TWO AREA CONTROL OF AGC USING PI & PID CONTROL BY FUZZY LOGIC

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ABSTRACT

This work presents an efficient method based on a modified fuzzy PI control with parallel fuzzy PD control for automatic generation control (AGC) of a two-area power system. This describes the control schemes required to operate the two-area power system in the steady state. The model of a two-area power system is established using the equations describing dynamic behaviour of a two-area power system and control schemes in Matlab-Simulink program respectively. The performances of different controllers for variable inputs are compared for the same two area power system. The dynamic response of the load frequency control problem are studied using MATLAB simulink software. The results indicate that the proposed Fuzzy logic controller exhibits better performance.

Keywords: PI Control, Parallel Fuzzy PD Control, Automatic Generation Control, Power Systems, Matlab/Simulink.

I. INTRODUCTION

Electrical Power systems are interconnected to provide secure and economical operation. [1]The main objective of automatic generation controller (AGC) is to maintain the balance between the generation and demand of a particular power system.

The interconnected power system is typically divided into control areas, with each consisting of one or more power utility companies. Sufficient supply for generation of each connected area to meet the load demand of its customers. In this paper Fuzzy Logic Controller (FLC) is used. This type of controller adds a pole at origin resulting in system type so reducing the steady state error. System load is never steady using controller these can be controlled. When uncontrolled case more oscillation, negative overshoot be observed but while comparing to conventional type controller PID and propose work result gives better performances of dynamic responses.

II. AGC FOR A TWO AREA SYSTEM

In an interconnected (multi area) system, there will be one ALFC (Automatic Load Frequency Control) loop for each control area. They are combined as shown in Figure 1 for the interconnected system operation. With a governor controller alone, we cannot bring steady state error to zero. However, we can bring steady state error to zero by using a supplementary control which set the value of Δ Pref. This supplementary control is known as automatic generation control. Value of Δ Pref is changed based on frequency deviation. In a two area power system, when an additional load is added in area 1, the frequency of entire system decreases [8]. Hence, generation in both area increases because of governor action. However, without AGC steady state frequency deviation will not be zero. Since generation in area 2 has increased, there will be tie line flow from area 2 to area 1 to share the additional load in area 1.

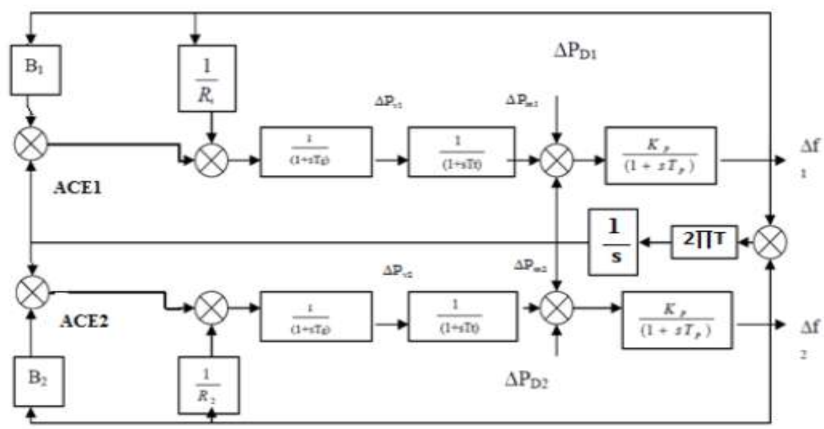


Fig. 1 Two area system with AGC

III. AGC CONTROL SCHEMES

3.1 PI Controller

The proportional plus integral controller produces an output signal consisting of two terms one proportional to error signal and other proportional to integral of error signal [12].

$$\text{Control signal}, u(t) = K_p e(t) + \frac{K_p}{Ti} \int e(t)\, \mathrm{dt}$$

Where,

Kp-Proportional gain

Ti- Integral time

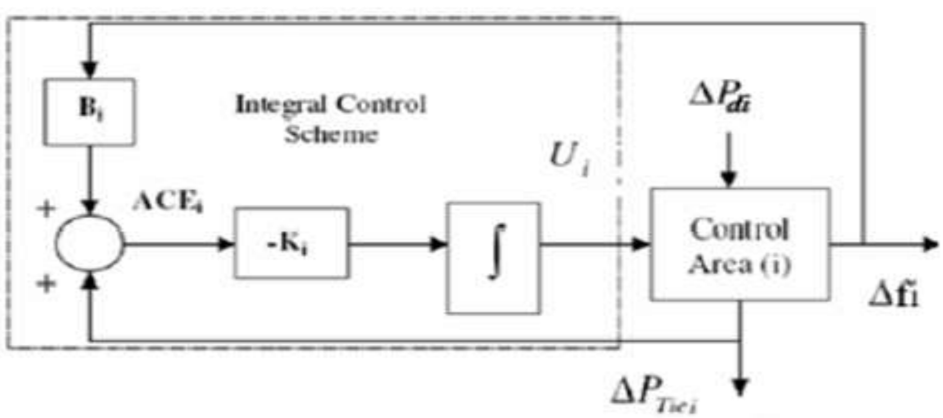


Fig. 2 Conventional PI controller

3.2 PID Controller

A proportional–integral–derivative controller (PID controller) is a generic control loop feedback mechanism widely used in industrial control systems – a PID is the most commonly used feedback controller. A PID controller calculates an "error" value as the difference between a measured process variable and a desired set point. The controller attempts to minimize the error by adjusting the process control inputs. In the absence of knowledge of the underlying process, PID controllers are the best controllers. However, for best performance, the PID parameters used in the calculation must be tuned according to the nature of the system – while the design is generic, the parameters depend on the specific system.

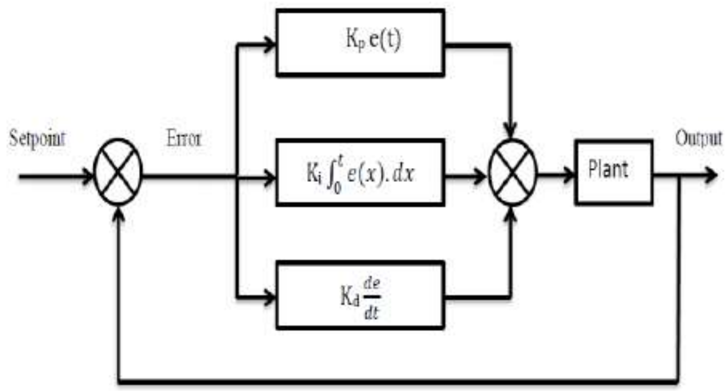


Fig.3 Basic block diagram of a conventional PID controller

The PID controller is probably the most-used feedback control design. PID is an acronym for Proportional-Integral-Derivative, referring to the three terms operating on the error signal to produce a control signal. If u(t) is the control signal sent to the system, y(t) is the measured output and r(t) is the desired output, and tracking error e(t) = r(t) − y(t),

a PID controller has the general form

$$u(t) = \mathrm{Kpe(t)} + \mathrm{Ki}\int \mathrm{e(t)dt} + \mathrm{Kd}\frac{\mathrm{d}}{\mathrm{dx}}\mathrm{e(t)}$$

IV. FUZZY LOGIC CONTROLLER

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. Fuzzy logic controller is designed to minimize fluctuation on system outputs. There are many studied on power system with fuzzy logic controller.

A fuzzy logic controller consist of three section namely fuzzifier, rule base and defuzzifier as shown in figure 4.

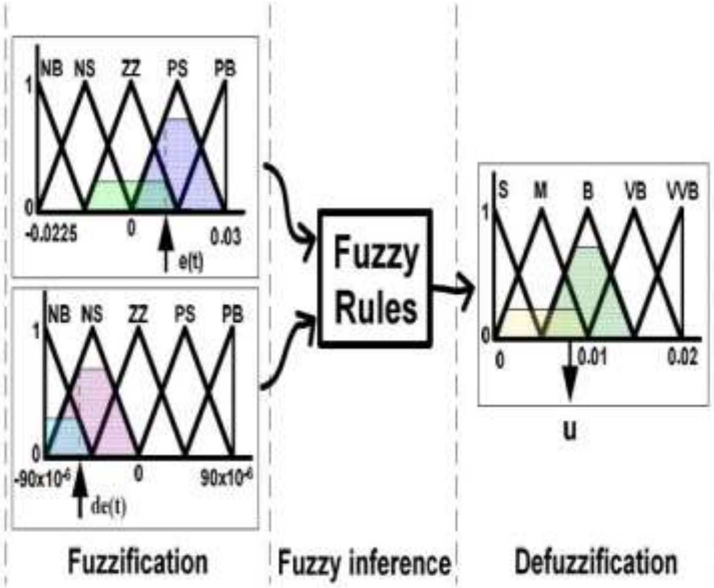


Fig.4. Fuzzy Inference system for FLC

The error e and change in error de are inputs of FLC. Two inputs signals are converted to fuzzy numbers first in fuzzifier using five membership functions.

Positive Big (PB), Positive Small(PS), Zero (ZZ),Negative Small(NS),Negative Big (NB), Small (S), Medium (M), Big (B), very Big (VB), Very Very Big (VVB).

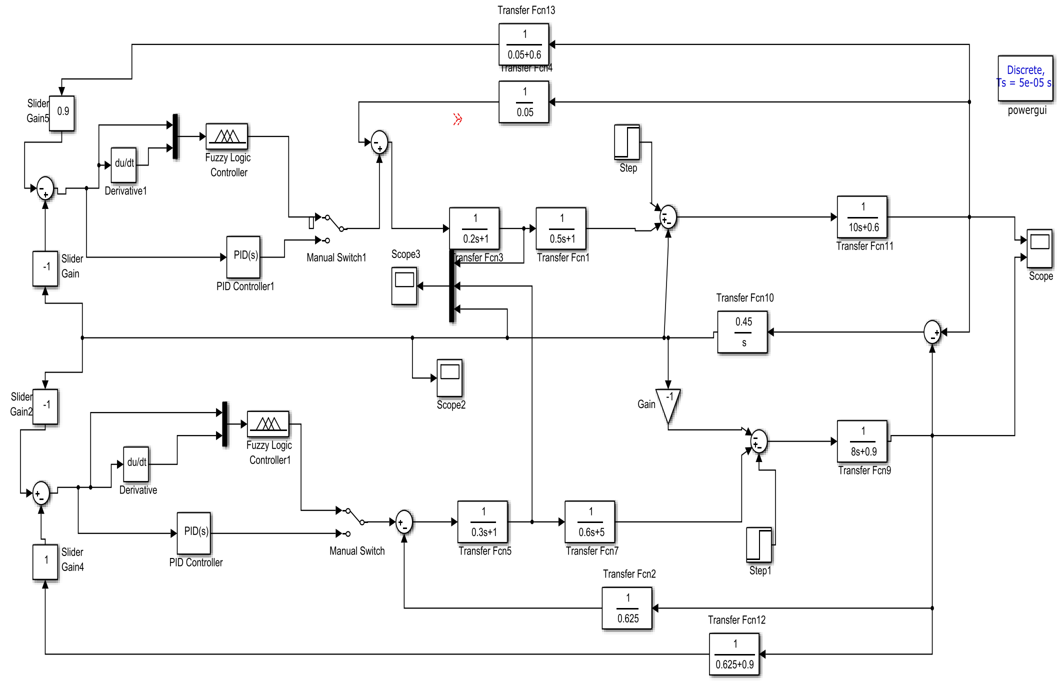
Finally resultant fuzzy subsets representing the controller output are converted to the crisp values using the central of area (COA) defuzzifier scheme.

TABLE I (Fuzzy Rule)

		ė				
		NB	NS	ZZ	PS	PB
e	NB	S	S	M	M	B
	NS	S	M	M	B	VB
	ZZ	M	M	B	VB	VB
	PS	M	B	VB	VB	VVB
	PB	B	VB	VB	VVB	VVB

V. SIMULATION AND RESULT

In this paper, the application of the fuzzy-PI+fuzzy-PD controller to AGC of a two-area power system is investigated. In the simulation, firstly, a step load increase in area 1 and then step load increase in area 1 and area 2



of the same power system are applied. The per-unit load changes from 0.01p.u.MW to 0.3 p.u.MW are applied to the power system with obtained the fuzzy-PI+fuzzy-PD controller. In this case, the frequency oscillations and tie-line power flow are investigated by using the simulation block diagrams. AGC is implemented to damp out the oscillations by using the fuzzy-PI+fuzzy-PD controller and conventional PID controller in each area in the power system.

Fig. 5 The simulation block diagram for automatic generation control of a two-area power system with Fuzzy PI+ Fuzzy PD controller

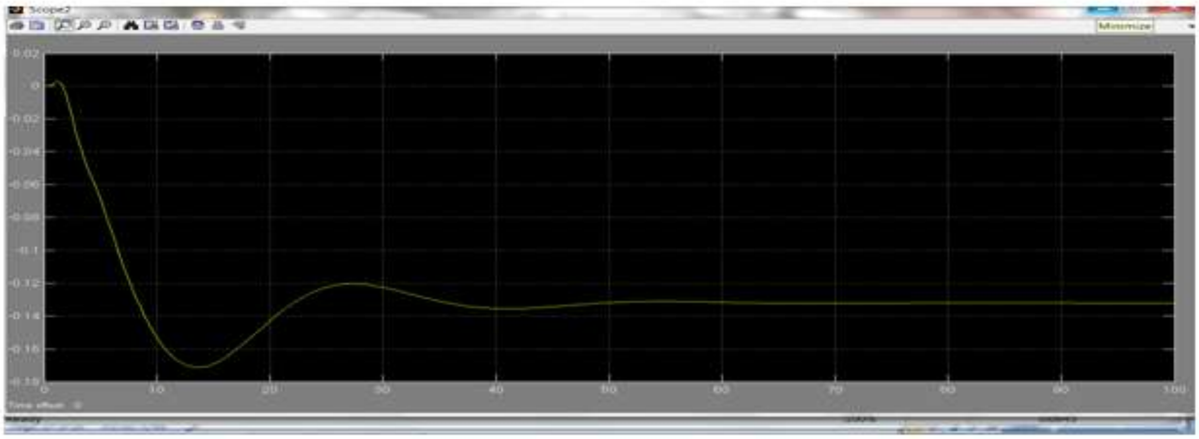


Fig.6 Output of Fuzzy Tie Line

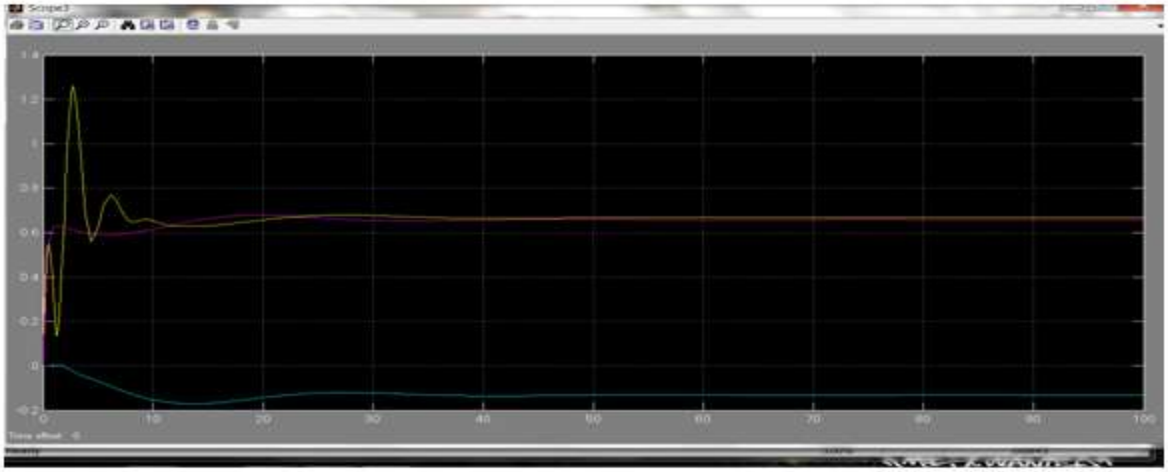


Fig.7 Output of Fuzzy PD

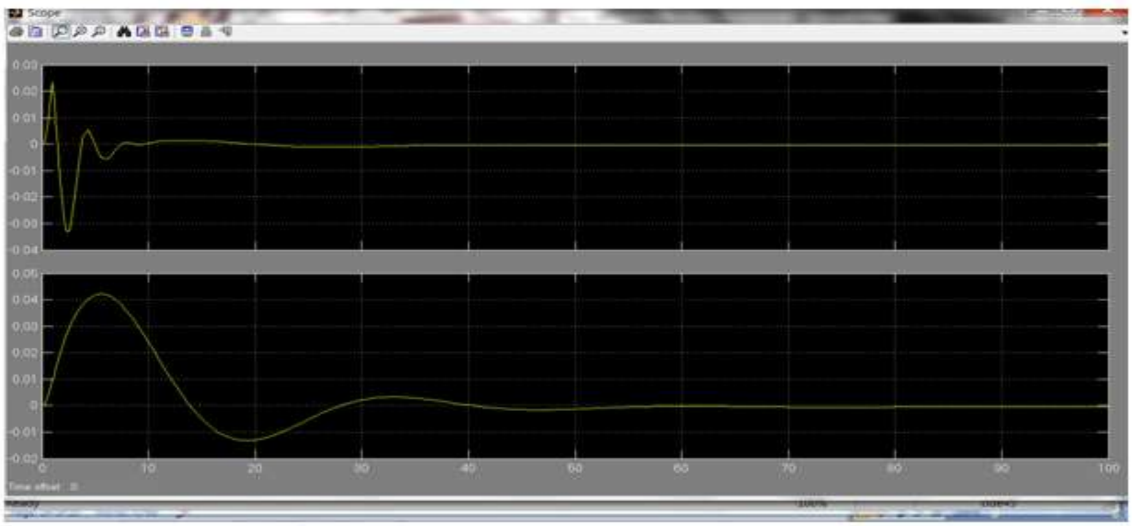


Fig. 8 Output of Area 1 and Area 2

In our simulation study, we chose the gain values of the conventional PID controller according to step load deviations in the power system with two areas.

The simulation results of a two area power system according to step load deviations are given as compare with the conventional PID controller and the fuzzy-PI+fuzzy-PD controller. The simulation results demonstrate show that the fuzzy-PI+fuzzy-PD controller improves effectively the damping of the oscillations after the load variation in one of the areas in the power system with two steam turbines. It can be observed that the responses with our proposed the fuzzy- PI+fuzzy-PD controller give better performance than the conventional PID controller.

VI. CONCLUSION

In this paper a fuzzy logic controller is designed for load frequency controller of two area interconnected power system. It can be implemented in four area power system and controlled by using advanced controller systems. The system performance is observed on the basis of dynamic parameters i.e. settling time, overshoot and undershoot. The system performance characteristics reveals that the performance of fuzzy logic controller better than other controllers.

As a further study, the proposed method can be applied to multi area power system load frequency control (ALFC) and also optimum values can be obtained by Genetic Algorithm and Neural networks.

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