



Improvement in Dynamic Response of Interconnected Hydrothermal System Using Fuzzy Controller

Karnail Singh¹, Ashwani Kumar²

PG Student[EE], Deptt.of EE, Hindu College of Engineering, Sonipat, India¹

Assistant Professor, Deptt.of EE, Hindu College of Engineering, Sonipat, India²

ABSTRACT: In a power system due to continuous change in rising and falling trends both active and reactive power demands changes. for this water input to hydro generator and steam input to turbo generator continuously changed to cover the active power demand. If it is not done machine speed will change with change in frequency. Also change in excitation must be done to match reactive demand in modern power system manual regulation is not possible and therefore automatic generation and voltage regulation equipment is installed on each generator. Various controllers are designed for different operating condition and they take care of small changes in load demand. The active power P is mainly dependent on the internal angle δ and is independent of the bus voltage magnitude. The hydro area is considered with either mechanical or electric governor and thermal area is considered with either single or double reheat turbine. Hydro thermal system with controlled mode of operation is explored with constant load condition. Here electric governor and mechanical governor are used with and with out rate constraints like single stage reheat turbine and two state reheat turbine on dynamic response have studied. Response is examined considering 1% step load perturbation in either thermal or hydro area.

Keywords: Automatic generation control, conventional controllers, reheat turbine, sampling time period, Fuzzy Controller.

I. INTRODUCTION

The objective of control strategy is to generate and deliver power in an interconnected power system as economically and reliably as possible while maintaining the voltage and frequency within specified limits. Changes in real power affect mainly the system frequency, while reactive power is less sensitive to changes in frequency and is mainly dependent on the changes in voltage magnitude. Thus, real and reactive powers are controlled separately.

The load frequency control (LFC) loop controls the real power and frequency and the automatic voltage regulator (AVR) loop regulates the reactive power (Q) and voltage magnitude (V). Load frequency control (LFC) has gained the importance with the growth of interconnected power system and has made the operation of the interconnected power system possible. The objective of the Automatic generation control is to hold the system frequency at or very close to a rated nominal value (eg.50 Hz), to maintain the correct value of interchange power Between control area and to maintain unit generation at the most economic value.

Automatic generation control means closed loop control systems which hold the system frequency within target limit. It also maintains the power interchange between adjacent system through tie lines.AGC helps generation of each plant within the area at economical value. The automatic generation controller design with better performance has received considerable attention during the past years and many control strategies have been developed for AGC problem. The availability of an accurate model of the system under study plays a crucial role in the development of the most control strategies like optimal control. However, an industrial process, such as a power system, contains different kinds of uncertainties due to changes in system parameters and characteristics, loads variation and errors in the modelling. On the

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

other hand, the operating points of a power system may change very much randomly during a daily cycle. The major part of the work reported so far has been performed by considering linearized models of two/multi area power systems [1, 4-8]. The effect of GRC was included in these types of studies, considering both continuous and discrete power system models [9-10]. It has been already illustrated that supplementary controller designs based on tie line bias control strategy is caused that the ACEs is regulated to zero effectively.

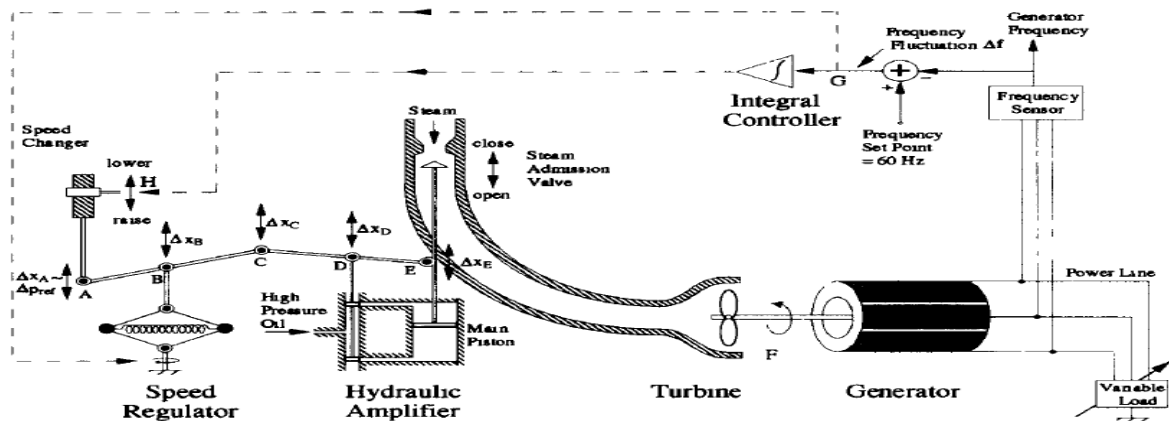


Fig1. Conventional Single Area System: Simplified Diagram

II. PROPOSED FUZZY LOGIC CONTROLLER

It has the capability of simulating human decision making based on fuzzy concept implications and the rules of inference in fuzzy logic. The knowledge based of an FLC is comprises of two components, a database and fuzzy control base. The concepts associated with a data base are used to characterize fuzzy control rule and a fuzzy data manipulation in a FLC. the design of a novel AGC controller based on fuzzy logic theory is explored. With the goal of damping the oscillations associated with power systems under the effect of small signals in local modes must be damped. The proposed solution of this problem is that a fuzzy controller is to be developed based on the optimal control theory.

		AREA CONTROL ERROR				
		NL	NS	ZE	PS	PL
CHANGE IN ACE	NL	NL	NL	NS	NS	ZE
	NS	NL	NL	NS	ZE	ZE
	ZE	NS	NS	ZE	PS	PS
	PS	ZE	PS	PS	PL	PL
	PL	ZE	ZE	PS	PL	PL
		FUZZY CONTROLLER OUT				

Fig2. Fuzzy Rules for 5 Membership Function

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

Fuzzy logic is a thinking process or problem-solving control methodology incorporated in control system engineering, to control systems when inputs are either imprecise or the mathematical models are not present at all. Fuzzy logic can process a reasonable number of inputs but the system complexity increases with the increase in the number of inputs and outputs, therefore distributed processors would probably be easier to implement. 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

Normalization

Normalization performs a scale transformation and it's also called input Normalization. It maps the physical values of the current process state variable into normalized universe of discourse. It also maps the normalized value of control output variable into physical domain. For this controller, normalization is got by dividing each crisp input to the upper boundary values for the associated universe.

Fuzzification

Fuzzification is the process of changing the crisp value to the fuzzy values. It could be defined as a mapping from an observed input space to fuzzy sets in certain input universe of discourse. Fuzzification plays an important role in dealing with uncertain information, which might be objective (or) subjective in nature. In fuzzy control applications, the observed data are usually crisp since the data manipulation in an LFC is based on fuzzy set theory. Fuzzification is necessary during the earlier stage. The choice of membership function for each Linguistic variable must be performed. This can be done by classification of control input and output into classified fuzzy set as shown in Figure 3.

The ACE and change in ACE are classified into:

{Negative Large (NL) , Negative Small (NS) , Zero (ZE) , Positive Small (PS) , Positive Large (PL)}

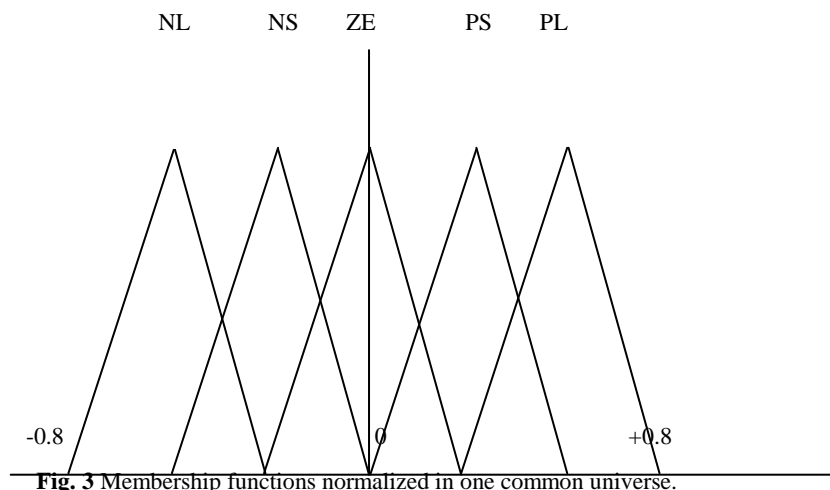


Fig. 3 Membership functions normalized in one common universe.

III. SYSTEM INVESTICATED

Both active and reactive power demands are never steady and they continually change with the rising or falling trend. Steam input to turbo-generators (or water input to hydro-generators) must, therefore be continuously regulated to match the active power demand, falling which the machine speed will vary with consequent change in frequency which may be highly undesirable (maximum permissible change in power frequency is ± 0.5 Hz). Also the excitation of generators must be feasible

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

and therefore automatic generation and voltage regulation equipment are installed on each generator. The controllers are set for a particular operating condition and they take care of small changes in load demand without exceeding the permissible limits. With the passage of time, as the change in load demand becomes large, the controllers must be reset either manually or automatically. The controllers are able to regulate change in frequency deviation and change in tie-line power deviation in an interconnected system. And bring back the interconnected system in an normal operating condition i.e stable condition. Controllers perform the operation to compensate the change in frequency deviation and tie-line deviation in an interconnected system. The main aim of the controller is to bring back the system from unstable mode to stable mode in case of small deviation. Different type of controllers are available they are used with different combination.

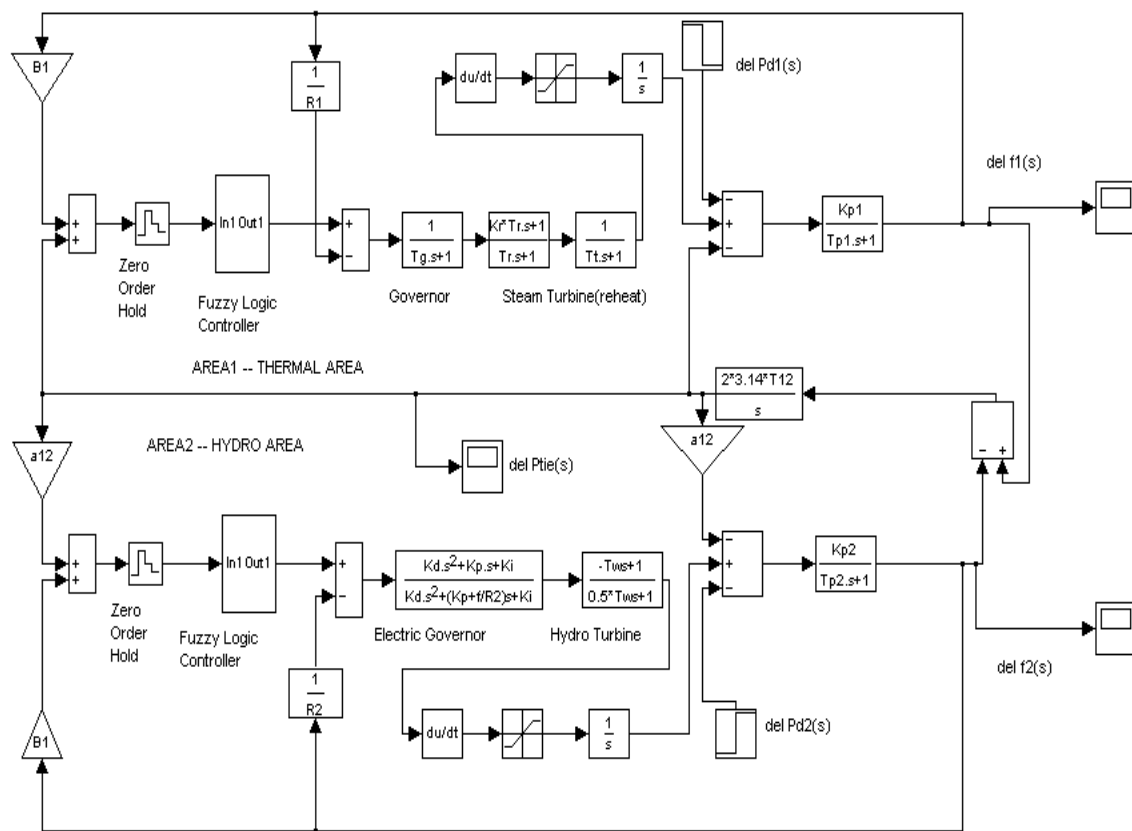


Fig.4. Transfer function model of an interconnected Two-area hydrothermal system.

III. RESULT & DISCUSSION

From the comparison of integral controllers and fuzzy logic controllers for the 1% step load perturbation, we can conclude that the fuzzy logic controller is better. The settling time of fuzzy logic controller is less where as the settling time for the convention integral controller is more as compared to fuzzy logic controller. With the new technique such as fuzzy logic controllers, it is easy for controller setting corresponding to the small frequency deviation and tie-line power deviation due to the small step load perturbation. Fig 4 (a). Dynamic response with 1% perturbation in thermal area.

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

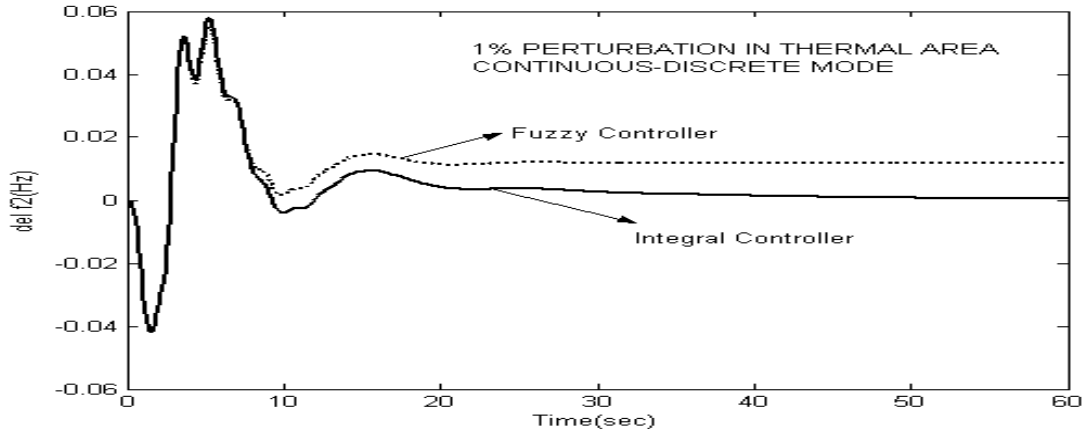


Fig 4(a). Dynamic response with 1% perturbation in thermal area.

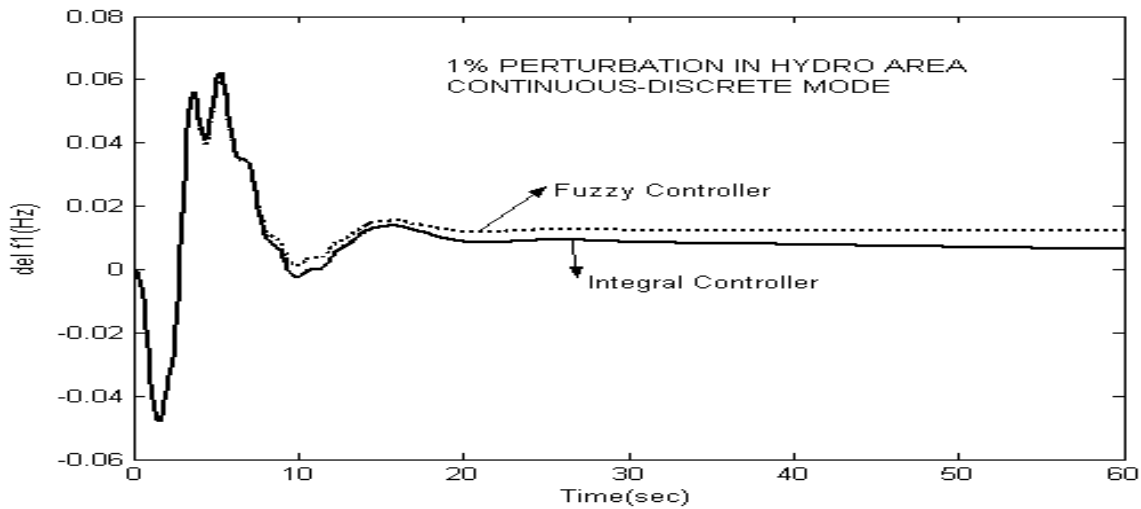


Fig 4(b). Dynamic response with 1% perturbation in hydro area

Table-I Comparative analysis of considering single reheat turbine in thermal and mechanical governor in hydro area with 1% perturbation in both area.

PARAMETERS	1% PERTURBATION IN BOTH AREA					
	INTEGRAL CONTROLLER			FUZZY LOGIC CONTROLLER		
	$\Delta f1$	ΔP_{tie}	$\Delta f2$	$\Delta f1$	ΔP_{tie}	$\Delta f2$
Settling time (t_s) in sec	48	40	59	30	25	33
Peak over shoot (M_p)	0.0297	0.00432	0.0281	0.0254	0.00433	0.0255



International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

Table-II Comparative analysis of considering double reheat turbine in thermal and electric governor in hydro area with 1% perturbation in both area.

PARAMETERS	1% PERTURBATION IN BOTH AREA					
	INTEGRAL CONTROLLER			FUZZY LOGIC CONTROLLER		
	$\Delta f1$	ΔP_{tie}	$\Delta f2$	$\Delta f1$	ΔP_{tie}	$\Delta f2$
Settling time (t_s) in sec	100	140	85	60	110	65
Peak over shoot (M_p)	0.016	0.0070	0.0178	0.0148	0.0071	0.0147

V.CONCLUSION

Thus from the table-I to table-II, we can conclude that fuzzy logic controller has good dynamic responses in overall closed loop system. From the dynamic response analysis, the fuzzy logic controller has found to provide better suppression of oscillations and also better damping of peak over shoot in same of the operating conditions. As compared to the conventional integral controller and fuzzy logic controller, in fuzzy logic controller provides fast and better responses. And the settling time and peak overshoot is less as compared to the conventional integral controllers. This comparison is made by considering 1% step load perturbation in both thermal and hydro area.

REFERENCES

- [1] Janardan Nanda, Ashish Mangla and Sanjay Sui, "Some New Findings on Automatic Generation Control of an Interconnected Hydrothermal System With Conventional Controllers" IEEE trans, Vol.21, No.1, March 2006.
- [2] J. Nanda and A. Mangla "Automatic Generation Control of an Interconnected Hydro-Thermal System Using Conventional Integral and Fuzzy Logic Controller" IEEE tans, April 2004.
- [3] O. I. Elgerd and C.E. Fosha, "Optimum megawatt-frequency control of multiarea electric energy system," IEEE tans. Power Appar. Syst., Vol.25, No.10, pp. 1063-1077, December 1997.
- [4] O. I. Elgerd, Electric Energy Systems Theory, New York: McGraw-Hill, 1971, pp.315-389.
- [5] C. Concordia and LK.Kirchmayer, "Tie-line power & frequency control of electric power system: Part II, " AISE Trans. III-A, vol.73, pp.133-146, April 1954.
- [6] L. K. Kirchmayer, Economic Control of Interconnected Systems. New York: Wiley, 1959.
- [7] D. G. Ramey and J. W. Skooglund, "Detailed hydro governor representation for system stability studies," IEEE Trans. Power App. Sust., vol. PAS-89, no.1, pp. 106-112, January 1970.
- [8] "IEEE Trans. Power Appar. Syst.," IEEE Committee Rep., vol. PAS-86, pp.384-395, 1966.
- [9] M. L. Kothari, J. Nanda, and P. S. Satsangi, "Automatic generation control of hydrothermal system considering generation rate constraint," J. Inst. Eng. India, vol.63, pp.289-297, June 1983.
- [10] M. L. Kothari, J. Nanda, and B. L. Kaul "Automatic generation control of hydrothermal system," J. Inst. Eng. India, pt EL2, vol.61, pp.85-91, October 1980.

BIOGRAPHY



He received her B. Tech. Degree in Electrical Engg from Hindu college of Engineering , MDU, Rohtak India in 2011. At present he is M.Tech. scholar from Hindu College Of Engg., Sonipat, (Haryana) India



Mr. Ashwani Kumar received his B.E. Degree from MDU, Rohtak, India in 2003 and M.E. Degree in Electrical Engg. From C.R.State college of Engg., Murthal, Sonipat (Haryana) India in 08. At Present he is working as Asst. Prof. in Dept. of Electrical Engg., Hindu College of Engineering, (Haryana) India. His academic experience is about nine years. His area of interest includes Power system control & Instrumentation, Wavelet Analysis.