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Automatic Load Frequency Control Of Two Area Power System Using Genetic Algorithm

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ABSTRACT

In this paper work we analyze and design Automatic load frequency control of two areas power system using Genetic Algorithm, generation control is becoming increasingly important in view of increased load demand & reducing generating resources. The increasing load demands are posing serious threats to reliable operation of power systems. This is because the increasing load demand leads to lowering of turbine speed (Ns) & therefore reduction of frequency (f) of output voltage of the generator. The healthy operation of generators feeding powers to various types of load is filled with challenges as the generating resources are coping up to keep pace with increasing load demand. Under this situation a great care is needed in maintaining load under the size of generating capacities. The healthy and undamaged operation of generator needs the control of the following parameters: (a) Frequency to be maintained constant i.e. at 50 Hz (b) the tie line power to be maintained between specified limits. If the above parameters are maintained with in desired limits the generation control is said to be most effective. There are so many techniques for automatic load frequency control like integral controller, PID controller.

KEYWORD: Automatic load frequency control, Multi area power system, Proportional integral (PID) controller, Genetic algorithm.

INTRODUCTION

Automatic generation control plays an important role in steady state operation or healthy operation of power system. As we all know that when there is mismatch between load (demand) and generation then changes in frequency occurs. When generation is greater than load then frequency increases and when generation is less than load then frequency decreases. There are so many methods to solve this kind of problem like by using integral controller, PID controller and for better results many artificial intelligent techniques like fuzzy logic, genetic algorithm, artificial Neural networks which gives better results and fast results means they take very less time(sec) to settle down the frequency deviations. In interconnected power systems the main goal of the ALFC is to maintain zero steady state errors for frequency deviation and good tracking load demands. With time, the operating point of a power system changes and hence, these systems may experience deviations in nominal system frequency and scheduled power exchanges to other areas, which may yield undesirable effects. In conventional LFC model the variations of frequency and tie-line power exchanges are weighted together by a linear combination to a single variable called the area control error (ACE). ACE is used as an input to the controller. Many investigations in the area of frequency and tie line power control of isolated and interconnected power systems have been reported in the past. In this work, first a multi-area AGC scheme suitable in a restructured power system has been developed then a Genetic Algorithm based PID (GAPID) controller has been proposed for this multi area AGC scheme. The proposed method of controller tuning implemented in an interconnected two area power systems. MATLAB SIMULINK has been used for simulation studies. By minimizing the fitness function we get the optimal parameters of PID controller. Integral of the square of the area control error (ISACE) have been utilized to select the fitness function for genetic algorithm. The population size 50 has been chosen for genetic algorithm to obtain the optimal values of PID controller.

A deregulated electricity market scenario has been assumed in both systems. The effect of generator rate constraint (GRC) has also been considered in the multi area AGC model. A combination of bilateral transactions and Pool co-based transactions has been considered, and it has been assumed that both the generators and the consumers are participating in the frequency regulation market. Simulation results show that the proposed GAPID Controller complies with NERC's standards. The present paper is devoted to design and implantation of optimal ALFC schemes using GA for optimizing the feedback gains for ALFC regulators. For the sake of comparison, the optimal ALFC scheme based on LQR (linear quadratic regulators) concept are also obtained. A two-area interconnected power system model consisting of reheat thermal plants has been selected for investigations. The incremental power flow through turbine controllers is considered as an additional state variable in system dynamic model. The designed optimal AGC schemes are implemented in the wake of 1% load perturbations in one of the power system areas

MATHEMATICAL MODELLING OF SYSTEM.

MATHEMATICAL MODELLING OF GENERATOR

Applying the swing equation of a synchronous machine to small perturbation, we have:

$$\frac{2H}{\omega}\frac{d^2\,\Delta\delta}{dt^2} = \Delta P_m \text{ - } \Delta P_e \qquad (1)$$

Taking Laplace Transform, we get

$$\Delta\Omega(s) = \frac{1}{2H_s}[\Delta P_m(\text{s}) \text{ -}\Delta P_e(\text{s}) \qquad (2)$$

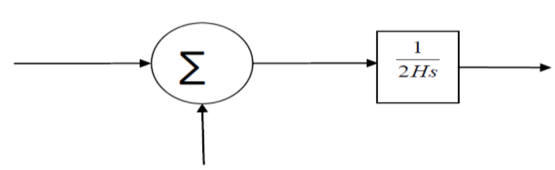

Fig .1 Represent the Block diagram of Generator

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MATHEMATICAL MODELLING OF LOAD.

The load on the power system consists of a verity of electrical drives. The equipments used for lighting purposes are basically resistive in nature and the revolving devices are basically a composite of the resistive and inductive components. The speed-load characteristic of the complex load is given by

$$\Delta Pe = \Delta PL + D\Delta\omega$$

where ΔPL is the non-frequency- sensitive load change, $D\Delta\omega$ is the frequency sensitive load change.

D is expressed as % change in load by percentage change in frequency

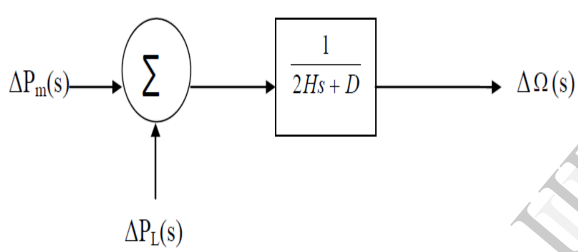


Fig.2 mathematical model of load

MATHEMATICAL MODELLING OF GOVERNOR

When the electrical the load is suddenly increases then the electrical power surpass the mechanical power input. As a result of this the deficiency of power in the load side is takeout from the rotating energy of the turbine. Due to this reason the kinetic energy of the turbine i.e. the energy stored in the machine is reduced and the governor sends a signal to supply more volumes of water or steam or gas to increase the speed of the prime-mover so as to counterbalance speed deficiency.

$$\Delta Pg = \Delta Pref - \frac{1}{R}\Delta f \qquad (3)$$

Or in s- domain

$$\Delta Pg(s) = \Delta Pref - \frac{1}{R}\Delta f \qquad (4)$$

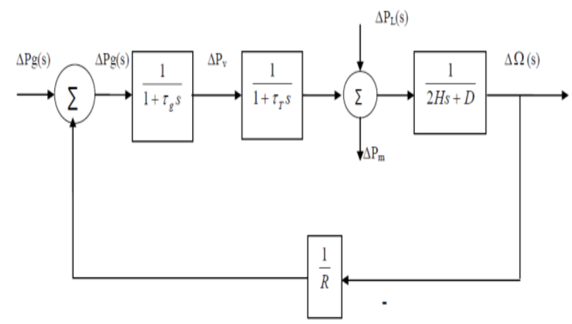


Fig .3 Block diagram of governor.

The command ΔPg is transformed through hydraulic amplifier to the steam valve position command ΔPV. We assume a linear relationship and consider simple time constant T we have the following s-domain relation:

$$\Delta PV(s) = \frac{1}{1+\tau_s}\Delta P_e(s) \qquad (5)$$

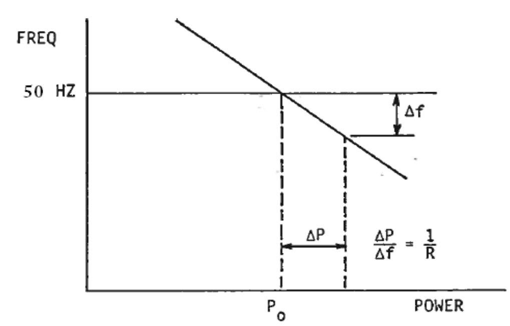


Figure-3 :Graphical Representation of speed regulation by governor.

GA AND ITS APPLICATION IN AGC

An optimal AGC strategy based on the linear state regulatory theory requires the feedback of all state variables of the system for its implementation, and an optimal control feedback law is obtained by solving the non-linear Riccati equation using suitable computational technique. To illustrate the effectiveness of the proposed control design and the algorithm to tune the feedback gains to the controller, a two area Restructured power system having two GENCOs and two DISCOs in each area is considered. The time-invariant state space representation as:

$$\dot{X} = A.X + B.U \quad (6)$$
$$Y = C.X$$

Where X is the state vector and, U is the control vector and Y is the output variable.

$$U = [\,\Delta PL1\ \Delta PL2\ \Delta PL3\ \Delta PL4\ \Delta Pd1\ \Delta Pd2]^{T} \quad (7)$$

For the system defined by the Eq.(6) and (7), the feedback control law is given as,

$$U = -K.Y$$

Where K is the feedback gain matrix. In this paper Evolutionary Genetic algorithms is used to optimize the feedback gains of the controller. Genetic algorithm (GA) is an optimization method based on the mechanics of natural selection. In nature, weak and unfit species within their environment are faced with extinction by natural selection. The efficiency of the GA gets increased as there is no need to encode/decode the solution variables into the binary type.

Chromosome structure

In GA terminology, a solution vector known as an individual or a chromosome. Chromosomes are made of discrete units called genes. Each gene controls one or more features of the chromosome [9]. The chromosome string comprises of all feedback gains encoded as a string of real numbers.

Fitness-Objective function evaluation

The objective here is to minimize the deviation in the frequency of two areas and the deviation in the tie line power flows and these variations are weighted together by a linear combination to a single variable called the ACE(area control error). The fitness function is taken as the Integral of time multiplied absolute value of ACE at every discrete time instant in the simulation [1], [2].

SIMULATION AND RESULT

In the present work, a two area interconnected power system has been developed using GA controllers and integral controllers to demonstrate the performance of load frequency control using MATLAB/SIMULINK. Fig. 5, 6, 7 & 8 respectively represent the plots of change in system frequency fig.9 we explain the response of AGC two area with GA-PID

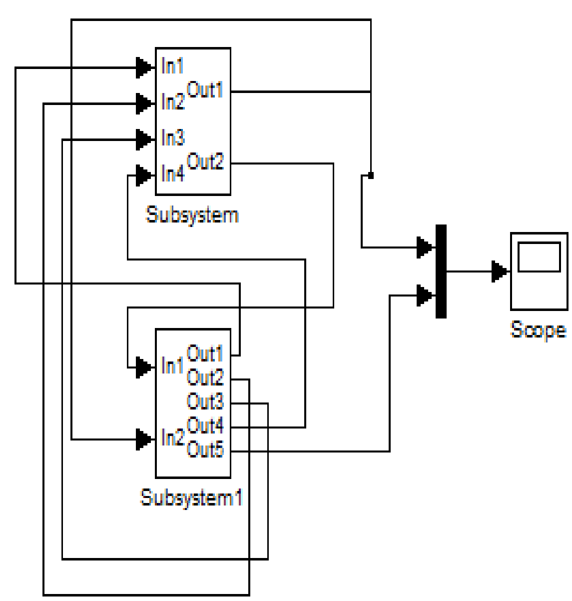


Fig.(4) two area power system network.

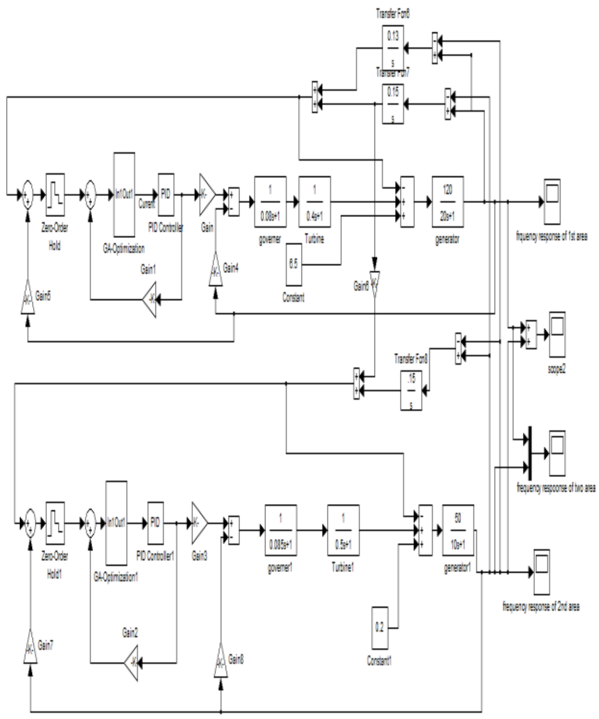
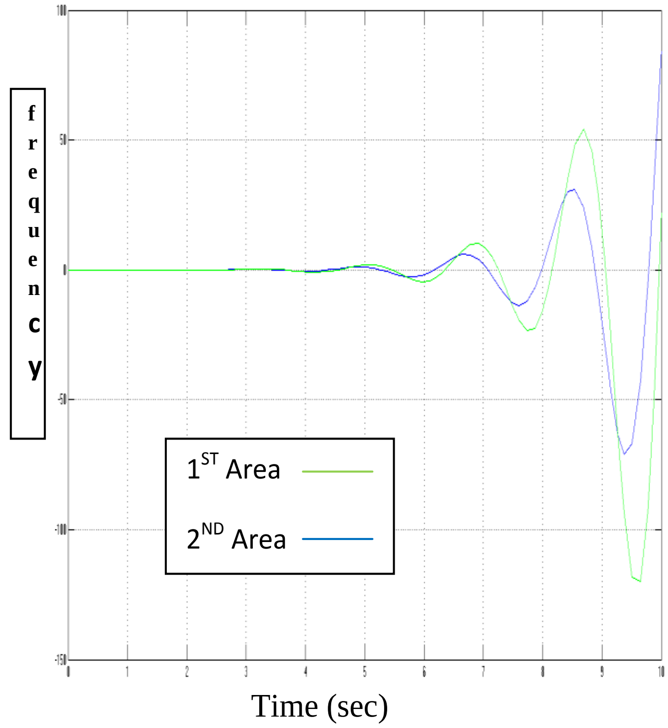


Fig.(5) two area power system GAPID.



Fig(6) uncontrolled frequency response of two area power system.

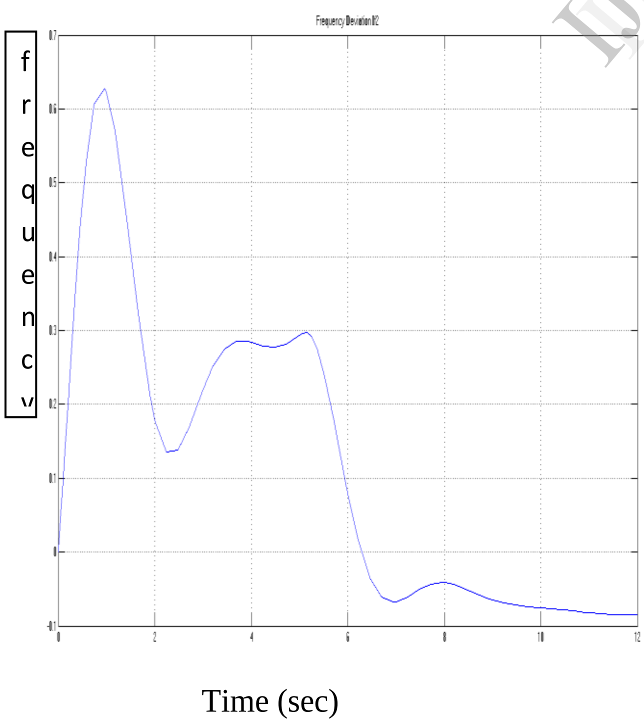


Fig.(8) frequency response of 2ND Area.

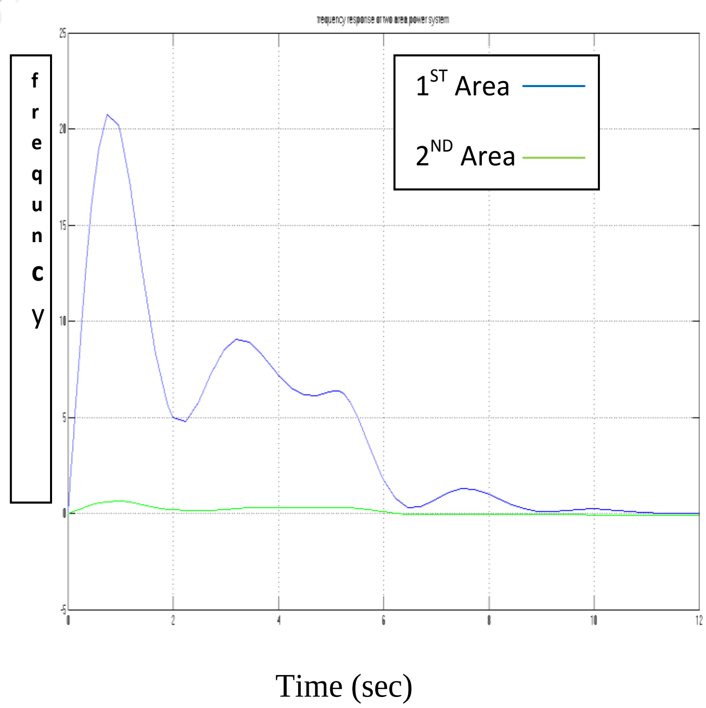


Fig.(9) frequency response of two area power system using GAPID.

CONCLUSION

In this paper we study the automatic load frequency control of two area power system using genetic algorithm, by varying the load we get the different response of frequency with different settling time. In fact there is a huge scope of improvement in this area where the power system study can be extended to a multi-area system that shall ensure stability in closed loop system, from fig.9 we can say that response of AGC two area power system using PID tuned by GA gives better result(11sec setteling time) .

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