



SPEED CONTROL OF INDUCTION MOTOR USING FUZZY LOGIC CONTROLLER

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ABSTRACT

This Paper presents the theory, design and simulation of a fuzzy logic based controller used for an indirect vector controlled three-phase induction motor. The analysis, design and simulation of the fuzzy logic controller for IVCIM drive system are carried out based on the fuzzy set theory. The FLC algorithm has been simulated on simulink Toolbox in Matlab. The performance of the proposed FLC has been investigated and compared to the results obtained from the conventional PI controller based drive at different operating conditions such as sudden change in load. The simulation results demonstrate that the performance of the FLC is better than for the conventional PI controller.

Keywords :- Induction motor drives, Speed control, Fuzzy Logic controller, Matlab/Simulink software

INTRODUCTION

Ac Induction motors are being applied today to a wider range of applications requiring variable speed. Generally, variable speed drives for Induction Motor (IM) require both wide operating range of speed and fast torque response, regardless of load variations. This leads to more advanced Control methods to meet the real demand. The conventional control methods have many difficulties.

Advanced control based on artificial intelligence technique is called intelligent control. Every system with artificial intelligence is called self-organizing system. Artificial intelligent techniques divide two groups: hard computation and soft computation. Expert system belongs to hard computation which has been the first artificial intelligent technique. In recent two decades, soft computation is used widely in electrical drives. They are,

1. Artificial Neural Network (ANN)
2. Fuzzy Logic Set (FLS)
3. Fuzzy-Neural Network (FNN)
4. Genetic Algorithm Based system (GAB)
5. Genetic Algorithm Assisted system (GAA)

Fuzzy logic is a technique to embody human-like thinking into a control system. A fuzzy controller can be designed to emulate human deductive thinking, that is, the process people use to infer conclusions from what they know. Fuzzy control has been primarily applied to the control of processes through fuzzy linguistic descriptions. Fuzzy control system consists of four blocks as shown in. This paper deals about the sandwich of artificial intelligence technique particularly fuzzy logic in the speed control of Induction motor.

I. DIRECT FUZZY LOGIC CONTROL TO I.M.

Fuzzy logic has been widely applied in power electronics systems. Application includes speed control of dc and ac drives. Here the concept of fuzzy logic has been applied to vector control induction motor drive.

The fuzzy logic controller has been designed using Fuzzy Inference System Editor provided in MATLAB.

The following step should be followed for constructing the FIS.

Step 1 : Open the FIS editor and edit the membership function

for the input and output as shown in the figure. Select the Mamdani or Sugeno method, fuzzification method, and defuzzification method.

The FIS editor displays general information about fuzzy system. A fuzzy logic controller has been designed with 2 inputs (error and rate of change of error) and one output as shown in figure.

In the FIS editor (choose either Mamdani or Sugeno model), we choose triangular membership function, and we can set the linguistic variables. The connective rules are formed and based on these rules the fuzzy associative memory table is formed. Also choose fuzzification method and defuzzification method. For each of the following we define the ranges from the data obtained and then we use the triangular membership functions and have four such membership functions for each FIS variable.

Step 2 : Click the input variable and edit the membership function as shown below

2.1 Error Signal

The MF editor displays and permits editing of all the MFs associated with the input and output variables. Range for the error signal (input 1) is taken [-1 to 1]. The shape for the input (error) signal is triangular. Figure 6.4 show the membership function for error signal.

Mf1: This membership function is designed as PB (Positive Big) and its range is from -0.058 to 0.185. [0.6 1 100].

Mf2: This membership function is designed as PM (Positive Medium) and its range is [0.4 0.7 1].

Mf3: This membership function is designed as PS (Positive Small) and its range is [0 0.3 0.6].

Mf4: This membership function is designed as ZE (Zero) and its range is from 0.5855 to 0.8. [-0.02 0 +0.02].

Mf5: This membership function is designed as NS (Negative Small) and its range is [-0.6 -0.3 0]

Mf6: This membership function is designed as NM (Negative Medium) and its range is from 0.5855 to 0.8. [-1 -0.7 -0.4]

Mf7: This membership function is designed as NB (Negative

Big) and its range is from 0.5855 to 0.8. [-100 -1 -0.6]

2.2 Change of Error Signal

The MF editor displays change in error (input 2) . Range for the error signal is taken [-1 to 1]. The shape for the input (change in error) signal is triangular.

The designed and range of Membership function of rate of change of error signal (input 2) is same as error signal (input 1).

Step 3: Click the output variable and edit the member ship function as shown below.

The MF editor displays output signal (output 1). Range for the error signal is taken [-1 to 1]. The shape for the input (change in error) signal is triangular. The designed and range of Membership function of Torque (output 1) is same as error signal (input 1).

Rules for the Fuzzy System (Rule Editor)

From the physical operation principal of the system, a simple control rule can be written in fuzzy logic as: If E is near zero (ZE) AND CE is slightly positive (PS) THEN the controller output U is small negative (NS).where E and CE are the input fuzzy variables, U is the output fuzzy variables, and ZE, PS, NS are the corresponding fuzzy set membership functions (MFs). The implication of this fuzzy control can be done by triangular MFs. The fuzzy sets are defined follows:

Seven MFs are chosen for E, CE and U signals. All the MFs are symmetrical for positive and negative values of the variables. Thus, maximum $7 \times 7 = 49$ rules can be formed as tabulated Table 1.

Step 4 : Edit the rule base by clicking the rule base from view menu. For our system we have defined seven membership functions .The rules shown above are for the seven membership functions . Greater the number of membership functions greater will be the accuracy. As far as the seven membership functions are concerned, there are 49 rules possible, but considering our system, we have defined 25 rules

TABLE – 1

E	NB	NM	NS	ZE	PS	PM	PB
CE							
NB	ZE	PS	PM	PB	PB	PB	PB
NM	NS	ZE	PS	PB	PB	PB	PB
NS	NM	NS	ZE	PM	PB	PB	PB
ZE	NB	NB	NS	ZE	PM	PB	PB
PS	NB	NB	NB	ZE	ZE	PS	PB
PM	NB	NB	NB	NM	NS	ZE	PS
PB	NB	NB	NB	NB	NM	NS	ZE

Step 5 : To view the rule viewer go to the view and click rule viewer. According to the rules defined, we have a surface viewer and rule viewer in MATLAB.

Step 6 : To view the surface viewer go to the view and click surface viewer.

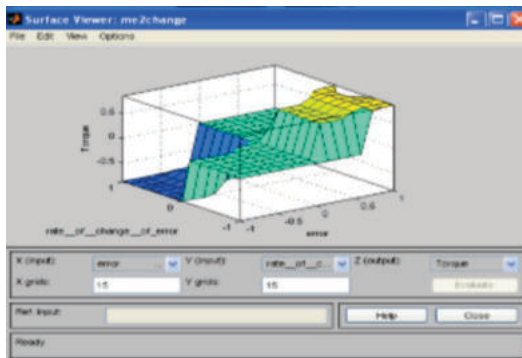


Figure 1: Surface viewer

II. DESIGNED OF PROPOSED FUZZY LOGIC CO-N-TR-OLLER

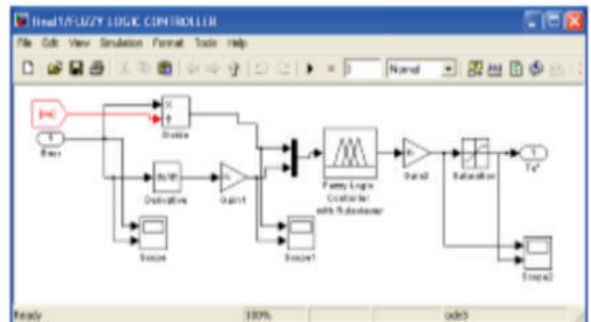


Figure 2: Fuzzy logic controller

III. Simulation

The vector control induction motor has been simulated using PI and Fuzzy controller in SIMULINK/MATLAB as shown below.

Vector control based speed control of I.M using Fuzzy Logic controller

The vector-control method has been optimized by using fuzzy controller instead of a simple PI controller. The presented hybrid controller combines the benefits of fuzzy logic and vector-control, than it's know as Hybrid controller based intelligent speed control of induction motor.

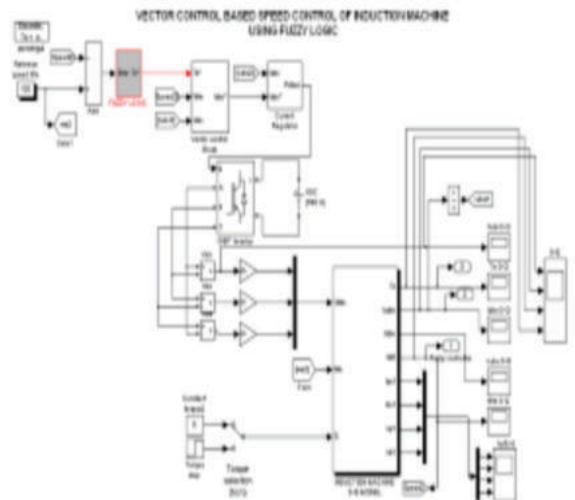


Figure :3 Vector control based speed control of I.M using Fuzzy Logic.

IV. SIMULATION RESULT

[A] Starting Current Response

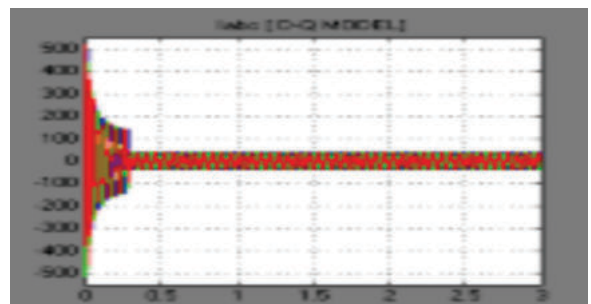


Figure 4: Fuzzy Controller Starting Current

[B] Speed Response

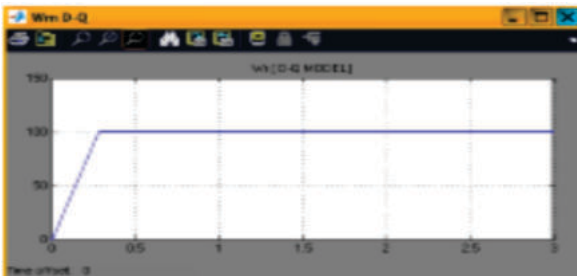


Figure 5: Fuzzy Controller Speed response

[C] Torque Response

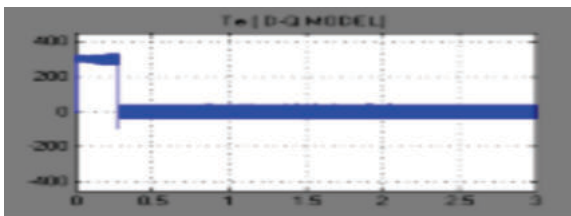


Figure 6: Torque response of Fuzzy Controller.

[D] Sudden increase in command speed response

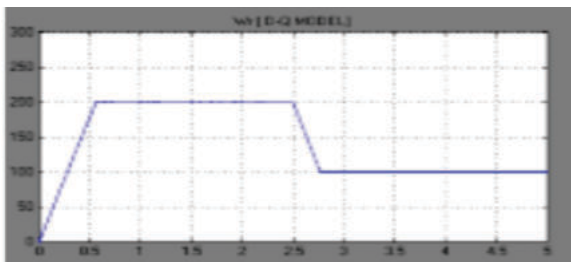


Figure 7: Change of speed command response of Fuzzy Controller

CONCLUSION

Thus, by using fuzzy controller the transient response of induction machine has been improved greatly and the dynamic response of the same has been made faster. The robustness in response is evident from the results. Since exact system parameters are not required in the implementation of the proposed controller, the performance of the drive system is robust, stable, and insensitive to parameters and operating condition variations. The performance has been investigated at different dynamic operating conditions.

REFERENCES

[1] "High performance induction motor Drive system using Fuzzy Logic controller" By N.B.Muthuselvan, Subharansu Sekhar Dash IEEE-2006 (1-4244-0549).
[2]"Hybrid controller based intelligent speed control of induction motor" by vinod kumar and R.R.Joshi JATIT -2005.[3]A fuzzy logic based controller for an indirect vector controlled three-phase induction motor by Norman Mariun, Samsul Bahari Mohd Noor, Jasronita Jasni, Omar S. Bennanes, IEEE -2004- 0-7803-8560-8/04.[4]Approach to fuzzy control of an indirect field-oriented induction motor drives by Hakju, Lee, Jaedo,lee – 0-7803-7090-2/101 IEEE- 2001.[5]Fuzzy logic application for intelligent control of induction motor drives by Yifan Tang , Longya Xu , IEEE- vol.94, No.4 1994.