Automatic Generation Control of Two Areas in Interconnected Power System

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***Abstract*- In this paper work hydro unit is considered with electric governor and thermal unit is considered with reheat turbine and mechanical governor. The primary purpose of the AGC is to balance the total system generation against system load and losses so that the desired frequency and power interchange with neighboring systems are maintained. Any mismatch between generation and demand causes the system frequency to deviate from scheduled value. Thus high frequency deviation may lead to system collapse. This necessitates an accurate and fast acting controller to maintain constant nominal frequency**

Key words: - Automatic generation control, Fuzzy logic Control, Neural networks, Neuro fuzzy networks

I. INTRODUCTION

Modern power system normally consists of a number of subsystems interconnected through tie lines. For each subsystem the requirements usually include matching system generation to system load and regulating system frequency. This is basically known as load-frequency control problem or automatic generation control (AGC) problem. Generation in large interconnected power systems comprises of mix type of thermal, hydro, nuclear and gas power generation. Nuclear units owing to their maximum efficiency and controllability problem are usually kept at base load close to their maximum output with no participation in system's automatic generation control. Gas power plants are ideal for Automatic Generation Control, but these plants form a very small percentage of total system generation. Thus the natural choice of AGC falls either on thermal or on hydro unit. However the characteristic of hydro turbine is altogether different from steam turbine in terms of transfer function, torque characteristics, generation rate constraints, speed governing system etc. [1]. Therefore it is difficult to achieve a suitable control strategy, which will work well in interconnected hydro-thermal system because they have entirely different characteristics. Conventional control schemes viz. Integral, PI and PID are slow and lack of efficiency in handling the system non- linearities. Many investigations in the field of automatic generation control of interconnected power system have been reported over the past few decades.

II.AGC OF AN ISOLATED AREA

A complete block diagram representation of an isolated power system comprising turbine, generator, governor and load is easily obtained by combining the block diagrams with feedback loop as shown in Fig. 1.

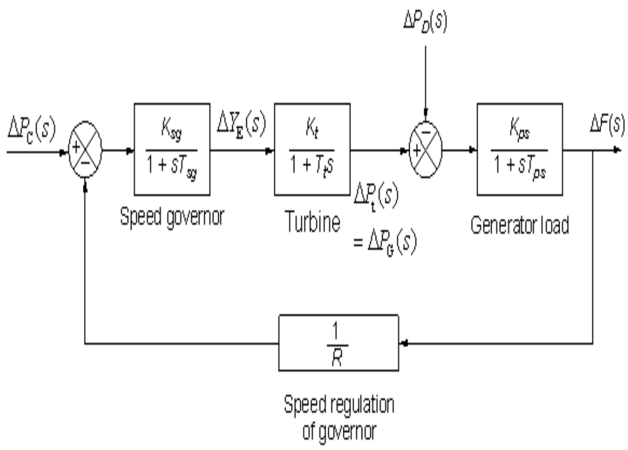

Fig. 1. Block Diagram Model of Load Frequency Control

The model of Fig. 1 shows that there are two important incremental inputs to the load frequency control system i.e. $-\Delta P_C$, the change in speed changer setting; and ΔP_D, the change in load demand. Let us consider the speed changer has a fixed setting (i.e. $\Delta P_C = 0$) and load demand changes. This is known as free governor operation.

III.CAPACITIVE ENERGY STORAGE UNIT

A capacitor stores the energy in its electrostatic field created between its plates in response to applied potential across it. So for realizing a CES unit we need a 3-phase ac to dc rectifier and a dc to ac inverter system and a capacitor bank. The capacitor bank consists of many small capacities capacitors connected in parallel. The capacity of the CES unit can be increased at any time by adding capacitors in parallel to the capacitor bank. Fig. 1 shows the electrical circuitry of a typical CES unit. ACE being a linear function of frequency deviation and tie line power deviation is a better option to damp the oscillations and reduce response time. After a sudden load disturbance, in either of the areas, the restoration time of capacitor bank to normal voltage is slow. For quick restoration, a negative feedback is applied by sensing the voltage deviation in the control loop of the CES unit as in Fig.1. The voltage deviation of the CES unit is limited to ±15% of the nominal value.

IV.NEURAL NETWORK FUZZY CONTROL

In the control scheme, neural network is chosen to create the real time dynamic model of the power system. In accordance with the current controller output u(r), the tie-line power deviation dPtie(r) and the frequency deviation df (r), the neural network is used to predict the next moment's frequency deviation df(r+1), thus calculate the ACE, the ACEN as well as CPS. The predicted CPS1 and CPS2 are used as input variables to the fuzzy controller that offers optimal controller parameters. Elman network is a typical dynamic recurrent neural network. Its feedback consists of a group of connected modules and is used to record the implicit memory. Meanwhile, the feedback, along with the network input, acts as the import to hidden units in the next moment. This nature renders recurrent neural network with dynamic memory and thus the capacity to predict future output, which is quite fitful to power system load frequency control. The Elman neural network structure in the Automatic generation control. The network structure is shown in Fig.1 α (0≤α≤1) is the feedback link gain. The external inputs to the network are the fuzzy controller output u (r) €R, the tie-line power deviation dPtie (r) €R and frequency deviation df (r) €R. The network output is the predicted frequency deviation for the next moment df (r+1) €R, in which r is the sampling instant.

V. DEREGULATED POWER SYSTEM

Deregulation is the collection of restructured rules and economic incentives that government set up to control and drives the electric power industry. Deregulated system will consist of generation companies. Distribution companies, transmission companies and independent system operator. GENCO, TRANSCO, DISCO, ISO and many ancillary services of a vertically integrated utility will have a different role to play and therefore have to be modeled differently. There are crucial differences between the AGC operation in a vertically integrated industry and horizontally integrated industry. In the reconstructed power system after deregulation, operation, simulation and optimization have to be reformulated although basic approach to AGC has been kept the same. In this case, a DISCO can contract individually with any GENCO for power and these transactions are made under the supervision of ISO. To understand how these contracts are implemented, DISCO participation matrix concept is used as in. The information flow of the contracts is superimposed on the traditional AGC system.

AGC of interconnected two-area power system in deregulated environment.

The power system contains two thermal units in both the areas. Restructured system contain several GENCOs and DISCOs, any DISCOs can contract with any GENCOs in another control area independently. This case is called as "bilateral transaction". All the transactions have to be implemented through an independent system operator (ISO). ISO has an impartial entity and control many of ancillary services, one of which is AGC. In restructured environment, DISCOs has a liberty to buy power from different GENCOs, which may or may not have contract in the same area as the DISCO. DISCO participation matrix (DPM) concept to make the visualization of contract easier. In DPM, the number of the rows equal to the number of GENCOs and the number of the columns equal to the number of DISCOs in the system.

VI. RESULT

The optimum values of controller gains for full state feedback, Integral optimal output feedback and PI Optimal output feedback controllers are obtained by minimizing the performance Index as described in mathematical back ground. Dynamic responses of the system are obtained for 1% step load perturbation in area-1 and area-2 through computersimulation.

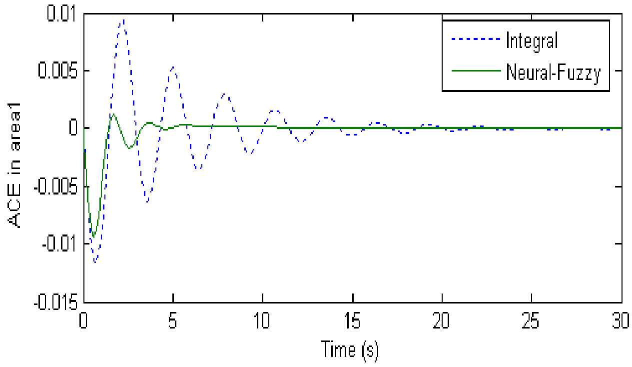

Fig. 2

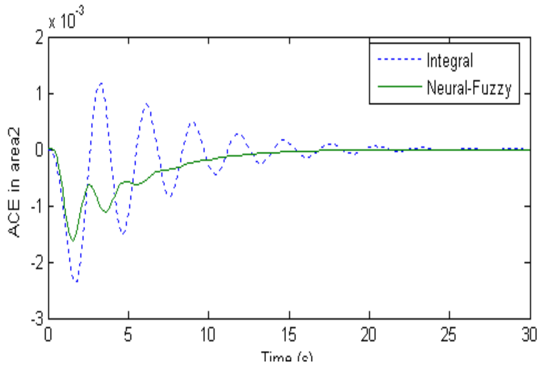

Fig. 3 Area control error of area1, 2

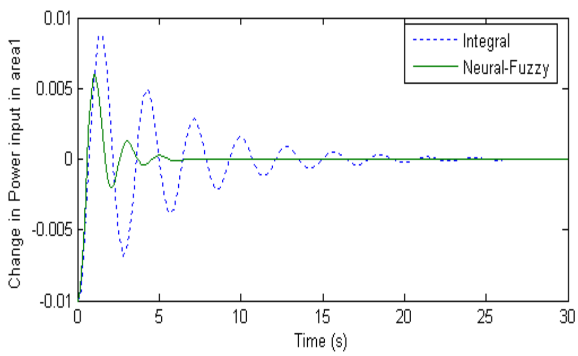

Fig. 4

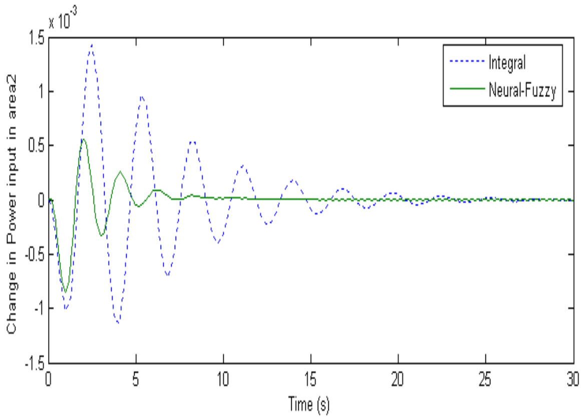

Fig 5 Change in power input of area 1, 2

VII. CONCLUSION

An attempt has been made to formulate the AGC problem for two area interconnected Hydro-thermal Power system.Incorporating low head turbine in hydro area and reheat type turbine in thermal area. The effectiveness of the optimal control design has been demonstrated on the two area interconnected system considered for study. In this paper the proposed controllers are tested and their dynamic responses are compared. Dynamic responses of thermal area and hydro area to 1% step load perturbations in either area with full state feedback, Integral optimal output feedback and PI Optimal output feedback controller have been obtained. In this paper, the dynamical response of the LFC problem is improved with a practical point of view because practically access to all of the state variables of system is limited and measurement of all of them is not feasible.

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