SPEED CONTROL OF THREE PHASE INDUCTION MOTOR USING FUZZY LOGIC TECHNIQUE

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***Abstract*:** In this paper "Speed Control Of Three Phase Induction Motor Using Fuzzy Logic Technique", the speed control of three phase induction motor is done by using Fuzzy logic controller (FLC). The supply voltage and the frequency of the induction motor is varied using three phase inverter constructed using power MOSFET. The firing angle of the gate pulse of the inverter is decided by FLC. Deviation in speed with respect to the reference speed and change in speed deviation of the induction motor are considered as the inputs to the FLC. The FLC output is change in switching control frequency of the three phase inverter. The induction motor considered for the simulation is three phase squirrel cage induction motor of rating 2h.p. Matlab Simulink is used for the simulation.

***IndexTerms* – Fuzzy Logic, V/F control.**

I.INTRODUCTION

In recent years, the control of induction motor has become an important research topic and a variety of control methods have been born [1]. This paper proposes a new motor speed control approach based on Fuzzy logic technique. The fundamental laws relating to the speed control of induction motors by simple stator voltage control and emphasizes the problems that may be caused by excessive input currents which cause stator overheating.. The speed control is obtained by varying the stator voltage of the motor [2].

Variable speed Drive (VSD) could be used to control the speed of the induction motor. But its performance depends on the type of the switching technique and controller used in VSD. Generally Pulse width modulation (PWM) switching techniques are used to control the switches of voltage source inverters (VSIs) and thereby regulate the output voltage and frequency to the induction machine. PWM switching techniques include the sinusoidal PWM (SPWM), hysteresis band PWM (HBPWM), and random pulse width modulation (RPWM). Here sine PWM (SPWM) technique is used as the switching technique.

There are two types of control, open loop and closed loop. To get a better dynamic response closed loop control is preferred. There are many controller used in closed-loop, including PID controller[3]. The difficulty faced in using PID controller is that the KP, KI and KD constants should be very accurate and their selection is also difficult [4]. To select appropriate values for P, I and D, we should have knowledge about the system parameters like moment of inertia, inductance, etc. Moreover in PID controller, either the settling time is more or the error is large.

The conventional controllers such as PID and artificial intelligence (AI) controllers such as an artificial neural network [5], adaptive neural fuzzy inference system, and fuzzy logic control are widely used for the drive controllers. Recently Fuzzy logic controller (FLC) [6] is widely used for the speed control and for any decision making. FLC is logic based and partially deterministic. We can merely observe the system and design the controller accordingly. The FLC is a knowledge-based control that uses fuzzy set theory and fuzzy logic for knowledge representation. This paper presents a fuzzy logic controller suitable for speed control of induction motor. This method gets rid of conventional control methods and the algorithm is very simple[7]. This technique is simple in design and the performance of the switching can be improved by the FLC. In this paper FLC based switching sequence and controller is designed. The development of the advanced switching techniques and controllers for the future induction motor drive is considered.

II. V/F CONTROL THEORY:

Speed control of induction motor can be done either from the stator or from rotor side. For squirrel cage induction motor, stator side control is only possible. The control from stator is,

- By changing the applied voltage method
- By changing the applied frequency method
- By changing the no of stator poles method
- By changing the applied voltage and frequency (V/F) method

In the above methods V/F control is the efficient and the safest method of control of induction motor.

The expression for the air gap flux is given by

$$Bg = \frac{1}{4.44KTph}(V/f) \qquad (1)$$

where, K= stator winding constant, T_{ph}= stator turns per phase, V = supply voltage and f =supply frequency.

From Eq. 1, if the supply frequency f is changed, the value of the air gap flux also gets affected and leads to saturation of stator and rotor cores. This increases the no load current. So to maintain air gap flux constant, the supply voltage V is also increased. By varying the voltage and the frequency and at the same time by keeping their ratio constant, the torque developed can be kept constant through the speed range [8].

III. FUZZY LOGIC CONTROLLER

Controller like PID is extensively used because of tits simple design. However, the disadvantage of using the PI controller is the difficulty in finding the best values of the PI controller parameters. FLC is popular because of their simplicity, and cheap implementation in the speed controller of three phase induction motor drive. Fuzzy logic controllers have three components: (1) Fuzzification, (2) Rule Base and (3) Defuzzification.

Fuzzification is the process of making a crisp quantity fuzzy. It considers the uncertainty. The RULE BASE use several variables both in the condition and the conclusion of the rules. Basically a linguistic controller contains rules in if – then format. A sample of the rule is given by Eq, 2.

If error is (.......) and change in error is (.........) then output is (........) (2)

Defuzzification is the process of converting a fuzzy quantity to a precise quantity. The output of a fuzzy process can be logical union of two or more fuzzy membership functions defined on the universe of discourse of the output variable. In this paper FLC is used to generate the firing pulse for the inverter circuit.

IV. THREE PHASE INVERTERS

Three phase inverters are normally used for high power applications. Three single phase, half or full bridge inverters can be connected in parallel, to form the configuration of three phase inverter. The gating signals of signal phase inverters should be advanced or delayed by 120 degree with respect to each other to obtain, three phase balanced voltage.Two types of control signals can be applied to the MOSFETS. (a)180^o conduction or (b) 120^o conduction. In 180^o conduction, each MOSFET conducts for 180 degree. Three MOSFETs remain on at any instant of time. The gating signal to the MOSFETs are shifted from each other by 60 degree to get three phase balanced voltages. In 120^o conduction **,** each MOSFET conducts for 120 degree and at any instant of time only two MOSFETs remain ON.

Voltage source inverter allows a variable frequency supply to be obtained from DC supply. In this method, a fixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the on and off periods of the inverter components. It is the most efficient method of internal control of inverter. The advantages possessed by PWM technique are the output voltage control with this method can be obtained without any additional components, and low order harmonics can be eliminated easily. Compared to other types of modulation Sinusoidal pulse modulation, is preferred since in this modulation the distortion factor and lower order harmonics are reduced significantly. The block diagram representation of the controller along with the induction motor is shown in Figure (1).

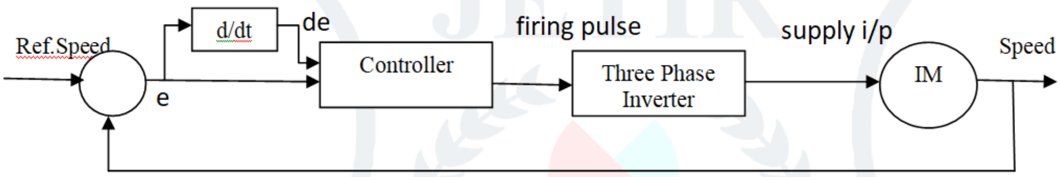

Figure (1). Block diagram representation of the controller wiith the induction motor.

V. SIMULATION

The induction motor considered for the simulation is three phase squirrel cage induction motor of rating 2h.p. The reference speed set is 1200 rpm. In FLC, Mamdani type is implementaed. The triangular membership function with five variables Negative Big (NB), Negative Small (NS) Zero (ZE) Positive Small (PS) Positive Big (PB) are considered for input and output variables. The rule base considered for the simulation is given in Table 1. Centroid method is used for defuzzification. Matlab Simulink is used for the simulation. Figure (2) represents the simulink diagram for the speed control of three phase induction motor using FLC. Figure (3) shows the firing pulses to the inverter circuit, obtained from the FLC. The output, speed of the induction motor is shown in figure (4). The output shows the induction motor attains the reference speed.

Table 1. Rule Base

e \ ė	NB	NS	ZE	PS	PB
NB	NB	NB	NB	NM	ZE
NS	NB	NM	NS	ZE	PS
ZE	NB	NS	ZE	PS	PB
PS	NS	ZE	PS	PM	PB
PB	ZE	PM	PB	PM	PB

VI. CONCLUSION

The speed control of three phase induction motor using Fuzzy logic is discussed. The required speed of the induction motor is obtained by varying the firing pulses of the three phase inverter constructed using power MOSFET. The firing angle of the gate pulse of the inverter is decided by FLC. Error in speed and the change in speed deviation of the induction motor are considered as the inputs to the FLC. The output response of the induction motor indicates how it obtained the set speed.

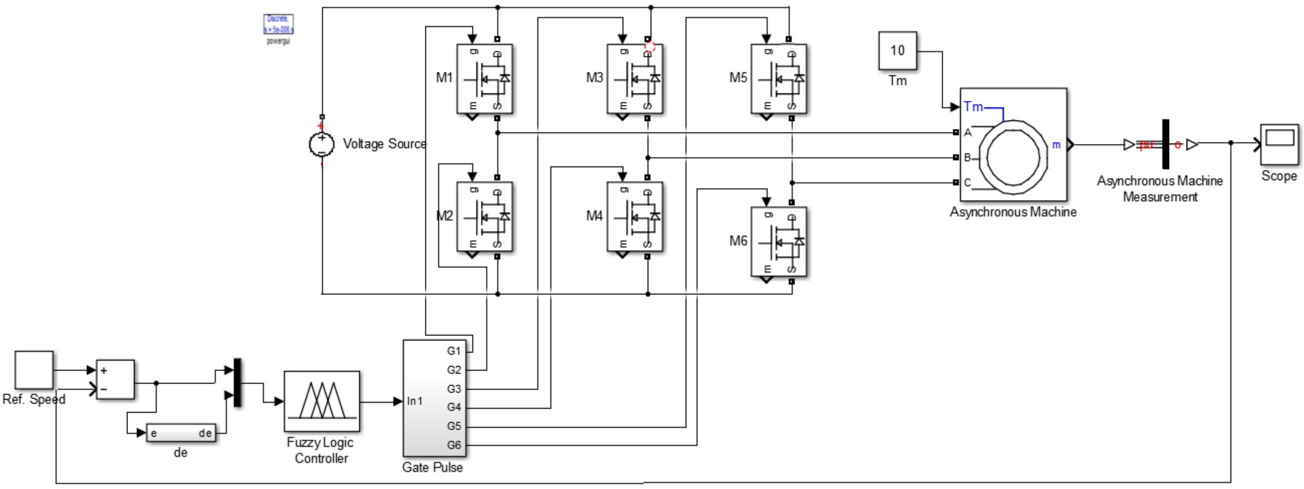

Figure (2). Simulink diagram of fuzzy logic based speed control of induction motor

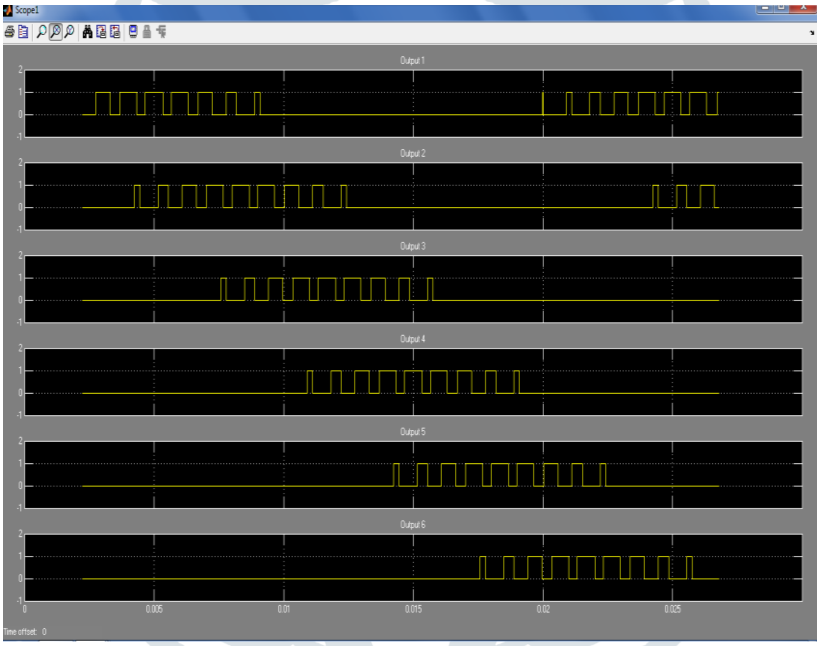

Figure (3). Firing pulse of inverter unit.

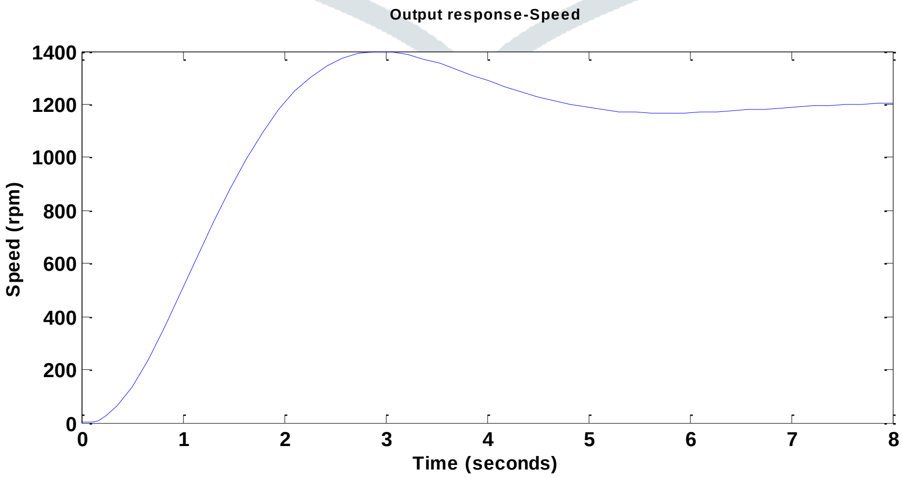

Figure (4). Output response for reference speed of 1200rpm

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