Comparative Analysis In Automaed Generation Control Using Pi PID And Fuzzy Logic Controller A Review

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Abstract-*This paper deals with load frequency control of interconnected power system. In this work single area and two area concepts is considered. The major intention of Load Frequency Control is to sustain the power performance of electric generator within a specified area, due to which alters in frequency of the system and tie-line loading. Thus, Load Flow Controller assists in sustaining the frequency of the system and tie-line power performance with other areas within their specified limits. Mostly LFCs are initially comprises of an integral and PID controller. The gain of the controller is building put to a value that gives better response among fast transient recovery and low overshoot in the performance of the entire power system.*

In this dissertation work we are using PID controller and fuzzy logic controller. The proposed controller guarantees the stability of the overall closed loop system. Simulation responses for a real two-area power system confirm the usefulness of the proposed LFC and proved its superiority without using controller. 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 problems are studied using MATLAB simulink software. The results indicate that the proposed Fuzzy logic controller exhibits better performance

I. INTRODUCTION

In our country every person needs the uninterrupted power supply. So it is not promising for the system to stay behind in normal steady state, in view of the fact that both the real and reactive power requirements are continuously alters through growing and diminishing trend. In modern grid power system where a number of equipments are interconnected and power is transferred among them over tie-line, The Automatic Generation Control issue is the major requirement. The deviation among power system generation and demand outcomes in alters the system frequency that is highly undesirable. The excitation of generator should be sustained to contest the reactive power requirement else bus voltage drops beyond the accessible limit. In modern grid power system instruction manual control is not possible; therefore automatic devices are operated on each generator. The major aim of control scheme is to generate and deliver power in a grid power system as inexpensively and constantly as probable while sustaining the voltage and frequency within their specified limits.

II. AUTOMATIC GENERATION CONTROL

When the loading in the power grid system increases, due to this its turbine speed falls behind the governor can sustain the input. Due to the fluctuation in the range of speed diminishes the signal of error will be smaller and the arrangements of governor range will be close to the required position, to sustain unvarying speed. Since the unvarying speed will not be the reference value and this will be the offset, to overcome this difficulty an integrator is added, which shall automatically control the generation to re-establish the frequency to its rated value. This technique is named as an automatic generation control (AGC).

The major aim of the Automatic Generation Control is to make steadiness the total system generation alongside all system load and losses, so that the frequency and power substitution with neighboring grid systems are controlled in order to reduce the transient deviations and to afford zero steady state error in particular time.

III. LOAD FREQUENCY CONTROL

The LFC, also known as generation control or p-f control of loading of the generating units for the system at normal frequency. The load in power system is never constant and the system frequency remains at its nominal value only when there is a match between the active power generation and the real power requirement. During the period of load change, the deviation from the nominal frequency, which may be called frequency error (Δf), is an index of mismatch and can be used to send the appropriate command to change the generation by adjusting the LFC system. It is basically controlling the opening of the inlet valves of prime movers according to the loading condition of the system.

In this control, a frequency sensor senses the changes in frequency and gives the signal Δf_i. The p-f controller responses the alters in frequency signal (Δf_i) and the enhancements in tie line real powers (P_{tie}) which give provide information regarding the incremental state factor error (δ_i). These sensor signal (Δf_i and P_{tie}) are amplified, mixed and transformed in to real power control signal ΔP_{ci}. The valve control mechanism takes ΔP_{ci} as the input signal and provides the output signal, which will change the position of the input valve of the prime mover. As a result, there will be a change in the prime mover output and hence a change in the real power generation ΔP_{ci}. This entire P-f control can be yielded by automatic load frequency control (ALFC) loop.

ADVANTAGES OF AGC

The automatic generation control has many advantages in power system .It improves the following factors-

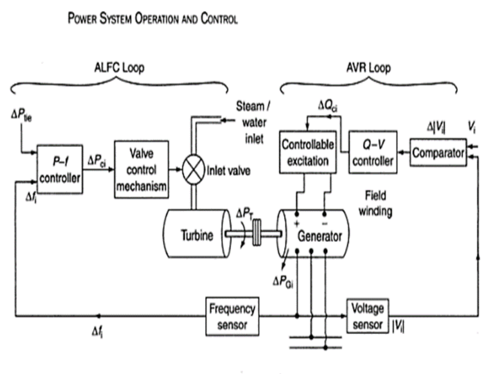


Figure: 1 P-f controller and Q-V controller

ECONOMY-

The automatic generation control divides the loads among the system, station and generator to achieve maximum economy. In other words, it distributes the required change in generation among the units to minimize the operating cost .Thus it make the electrical power system to work properly at low operating cost to improve the economy.

APPLICATIONS OF AGC

The automatic generation control has many application which are given as following-

- The automatic generation control is applicable in electric grid system for maintaining the power response of multiple generators at dissimilar power plants, in results to variation in the load.
- The automatic generation control is applicable for regulating the frequency and voltage in electric power system for –
  - One area
  - Two area
  - Multiple area

Thus the automatic generation control is applicable in one area, two area and multiple area interconnected power system to maintain the frequency and interchange power between control areas at scheduled value.

Block Diagram Representation

I will formulate the block diagram for a two area AGC system in the deregulated scenario. Whenever a load demanded by a DISCO changes, it is reflected as a local load in the area to which this DISCO belongs. This corresponds to the local loads ΔPL1 and ΔPL2 and should be reflected in the deregulated AGC system block diagram at the point of input to the power system block. As there are many GENCOs in each area, ACE signal has to be distributed among them in proportion to their participation in AGC. Coefficients that distribute ACE to several GENCOs are termed as " ACE participation factors". Note that

The scheduled steady state power flow on the tie-line is given as:

Scheduled

ΔP_{tie12} = (Demand of DISCOs in area-2 from GENCOs in area-1) – (Demand of DISCOs in area-1 from GENCOs of area-2)

Scheduled

$\Delta P_{tie12} = \sum_{i=1}^{2} 1 \sum_{j=3}^{4} cpfij \Delta PL_j - \sum_{i=3}^{4} 1 \sum_{j=1}^{2} cpfij \Delta PL_j$

At any given time, the tie-line power error is defined as:

Error = actual - scheduled

$\Delta P_{tie12} = \Delta P_{tie12} - \Delta P_{tie12}$

The tie-line power error vanishes in the stedy-state as the actual tie-line power flow reaches the scheduled power flow. This error signal is used to generate the respective ACE signals as in the traditional scenario:

$ACE_1 = B_1 \Delta F_1 + \Delta P^{error}_{tie12}$

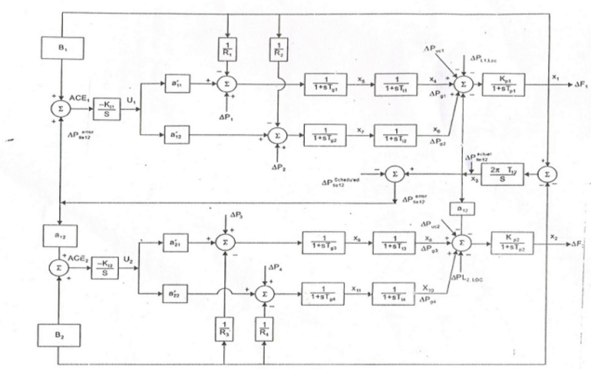
$ACE_2 = B_2 \Delta F_2 + \alpha_{12} \Delta P^{error}_{tie12}$

For two area system contracted power supplied by i-th GENCO is given as:

$\Delta P_i = \sum_{j=1}^{NDISCO=4} cpfij \Delta PL_j$

The block diagram of two area AGC system in a deregulated environment is shown in figure below:

The state space model for above diagram is shown in figure below:



simplified representation of fig.

For i=1

$\Delta P_1 = cpf_{11} \Delta PL_1 + cpf_{12} \Delta PL_2 + cpf_{13} \Delta PL_3 + cpf_{14} \Delta PL_4$

Similarly, ΔP_2, ΔP_3, ΔP_4 can easily be calculated.

In this closed loop model above ΔP_{uc1} and ΔP_{uc2} are subcontracted power demand (if any).

Also from this closed loop model $\Delta PL_{1, LOC} = \Delta PL_1 + \Delta PL_2$ and $\Delta PL_{2, LOC} = \Delta PL_3 + \Delta PL_4$

In the proposed AGC implementation, contracted load is fed forward through the DPM matrix to GENCO set points i.e. ΔP_1, ΔP_2, ΔP_3 and ΔP_4 as shown in closed loop model. The actual loads affect system dynamics via the inputs $\Delta PL_{, LOC}$ to the power system blocks. Any mismatch between actual and contracted demands will result in a frequency deviation that will result in a frequency deviation that will drive AGC to redispatch GENCOs according to ACE participation factors. The AGC scheme does not measurement of actual loads. The inputs $\Delta PL_{1, LOC}$ and $\Delta PL_{2, LOC}$ in the closed loop model are part of the power system model, not part of AGC or LFC i.e. load frequency control.

Integral control law for area-1 and area-2 are given as:

$U1 = -K_{11} \int ACE1\, dt$

$U2 = -K_{12} \int ACE2\, dt$

K11 and K12 are the integral gain settings of area-1 and area-2 respectively.

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 fig

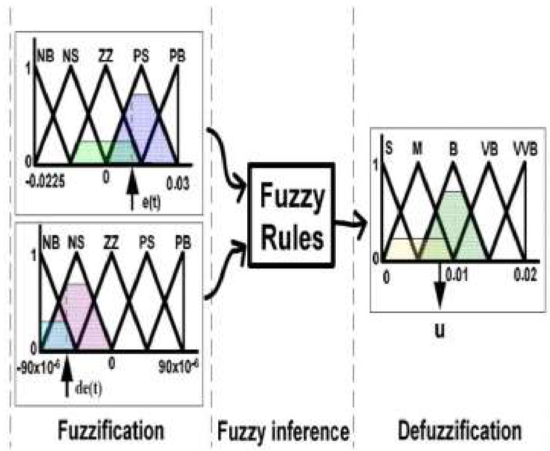


Fig.4. Fuzzy Inference system for FLC

Simulations And Result

Assumption and Requirement

Extensive testing was involved in the completion of this project. Not only was our final automatic generation control with deregulation tested, but also intermediate steps in the development of that block diagram. The testing of our load frequency control system was done in MATLAB SIMULATION LAB. The testing was completed using the MATLAB Simulink tool. Testing was done on each of the individual blocks of the AGC system and the tests are conducted for single area and two area system without considering deregulation. Each test included in testing the block diagram into simulink and plugging in the values for each of the parameters. Also involved was the addition of the scopes that would be used to measure the outputs of the system. The inputs for each of the text were varied to allow for more data. The testing forms and the completed testing forms are included in this report. The following assumptions are made and are shown in table:

Assumptions

- ⇒ We assumed the basic block diagram for a two area AGC system.
- ⇒ We assumed the system is in normal operating state.
- ⇒ The loss of a generating unit will not be considered.
- ⇒ We also extend this block diagram up to 4 generating units .

Limitations

- ⇒ The area control error or the power interchange between areas must be equal to zero at least one time for every 10 minutes.
- ⇒ The average power interchange between areas must be zero in ten minutes period and follow limits of the generation system.
- ⇒ Power interchange between areas must be returned to zero in 10 minutes.
- ⇒ Corrective actions must be accommodating within one minute of a disturbance.

Open Loop AGC System for single Area System

Open loop AGC simulation for single area system is shown in figure 5.1

The plot between frequency and time is shown in figure 5.2. It is found that with change in load of 2000 MW, frequency deviates and error is continuously exists in the system. This frequency error must be removed.

It is found from graph that with open loop if demand changes to 0.2 pu, a steady state error exists in frequency of 0.

Close Loop AGC for Single Area System

System frequency specifications are rather stringent and, therefore, so much change in frequency cannot be tolerated. In fact, it is expected that the steady change in frequency cannot be tolerated. In fact, it is expected that the steady change in frequency will be zero. While steady state frequency can be brought back to the scheduled value by adjusting speed changer setting, the system could undergo intolerable dynamic frequency changes with change in load. It leads to the natural suggestion that the speed changer setting be adjusted automatically by monitoring the frequency changes. For this purpose, a signal from ΔF is fed through an integrator to the speed changer. The closed loop AGC system is shown in figure 5.3.

The frequency response is as shown:

It is concluded that the system now modifies to a proportional plus integral controller, which, as is well known from control theory, gives zero steady state error, i.e. $\Delta f(\text{steady state}) = 0$.

V. CONCLUSION

AGC provides a relatively simple, yet extremely effective method of adjusting generation to minimize frequency deviations and regulate tie-line flows. This important role will continue in restructured electricity markets. However some important modifications are necessary to cater for bilateral contracts that span control areas. Bilateral contracts can exist between DISCOs in one control area and GENCOs in other control areas. The scheduled flow on a tie-line between two control areas must exactly match the net sum of the contracts that exist between market participants on opposite sides of the tie-line (taking account of contract directions). If a contract is adjusted, the scheduled tie-line flow must be adjusted accordingly.

In this we made a simulink model of single area amd two area model has been designed. After that PID and fuzzy logic controller is used to reduce the oscillations and settling time. After seeing the results on comparing between without controller and PID controller, PID gives better results and reduced oscillations. But fuzzy logic controller gives more accurate results than PID controller.

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