Torque Control of Three Phase Induction Motor using Fuzzy Controller in Lab View

S.Sridivya[1]
[1]*MTech Student Department of Electrical Engineering, GRIET, Hyderabad-500072*

Abstract: The aim of this thesis is to provide efficient and simple method for Torque control of Induction Motor using Fuzzy Logic controller based on Lab VIEW environment. The induction motors have wide range of applications for due to its well-known advantages like brushless structures, low costs and robust performances. Most of its applications need fast and intelligent speed control system. This project presents a rule-based fuzzy logic controller in Lab VIEW applied to a scalar closed loop Volts/Hz control Induction motor to achieve maximum torque and efficiency. The motor model is designed and membership functions are chosen according to the parameters of the motor model. The control design is tested using various tool boxes in Lab VIEW. By using the graphic programming environment Lab VIEW, complex high performance applications can be done, at relatively low costs. The result concludes that the reliability of the proposed torque controller is satisfactory.
Keywords: Lab View software, Induction motors, scalar v/f control, DAQ NI USB 6008, Fuzzy system, Fuzzy logic controller, Membership Functions.

I. INTRODUCTION

The use of induction motors has increased tremendously since the day of its invention. They are being used as actuators in various industrial processes, robotics, house appliances and other similar applications. The reason for its day by day increasing popularity can be primarily attributed to its robust construction, simplicity in design and cost effectiveness. These have also proved to be more reliable than DC motors. Apart from these advantages, they have some unfavorable features like their time varying and non-linear dynamics. The highly non-linear nature of the induction motor control dynamics demands strenuous control algorithms for the control of speed and torque. The controller types that are regularly used are: Proportional Integral (PI), Proportional Derivative (PD), Proportional Integral Derivative (PID), Fuzzy Logic Controller (FLC) or a blend between them. Fuzzy logic may be viewed as form of set theory. At the present time, Lab VIEW simplifies the scientific computation, process control, research, industrial application and measurement applications. Because Lab VIEW has the flexibility of a programming language combined with built-in tools designed specifically for test, measurement, and control. By using the integrated Lab VIEW environment to interface with real-world signals, analyze data for meaningful information, and share results.

In this paper, we have presented method to torque control of induction motor using fuzzy logic system in Lab VIEW. Here we are connected DC generator to AC motor so as to load it. The fuzzy logic controller is designed in Lab VIEW. The inputs for the controller are reference current and the actual current of the stator. And this current is measured by creating a closed loop torque control. The FLC gives the control voltage based on the fuzzy rule base of reference current and actual current of the stator. This control voltage is given to the AC drive through the DAQ. Fuzzy controller generates a control signal for AC drive by reducing error between reference current and actual current. The bulbs are connected as a load to the dc generators by relays and they are operated by using pushbutton switches in Lab VIEW. The torque response of induction motor as a result and hardware kit components and Lab VIEW software are explained in the further part of the paper.

II. FUZZY LOGIC CONTROLLER

Over In application Fuzzy Logic has met a tremendous interest in application over past few years, and almost among manufacturers of control equipment**.** Fuzzy Logic was initiated in 1965 by Lotfi A. Zadeh, professor for computer science at the University of California in Berkeley. Basically, Fuzzy Logic (FL) is a multi valued logic that allows intermediate values to be defined between conventional evaluations like true/false, yes/no, high/low, etc. Notions like rather tall or very fast can be formulated mathematically and processed by computers, in order to apply a more human-like way of thinking in the programming of computers.

A Fuzzy system is a system of variables that are associated using fuzzy logic. A Fuzzy controller uses defined rules to control a fuzzy system based on the current values of input variables. Fuzzy systems consist of three main parts: A) Linguistic variables B) Membership functions C) Control rules. Linguistic variables represent, in words, the input variables and output variables of the

system you want to control. Linguistic terms represent, in words, categories for the values of a linguistic variable. Membership functions are numerical functions corresponding to linguistic terms. A Membership function represents the degree of membership of linguistic variables within their linguistic terms. The degree of membership is continuous between 0 and 1, where 0 is equal to 0% membership and 1 is equal to 100% membership. Control rules describe, in words, the relationships between input and output linguistic variables based on their linguistic terms. A fuzzy system is a system of variables that are associated using fuzzy logic. A fuzzy controller uses defined rules to control a fuzzy system based on the current values of input variables.

The process of fuzzy logic controller consists of a) Fuzzification b)Implementation of a Linguistic control strategy c) Defuzzification. Fuzzification is the process of associating crisp, or numerical, input values with the linguistic terms of the corresponding input linguistic variables. After a fuzzy controller fuzzifies the input values of a fuzzy system, the fuzzy controller uses the corresponding input linguistic terms and the rule base to determine the resulting linguistic terms of the output linguistic variables. The degree of support can be specified for each rule of a fuzzy system. The weight of a rule is equal to the degree of support multiplied by the truth value of the aggregated rule antecedent. The fuzzy controller uses an implication method to scale the membership functions of an output linguistic variable based on the rule weight before performing defuzzification. Defuzzification is the process of converting the degrees of membership of output linguistic variables within their linguistic terms into crisp numerical values. A fuzzy controller can use one of several mathematical methods to perform defuzzification. The most accurate defuzzification method for a fuzzy controller varies based on the control application
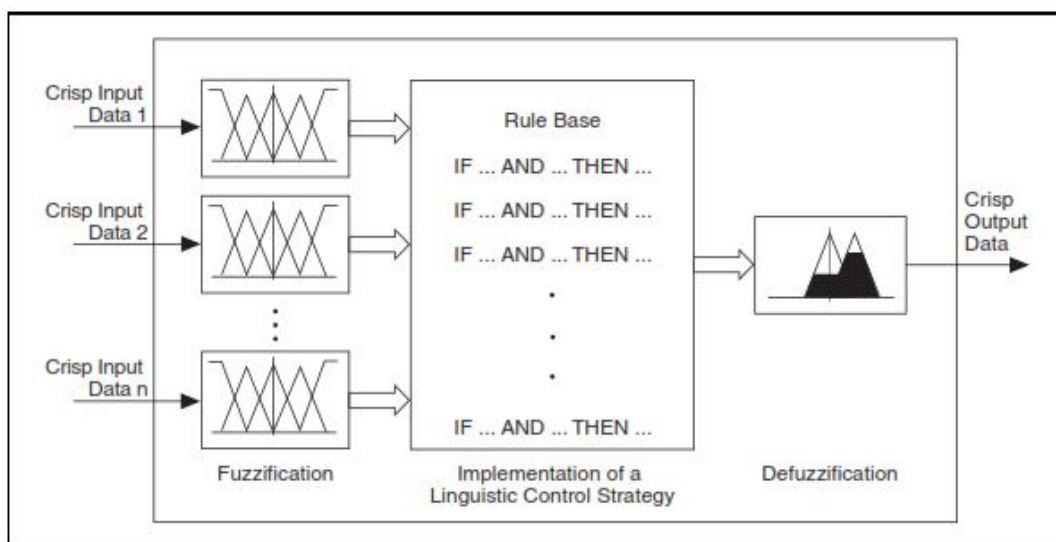

Fig .1. Block diagram of Fuzzy Logic Controller.

A.   Advantages of Fuzzy Logic Controller

It can work with less precise inputs , doesn't need fast processors, needs less data storage in the form of membership functions and rules than the conventional look up table for nonlinear controllers and is more robust than other non-linear controllers. The fuzzy logic approach offers a simpler, quicker and more reliable solution that is clear advantages over conventional techniques.

III.   TORQUE CONTROL OF THREE PHASE INDUCTION MOTOR USING Lab View

The torque is produced by interaction between two rotating magnetic fields with relative speed between them is zero but the two rotating magnetic fields must have relative space difference between them. V/F Control is the most popular and has found widespread use in industrial and domestic applications because of its ease-of-implementation The V/F controlled drives parameters are independent, easy to implement and low cost but they are classified as inferior performance of electrical drives. Scalar controlled drives give somewhat inferior performance than the other control schemes but they are the easy to implement. In V/F control methods, the stator voltage is adjusted in a part of the supply frequency, except for low and above base speeds. At low frequency operation the voltage drop across stator resistance must be taken into account. The simplest stator resistance compensation method consists of boosting the stator voltage to compensate the voltage drop across the stator resistance. However, it is not easy to determine the boost voltage as it is easy to get flux saturated .However; it has inferior dynamic performance compared to vector control.

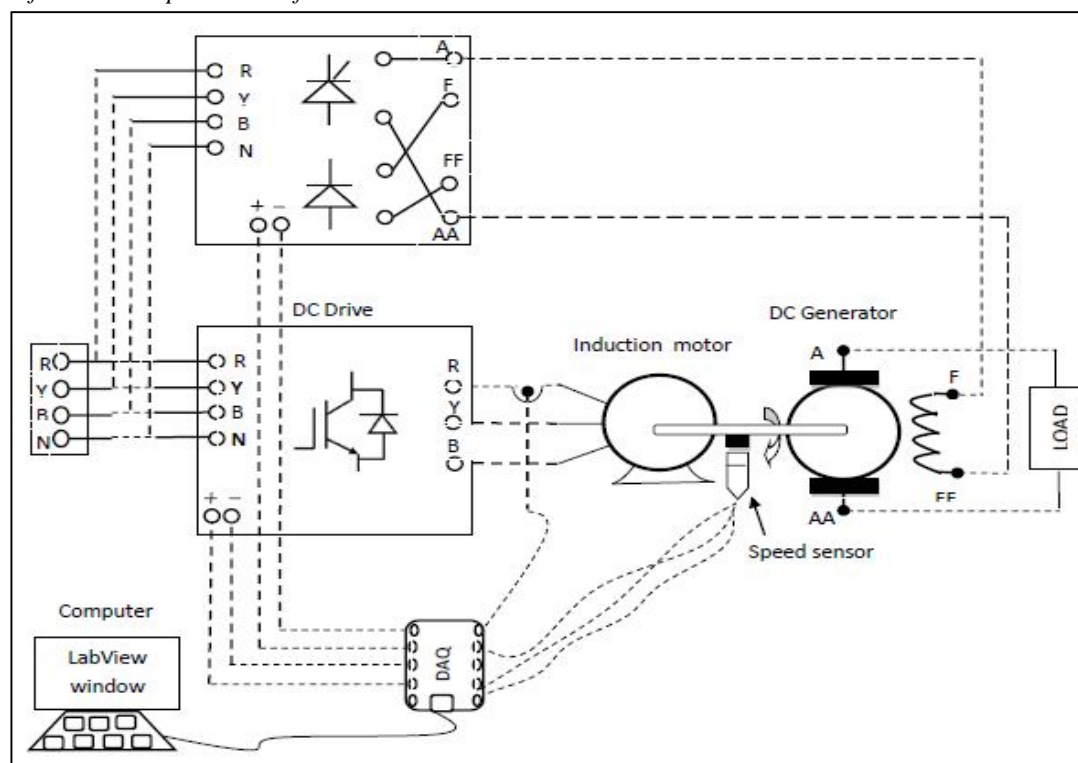*A. Block Diagram Of Closed Loop Control Of Induction Motor*

Fig .2. Block diagram of closed loop control of induction control using Lab View.

In the above system supply terminals are connected to AC and DC drives, and these drives are controlled by DAQ. The PWM inverter is used to produce required output voltage to feed the AC drive system. The rectifier- inverter combination is used in drive systems for speed and performance control along with the reduction of ripples and harmonics. The rectifier circuit is connected to the field terminals of the dc generator to produce the required flux. The PWM inverter circuit is connected to the ac induction motor so as to produce the ripple free sinusoidal input to the ac motor terminals. Speed sensors are present at the shaft this actual speed is compared with the reference speed to attain the speed control or required speed. As the shafts of induction motor and dc generator are coupled, so the load applied to the dc generator indirectly acts as a load to the induction motor. The output current of inverter is taken as feedback and controlled by fuzzy logic controller of Lab View. The reference and actual currents of the inverter output current are compared by the fuzzy controller and the output voltage obtained is used to control the torque of induction motor. The fuzzy rules are designed in fuzzy system designer by considering reference current, actual current and output voltage values. These values are obtained by keeping the generator field voltage at maximum and by varying the current value of motor, indirectly varying the load value output voltage is noted, by which the torque control of induction motor is done.

IV.   LAB VIEW SIMULATION AND RESULTS

Lab VIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming environment suited for high-level or system-level design. The programming language used in Lab VIEW, also referred to as G, is a dataflow programming language. Lab VIEW ties the creation of user interfaces (called front panels) into the development cycle. Lab VIEW programs/subroutines are called virtual instruments (VIs). Each VI has three components: a block diagram, a front panel and a connector panel. In this project the Fuzzy Logic controlled is designed in Lab VIEW. The output of FLC is control voltage applied to the AC Drive circuit through DAQ.

A. Designing Fuzzy Logic Controller in Lab VIEW

The Fuzzy Logic Controller are the actual speed of the rotor ω_a & reference speed ω_r. the speed of the rotor is sensed by the speed sensor. In order to create the membership functions, It needs the data. The block diagram is created in Lab VIEW block diagram.vi

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to get the data that how the speed of the rotor varies with varying the control voltage knob in Lab VIEW front panel. The block diagram and the front panel are shown in figures.

Fig 3 . Block diagram for Data in Fuzzy Logic Controller.

Fig 4: Front panel diagram for Data

B. Fuzzy System Design in Lab VIEW

The operation of a FLC is based on heuristic knowledge and linguistic description to perform a task. The performance of the FLC is then improved by adjusting the rules and membership function. The designed FLC consists of three components. a) Fuzzification of input values b) Fuzzy inference c) Defuzzification of fuzzy output. Fuzzification block transforms crisp input signal to linguistic variable, fuzzy inference handles the rules to infer the output contributed from each rule and defuzzification block transforms linguistic output to crisp output signal.

Fig 5: Membership Functions in Fuzzy System Designer

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C. Control Rules

The collection of rules is called a rule base. The fuzzy inference operation is implemented by using the 36 rules.

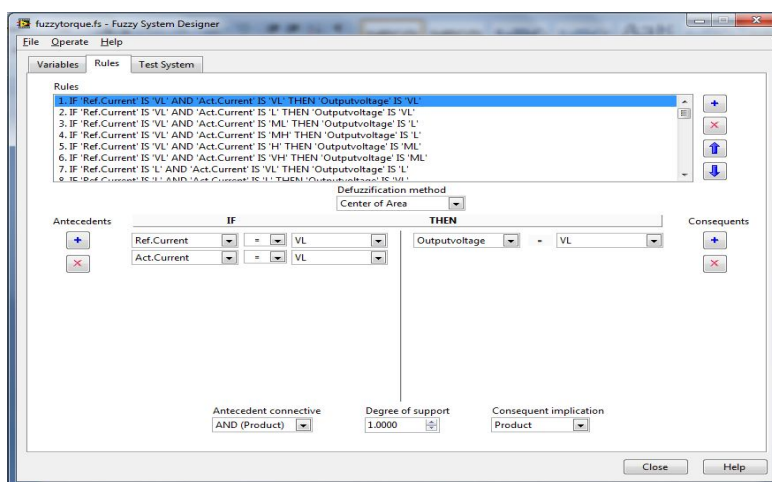| RI \ AI	VL	L	ML	MH	H	VH
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L	L	L	L	L	ML	H
ML	L	ML	ML	ML	MH	H
MH	ML	ML	MH	MH	MH	H
H	MH	MH	H	H	H	H
VH	H	H	MH	VH	VH	VH

Fig 6: Control Rules in Fuzzy System Designer

D. Results

The path of the Fuzzy System Designer is given to the Fuzzy Logic Controller block in the block diagram. The block diagram of the project is shown in Fig and the front panel is shown in Fig.
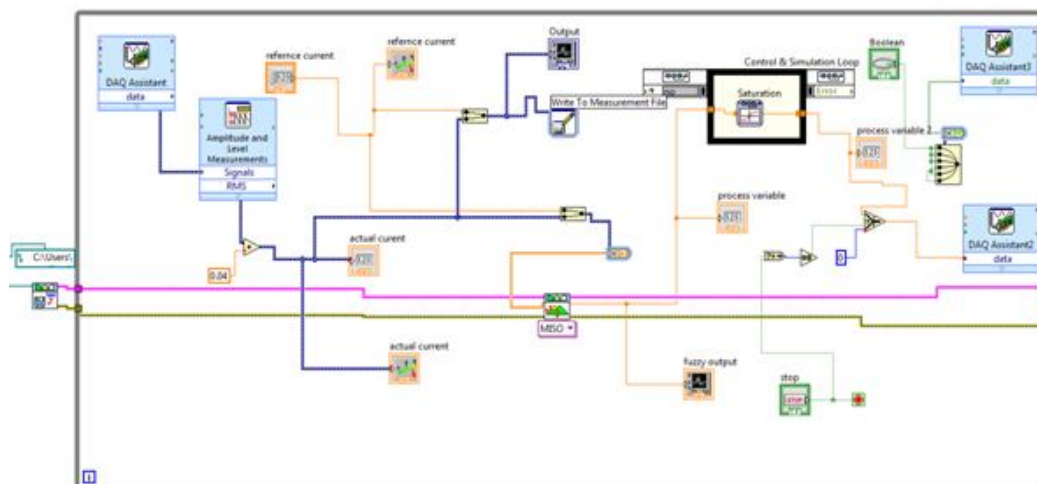

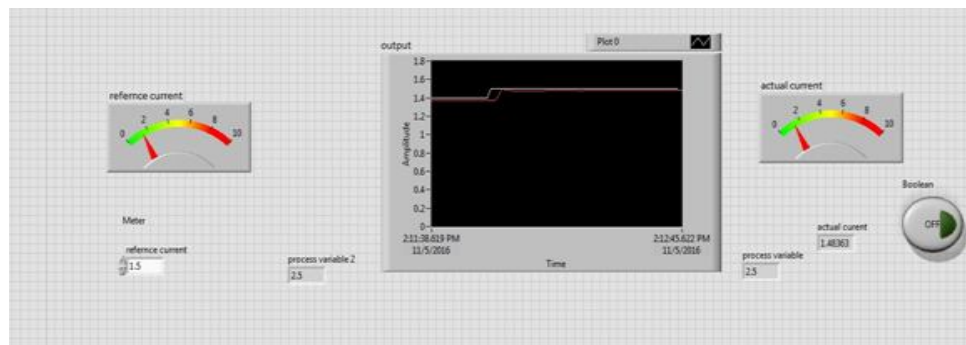Fig 7: Block Diagram of the paper in Lab View

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Fig 8: Front panel of the paper in Lab View

E. Hardware Setup

V. CONCLUSION

In this paper, Torque control is done by constant V/F method. Torque of Induction motor is controlled by varying the current value. The reference current is set in lab VIEW and Fuzzy Logic Controller is designed in such a way that to reduce the error between the reference current and actual current. From the results of the experiment we can conclude that by using FLC, the response of the output is fast and flexible.

VI. FUTURE SCOPE

In this paper, torque control of induction motor using Fuzzy controller has been explained. In future, torque response of the system can be improved by Fuzzy PID controller.

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Expansion for this project can be done by extension of analog quantities like over current protection, thermal protection.

By connecting required number of electrical devices, it can extend to develop the SCADA system and those types of systems are more reliable.

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