SPEED CONTROL OF INDUCTION MOTOR USING FUZZY LOGIC : A REVIEW

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Abstract : A three phase induction motor is the most widely used motor in the industries. In this paper a method of controlling the speed of the induction motor by using the fuzzy logic is illustrated. The ida is to use the fuzzy logic to change the frequency of the input to the motor keeping the voltage to frequency ratio constant by using fuzzy logic. Idea of fuzzy logic is illustrated and how it can be utilised to increase the response time of controlling is described.

keywords : Fuzzy Logic, Knowledge Based Decision Making, Fuzzy Logic Control, Three Phase Induction Motor

Introduction : Induction motor is the most widely used mostor in industries **.** due to its simple construction and rugged performance it is the most economical motor in the industries. It operates on AC supply and the only major disadvantage associated with the induction motor is that the speed control is very much tedious. To control the speed it is needed to either change the operating slip,number of poles or the input frequency of the supply.

Among all the methods changing the frequency is the most suitable method as it gives the smooth speed control. Earlier changing the supply frequency was the tedious task but with the advent of fast power electronic devices changing the input frequency became possible.

As by using power electronic devices changing frequency of the input supply became possible it still needs a control system to change the input frequency according to the need of the load connected with the induction motor.

Various researchers gave the methods to control the speed assuming a certain mathematical model of the system but the behavour of the three phase induction motor is not linear so ideal mathematical model of the three phase induction motor is not available.

In this paper using fuzzy logic to control the speed of the induction motor is described. Fuzzy logic works on the linguistic variable. So the error associated with the speed with respect to the reference speed is divided into many linguistic variables nad the proper knowledge of the induction motor allows the fuzzy logic control system to decide the output control signal as per the load requirement just by knowing the actual speed of the motor. Thus by this way without having a proper mathematical model fuzzy logic controlling enables the system to change the speed of the motor to match up with the reference speed and reducing the error with a very fast rate thereby this method aso improves the dynamic performance of the system

Three phase induction motor : A three phase induction motor is an AC motor in which three phase supply is given to the stator in which winding is placed at 120 electrical degree apart. The stator has the three phase distributed winding. The three phase supply creates a rotating magnetic field as shown in figure 1.

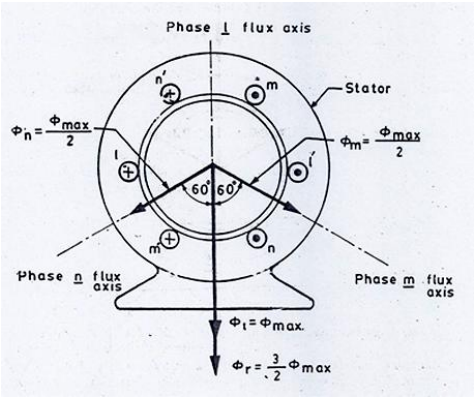

Fig 1 Rotating magnetic field in a three phase induction motor

Three is basically two types of rotor structure for the induction motor. They are slip ring rotor/wound rotor and the squirrel cage induction motor. Figure 2 shows the

structure of squirrel cage and the slip ring induction motor/wound rotor.

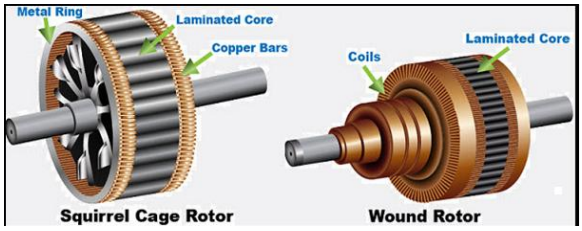

Fig 2 Squireel cage and wound rotor induction motor

The speed of rotating magnetic field is termed as synchronous speed given by

$N_s = \frac{120f}{P}$ here f is the input frequency and P is the number of poles. The flux cut by the rotor conductors due to the rotatingmagnetic field creates a torque which causes the induction motor to rotate but as the torque production requires the relative motion between rotor conductors and rotating magnetic field the rotor speed never attains is speed equal to synchronous speed. The rotor speed of a three phase induction motor is given by

$N_r = (1-s)N_s = (1-s)\frac{120f}{P}$ ----(1)Here s is the slip.

Speed Control of A Three Phase Induction Motor : As seen from the equation 1 there are three methods of controlling the speed of the induction motor that is by changing slip,number of poles or the frequency. Out of these changing the operating slip is possible only in slip ring induction motor as it requires addition of rotor resistance which is possible only in the slip ring induction motor, chaging the number of poles is possible but it will change the speed only in steps as poles can be only in even number 2,4,6 etc. the best method to cahnge the speed smoothly is by changing the supply frequency. It should be kept in mind that changing the supply frequency can cause reduction in motor torque if the ratio of voltage and frequency is disturbed as the motor torque relation is given by

$T\alpha\frac{V}{f}$ --(2)

If the motor torque becomes lesser than the load torque then motor fails to start.

Fuzzy logic control : Fuzzy logic is an intelligent logic system. It involves using logic in terms of lingistic variable. In clasical logic there is a single threshold and the logic involves decision of yes or no according to threshold. In fuzzy logic an input variable is converted into many linguistic variable for different range of the input variable. The logic is applied according to the linguistic variable the output obtained is also linguistic nature. That output is then converted into normal form.

Using a fuzzy logic in control system involves three steps.:

1. The error and the change in error signal is fed into the fuzzy logic control system. The first step in the fuzzy logic control system is to change the input variables into the linguistic variables. This is known as Fuzzification. The number of linguistic variables can be according to the need. As the number of linguistic variables are increased the number of rules made in the second step also gets increased.
2. In the second steps according to the knowledge of the induction motor speed control characteristics the decision making rules are created. The output of the fuzzy logic system is based on the rules made. With proper knowledge if the rules are made then fuzzy logic control is very much dynamic.
3. In the last step thye output control signal that is obtained which is in linguistic form needs to be converted back into numeric form which is done in this stage known as defuzzification .

   The complete steps in the fuzzy logic control can be understood from the following process diagram shown in figure 2.

Fig 3 Fuzzy logic control process

The complete block diagram of the control system is as shown in the figure 4

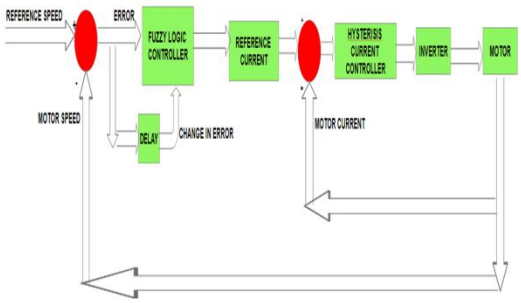

Fig 4 complete block diagram.

Fuzzy logic block. From the fuzzy logic controller block reference current signal is generated which is then compared with the stator current of the motor. Then hysterisis current controller is used to track the reference current and inverter is controlled according to that. The output of the inverter is modified which reduces the error in the speed. All the controlling is on based on the rules made in the fuzzy logic controller block the rules are made such as to reduce the error as fast as possible. by this method fast speed controlling is possible and also the mathematical model of the sinduction motor is also not needed.

Discussion : The method illustrated in this paper can prove to be very much useful in controlling the speed of the induction motor as fast as possible. with the fast computers fuzzy logic control will prove to be a new technology in controlling process and it will reduce the complication associated with the traditional controlling. Also it is an intelligent controlling. In future the controlling can be made adaptible to the changes associated with the system which creates non linearity in the system.

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