Frequency Stabilization Of Two Area Interconnected Power System Using Fuzzy Logic Controller And PID Controller

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Abstract

The large- scale power systems are usually divided into control areas and these control areas are interconnected through tie lines. Because load in the power system is never constant, so fixed gain controllers may fail to provide best control performance. In this paper an Automatic Generation Control scheme for two area power system using Fuzzy Logic controller and conventional controller is presented. The simulation results of two areas are compared using MATLAB/SIMULINK software. Automatic Generation Control is a very important process to balance the generation and load. Fuzzy Logic controller is designed using five membership functions. MATLAB Simulation software can also be used for fine tuning of the PID controller used in this two area interconnected power system.

Keywords: Automatic Generation Control (AGC), Multi Area Power Systems (MAPS), Proportional- Integral- Derivative (PID) Controller,

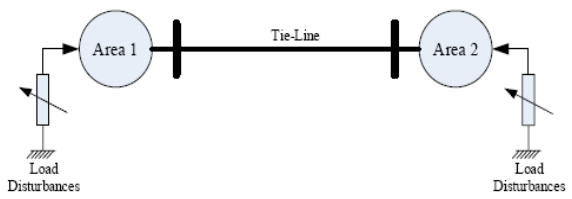
1. Introduction:

Automatic Generation Control or Load Frequency Control is an important issue in power system for delivering sufficient and reliable power. Load Frequency control is one of the important control problems in power system operation. The main objective of AGC is to establish a normal operating state and optimum scheduling of generation with good quality of power. Since load demand varies continuously, so the generation is expected to overcome these variations without any change in the voltage and frequency. Therefore voltage and frequency controllers are installed to maintain the desired megawatt output. To maintain desired megawatt output of a generator unit Automatic Generation Control is required. AGC also controls the frequency of larger interconnected power system. AGC has made the operation of interconnected system possible. The main purpose of designing Fuzzy Logic based load frequency control is to ensure stable and reliable power system operation. Automatic Generation Control equipments are installed for each generator in the power system. Automatic Generation Control also helps to maintain the net interchange of power between pool members at pre-specified values. In the conventional control design the integral of control error is taken as the control signal. By using integral controller zero steady state frequency deviation can be achieved but it gives poor dynamic response. Due to sudden load change in the system, there occurs fluctuations in the frequency which remains for a long time. One method to restore the frequency to its nominal value is to add integrator in the power system network. But conventional controllers do not better results. The results obtained shows that the

performance of fuzzy logic based controller is better than the conventional controller.

2. Two Area Power System:

Automatic Generation Control may be defined as the scheme used to restore frequency to the normal value by adjusting the generation automatically when there is continuous change in the system load. Automatic Generation Control problem of two area power system is studied by dividing the whole system into control areas. Control Area may be defined as a part of the power system to which a common generation scheme is applied. In the control areas the frequency is assumed to be the same in static as well as in dynamic conditions. These control areas are connected to each other by tie lines. All the generators in the control area form a coherent group and swing in unison. To maintain the frequency and voltage profile of the overall system each control area of the power system should help. A multi area power system is one that consists of a number of control areas and these control areas are expected to absorb its own load changes. The control system regulates the frequency of each area and simultaneously regulates the tie line power. In large interconnected power system networks regulation by using manual methods is not feasible. So automatic equipments for regulation are installed on each generator. A simplified two area interconnected power system is shown in fig. 1



Fig, 1 Simplified two area interconnected power system

The overall system can be represented as a multi variable system in the following form:

$$\dot{x} = Ax(t) + Bu(t) + Ld(t), \qquad (1)$$

Where A = system matrix, B and L are the input and disturbance distribution matrices, and $x(t)$, $u(t)$ and $d(t)$ are state, control signal and load change disturbance vectors, respectively.

The system output depends on area control error (ACE) which is given as:

$$y(t) = \begin{bmatrix} y_1(t) \\ y_2(t) \end{bmatrix} = \begin{bmatrix} ACE_1 \\ ACE_2 \end{bmatrix} = C\,x(t), \qquad (2)$$

$$ACE_i = \Delta P_{tie} + b_i \Delta f_i, \quad i = 1,2, \qquad (3)$$

Where bi= frequency bias constant, Δfi=frequency deviation, $\Delta Ptie$ = change in tie-line power for area i and C = output matrix. The transient response can be improved by using Fuzzy Logic Controller controller as compared to conventional controller.

3. Fuzzy logic controller:

Fuzzy Logic controller is used for automatic generation control in a two area power system. The methodology of fuzzy logic controller is very useful when the systems are too complex for analysis by using conventional methods. Fuzzy logic controller mainly consists of four components (1) Fuzzification Interface (2) Knowledge Base (3) Decision Making Logic (4) Defuzzification Interface. The fuzzification interface measures the values of input variables and converts the input data into suitable linguistic values. The Knowledge Base provides necessary definitions that are used to define the linguistic control rules. The decision making logic has the capability of simulating human decision- making based on fuzzy concepts. The defuzzification Interface

converts the output variables into corresponding universe of discourse. Membership functions used for designing of fuzzy logic controller for automatic generation control of two area power system are given below:

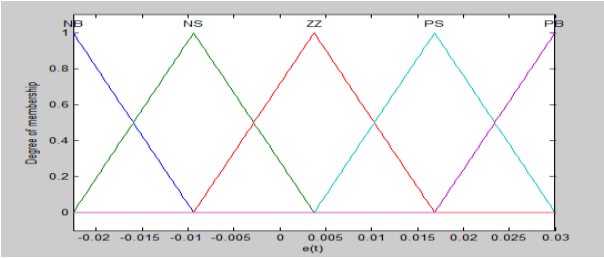


Fig. 2 membership functions of input1

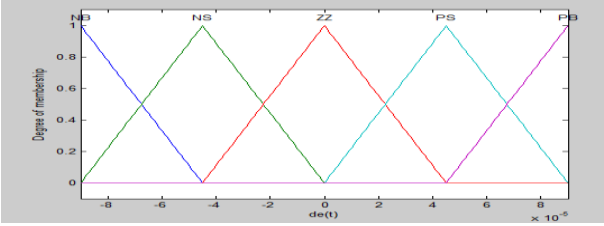


Fig. 3 membership functions of input2

Rule base (with five membership functions) are used for designing of Fuzzy Logic controller. The rules used for designing of controller are based on the output responses obtained by corresponding inputs. The interpretation of rules is done as follows: If ACE is NB and d/dt ACE is NB then output is S, If ACE is NB and d/dt ACE is NS then output is S, And so on.

4. AGC and AVR Model Description:

The first step in the design of a control system is mathematical modelling of the power system. The most common methods are the transfer function method and state variable approach. The state variable approach can be used for linear as well as non linear systems. In order to use linear state equations, the system first must be linearized. Automatic Generation Control model of two area power system using fuzzy logic controller and PID controller is given in the fig. 4.

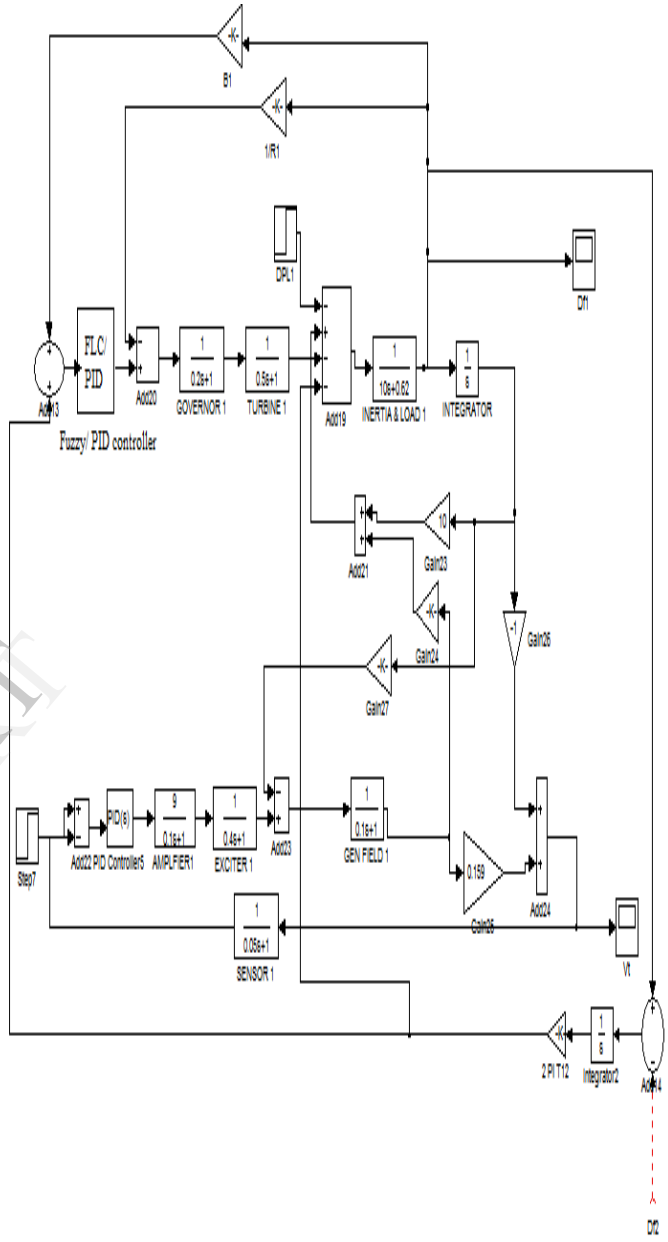


Fig4: Area 1 (with AGC and AVR) of two area power system using FLC/ PID Controller

In this scheme fuzzy logic controller and PID controller are used for frequency control of two area power system and the results of both controllers are compared, then it is found that fuzzy logic controller gives better results as compared to PID controller. Automatic

Voltage Regulation is performed by using PID controller.

5. Simulation Results and Discussions:

Fuzzy logic controller is used in AGC modelling of the two area power system. The results obtained by using fuzzy logic controller are compared with the results obtained by using conventional controller. PID controllers used in this two area power system are tuned by making an initial guess. Later the parameters settings are improved by using MATLAB Simulink. Figs show the resulting responses of the simulation model. Fig 5, 6 shows the frequency responses of the two area power system using fuzzy logic controller and PID controller. Fig 7, 8 shows the terminal voltage of the area-1 and area-2 using PID controller. From all these figures we obtain that the results with fuzzy logic controller are better as compared to PID controller. The results obtained with Fuzzy Logic controller has less overshoot/ undershoot and less settling time as compared to PID controller.

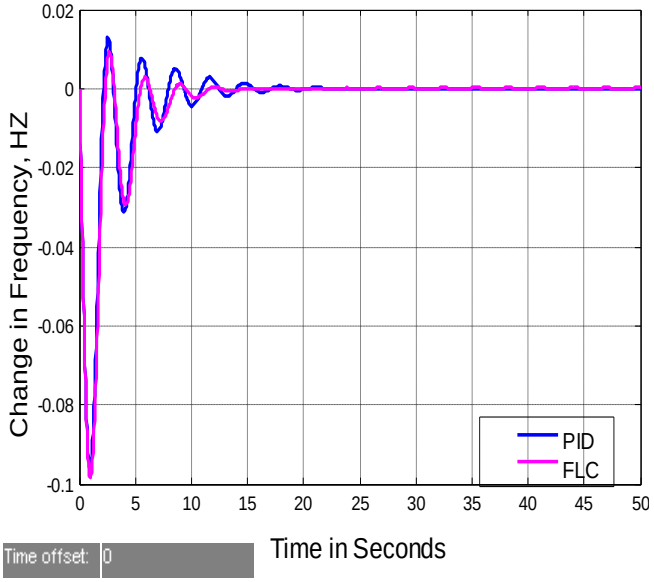


Fig. 5: Frequency response of area-1

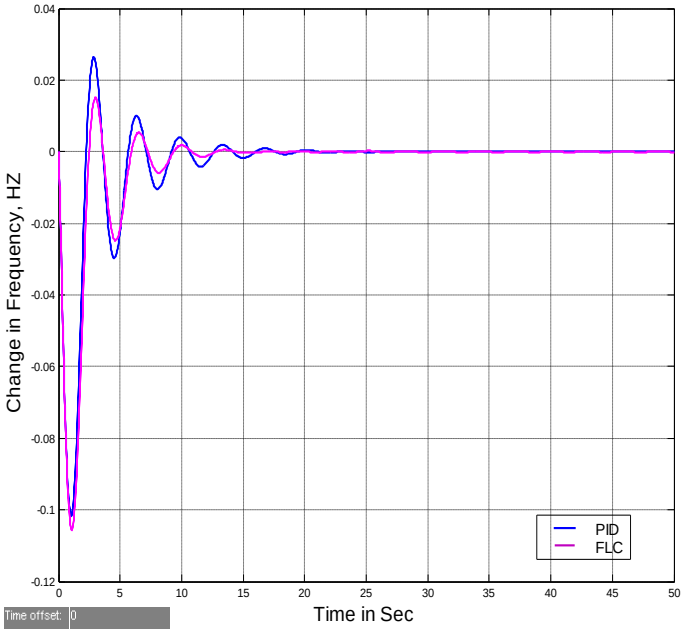


Fig. 6: Frequency response of area-2

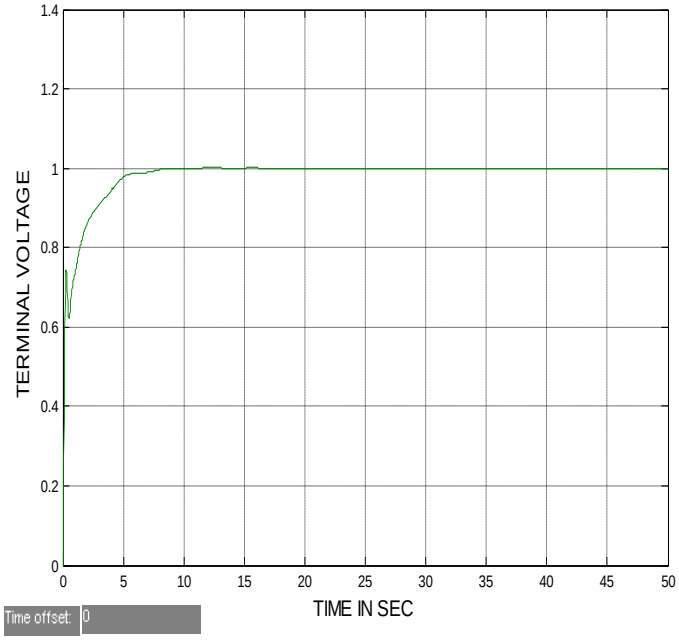


Fig. 7: Terminal Voltage of area-1

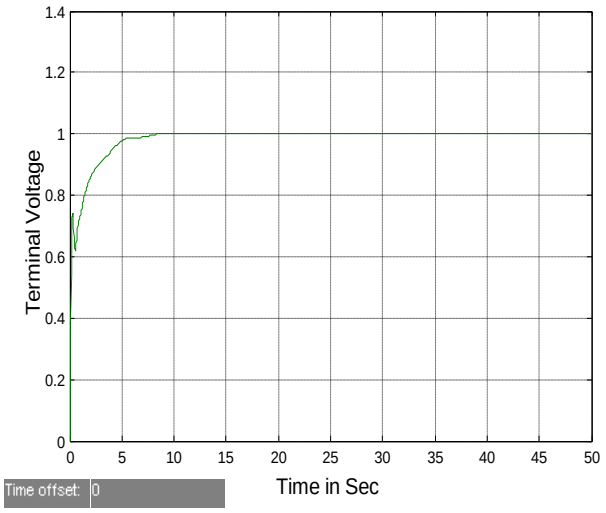


Fig. 8: Terminal Voltage of area-2

6. Conclusions:

In this paper, a Fuzzy Logic controller has been investigated for automatic generation control of two area power system in order to improve the performance of the system. Automatic Voltage Regulation is done by using PID controller. For this purpose, PID controller is tuned by using a new simple tuning method. Performance comparison of the proposed paper shows that Fuzzy Logic controller has a shorter settling time as compared to PID controller. In order to improve transient response of the system Fuzzy Logic controller can be used.

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