**To Study and Survey About Load Frequency Control for Stability Improvement of Power System With Excitation Control**

*R.Dhanalakshmi*
*Research Scholar Anna University,*
*Coimbatore.*

*Dr S.Palaniswami*
*HOD, Electrical and Electronics Engg Dept*
*Govt College of Technology, Coimbatore.*

## Abstract

The modern power systems with industrial and commercial loads need to operate at constant frequency with reliable power. The load frequency control of an interconnected power system is being improved over the last few years. The goals of the LFC are to maintain stability improvement of power system. Fuzzy logic controller application of load frequency control (LFC) of a single area power system by using a fuzzy logic is presented. The study has been designed for a single area interconnected power system. The comparison between a conventional Proportional and Integral (PI) controller and the proposed artificial neural networks controller is showed that the proposed controller can generate the best dynamic response for a step load change. For this application, MATLAB-Simulink software is used.

## 1. INTRODUCTION

In a power system, load-frequency control (LFC) obtains an essential role to allow power exchanges and to supply better conditions for the electricity trading. Also, time delays in such systems can reduce system performance and even cause system instability on frequency or other parameters . The dynamic behavior of many power systems and resulted in industrial loads heavily depends on disturbances and in particular on changes in the operating point. Load frequency control in power systems is very important in order to supply reliable electric power with good quality. The goal of the LFC is to maintain zero steady state errors in a multi area interconnected power system. In addition, the power system should fulfill the proposed dispatch conditions. Power systems are divided into control areas connected by tie lines. All generators are supposed to constitute a coherent group in each control area. From the experiments on the power system, it can be seen that each area needs its system frequency to be controlled.

In this study, a single area power system is chosen and load frequency control of this system is made by a fuzzy logic controller and a conventional PI controller comparatively. Basically, single area power system consists of a governor, a turbine, and a generator with feedback of regulation constant. System also includes step load change input to the generator. This work mainly, related with the controller unit of a single area power system. Simple block diagram of a single area power system with the controller is shown in Figure 1. A lot of studies have been made in the past about the load frequency control. In the literature, some control

strategies have been suggested based on the conventional control theory . These controllers may be  unsuitable in some operating conditions due to the complexity of the power systems such as nonlinear load characteristics and variable operating points. To some authors, variable structure control  maintains stability of system frequency.
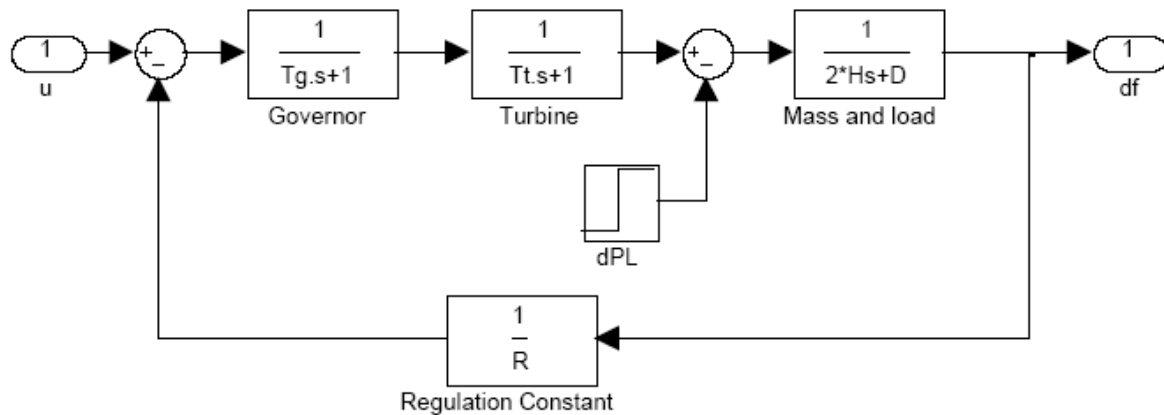


Fig 1 A single area power system with the controllers

However, this method needs some information for system states, which are very difficult to know completely. Also, the growing needs of complex and huge modern power systems require optimal and flexible operation of them. The dynamic and static properties of the system must be well known to design an efficient controller. On the other hand, to handle such a complex system is quite complicated. Recently the LFC systems use the proportional integral (PI) controllers in practice. Since the dynamic behavior even for a reduced mathematical model of a power system is usually nonlinear, time-variant and governed by strong cross-couplings of the input variables, special care has to be taken for the design of the controllers. Gain scheduling is a controller design technique used for non-linear systems. Therefore, a gain scheduling controller can be used for this purpose. In this method, since parameter estimation is not required, control Parameters can be changed very quickly. In addition, gain scheduling application is easier than both automatic tuning and adaptation of controller parameters methods. However, the Transient response for this controller can be unstable because of abruptness in system Parameters. Besides, it can not be obtained accurate linear time variant models at variable Operating points. To solve all these problems in the above mentioned papers, fuzzy logic Controller is proposed in this study. The fuzzy logic controller has been established to apply a single area power system in the different operating points under different load disturbances by using the learning capability of the fuzzy logic to improve the stability of the overall system and also its good dynamic performance achievement. In this study, it is shown that the Overshoots and settling times with the proposed FLC controller are better than the outputs of the other controller.

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## 2 USAGE OF FUZZY LOGIC CONTROLLER

The concept of fuzzy logic was developed by Lotfi.A.Zadeh in 1965 to address uncertainty and imprecision which widely exists in engineering problems. His process approach emphasized modeling uncertainties that arise commonly in human thought processes. The design of FLC can be normally divided into three areas namely allocation of area of inputs, determination of rules and defuzzifying of output into a real value. In this paper the proposed fuzzy controller takes the input as ACE and ACĖ, which is given as,

$$ACE_i = \Delta F_i B_i + \Delta P_{tie}$$

The method of fuzzification has found increasing applications in power systems. The applications of fuzzy sets signify a major enhancement of power systems analysis by avoiding heuristic assumptions in practical cases. This is because fuzzy sets could be deployed properly to represent power system uncertainties. The parameter Bi may be optimized, but here, chosen as,

$$\frac{1}{K_{pi}} + \frac{1}{R_i}$$

The Block diagram of Fuzzy Logic Controller is shown in figure 2. Membership Function (MF) specifies the degree to which a given input belongs to a set. Here, seven membership function have been used to explore best dynamic responses, namely Negative Big (NB), Negative Medium (NM), Negative Small (NS), Zero (ZO), Positive Small (PS), Positive Medium (PM) and Positive Big (PB). Fuzzy rules are conditional statement that specifies the relationship among fuzzy variables. These rules help us to describe the control action in quantitative terms and have been obtained by examining the output response to corresponding inputs to the fuzzy controller. Rules are given in Table I. The rules are interpreted as follows,
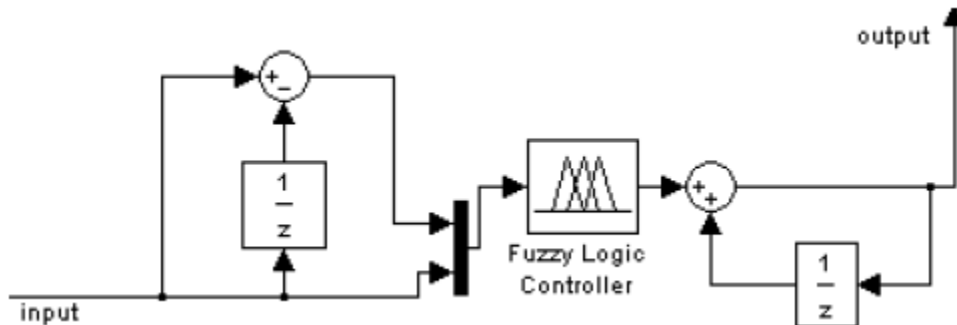


Fig 2  Fuzzy Logic Controller

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Table 1

### Fuzzy Control Rules

| | | ACE | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | NB | NM | NS | ZO | PS | PM | PB |
| | NB | PB | PB | PB | PB | PM | PM | PS |
| | NM | PB | PM | PM | PM | PS | PS | PS |
| | NS | PM | PM | PS | PS | PS | PS | ZO |
| ACĖ | ZO | NS | NS | NS | ZO | PS | PS | PS |
| | PS | ZO | NS | NS | NS | NS | NM | NM |
| | PM | NS | NS | NM | NM | NM | NB | NB |
| | PB | NS | NM | NB | NB | NB | NB | NB |

## 3 SIMULATION STUDY

The single area power system's parameters are given in Table 2. System block scheme and simulation results for the single area power system are shown in Figure 3 and 4. As can be observed, the settling time and overshoots with the proposed Fuzzy logic controller are much shorter than that with the conventional PI controller. From the figure, it is shown that the settling time of conventional PI controller is much longer than the proposed Fuzzy logic controller and the overshoots of the proposed controller is almost better than the PI controller's. Therefore, the proposed Fuzzy logic controller provides better performance than conventional I controller for the single area power system.

TABLE 2

Parameters of the single area power system

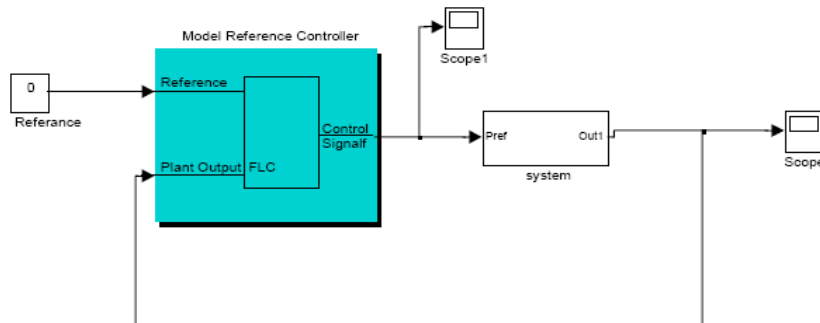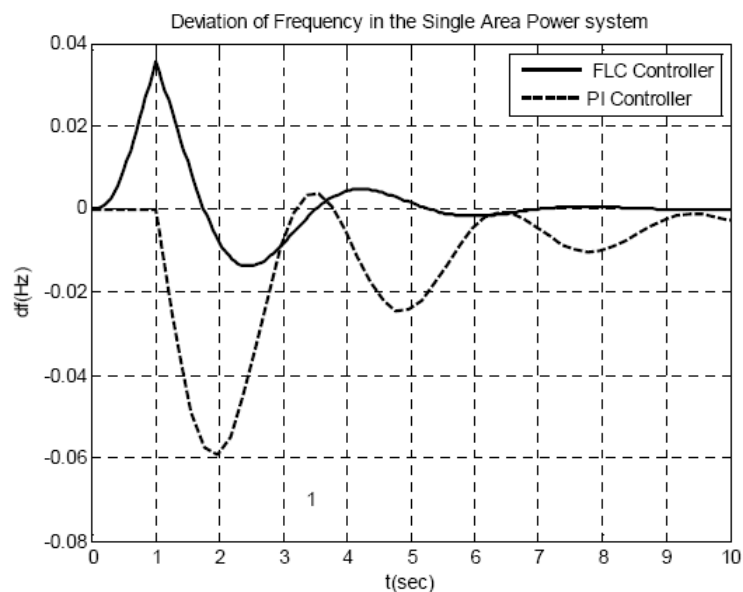| Tg=0.2 | Tt=0.5 | R=0.05 | D=0.8 | H=5 | Ki=7 | Kp=10 |
|---|---|---|---|---|---|---|

Fig 3System block scheme



Fig 4 Deviation of frequency of the single area power system

# 4 CONCLUSIONS

In this study, a Fuzzy Logic controller has been investigated for automatic load frequency control of single area power systems. For this purpose, first, a FLC controller was designed for improvement sensitivity of the system. Also, a conventional PI controller was applied to the system for Comparison. It has been shown that the proposed control algorithm is effective and provides significant improvement in system performance. Therefore, the proposed FLC controller is recommended to generate good quality and reliable.

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