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Controlling of Load Frequency

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Abstract

This research project presents decentralized control scheme for Load Frequency Control in a multi-area Power System by appreciating the performance of the methods in a single area power system. In an interconnected power system, if a load demand changes randomly, both frequency and tie line power varies. The main aim of load frequency control is to minimise the transient variations in these variables and also to make sure that their steady state errors is zero. A number of modern control techniques are adopted to implement a reliable stabilizing controller. The objective of these control techniques is to produce and deliver power reliably by maintaining both voltage and frequency within permissible range. When real power changes, system frequency gets affected while reactive power is dependent on variation in voltage value. That’s why real and reactive power are controlled separately. This thesis studies the robustness and reliability of the various control techniques of load frequency control of the proposed system through simulation in the MATLAB-Simulink environment.

Keywords: *Frequency, ALFC, AVR, AGC.*

Introduction

The main objective of power system operation and control is to maintain continuous supply of power with an acceptable quality, to all the consumers in the system. The system will be in equilibrium, when there is a balance between the power demand and the power generated. As the power in AC form has real and reactive components: the real power balance; as well as the reactive power balance is to be achieved.

For example, steam input to turbine must be continuously regulated to match the active power demand. The system frequency otherwise will change which is not desirable. (A change in the electric power consumption will result in a deviation of the frequency from its steady state value. The consumers require a value of frequency and voltage constant. To maintain these parameters, controls are required on the system and must guarantee a good level of voltage with an industrial frequency).

Excitation of the generator must also be maintained continuously to match the reactive power demand; otherwise the voltage at various system buses may go beyond the specified limit. Manual regulation is not possible. There are two basic control mechanisms used to achieve reactive power balance (acceptable voltage profile) and real power balance (acceptable frequency values). The former is called the automatic voltage regulator (AVR) and the latter is called the automatic load frequency control (ALFC) or automatic generation control (AGC). Thus, Voltage is maintained by the control of excitation of the generator and frequency is maintained by the elimination of the difference in power between the power provided by the turbine and the power required by the load. It is known that although the loads are time-variant, the variations are relatively slow. The controllers are set for a particular operating condition and they take care of small change in load demand without frequency and voltage exceeding the précised limits .As the change in load demand becomes large, the controllers must be reset either manually or automatically.

Load frequency control

The main purpose of operating the load frequency control is to keep the uniform frequency changes during the load changes. During the power system operation rotor angle, frequency and active power are the main parameters to change.

In multi area system a change of power in one area is met by the increase in generation in all areas associated with a change in the tie-line power and a reduction in frequency. In the normal operating state the power system demands of areas are satisfied at the nominal frequency.

The basic role of Load Frequency Control is:

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1. To maintain the desired megawatt output power of a generator matching with the changing load.
2. To assist in controlling the frequency of larger interconnection.
3. To keep the net interchange power between pool members, at the predetermined values.

Results and Discussion

In this study here, first an optimal control law is generated for the power system stability, then the states are estimated by Kalman filter at the presence process and measurement noises taken as white Gaussian noise. Then combining those both optimal compensator is designed which recovers the responses of optimal regulator at the presence of noise. So, the operation of optimal compensator is equal to the operation of optimal regulator but it can work noise environment.

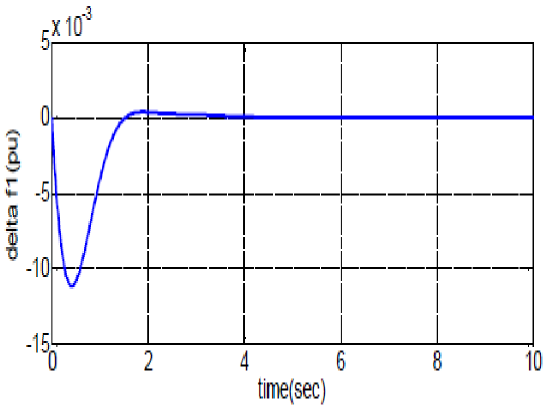

Figure 1: Change in frequency V/S time in area-1 for 0.01 step load change in area-1

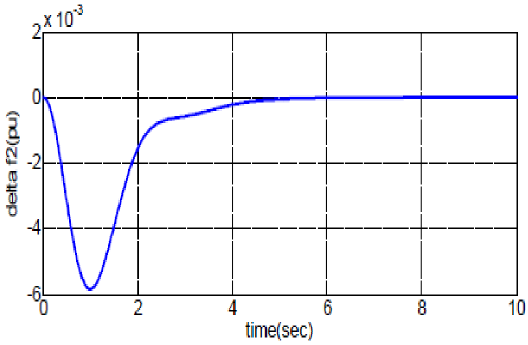

Figure 2: Change in frequency V/S time in area-2 for 0.01 step load change in area-1

In these figure are showing the dynamic responses of deviation in frequency for both the areas (Δf_1, Δf_2) and the power deviation in tie line ($\Delta P_{tie(1,2)}$) for a power system heaving two control areas with thermal non-reheat turbines. The changes in load powers which are the input disturbance are taken as d_1 = 0.01 pu, d_2 = 0.00 pu. The figures here are comparing the results of LQR with the results of LQG for a two area power system. They show that the responses of LQG are around same as the responses of LQR. From the figures we can clearly see that, LQG recovers the performance of LQR from noise environment.

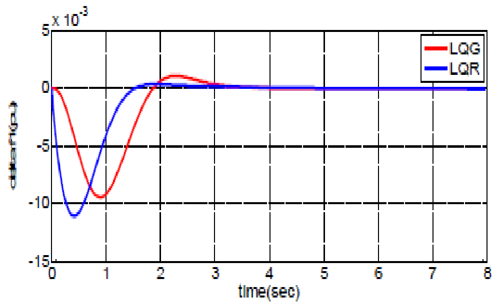

Figure 3: Change in frequency V/S time in area-1 for 0.01 step load change in area-1

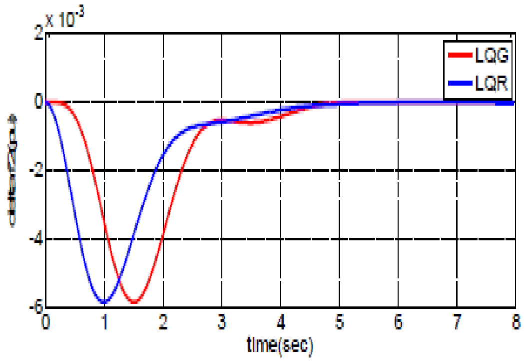

Figure 4: Change in frequency V/S time in area-2 for 0.01 step load change in area-1

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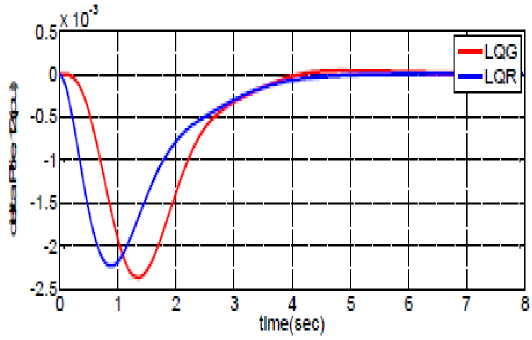

Figure 5: change in tie line power V/S time for 0.01 step load change in area-1

In these figure are showing the dynamic responses of deviation in frequency for both the areas (Δf_1,Δf_2) and the power deviation in tie line ($\Delta P_{tie(1,2)}$) for a power system heaving two control areas with thermal non-reheat turbines. The figures show the performances of a PID controller for LFC of power system, tuned via Internal Model Control (IMC). From figures we can clearly see that the responses are stable with very less overshoot and less settling time. So IMC-PID controller is a powerful controller which gives better stability for LFC of a two area power system.

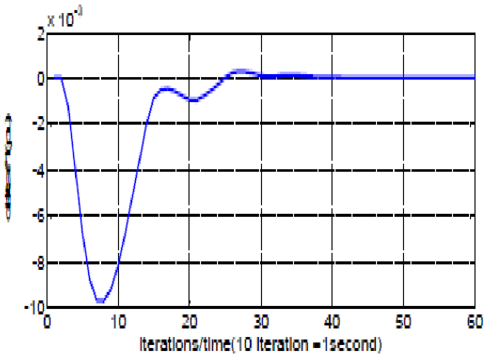

Figure 6: Change in frequency V/S time in area-1 for 0.01 step load change in area-1

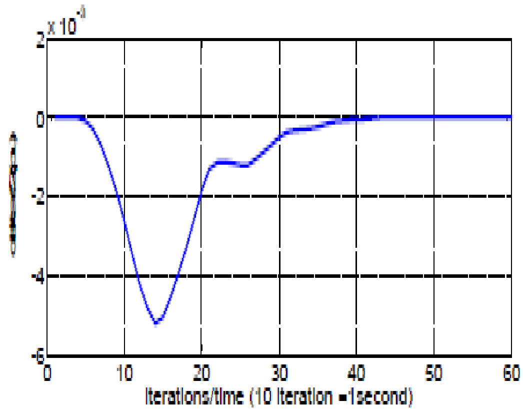

Figure 7: Change in frequency V/S time in area-2 for 0.01 step load change in area-1

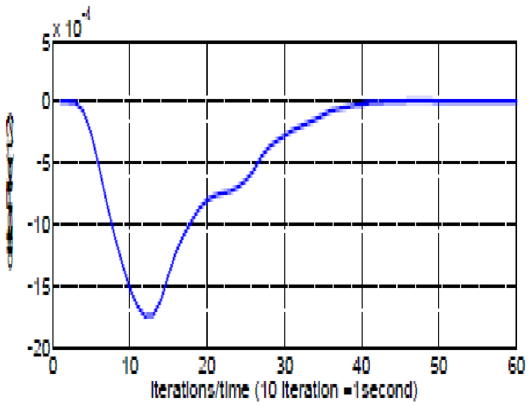

Figure 8: Change in tie line power V/S time for 0.01 step load change in area-1

Conclusion and Future Scope

Load frequency control investigated in this project has recently come into question in operation of interconnected power networks. Frequency is a sensitive parameter which affects the system operation so it is controlled certainly. Therefore, power utilities consider the frequency and active power balance throughout their networks to sustain the interconnection. In interconnection between national/continental networks, providing the constant frequency between areas is a serious operational problem. Hence fast and no delay decision-making mechanism have to be installed in network control units namely the LFC.

The load frequency control is achieved within tree levels, considering many issues from maintaining constant frequency and the minimization of losses through tie lines to the optimal dispatch of generation between units or even areas.

The simulation techniques are very useful in studying and predicting the response of control systems, giving the opportunity to optimize the response and so the behaviour of the system under study.

The great importance of the PID controllers is recognized, considering the facilities it offers by the different combinations of its terms.

As a further work, study could be extended to consider methods of optimal design of the gains of the PID controllers, like considering the artificial intelligence methods or the fussy logic giving the opportunity to obtain an optimal response of the control systems.

The economic dispatch of generation plays a vital rule in the AGC, and this issue could be studied as an extension of this project, adding an additional dimension to the task of our project.

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