Scientific Journal Impact Factor (SJIF): 1.711
International Journal of Modern Trends in Engineering and Research
ISSN (ONLINE) : 2349 - 9745
ISSN (PRINT) : 2393 - 8161

Fuzzy- Proportional Integral controller based Automatic Load Frequency Control Load in Single area

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Abstract: This paper deals with Automatic Load Frequency Control of Single area system with conventional Proportional integral (PI) Controller and fuzzy logic proportional integral controller (FL-PI). In fuzzy logic controller, triangular membership function is used for making the rule base, because triangular membership function gives easy way to make the rule base compared to other membership functions. The investigation revealed that the fuzzy logic proportional integral controller (FL-PI) performs better than the conventional proportional integral (PI) Controller, The simulation is realized by using Matlab/Simulink software.

Keywords— Automatic Load Frequency Control, Fuzzy Logic PI Controller and Matlab/Simulink Software.

I. INTRODUCTION

Automatic Load Frequency Control or Load Frequency Control is a very important issue in power system operation and control for supplying sufficient and reliable electric power with good quality. An interconnected power system can be considered as being divided into control area, all generators are assumed to form a coherent group Load Frequency Control (LFC) is being used for several years as part of the Automatic Generation Control (AGC) scheme in electric power systems. One of the objectives of AGC is to maintain the system frequency at nominal value (50 Hz). In the steady state operation of power system, the load demand is increased or decreased in the form of Kinetic Energy stored in generator prime mover set, which results the variation of speed and frequency accordingly. Therefore, the control of load frequency is essential to have safe operation of the power system [1]. The power system frequency regulation can be affected due to water flow fluctuation. This leads to imbalance between power generation and power demand, and as a result, frequency will deviate from its nominal value. Significant frequency deviations may cause under/over frequency relay operations and finale disconnect some parts of system loads and generations [2]. LFC is a very important factor in power system operation and control for supplying sufficient and reliable electric power with good quality. There has been continuing interest in designing load frequency controller with better performance during the past 30 years [3].In the past, several control designs of Load Frequency Control power systems has been studied. The conventional control strategy for the LFC problem is to take the integral of the control error as the control signal. An integral (I) controller provides zero steady state frequency deviation but it exhibits poor dynamic performance. Optimal control [4-5] and Artificial neural networks have been successfully applied to the Load Frequency Control [6].Recently, applications of fuzzy logic theory to the engineering issues have drawn tremendous attention from researchers. The fuzzy logic controller has a number of distinguished advantages over the conventional controllers. It is not so sensitive to the variation of system structure, parameters and operation points and can be easily implemented in a large scale nonlinear system. Furthermore, the fuzzy logic controller is a sophisticated technique that is easy to design and implement.

Volume 02, Issue 08, [August– 2015] ISSN (Online):2349–9745 ; ISSN (Print):2393-8161

II. The Basic Introduction of Automatic Load Frequency Control

The main purpose of designing load-frequency controllers is to ensure the stable and reliable operation of power systems. Since the components of a power system are non linear, a linearized model around an operating point is used in the design process of L-F controllers. Some of the proposed methods in literature deal with system stability using fixed local plant models ignoring. the changes on some system parameters.LFC are to maintain reasonably uniform frequency, to divide the load between generators, and to control the tie-line interchange schedules. 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 [7-8]. This work mainly related with the controller unit of a single area power system. Simple block diagram of a single area power system is shown in Fig.1.

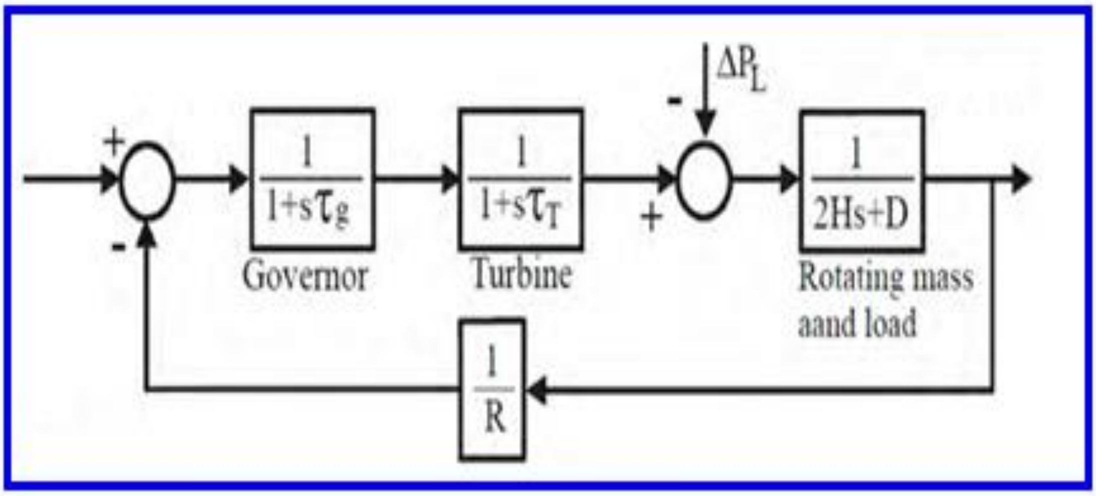


Fig.1. Automatic Load Frequency Control single area power system

III. Fuzzy Logic Control

3.1 Introduction to Fuzzy Logic Control

Fuzzy logic-based control (FLC) has been become an important methodology in control engineering and has been rapidly gaining popularity among engineers during the past few years. This increased popularity can be attributed to the fact that fuzzy logic provides a powerful vehicle that allows engineers to incorporate human reasoning in control algorithm. The fuzzy logic is used in system control design because it shortens the time for engineering development and sometimes in the case of highly complex systems is the only way to solve the problem [9].Since power system dynamic characteristics are complex and variable, conventional control methods cannot provide desired results. Intelligent controller can be replaced with conventional controller to get fast and good dynamic response in load frequency problems. Fuzzy Logic Controller (FLC) can be more useful in solving large scale of controlling problems with respect to conventional controller are slower. Main Components of fuzzy logic controller is show in the fig 2. Fuzzy logic controller is designed to minimize fluctuation on system outputs. There are many studied on power system with fuzzy logic controller [10].

There are three principal elements to a fuzzy logic controller:

- Fuzzification module (Fuzzifer)
- Rule base and Inference engine
- Defuzzification module (Defuzzifier)

Volume 02, Issue 08, [August– 2015] ISSN (Online):2349–9745 ; ISSN (Print):2393-8161

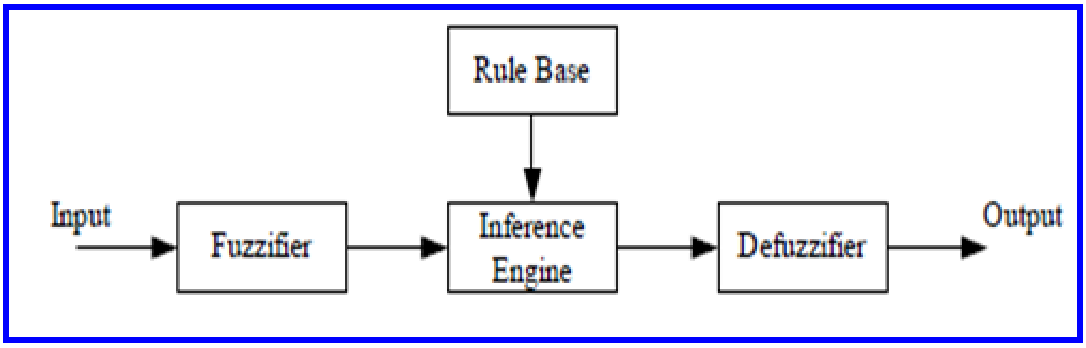


Fig 2 main Components of fuzzy logic controller

Fuzzy control is based on a logical system called fuzzy logic. It is much close in spirit to human Thinking than classical logical systems. The LFC has been reported in several papers is to maintain Balance between production and consumption of electrical power. Due to the complexity and Multi-variable nature of power systems, a conventional control method has not provided satisfactory solutions

3.2 The Fuzzy Logic Base Proportional Integral Controller

Fuzzy set theory and fuzzy logic establish the rules of a non-linear mapping. The use of fuzzy sets provides a basis for a systematic way for the application of uncertain and indefinite models. Fuzzy set is based on a logical system called fuzzy logic controller. It is much closer in spirit to human thinking and natural language than classical logical systems. Nowadays, fuzzy logic is used in almost all sectors of industry and science. One of them is the LFC problem. Because of the complexity and multivariable conditions of the power system, conventional control methods may not give satisfactory solutions. On the other hand, robustness and reliability make the fuzzy logic controller useful in solving a wide range of control problems. The FLPI controller to solve the problem, as presented in fuzzy logic proportional integral controller (FL-PI) show in the Fig. 3, consists of a fuzzy logic controller and a conventional PI controller, connecting in series. The fuzzy logic controller has two input signals, namely, ACE and ACE•, and then the output signal (y) of the fuzzy logic controller is the input signal of the conventional PI controller. Finally, the output signal from the conventional PI controller called the control signal (u) is used for controlling the LFC in the interconnected power system.

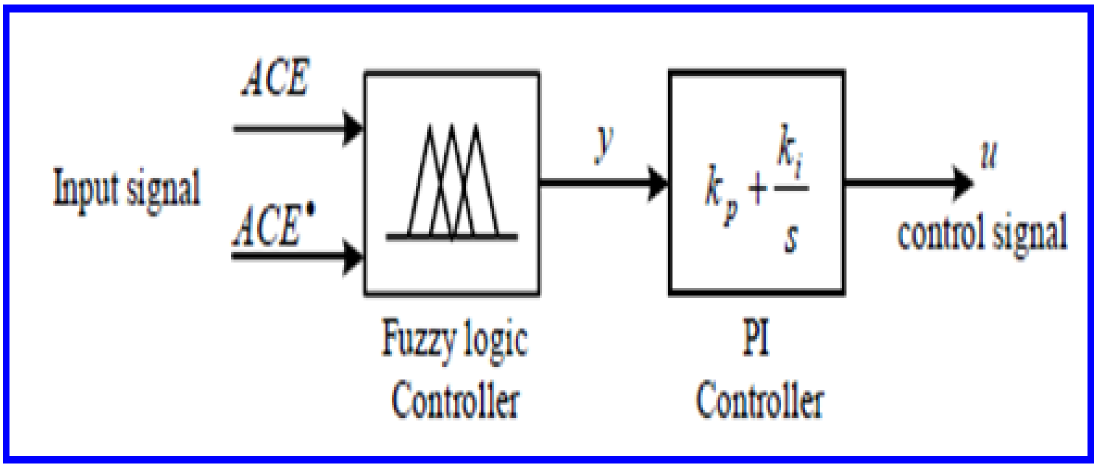


Fig 3 fuzzy logic proportional integral controller (FL-PI).

This paper presents a methodology for rule base fuzzy logic PI controller applied to a system. Before running the simulation in MATLAB/SIMULINK, the Fuzzy Logic Controller is to be designed. The design of a Fuzzy Logic Controller requires the choice of Membership Functions. After the appropriate membership functions are chosen, a rule base is created. The various linguistic variables to design rule base for output of the fuzzy logic controller are enlisted in Table I ,This work proposes a fuzzy controller with up to 25 rules with 5 membership function as negative high (NH) , negative medium (NM) , zero (ZE) positive small (PS) , positive high (PH) For the control of Area control error (ACE) , there are two controllers , ACE and d/dt (ACE) **.** Fuzzy controller is created and the membership functions and fuzzy rules are determined. Membership functions for inputs are shown below in Fig. 4, fig 5 and the MF for output is shown in fig. 6.

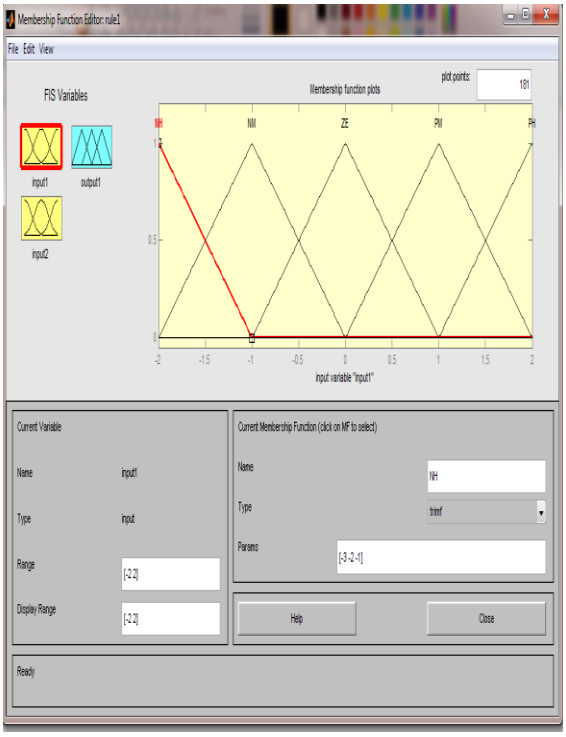


Fig 4 Fuzzy input variables "error"

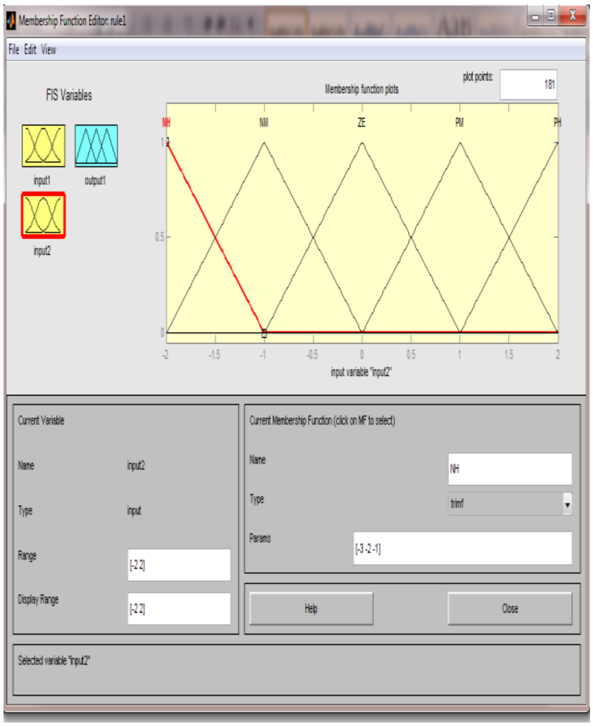


Fig 5 Fuzzy input variables change in error

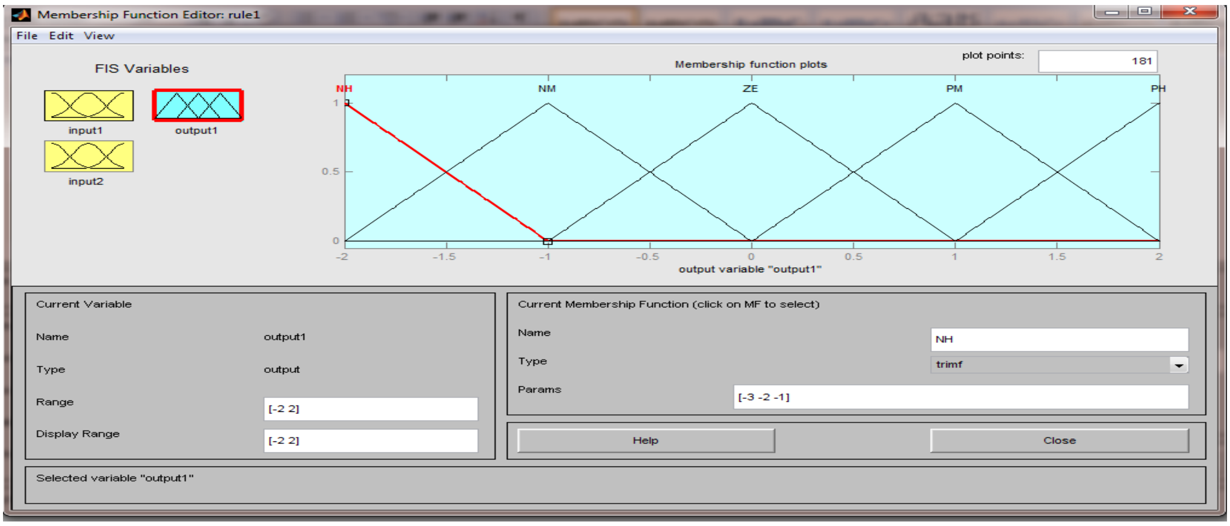
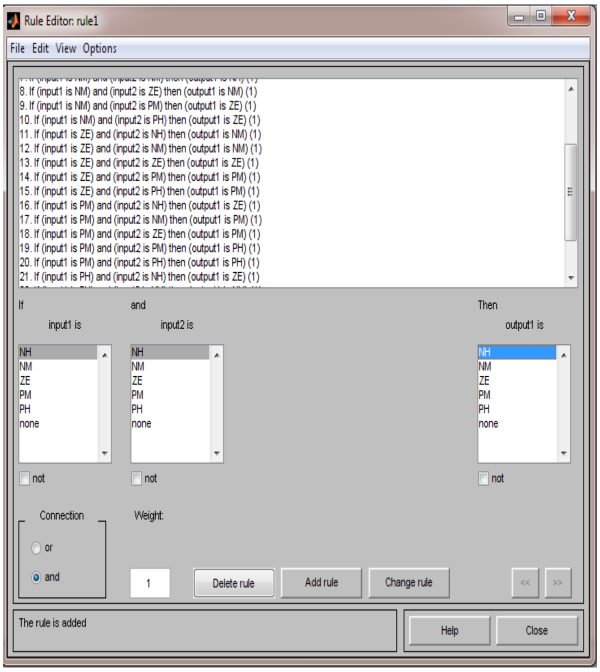


Fig 6 Fuzzy output variable control.

International Journal of Modern Trends in Engineering and Research (IJMTER)
Volume 02, Issue 08, [August– 2015] ISSN (Online):2349–9745 ; ISSN (Print):2393-8161

In figure 7 fuzzy if-then rules are shown and in figure 8 Analysis of the two inputs (error and change in error) and output are shown. There are total 25 rules output variable.



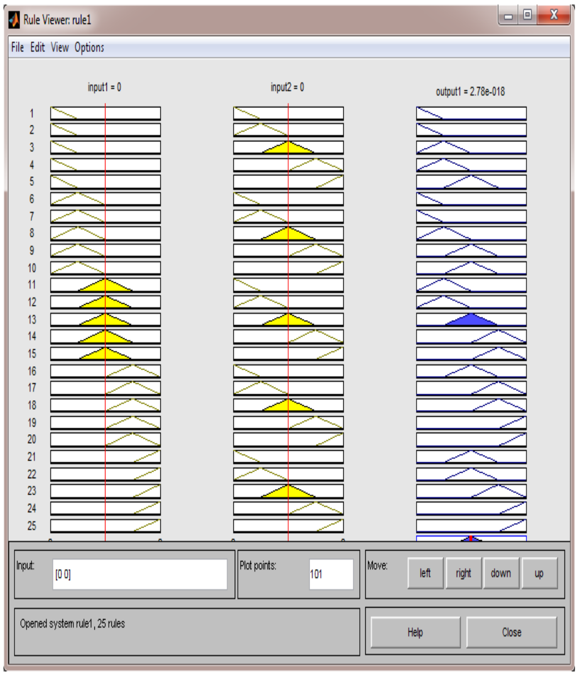


Fig 7 Fuzzy-PI rules *Fig 8 Analysis of both the inputs and outputs of fuzzy-PI*

IV. SIMULATION MODEL AND RESULT

The simulation results of Single area system area are shown the fig 1. In this two cases are considered based on the values used for ALFC parameters. Data parameter taken by paper []. The system dynamic performance is observed for two different controller structures, PI (Proportional Integral) and Fuzzy logic controller-PI Controller.

Test system -5.1 : In this case we consider PI Controller, PI controller show in the fig 9 and in this case Frequency response of single area with PI controller is show in the fig 10,settling time of PI controller 14 sec in this case

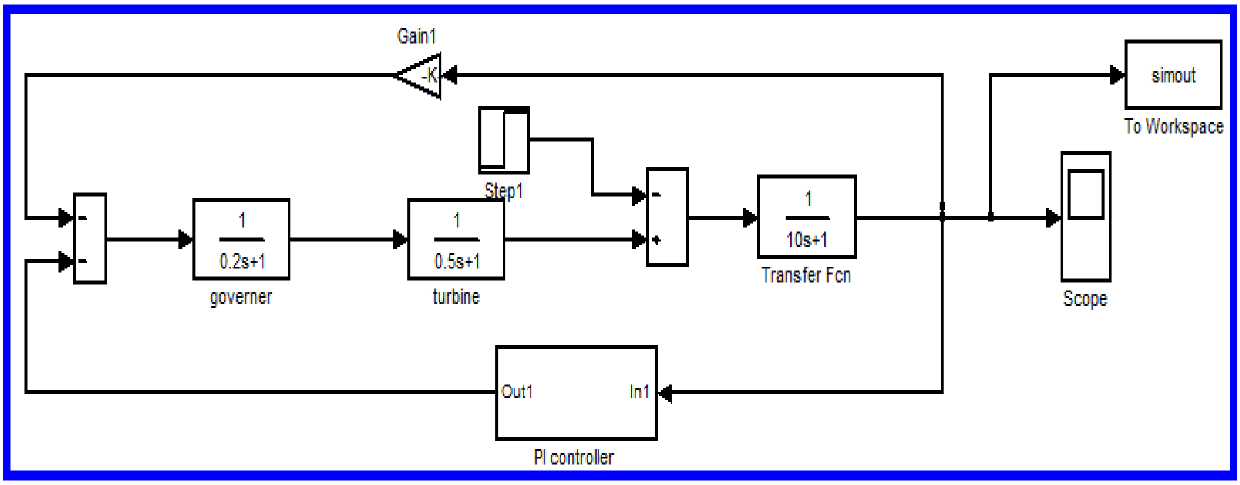


Fig 9 Proportional Integral controller

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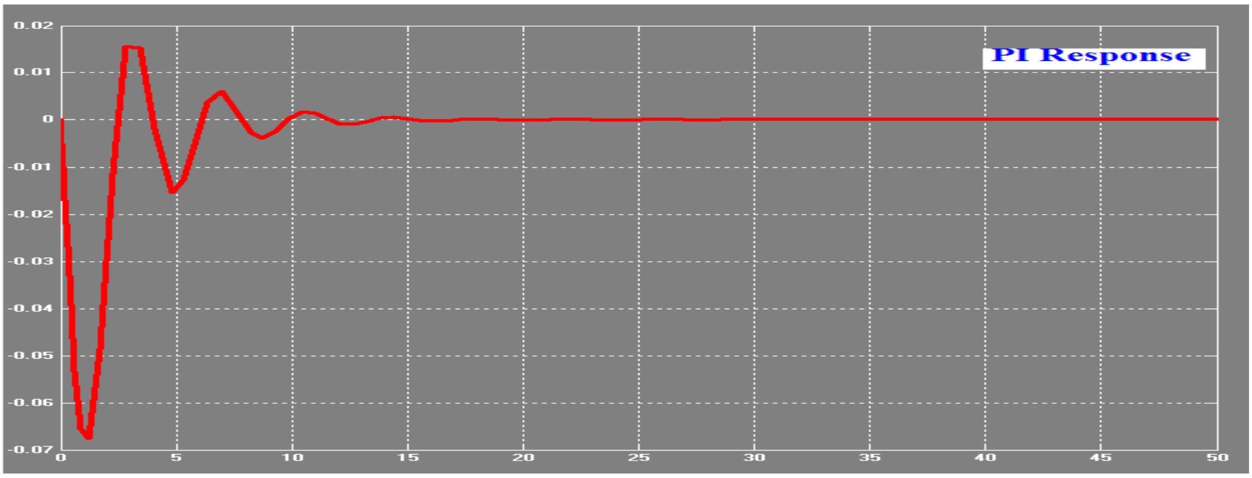


Fig 10 Frequency response of single area with Proportional Integral controller

Test system 5.2 : In this case we consider fuzzy-PI Controller, fuzzy-PI controller show in the fig 11 and in this case Frequency response of single area with fuzzy-PI controller is show in the fig 12,settling time of PI controller 10 sec in this case.

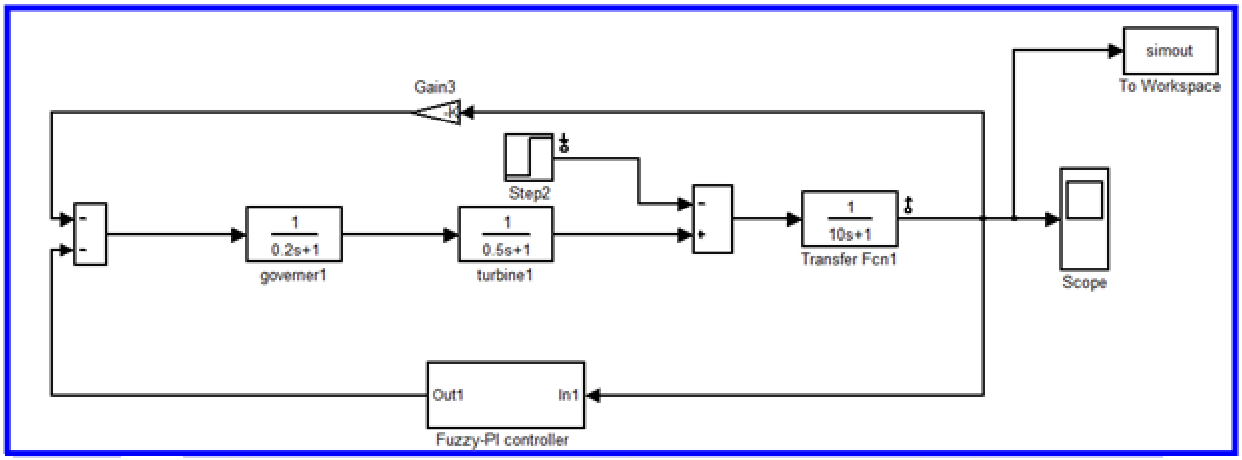


Fig 11 fuzzy- Proportional Integral controller

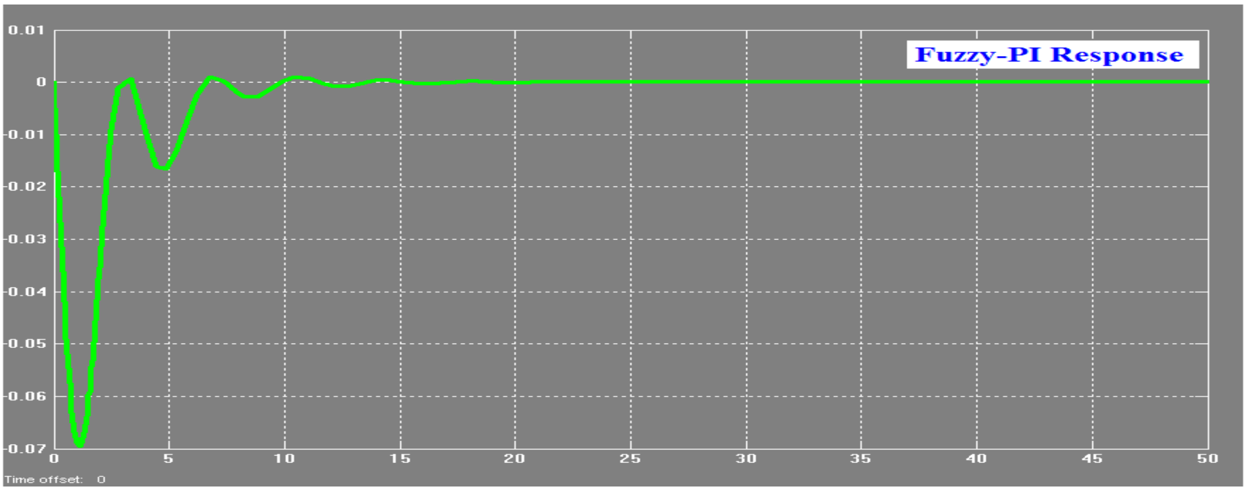
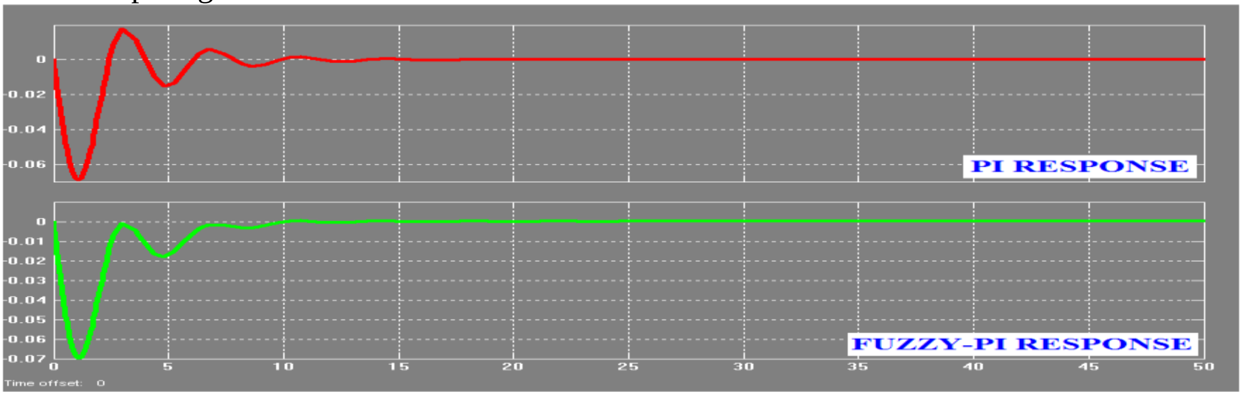


Fig 12 Frequency response of single area with fuzzy- Proportional Integral controller

V. CONCLUSION

In this paper, a fuzzy logic controller technique is designed for automatic load frequency control of single area systems. Frequency response of single area PI controller and fuzzy-PI controller show in the given below, the easily compare the output responses PI and proposed Fuzzy logic controller (FLC) with PI Controller. The system having Fuzzy logic controller (FLC) with PI Controller gives better dynamic responses comparing to conventional PI controller.



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