltage by keeping the voltage to frequency ratio constant.

Gauri V. Deshpande et.al, presented Speed Control of Induction Motors using Hybrid PI plus Fuzzy Controller. A PI plus fuzzy hybrid controller is designed which eliminates the stability problem associated with the vector controlled induction motor. The PI controller eliminates the study state error and the fuzzy controller improves the dynamic performance of the Induction motor.

M. R. Chekkouri ET. Al, presented Fuzzy Adaptive Control of an Induction Motor Drive. An adaptive control algorithm is presented with very less computations is presented in this paper. A self-tuning control is presented based on supervisory fuzzy adaptation. The status of the system is continuously monitored by supervisor and changes in K_i is done accordingly to adjust with the plant evolution.

Lakhya Jyoti Phukon ET. Al, presented Fuzzy Logic based Speed Control of an Induction Motor Using Indirect Vector Control Method. In this paper an intelligent control scheme is

implemented in indirect vector control of an induction motor. The scheme is applied in field oriented control of induction motor. Comparative analysis with conventional controller is done.

M. Nageswara Rao et.al, presented speed control of induction motor using fuzzy logic approach. It deals with fast stabilization of the induction motor. First of all an induction motor is designed according to d-q theory and fuzzy logic controller is compared against the PI controller.

Naveena G.J et.al presented speed control of induction motor using fuzzy logic and PI controller and comparison of controller based on speed. This paper proposes a fuzzy logic controller for the induction motor control. The result shows that on using fuzzy logic controller the efficiency, reliability and performance of Induction motor has been improved.

R.Kavitha et.al presented Modeling and Implementation of fuzzy vector control for Induction motor Drive. This paper presents a methodology for implementation of a rule based fuzzy logic controller applied to a closed loop vector speed control induction motor. The induction motor is modeled using a dq axis theory. The designed Fuzzy Logic controller's performance is weighed against with that of PI controller. The results obtained by using conventional PI controller and the designed fuzzy logic controller has been studied and compared.

Kamini devi et.al presented Speed Control of Induction Motor Using Fuzzy Logic Approach. This paper presents a rule-based fuzzy logic controller applied to a scalar closed loop Volts/Hz induction motor (IM) control with slip regulation and its simulation results. The IM is model in terms of d-q windings, with synchronous frame associated with the frequency ωs of the stator excitation. The results obtained in the simulation are interesting, considering the presence of strong non-linearity in the IM model. A fuzzy logic control for a speed control of Induction motor the simulation developed by using Fuzzy MATLAB Toolbox and SIMULINK.

Rathod Nirali et.al presented Fuzzy Decision Based Soft Multi Agent Controller for Speed Control of Three Phase Induction Motor. Paper describes multi agent based approach to control speed of Induction motor. Design and simulation of Multi Agent System is developed for indirect vector controlled 3-phase Induction motor. Soft computing techniques are used for implementation. Three types of controllers: Classical controller (PI), Fuzzy (FLC) & Neural Network ANN) are constituting of the Multi Agent system.

Simulated speed responses parameters viz: rise time, steady state error and overshoot of SIMULINK models are used to make by a fuzzy logic is used to select the best controller from the constituents.

Jaime Fonseca et.al presented fuzzy logic speed control of Induction motor. This paper describes the use of fuzzy logic in controlling the speed of the three phase Induction Motor. Software implementation is done in mat lab simulink and hardware implementation is done using 16/32 bit microcontroller. The system performance is evaluated and compared with the traditional PI controller.

Ashok Kusagur et.al presented Modeling of Induction Motor & Control of Speed Using Hybrid Controller Technology. This paper presents a novel design of a Takagi-Sugeno fuzzy logic control scheme for controlling some of the parameters, such as speed, torque, flux, voltage, etc. of the induction motor. The Takagi-Sugeno control strategy coupled with rule based approach in a fuzzy system when employed to the induction motor yields excellent results compared to the other methods as this becomes a hybrid & integrated method of approach. The result shows that this technology provides reasonable degree of accuracy.

K.Satheeshkumar et.al presented Performance Enhancement of 3 Φ IM Drive using Fuzzy Logic Based DTC Technique. This paper presents a direct flux and torque control (DTC) of three phase induction motor drive (IMD) using PI and fuzzy logic controllers (FLC) for speed regulator (SR) and low torque ripples. This control method is based on DTC operating principles. It presented the drawbacks associated with the conventional direct to torque control in Induction Motor Drive. The main drawback is high stator flux and torque ripples and the speed of IMD is reduced under transient and dynamic state of operating condition. The simulation results of proposed DTC shows the low stator flux linkage, torque ripples and good speed regulator than conventional DTC technique using MATLAB/SIMULINK.

Opas Ruksaboon et.al presented Fuzzy PID Control Compensation System for Speed of VVVF Induction Motor Drive. The objective of research was to present the closed loop speed controller of variable-voltage variable-frequency (VVVF) induction motor drive. The main issues regarding a Fuzzy PID controller were designed for controlling an induction motor. The proposed controller is composed the rule base with analysis two degree of freedom to fuzzy rule. The little fluctuation slope of rise time can be minimize with compensation Fuzzy and PID controllers. The study used LabVIEW program and adjustment of controller parameters were set consistently with the mathematic equation of

the motor. In this study, the 0.375 kW model of three phase induction motor was used in the simulation. The results showed that the Fuzzy PID controller can drive the induction motor system more effectively with good tracking and found robust is suitable for controlling the system.

2.2. Problem statement:

In today's world the ever increasing usage of the three phase induction motor and its many benefits it is desired to improve the performance of the three phase induction motor and use it in the best possible ways and in as much applications as possible. In literature there are many ways for obtaining the desired performance. Out of the different methods many of the methods require the mathematical modeling of the three phase induction motor which is not accurate and some methods dost require mathematical modeling but the controlling methods are complex which increases complexities and cost of the control circuit. In the proposed research a very simple control concept is proposed which improves the dynamic performance as well as the robustness nature of the induction motor.

3. Conclusion:

Induction motors are the most widely used motors as it has so much benefits and its maintenance cost is very less. Generally induction motors are used for constant speed applications. By using the proposed methodology induction motors can prove to be useful for variable speed drives as well. With the advent of fast computers and microcontrollers implementing the fuzzy control becomes very much easy and economical. So by using this technology in future cheap induction motor drives will be available for variable speed applications.The fuzzy conntroller provides a very good result for speed controlling of a three phase induction motor. From the study of various paper we can say that by using the fuzzy logic in controlling there is no need of mathematical modelling of the induction motor.Also varying speed the induction motor adjusts itself very quickly this shows that the dynamic performance of the induction motor is incresed. As far as controlling is considered the controlling scheme is very much simple and easy to be implemented.

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