GENERATION CONTROL OF HYDRO-THERMAL INTERCONNECTED POWER SYSTEM

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Abstract: As our power demand has increased, there has been a higher demand of electrical power on all sectors in the market. As the load increases, it is very important to manage load properly since a failure to do so results in frequency fluctuation and voltage drops. So it is imperative to manage generation and load intelligently. This paper deals with automatic generation control of two area thermal-hydropower system. Simulation is done for two area interconnected Thermal-Hydropower system using MATLAB/Simulink Software. The control methodologies like Integral, PI, Fuzzy logic controllers are used and comparative results of frequency deviation in respective area are shown with a 1% step disturbance. From the simulation study, I found that integral controller takes larger overshooting time which is compensates by PI controller bu PI controller has High peak overshoot problem. Which is overcome by Fuzzy Logic controller.
Keyword: Load frequency control, Interconnected two area power system, Integral feedback controller, PI controller and Fuzzy Logic controller.

I. INTRODUCTION

Main objective of Automatic generation control or load frequency control is to maintain a balance between generation and demand at any time in the power system [7]. Electrical power systems are interconnected to provide secure and economical operation. The interconnection is divided into controlarea. The control areas are connected by transmission lines commonly referred to as tie-linesand the power flowing between control areas is called tie-line interchange power. When the load increases in a particular control area, it is supplied initially by the kinetic energy stored in the rotating masses of the turbine generators. The result is a drop in the system frequency throughout the interconnected system. All generators in the interconnection respond to the speed change and adjust generation to return the frequency to a new steady state value, thereby establishing a balance between the total system generation and the total system load. It is the function of AGC in the disturbed control area to readjust its generation in an economical manner such that any tie-line interchange power deviation that resulted from the load change is returned to zero, and the new steady-state frequency is brought back to the scheduled value. So frequency is a useful index to indicate generation load imbalance. [12] So control strategy is required that not only maintains constancy of frequency and desired tie-power flow but also achieves zerosteady state error and inadvertent interchange.[8] Among the various types of load frequency controllers, the most widely employed isthe conventional proportional integral (PI) controller. The PI controller is very simple for implementation and gives better dynamicresponse, but their performances deteriorate when the complexity in the system increases due to disturbances like load variation boiler dynamics[2] (Talaq J et al, 1999). Therefore, there is need of a controller which can overcome this problem. The Artificial Intelligent controllers like Fuzzy and Neural control approaches are more suitable in this respect. So I have use Fuzzy logic controller to overcome above problem. Literature survey shows that most of earlier work in the area of LFC relates to interconnected thermal system and relatively lesser attention has been devoted to the LFC of interconnected hydro-thermal system [2]. The fuzzy controller offers better performance over the conventional controllers, especially, in complex and nonlinearities associated system.(Magla A et al, 2004) Fuzzy Controller to the two region interconnected reheat thermal and hydropower system gives good dynamics when selecting the specific number of membership function.

II. POWER SYSTEM UNDER INVESTIGATED

With primary speed control action, change in system load result in a steady state frequency deviation, depending on the governor droop characteristics and frequency sensitivity of the load. All generating unit will contribute to the overall change in generation. Two area interconnected Hydro-Thermal power system is shown below. Here both control area is interconnected by tie line.

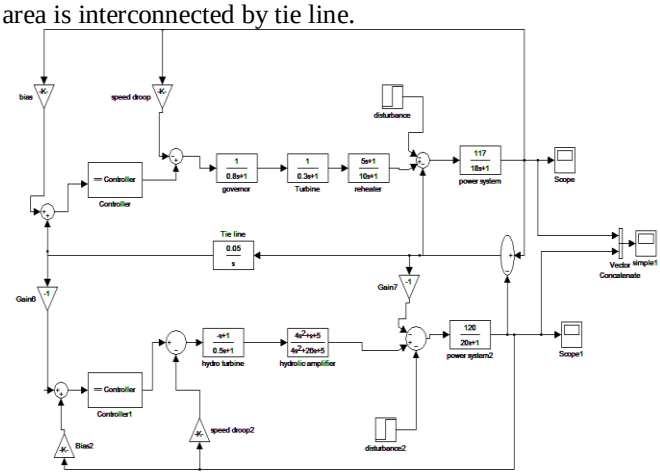

Figure 1 Two area Hydro-Thermal power system

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The main control objectives are as follows: [8]

- Each control area as for as possible should supply its own load demand and power transfer through tie line should be on mutual agreement.
- All control areas should controllable to the frequency control.

III. CONTROL METHODOLOGY

For simulation and analysis purposes, a software package, MATLAB, distributed by The Math Works,Inc. provides the required dynamic modeling and graphical output capabilities. Figure 2.1 shows basic MATLAB model of two area Hydro-Thermal power system. In this, there is a controller portion which is used to control or maintain generation-load balance. In this paper I shall discuss following types of controllers.

A. Simple feedback integral controller

In this type of controller, controller works based on the signals receives from the power system and adjust generation. When there is a mismatch of generation-load, ACE gives error signal to controller then this integral controller try to reduce error. This controller reduces steady state error but it gives worse transient response. When there is a disturbance of 1% in area 1 then Fig. 2 shows simulation result of simple feedback integral controller. Which shows that, this controller requires more settling time to compensate for frequency disturbance.

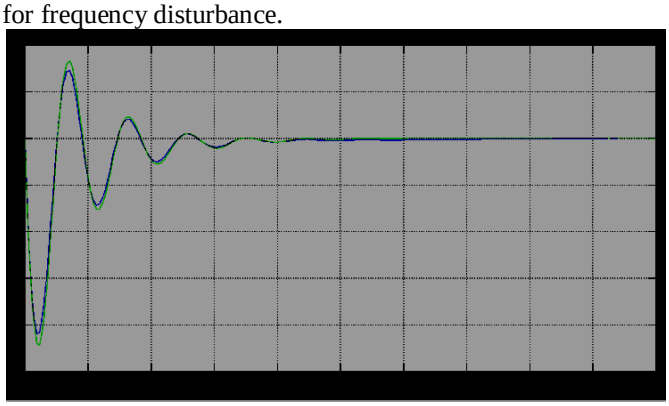

Figure 2 Change in frequency for both area due to step load (0.01 PU) change in area 1 for integral controller

IV. PI CONTROLLER

This is one of the most widely used controller in Thermal-Hydro power station. Proportional controller is used to reach the steady state condition much quicker because of the faster transient response with proportional controller. The proportional term of the controller produces a control signal proportional to the error in the system, so that u (t) = Kp e (t). Typically, given a step change of load demand, low values of Kp give rise to stable responses with large steady-state errors. Higher values of Kp give better steady-state performance, but worse transient response. Therefore, the higher value of Kp is used to reduce the steady state error, although increasing the gain Kp decreases the system time constant and damping. Therefore, it is necessary to choose the optimum value of Kp. The proportional action can never eliminate the steady stateerror in the system because some (small) error must be present in order to produce a control output. A simple method to reduce the steady state error is by incorporating integral action into the controller.Here, the control signal generated is proportional to theintegral of the error signal, that is,

$$u(t)=Ki \int e(t)dt \qquad \ldots.1$$

Where Ki is the integral gain. While an error exists, the integrator tends to increase control action, thus driving the plant output towards the demand output. when the error disappears, the continuing integrator output can be used to maintain the control action necessary for steady-state conditions. But, if the gain of integrator Ki is sufficiently high, overshoot will occur which is highly undesirable. Lower value of Ki reduces overshoot but increases rise time of the system. So it is necessary to select a proper value of Kp and Ki.

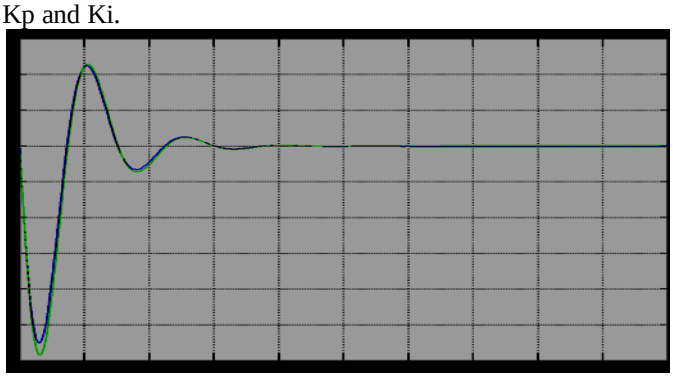

Figure 3 Change in frequency for both area due to step load (0.01 pu) change in area1 for PI Controller

V. FUZZY LOGIC CONTROLLER

Fuzzy logic is a thinking process or problem-solving control methodology incorporated in control system engineering, tocontrol systems when inputs are either imprecise or the mathematical models are not present at all[8].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.[1] A fuzzy logic controller consist of three section namely fuzzifier, rule base and defuzzifier.

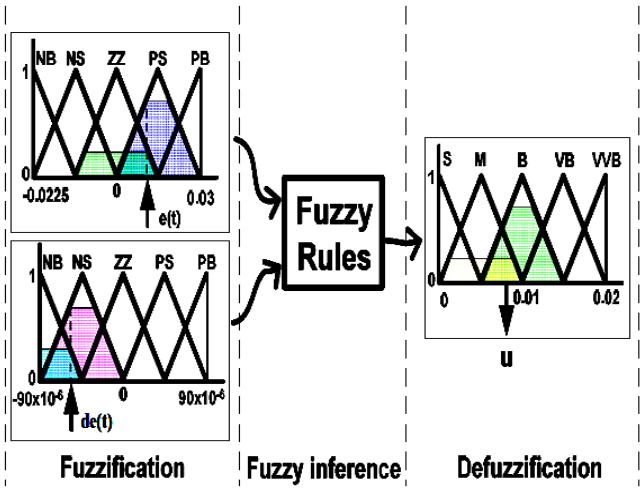

Figure 4 Fuzzy Logic Controller

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Fuzzification is process of making a crisp quantity into the fuzzy. They carry considerable uncertainty. If the form of uncertainty happens to arise because of imprecision, ambiguity, or vagueness, then the variable is probably fuzzy and can be represented by a membership function. Defuzzification is the conversion of a fuzzy quantity to a crisp quantity. There are many methods of defuzzification, like centroid , bisector , smallest of maximum etc. out of which I have used bisector method to make fuzzy inference system. For Load Frequency Controlthe process operator is assumed to respond to variables error (e) and change of error (ce). The fuzzy logic controller with error andchange in error is shown below.

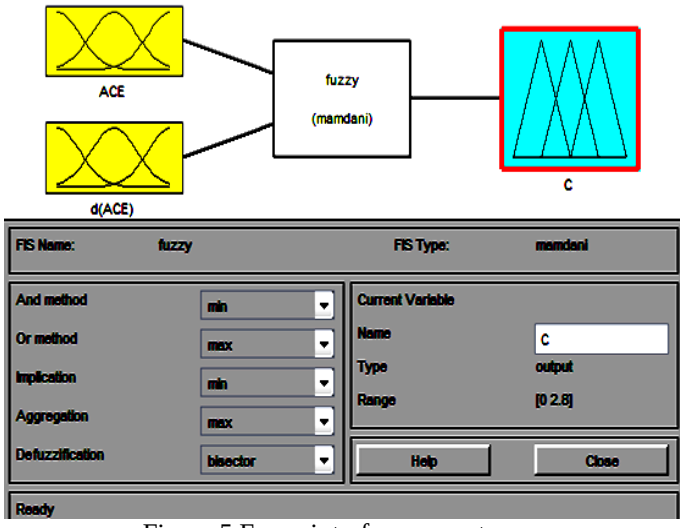

Figure 5 Fuzzy interference system

Following figure shows various membership functions that are used to create a fuzzy inference system.

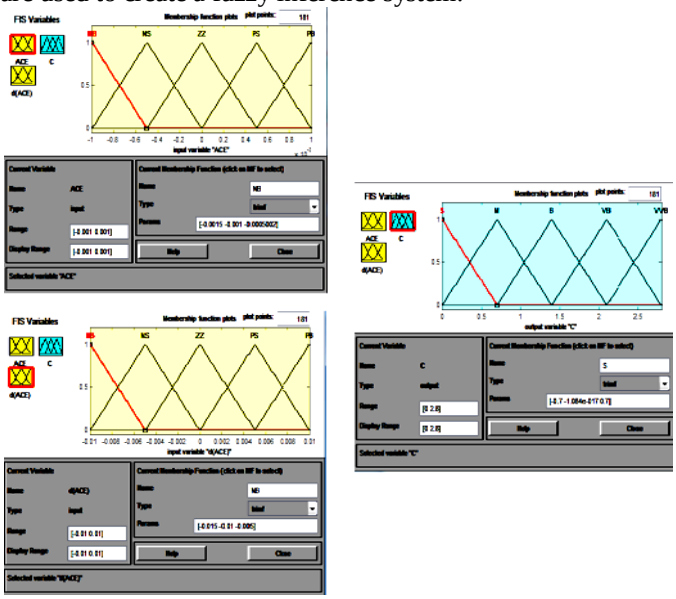

Figure 6 various membership Functions

Whenever there is a disturbance of 1% in area1 then fuzzy logic controller gives better performance compare to other two type of controller. Peak overshoot is reduced in fuzzy controller compare to PI controller but it takes more setting time to settle frequency deviation than PI controller.

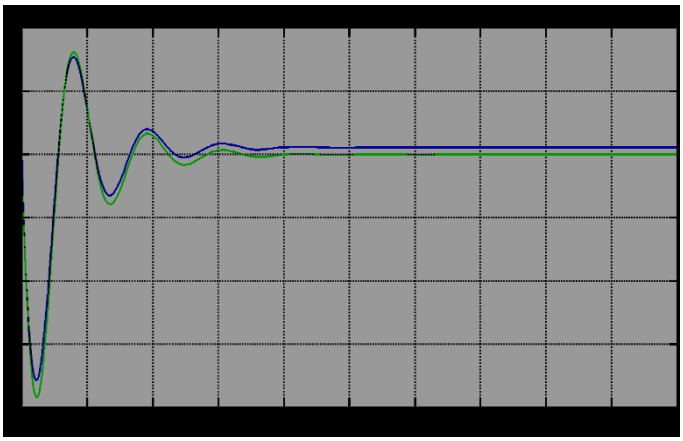

Figure 7 Change in frequency for both area due to step load (0.01 pu) change in area1(Fuzzy)

VI. CONCLUSION

The For two area interconnected Hydro-Thermal power system we use different type of control methodologies like simple integral feedback path , PI controller and Fuzzy controller And All this control methodologies take different time to settle at normal frequency from 1 % step disturbance in area1. 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 intelligent controller(fuzzy logic controller)reduces peak overshooting.

Appendix

Parameters are as follows:

f = 50 Hz, R1 =R2=3.4 Hz/ per unit MW;
Tg1=Tg2 = 0.08 sec;
Tp1=Tp2=20 sec;
P tie, max = 200 MW ; Tr = 10 sec;
Kr = 0.5, H1 =H2= 5 sec;
Pr1 = Pr2=2000MW;
Tt1=Tt2 = 0.3 sec;
Kp1=Kp2= 120 Hz.p.u /MW;
Kd =4.0;Ki = 5.0 ; Tw = 1.0 sec; D1 =D2= 8.33 * 10-3 p.u MW/Hz.;
B1=B2=0.425 p.u. MW/Hz;
a=2*pi*T12=0.545
delPd1= delPd2 =0.01

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