Speed Control of Three Phase Induction Motor Drive using Automatic Sensing Controller Based on Fuzzy Logic

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Abstract : Over the years, induction motors have been reliable choice in industry for electromechanical device. On account of its robust construction, low maintenance cost and wide range of load carrying capacities they found a wide range of applications. Typical industrial applications include generators, fan loads, and compressors. Motor starting on isolated or vulnerable grid systems is a highly unstable process which may cause harm to motor and load. The induction motor draws reactive lagging currents during steady-state operation, and is subjected to variable grid voltages that decrease motor working performance and life expectancy. To improve motor performance and overall system efficiency, soft start and speed control methods are available which are often referred as electrical drives and particularly for the system under consideration, as induction motor drives. The conventional induction motor drives are made intelligent with modern PWM and closed loop control techniques. This paper explores fuzzy logic based speed control of three phase induction motor. MATLAB simulation and results are explained

***Index Terms* - Three phase induction motor, fuzzy logic, speed control, PWM.**

I. INTRODUCTION

The control of high-performance induction motor drives has gained widespread interest in research in recent years. It has been more valued not only because it is the industry's most used engine, but also because of its various modes of operation. It also has excellent self-starting ability, simple, robust design, low cost and reliability, etc. Its low susceptibility to disruption and maintenance-free operation is the primary property that makes it more useful for industries. There are also some drawbacks, despite the many advantages of the induction motor. Just as the constant speed engine is not true, the slip varies from less than 1% to more than 5%. It is also not capable of operating at variable speeds. But because it is so helpful for industries, we need to find a solution to solve these limitations, and the solution is a speed controller that can take the necessary control measures to provide the speed needed. It can control different parameters of the induction machine, such as flux, torque, voltage, stator current and not just speed. Out of several induction speed control techniques such as pole no change, rotor resistance control, stator voltage control, slip power recovery scheme and constant V/f control, the most popular method used for speed control is the closed loop constant V/f speed control method. The V/f ratio is kept constant in this method, which in turn maintains the constant of magnetizing flux that eliminates the harmonic problem and also does not change the maximum torque. So, it's a kind of complete motor utilization. And conventional P-I controllers, and fuzzy logic controllers, are the controllers used.

II. SPEED CONTROL METHODS OF INDUCTION MOTOR

The speed of induction motor can be controlled from rotor side or stator side. The stator side speed control strategies are [1- 4]

- Changing the number of stator poles
- Controlling supply voltage
- Controlling supply frequency
- V / f control or frequency control

The speed controls of three phase induction motor from rotor side are further classified as:

- Adding external resistance on rotor side.
- Cascade control method.
- Injecting slip frequency emf into rotor side.

Out of the above speed control methods, V/F speed control is widely used

III. Fuzzy Logic based Speed Control

Fuzzy logic is a logic system that is intelligent. In terms of linguistic variables, it involves using logic. There is a single threshold in classical logic, and logic involves the choice of yes or no according to the threshold. An input variable in fuzzy logic is converted into many linguistic variables for different input variable ranges. The logic is applied according to the linguistic variable that is also linguistic in nature, the output obtained. The output is then transformed into normal form.

By using automatically sensing controller based on fuzzy logic instead of the conventional PI controller, excellent control performance can be achieved even though there is change in external parameters and effect of nonlinear loads on drive performance [5].

Three steps are required to use fuzzy logic in the control system

1. The error and error signal change is fed into the fuzzy logic control system. The first step is to change the input variables into linguistic variables in the fuzzy logic control system. This is called as Fuzzification. Depending on the need, the number of linguistic variables can be As the number of language variables increases, the number of rules made in the second stage also increases
2. The decision-making rules are developed in the second steps according to the knowledge of the induction motor speed control characteristics. The output of the fuzzy logic system is based on the rules that have been produced. If the rules are made with proper knowledge, then fuzzy logic control is very dynamic.
3. The output control signal that is obtained in linguistic form must be converted back into a numerical form in the last stage, known as de-fuzzification, which is done in this stage. In the following process diagram shown in Figure 1, the complete steps in fuzzy logic control can be understood.

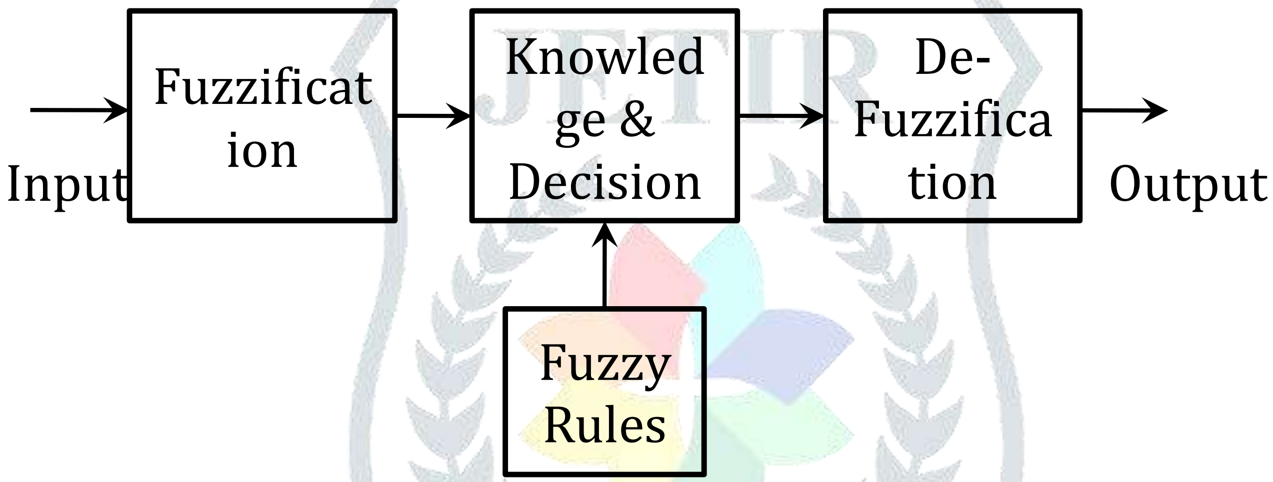

Figure 1: typical fuzzy logic controller

IV. MATLAB Simulation & Results

The speed control of three phase induction motor with fuzzy logic controller is implemented through MATLAB Simulink. Simulation is performed for indirect vector controlled induction motor drive using both the PI controller and fuzzy logic based intelligent controller for various operating conditions. Comparison of speed regulation with PI control and fuzzy control is presented. Figure 2 and figure 3 presents indirect vector controlled induction motor block diagram with the Fuzzy Logic Controller. figure 4 shows membership function of fuzzy logic controller.

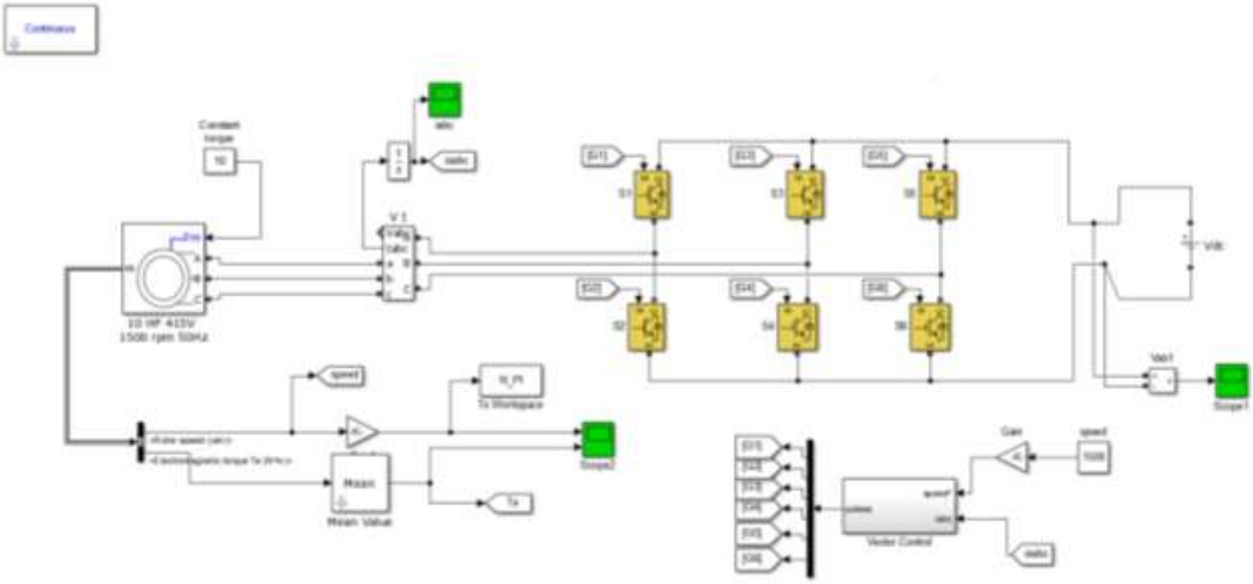

Figure 2: Simulink Model of three phase induction motor drive

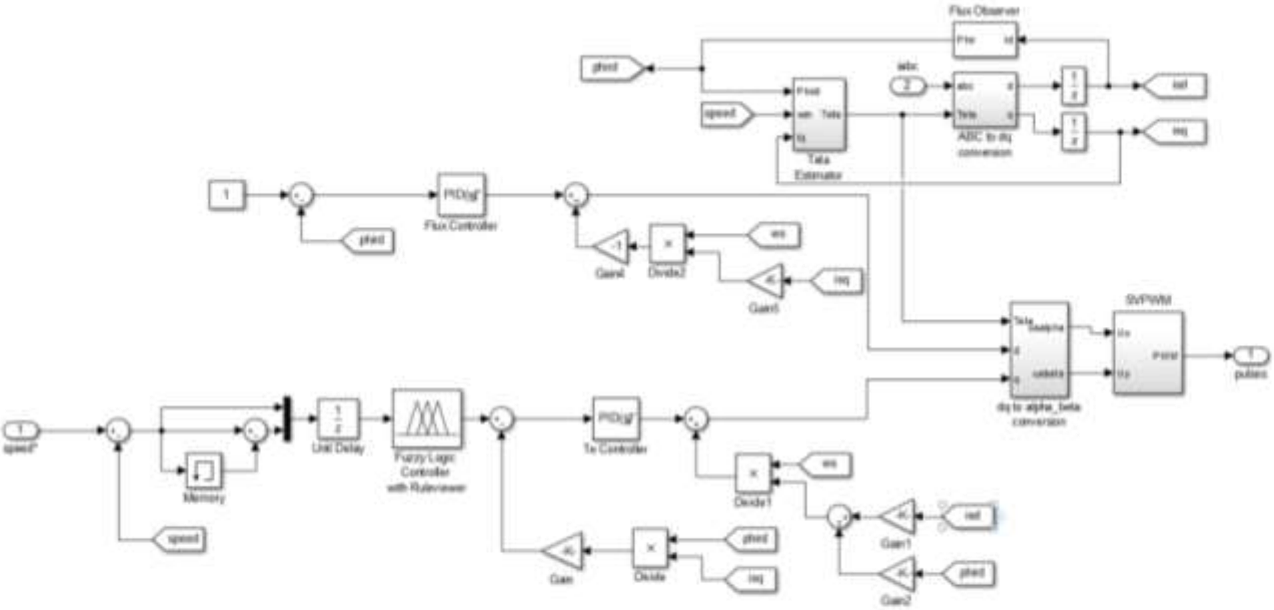

Figure 3: Fuzzy Logic Controller

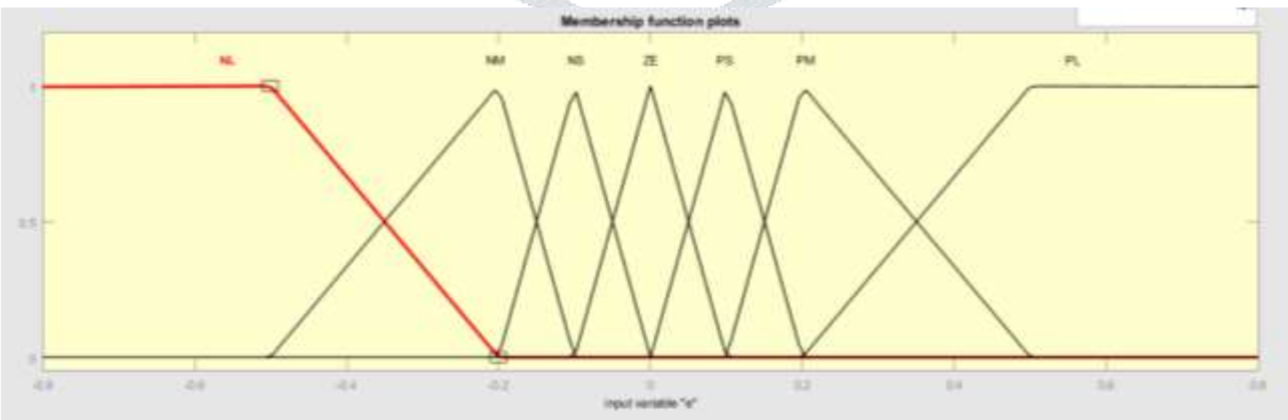

Figure 4: Membership function plot for fuzzy logic controller

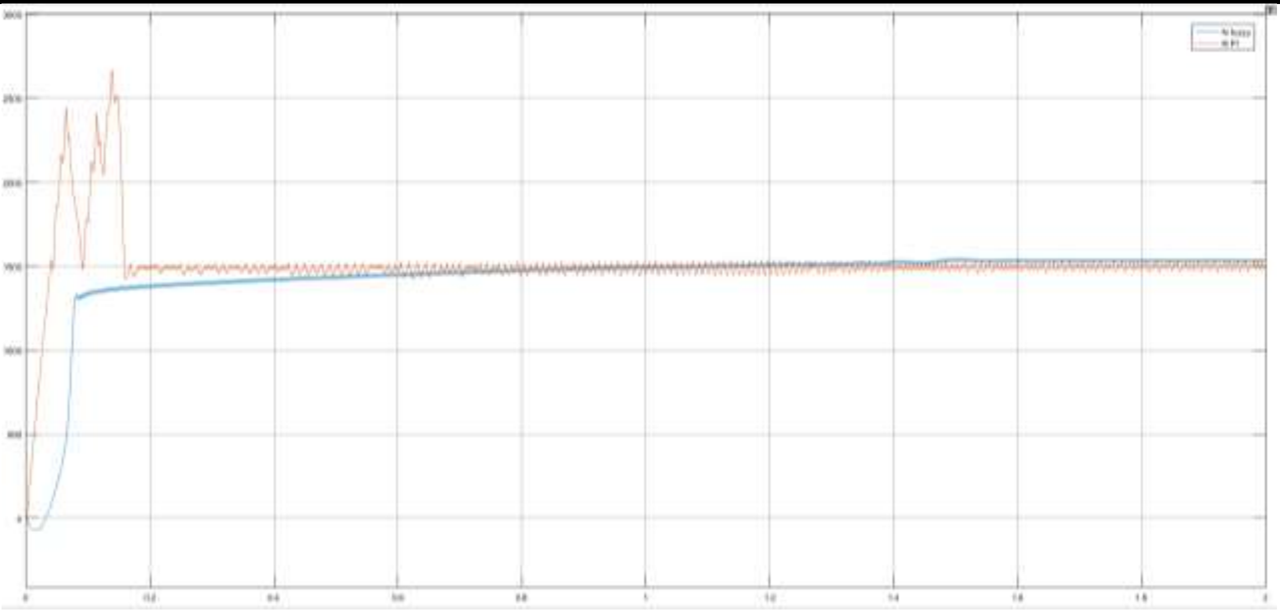

Figure 5: Speed regulation by fuzzy control & PI control

Figure 5 shows comparative analysis of speed control by using fuzzy logic control as well as PI control. It is clearly seen that the speed characteristics are much smoother with fuzzy controller.

V. Conclusion

Speed control of three phase induction motor with fuzzy logic is presented in this paper. It is clearly seen that the speed control with fuzzy logic controller provides much smoother characteristics as compared with PI controller. The fuzzy controller eliminates speed transients in the soft start part.

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