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Intelligent Controlling of Three Phase Induction Motor for Dynamic Performance Improvement

Mohsin Ansari
Power system, Scope college of Engineering
Bhopal M.P

Mr. N.K. Singh
Head of Department, Electrical and Electronics Engineering
Scope College of Engineering, Bhopal M.P

Abstract:- This paper proposes fuzzy logic controller based speed control of a three phase induction motor. The system is modeled in a MATLAB simu link and the result is being compared with the conventional PI controller. Constant v/f control scheme is being implemented in the scheme. The controller is designed such that it can reduce the error between rotor speed and reference speed as fast as possible. the performance of the controller with the change in reference speed is simulated and the dynamic performance of the motor is observed. Result show that the dynamic performance of the induction motor is improved. Along with that result shows that the system is not much affected to the disturbance occurring in the system. The induction motor attains adaptability to the system disturbances which proves to be very useful for the robust performance of the motor.

Keywords:- *Fuzzy Logic Controller, Three Phase Induction Motor, Fuzzification, Constant V/F Control.*

I. INTRODUCTION

Most of the motors used nowadays in industries is the three phase induction motor. It has many advantages like self starting capability, rugged performance, satisfactory torque, simple construction and economical. The only disadvantage associated with induction motor is that the speed control of induction motor is quite complex. For its speed control it requires, pole changing, slip changing and frequency changing. The pole changing causes the speed change in steps and though this wide range of speed is not possible. the slip changing requires the variation of rotor resistance which is not possible in the slip ring induction motor. So the only method to obtain wide speed range is the frequency control.

Frequency control can also be done in two manner first is to change frequency keeping the ratio of voltage and frequency constant this will ensure the value of maximum toque to be constant. Secondly varying frequency without keeping the ratio of voltage and speed to be constant but by this way the speed can be increased beyond base speed. But for large load variable v/f speed control cannot be applied.

Various methods had been proposed to control the frequency according to the load demand and reference speed. That method requires the mathematical modelling of the induction motor. In this method the fuzzy logic speed controlling is proposed which requires only the knowledge of speed variation of induction motor with the change of various parameters of the supply.

II. FUZZY LOGIC CONTROL

Fuzzy logic controlling is the intelligent controlling technique by which human like thinking is employed for the controlling purpose. Fuzzy logic controlling requires three stages of the controlling. In every controlling structure there is one reference and one output and it is desired to reduce the difference between the reference and the output (error) as fast as possible. The error signal and the change in error signal are given as the input to the fuzzy logic.

As the fuzzy logic works only according to the linguistic variables the input error signals which are in numeric form are converted to the linguistic variable by the fuzzifier. As the numbers of the fuzzified linguistic variables are increased the number of rules gets increased.

In the second stage knowledge based rules are made to obtain the output control signal in linguistic form. The number of linguistic that the fuzzifier has converted the input increase the number of rules required for obtaining the output variable. In the last stage the output linguistic variables are defuzzifeied and converted to the numeric control signals and the controlling is done accordingly.

III. DESIGNING FUZZY LOGIC CONTROLLER

The block diagram to control the speed of the induction motor is shown in fig 1

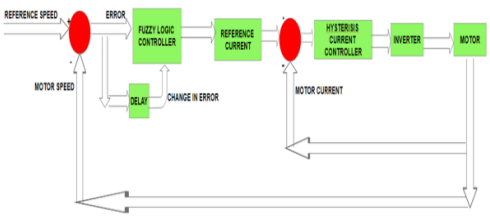

Fig 1:- Block Diagram of Control Structure

As shown in the block diagram the motor speed is taken as the feedback element. The motor speed is compared with the reference speed and the error signal e(k) is obtained. The difference of error signal and unit change in error signal gives the change in error signal ce(k). The signals e(k) and ce(k) is given as the input to the fuzzy logic controller. The inputs are fuzzified in the fuzzy logic controller and proper rules are set. Then according to the rules output is obtained which is then defuzzified to obtain the control signal. The control signal is then used to modify the output frequency and voltage of the inverter to obtain the desired speed.

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IV. SIMULATION DIAGRAM

The simulation diagram is shown in the fig. 2 .As shown the induction motor is fed through the inverter. The input to the inverter is assumed to be a stiff dc source. The motor output speed is taken as a feedback it is compared with the reference speed which can be changed accordingly. The error and change in error input is given to the fuzzy logic controller whose output modifies the control signal according to the need. According to the control signal a three phase reference current waves are generated which acts as a reference current waves and that reference current waves are tracked by suitable gate pulse of the inverter. Here hytersisis current control scheme is utilized to track the reference current.

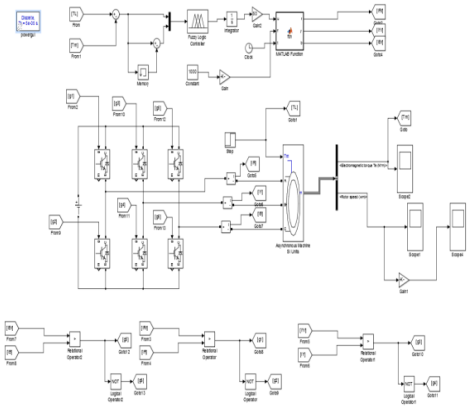

Fig 2:- Simulation Diagram

V. SIMULATION DIAGRAM

To simulate the effect of the disturbance in the speed of induction motor the load torque in a motor is varied the fig 3describes the variation of load torque with time

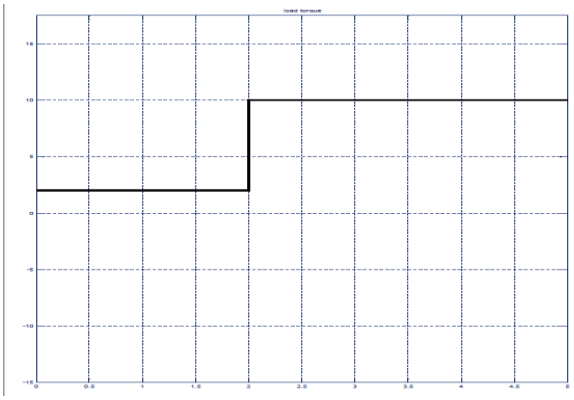

Fig 3:- Variation of Load Torque with Time

Fig 4 , fig 5 , fig 6 describes the fuzzification of the error signal, change in error signal and output variable of the fuzzy logic controller.

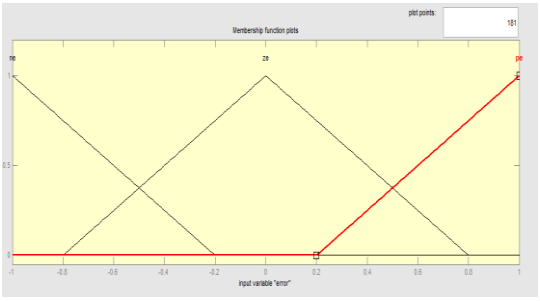

Fig 4:- Membership Plot of Error

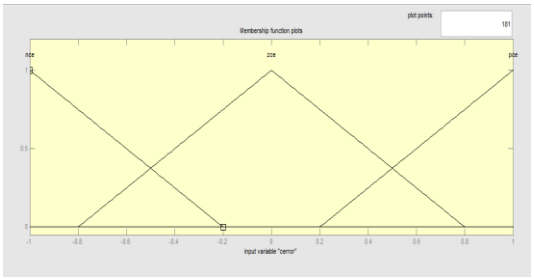

Fig 5:- Membership Plot of Change in Error

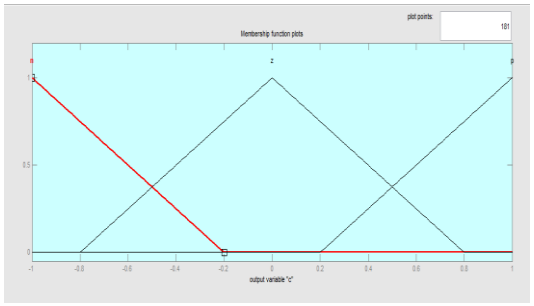

Fig 6:- Membership Plot of Output Variable

Fig 7 describes the rules that are made to obtain the output variable and fig 8 describes the surface view of the rules

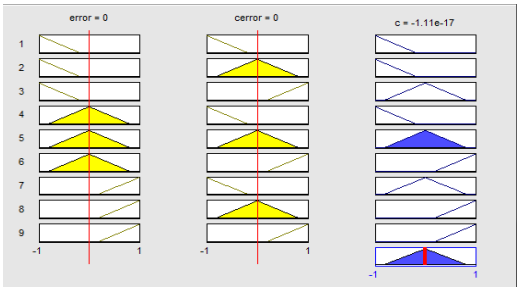

Fig 7:- Rule Viewer Plot

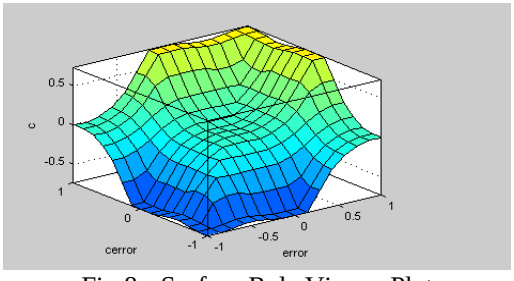

Fig 8:- Surface Rule Viewer Plot

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VI. RESULTS AND DISCUSSION

The figure shows the variation of rotor speed with time. It is seen that the motor quickly settles to the reference speed by adjusting the reference current of the inverter. It is also seen in the intermediate time when there is a load disturbance then there is slight variation in the motor speed but the motor quickly adjusts itself to the steady state value.

Fig 9 describes the variation of motor torque with time. Initially motor torque is less but at the time when load increases the motor torque increases so as the cope up with the load and maintains stability.

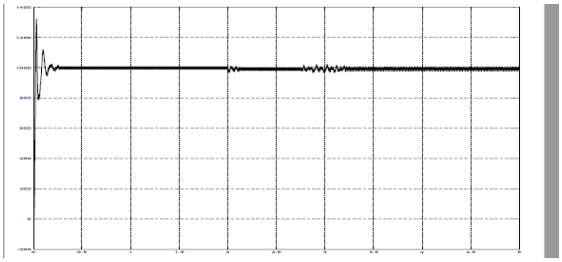

Fig 9:- Variation of Motor Speed with Time

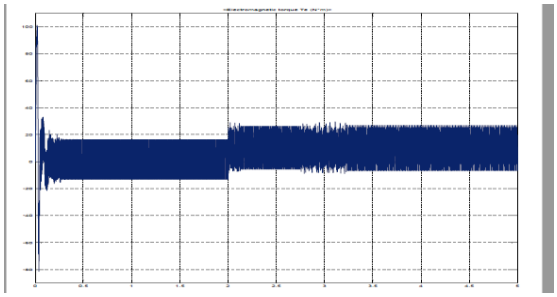

Fig 10:- Variation of load torque with time

From the various result obtained it is evident that the proposed methodology to control the speed of the three phase induction motor is highly dynamic and simple in application. Along with that this control scheme is highly robust that is it is not very much affected by the disturbances occurring in the system. As the complexity in controlling is not very much as the mathematical modelling of the system is not required hence it is simple to be applied and the system is highly adaptable.

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