The International Journal of Engineering and Science (IJES)
|| Volume || 6 || Issue || 8 || Pages || PP 14-22 || 2017 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

Automatic Generation Control of Power System in Deregulated Environment Using G.A

[1]Ghazala Perween, [2]Ritu Jain
+[1]Department of Electrical Engineering, Suresh Gyan Vihar University
[2]Assistant Professor, Suresh Gyan Vihar University, Jaipur, Rajasthan,India
Email: ghazalaperween1@gmail.com

--ABSTRACT--
This paper addresses with the optimization of two area interconnected power system with the application of Genetic Algorithm, and has been studied in restructured environment with traditional Automatic Generation Control (AGC), for optimization of integral control gains and bias factors by using MATLAB- SIMULINK . The concept of distribution company (DISCO) participation matrix (DPM) is to simulate the possible bilateral contracts between generating companies (GENCOs) and DISCOs which are reflected in the two-area system. The Dynamic responses obtained through the result satisfy the AGC requirements. AGC is a control system which examine that frequency deviation from the nominal value is brought to zero, and the power flows between 2-area in as interconnected system are regulated.GA are shown to be effective for both levels of the system optimization problems.
Keywords: *Automatic generation control, Area control error, bilateral contracts, Deregulation, Genetic algorithm, Optimization.*

Date of Submission: 25-07-2017 Date of Publication: 19-08-2017

I. INTRODUCTION

In the present scenario of fast pace economy, the need of electricity is growing day by day. The power industry is taking a giant shape because of the rapidly growing population. To fulfill the requirement in restructured environment, various numbers of utilities are interconnected through a tie-line by which power is exchanged between them. [1] In power system any sudden load variation between the tie line power and frequency causes perturbation [2]. Automatic Generation control (AGC) system is used in power system which is responsible for the frequency control and power interchange which operates frequently to balance the generation and load in power system at a minimum cost [3]. AGC reduces the response time to a minute or two, more or less. The main purpose of AGC power systems is to provide control signals which can regulate the real power outputs within a prescribed area of various electric generators in order is to sustain the system frequency and tie line flow at their scheduled values during normal operation and also during small perturbations so as to maintain the approved values [4].In past few years many of the researchers [5]have studied the AGC in deregulated environment. In conservative power system, utilities have their own generation, transmission and distribution. Where Deregulated system is the combination of Generation companies (GENCO), Distribution companies (DISCO), Transmission companies (TRANSCOs) and Independent system operator (ISO). In the restructured power system AGC has to be reformulated. In the new environment, DISCO can convent power from any GENCOs and ISO has to control these contracts [6]- [7].

From last few years many authors have studied about AGC with SMES, TCP in restructured power system [8]- [9]There has been considerable research work attempt to intend better AGC systems based on modern control theory such as artificial neural network, fuzzy system theory, Newton Algorithm [5], But few interest has been developed on the study of AGC in deregulated environment using GA. The concept of using GA for optimization is better technique so called "survival of fittest" GA is a numerical optimization algorithm techniques that avoid many of the shortcoming exhibit by confined search techniques on complicated search places which is capable of being applied to a wide range [10]- [11], GA are global, robustness, simplicity, stochastic and time intensive search methods. GA has also been applied for fault detection, combinatorial problems, stability analysis, robot path-planning [12]. In this paper, real coded GA is used to optimize the parameters of AGC after Deregulation in the power system. The study is unmitigated for the two-area power system considering reheat and non-reheat type turbines. A wide analysis is done allowing for different possible contracts between GENCOs and DISCOs.

II. RESTRUCTURED SYSTEM

In the restructured environment GENCOs gives power supply to various DISCOs at aggressive prices. Thus, DISCOs have the autonomy to choose the GENCOs for contracts. They may or may not have contracts with the GENCOs in their own region. This makes various combinations of GENCO to DISCO agreement possible in practice. We introduce the concept of a "DISCO participation matrix" (DPM) to make the perception of contracts much better and easier [5]

The DPM is a matrix which consist the number of equal rows to the number of GENCOs and the number of columns equal to the number of DISCOs in the system. Each entry in this matrix can be thought of as a part of a total load contracted by a DISCO (column) concerning a GENCO (row). [5] The sum of all total utilities in a column in this matrix is unity. Such as we Consider a two-area system in which each area has two GENCOs and two DISCOs in it, Let GENCO(1) , GENCO(2) , DISCO(1) , and DISCO(2) be in area I and GENCO(3) , GENCO(4) , DISCO (3), and DISCO(4) be in area

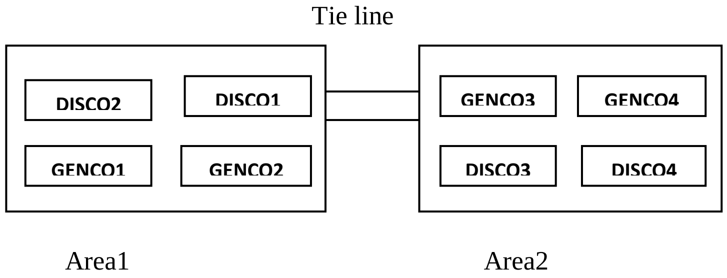


Fig1: schematic diagram of two area power system in restructured environment.

The result of corresponding DPM will result as follows,

The DPM may be defined as [5]

$$DCM=\begin{Bmatrix} cpf11 & cpf12 & cpf13 & cpf14 \\ cpf21 & cpf22 & cpf23 & cpf24 \\ cpf31 & cpf32 & cpf33 & cpf34 \\ cpf41 & cpf42 & cpf43 & cpf44 \end{Bmatrix} \quad (1)$$

Where 'cpf 'stands for "contract participation factor". As like that DISCO3 will demand 0.1pu MW Power, out of which 0.025 Pu MW is demanded by GENCO1,i.e 0.03pu MW from GENCO2. 0.035pu MW from GENCO3 and 0.01pu MW from GENCO3, and it is noted that $\sum_i cpfij$=1 [5]

III. POWER SYSTEM MODEL

In this paper the AGC system has been studied by Donde et.al so as to apply Genetic algorithm (GA) for optimization and study of AGC. As considered non-reheat type turbines, but at present advance study has been widespread for reheat type turbines in the two area interconnected power system. Coefficients that distribute ACE to several GENCOs are term as ACE participation factors (APF). Note that $\sum_{j=1}^{m} apf = 1$where m is the number of GENCOs. As a scrupulous set of GENCOs are theoretical to follow the load demand by a DISCO, in sequence must flow from a DISCO to a particular GENCO specify consequent demands. The demands are specified by cpfs (elements of DPM) and the Pu MW load of a DISCO. These signals bear information as to which GENCO has to follow a load demanded by which DISCO have. The scheduled steady state power flow on the tie line will be given in next page.

$\Delta ptie_{1-2schd}$ = (demand of DISCOs in area 2 from GENCOs in area 1) - (demand of DISCOs in area I from GENCOs in area 2) (2)

At any time, the tie line power error $\Delta ptie_{1-2}$, error is defined as,

$\Delta ptie_{1-2}$, error = $\Delta ptie_{1-2}$actual - $\Delta ptie_{1-2}$, scheduled (3)

$\Delta ptie_{1-2}$, error vanishes in the steady state as the a3ctual tie-line power flow reaches the scheduled power flow.

The area control error may be given as-:

$$ACE_1=B_1\Delta f_1 +\Delta ptie1\text{-}2,\ error$$
$$ACE_2=B_2\Delta f_2+\Delta ptie2\text{-}1,\ error \qquad (4)$$

In this manuscript the AGC of two different power systems in deregulated environment is deliberated using GA. The MATLAB replication model of first power system example based on the concept of non-reheat type turbines can be seen in fig(2).Whereas the MATLAB simulation model of second power system illustration is modified by making an allowance for reheat type turbines in place of non-reheat type turbines in each area and can be shown in Fig. (3) Respectively. The closed loop of two area power systems shown in Fig 2 and Fig 3 may be regarded as in the steady state form as follows:

$$x=A^{c1}{}_{x}+B^{c1}{}_{\mu} \qquad (5)$$

Here x is the state vector and µ is the vector of demand of the DISCOs. A^{cl} and B^{cl} are system matrices of suitable dimensions. In this paper as in [5] three different cases for the study of AGC are measured.

IV. IV. APPLICATION OF GA FOR OPTIMIZATION OF AGC PARAMETERS

In this paper, the management key considered is given as:

$$ISE=\int_{\theta}^{w} e^2(t)\,dt, \quad \text{where e is the error.} \qquad (6)$$

Where, ISE is "INTEGRAL SQUARE ERROR" In ISE, only error is measured and therefore no influence is given to time level of error but in AGC there is a problem, as in this the settling time should be less and also oscillations should die out quick [10] The intent (cost) intention should be minimised and is given as follows:

$$J=\int_{0}^{w} (ACE1)^{2} \qquad (7)$$

Where T is taken as simulation time, and

$$ACEi=\Delta Ptiei+ Bi\Delta fi \qquad (8)$$
$$Bi= \frac{1}{Ri}+Di \qquad (9)$$

The genetic algorithm [10]- [13] is a worldwide search techniques, based on the operations observed in natural selection and genetics skill to obtain optimum values, which is based on the theory of natural selection, the process that drives biological development also operate on population of present approximation-the individual-initially drawn at random, from which enhancement is hunted thereafter the selected individuals are then modified through the application of genetic operators, in order to operate the next generation. There are three different genetic operators [11] which have been applied on parents to form children for further generation:

Reproduction – Select the fittest folks in the current population to be used in generating the next population. The children are called Elite children.

Cross-over – It causes pair of folks to swap genetic information with one another. The children are called crossover children.

Mutation- It causes person genetic representation to be changed according to some probabilistic rule. The children in this case are called Mutation children.

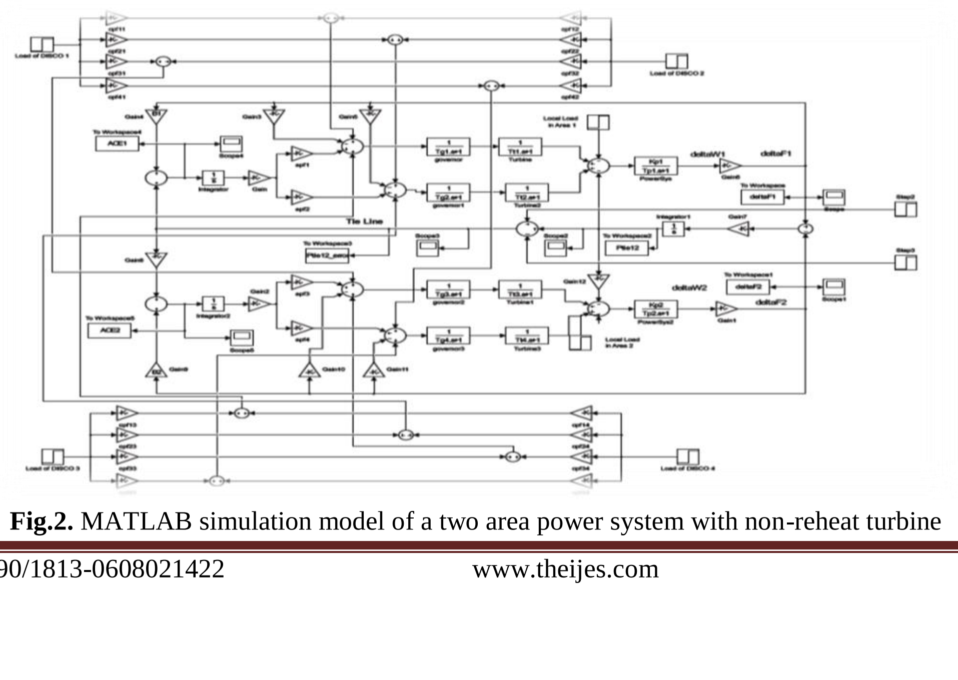


Fig.2. MATLAB simulation model of a two area power system with non-reheat turbine

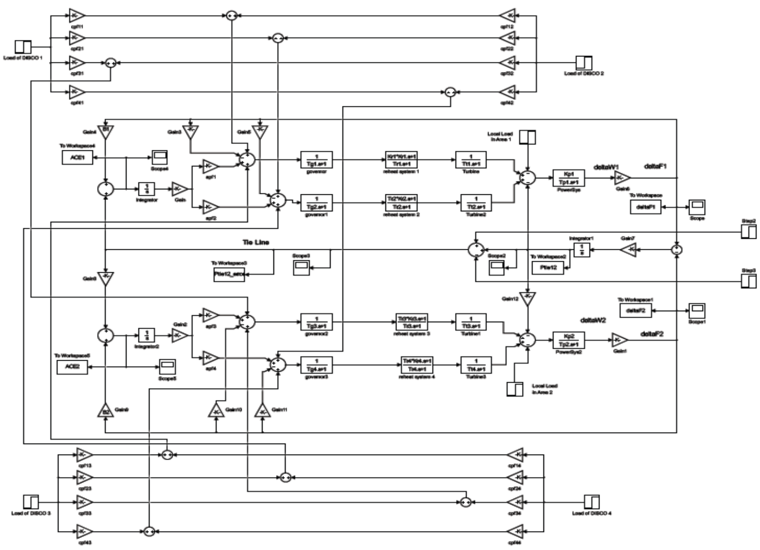


Fig. 3. MATLAB simulation model of a two area power system with reheat system

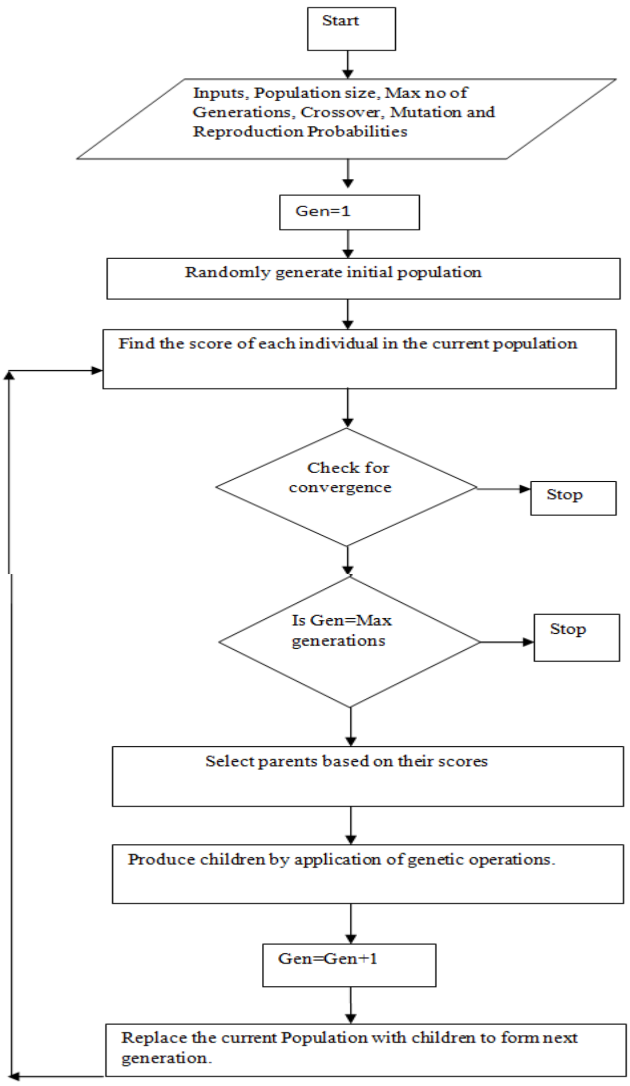


Fig-4. Flow chart for genetic algorithm

V. SIMULATION RESULTS AND DISCUSSION

The AGC of two power system models shown in Fig. (2) and Fig. (3) With analogous parameters given in cross-reference is studied under different contract situation. The AGC parameters are optimized using GA. The diverse possible contracts between DISCOs and GENCOs are deliberated as described in case-1 and case-2. Following is the detailed analysis case wise.

A Case 1

In this case we believe that all GENCOs of each area participate equally in AGC, i.e., ACE contribution factors are apf1= 0.5, apf2 = 1- apf1= 0.5, apf3= 0.5, apf4= 1-apf3 = 0.5. It is presume that the load changes occur only in area I, therefore DISCO1 and DISCO2 demands. Let the value of load demand be 0.1pu MW for each of them. Referring to (1), DPM becomes,

$$\text{DCM}=\begin{Bmatrix} 0.5 & 0.5 & 0 & 0 \\ 0.5 & 0.5 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{Bmatrix} \qquad (10)$$

So note that DISCO3 and DISCO4 have no demand from any GENCOs, and therefore their analogous participation factors are zero. In steady state, invention of a GENCO must match the accurate of the DISCOs according to contract within it. The total demand of DISCOs are given [5] as

$$\Delta \text{PMi} = \sum_j cpfij\ \Delta \text{Plf} \qquad (11)$$

Where ΔPLj the total demand of DISCO j and cpfs are given by DPM. In the two area case,

$$\Delta \text{PMi} = \text{cpfi1}\Delta\text{PL1} + \text{cpfi2}\Delta\text{PL2} + \text{cpfi3}\Delta\text{Pl3} + \text{cpfi4}\Delta\text{Pi4} \qquad (12)$$

For the case under consideration, we have,

$$\Delta\text{PM1}= 0.5\times\Delta\text{PL1}+0.5\times\Delta\text{PL2} = 0.1\text{pu MW}$$

And in the same way,

ΔPM2 = 0.1pu MW,
ΔPM3 = 0.1pu MW,
ΔPM4 = 0.1pu MW,

B. CASE 2

In this case we believe that all DISCOs deal with the GENCOs for power as per the following DPM:

$$\text{DPM}=\begin{Bmatrix} 0.5 & 0.25 & 0 & 0.3 \\ 0.2 & 0.25 & 0 & 0 \\ 0 & 0.25 & 1 & 0.7 \\ 0.3 & 0.25 & 0 & 0 \end{Bmatrix}$$

Each DISCO has a requirement of 0.1puMW power from GENCOs as per the DPM matrix and each GENCO participation in AGC is defined by following apfs:

apf*1*= 0.75, apf2 = 1 - apf1 = 0.25, apf3 = 0.25, apf4 = 1- apf3 = 0.5,

The designed power on the tie line are from area 1 to area 2 is,

$$\Delta\text{Ptie-line1-2, schd} = \sum_{j=1}^{2}\ \sum_{j=3}^{4}\ \text{cpfij}\Delta\text{pLj}-\sum_{i=3}^{4}\ \sum_{j=1}^{2}\ \text{cpfij}\Delta\text{pLj}$$

As given by equation (11), in steady state we observed that the GENCO must generate,

$$\Delta\text{PM1}= 0.5(0.1) + 0.25(0.1) + 0 + 0.3(0.1) = 0.105\text{pu MW}$$

And so on,

ΔPM2=0.045pu MW,
ΔPM3=0.195pu MW,
ΔPM4=0.055pu MW,

ACE parameter, Ki and B for two area systems under deregulated environment are optimised using technique genetic algorithm. The step for the integration is elected as 0.01s. Sampling time is taken as 0.2s. The data for the system premeditated are given in appendix A. The real values of variables are used in G.A, while AGC formation uses different values of same variables from their supposed values. The simulation is done using MATLAB from Meta files. The optimised parameters for non-reheat and reheat turbine models are given in following table 1 and table 2 respectively.

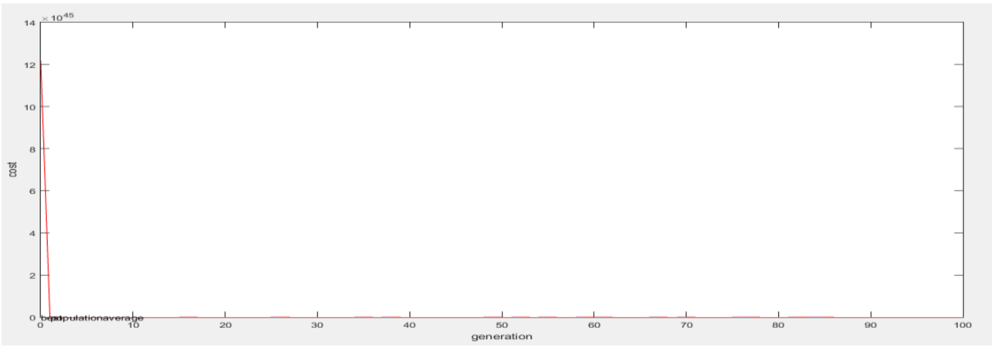
Table.1. Optimised parameters for non-reheat type model.

Parameters	Case 1	Case2
Ki1	0.0872	0.1902
Ki2	0.0845	0.1564
B1	0.06564	0.5802
B2	0.5998	0.5568

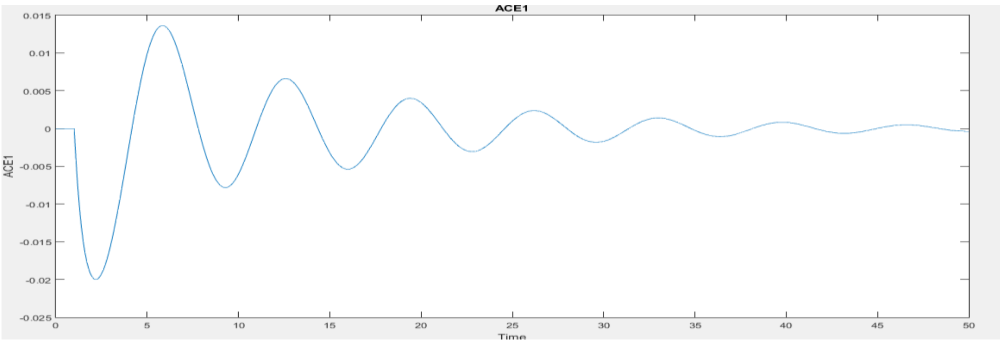
Table.2. Optimized parameters for reheat type model

Parameters	Case1	Case2
Ki1	0.0764	0.1702
Ki2	0.0862	0.1256
B1	0.6324	0.5732
B2	0.5934	0.5678

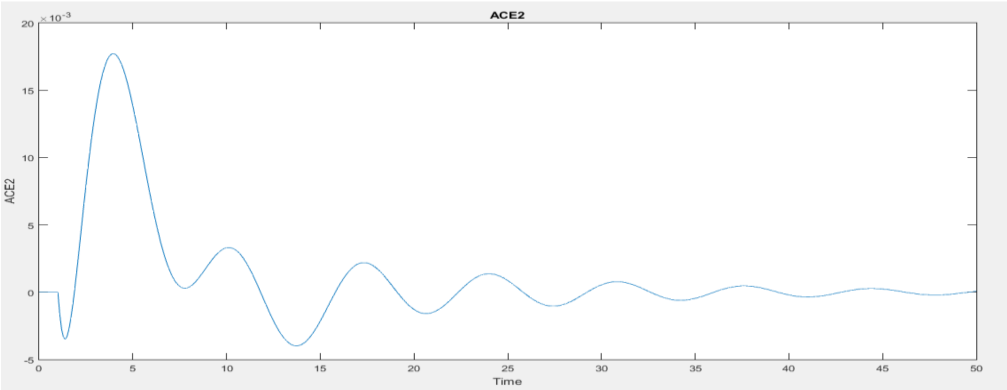
The dynamic response of frequency and tie line power in case 1 for non-reheat type and reheat type system are shown in fir .5(a)-(c). And the dynamic response of frequency and tie line power in case 2 for non-reheat and reheat type system are shown in fig.7(a)-(c).(a)



(a)

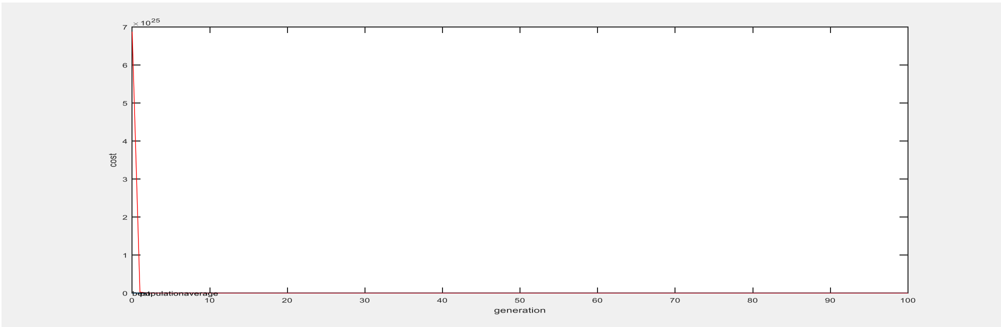


(b)

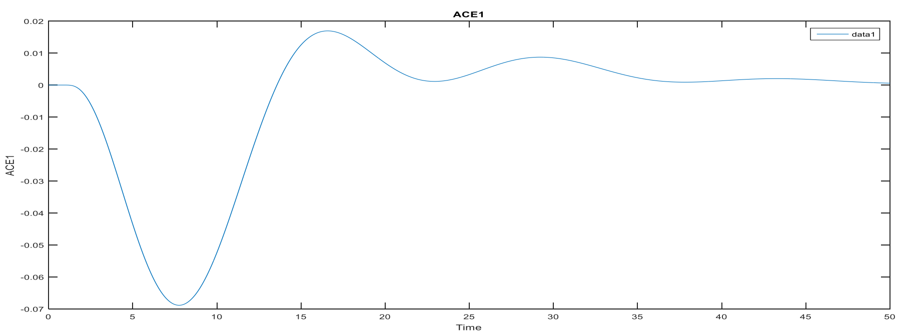


(c)

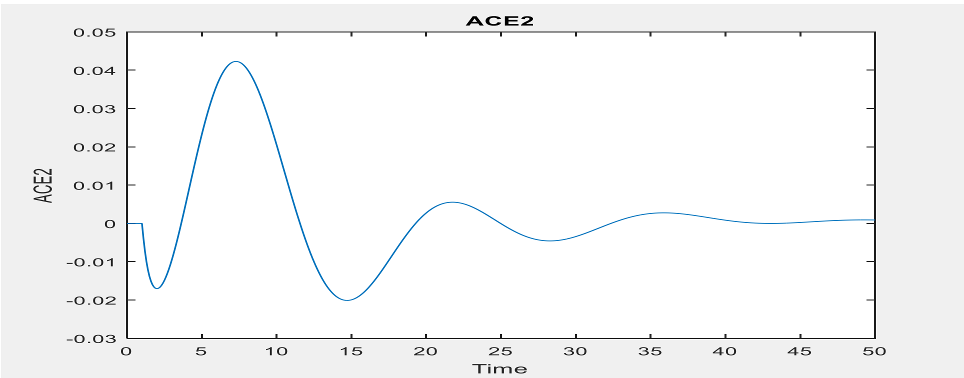
Fig. 5(a) Frequency deviation in area 1,(b) Frequency deviation in area 2, (c) Deviation in tie line power for, case 1 with non-reheat type model.



(a)

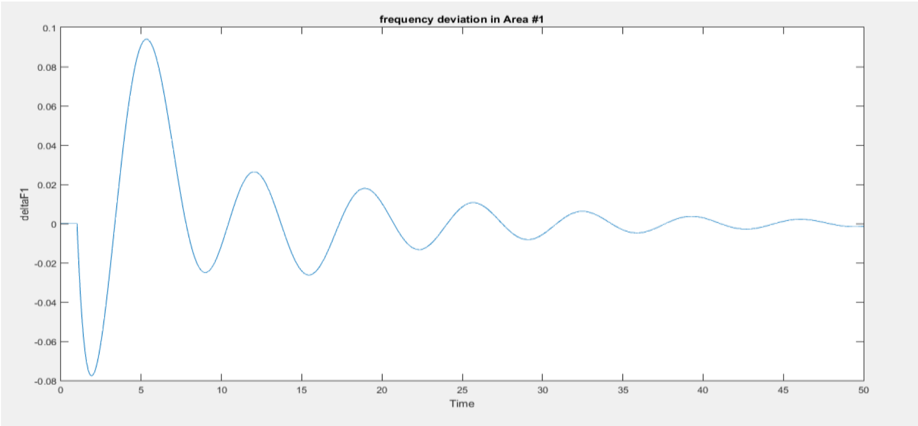


(b)

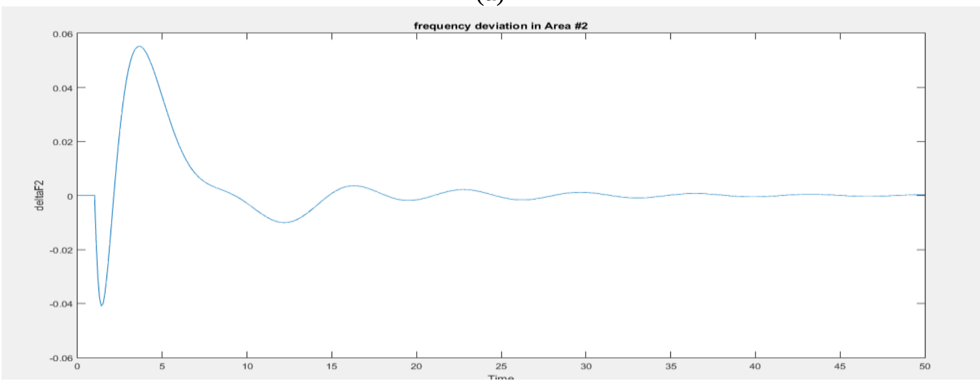


(c)

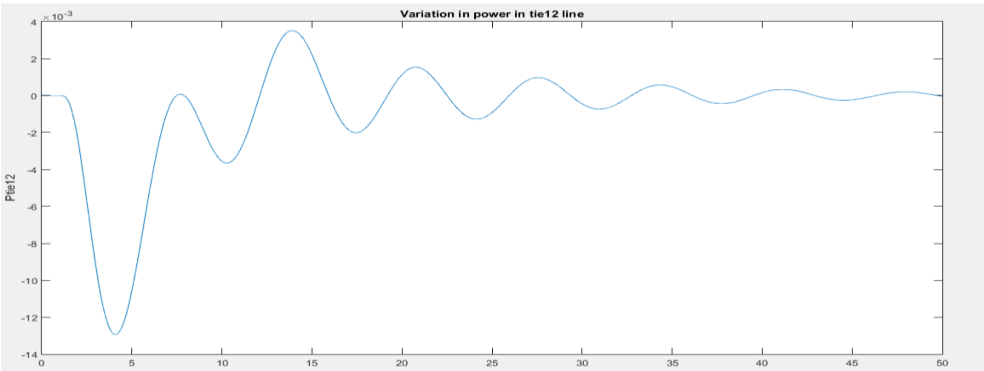
Fig. 6(a) Frequency deviation in area 1, (b) Frequency deviation in area 2, (c) Deviation in tie line power, for case 1 with reheat type model.



(a)

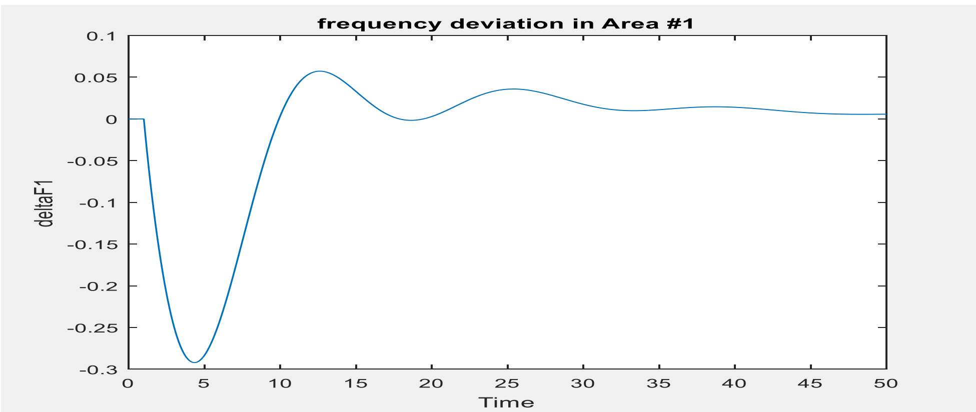


(b)

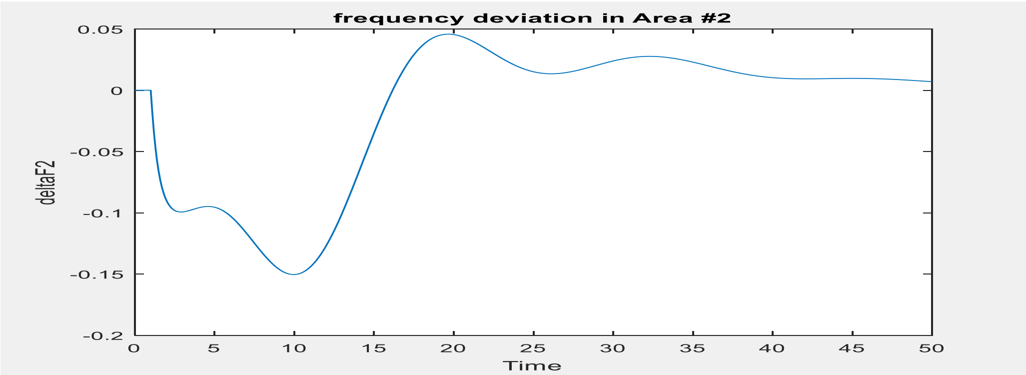


(c)

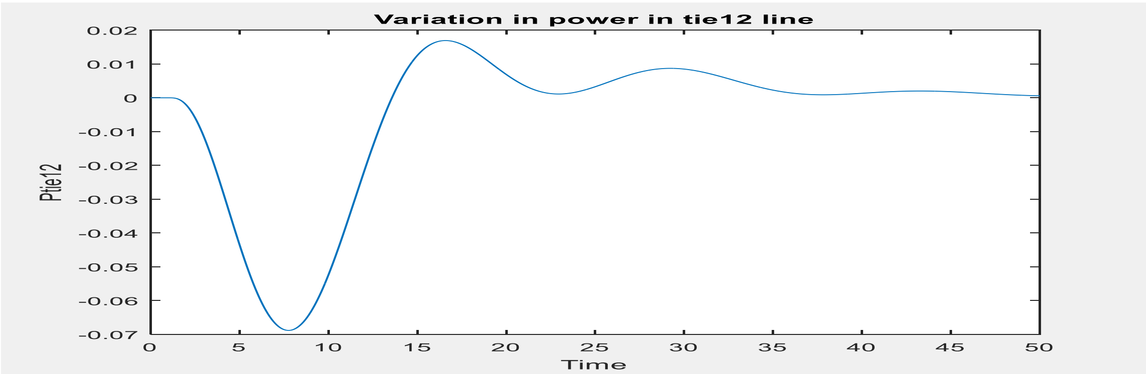
Fig.7 (a) Frequency deviation in area 1 (b) Frequency deviation in area 2, (c) Deviation in tie –line power, for case-2 with non-reheat type model.



(a)



(b)



(c)

Fig. 8 (a) Frequency deviation in area 1, (b) Frequency deviation in area 2, (c) Deviation in tie line power, for case 2 with reheat type model.

VI. CONCLUSION AND FUTURE SCOPES

AGC plays a vital role in optimization of power system. The frequency and tie line-line power deviation reaction are obtained for 1% SLP. In this paper, we contrast the dynamic response of frequency and tie-line power for non-reheat and reheat type systems in deregulated environment for further diverse areas. The conception of DISCO and GENCO plays very important role in deregulated environment. The simulation results are reasonable for two different operating cases in modified AGC after deregulation. In future we can apply some other artificial intelligent technique for better result with energy storage devices such as PSO (particle swarm optimization), integrated circuits optimal classical, artificial neural network (ANN) and fuzzy logic etc.

REFERENCES

[1]. C. E. Fosha and O. L. Elgerd, ""The megawatt-frequency control problem-A new approach via optimal control theory"," IEEE Trans.Power App.Syst., Vols. PAS-89, no. no-4, pp. 563-577, 1970.
[2]. S. Tripathy, G. Hope and O. Malik., ""Optimization of load- frequency control parameters for power system with reheat steam turbines and governor deadbandnon-linearity'," Proc IEE;Part C, vol. 129, no. NO1, pp. 10-16, 1982.
[3]. P.Kundur, "Power Syatem Stability & Control", New York: McGraw-Hill, 1994, pp. 418-448.
[4]. K. J, H. N. Kah and G. Sheble, ""AGC Simulator for price-based operation:part II"," IEEE Trans.Power System, vol. 12, no. 2, pp. 533 - 538, 1997.
[5]. D. V, M. Pai and I. Hiskens., ""Simulation and optimization in an AGC system after Deregulation"," IEE Transactions on Power System, vol. 16, no. N0-3, pp. 481-489, 2001.
[6]. N. Pardeep, K. S. Parmar and A. K. Singh, ""Automatic Generation Control of an interconnected power system before and after Deregulation"," International journal of computer Apllicatios(0975-8887), vol. 61, no. No-15, pp. 11-16, january 2013.
[7]. V. Rohilla, K. S. Parmar and S. Saini, ""Optimization of AGC Parameters in the Restructured Power Syatem Enviroment using GA"," International Journal of Engineering Sciences & Emerging Technologies, vol. 3, no. 2, pp. 30-40, Oct.2012.
[8]. R. Roy, S. P. Ghoshal and P. Bhatt, ""Evolutionary Computation based Four-Area Atumatic Generation Control in Restructured Enviroment"," Third International Conference on Power system,Kharagpur, INDIA, vol. 3, no. 138, pp. 1-6, December 27-29, 2009.
[9]. P. Bhatt, R. Roy and S. P. Ghosal, ""Coordinate control of TCPS and SMES for frequency regulation of interconnected restructured power systems with dynamic participation from DFIG based wind farm"," Renewable Energy, vol. 40, no. 1, pp. 40-50, April 2012.
[10]. J. J. Grefenstette, ""Optimization of control Parameters for Genetic Algorithm"," IEEE Transactions on system,MAN,And Cybernetics, vol. 16, no. no-1, pp. 122-128, jan/feb,1986.

[11]. H. Golpira and H. Bevrani, ""Application of GA optimization for automatic generation control design in an interconnected power system"," Energy conversion and mangement, vol. 52, pp. 2247-2255, 2011.
[12]. P. J. Fleming and C. M. Fonseca, ""Genetic algorithms in control Syatems E ngineering"," International Federation of Automatic Control, vol. 26, no. 2, pp. 605-612, 1993.
[13]. Y. L. Magid and M. M. Dawoud, ""Optimal AGC tuning with genetic algorithim"," Electrical power systems and research, vol. 38, no. 3, pp. 231-238, sept 1980.

AUTHOR

Ghazala Perween, M.Tech (pursuing), Electrical Department from Suresh Gyan Vihar University, Jagatpura, Jaipur, Rajasthan, B.E , Electrical and Electronics, RGPV(BHOPAL), Madhya Pradesh

Ghazala Perween. "Automatic Generation Control of Power System in Deregulated Environment Using G.A." The International Journal of Engineering and Science (IJES), vol. 6, no. 8, 2017, pp. 14–22.