Automatic Generation Control By Using Load Frequency Control of multi Area Interconnected System

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Abstract- *Load frequency control in power system implemented to maintains the system frequency and tie line power of interconnected system within the specific limits. In this paper frequency of two are interconnected power system is controlled by PI Controller and PID controller and tie line power of is also controlled. As we know that load can never be constant. The high random variation in power demand disturb the operating point of power system. The Simulink model is studied under the step load change. The model of performance of both PI and PID controller is shown in this paper and simulated through the MATLAB software.*

Keywords- Load Frequency Control, Power System, Active Power Control, Tie Line Power Control, Automatic Generation Control.

I. INTRODUCTION

Load frequency control is important in power system design and operation. The main motive of load frequency control is to maintain the standard frequency 50 Hz and tie line power within limit by adjusting the active power of generator. Due to some disturbance the operating point is change or by changing the load of power system, it should provide acceptable high level power quality to maintain the frequency and tie line power. Automated generation control: Automatic generation control (AGC) is a system for adjusting the power output with change in load [14]. System load will vary from time to time so it is necessary to maintain the system frequency .Load frequency control**:** load frequency control in power system to ensure that adequate power is delivered to load reliable and economically. Power system control is required to maintain the balance between generation and load demand. The operation of a power system can be better controlled if the frequency error is kept within limit. Multi area interconnected in which two or more areas interconnected by tie line [6]. The research on load frequency control is carried out by use method of soft computing techniques is fuzzy logic method, artificial neutral network, genetic algorithm.LFC issue on renewable sources is also discussed.

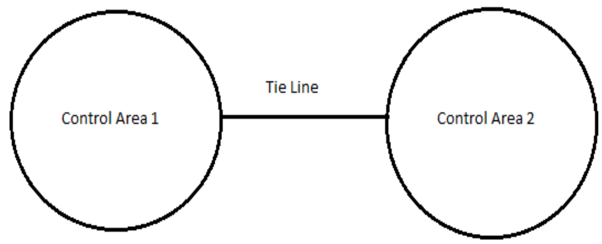

Fig 1.1 Multi-area interconnected system

1.1.1 Automatic generation control

Automatic generation control is balance between our generation and load demand. As the load demand is never steady. It vary time by time. The important task for automatic generation control is maintaining the tie line power exchange and load frequency control between the interconnected systems. There is two loops in automatic generation control. Automatic voltage loop and automatic frequency loop.Load frequency is controlled by the active power flow in system and voltage is controlled by the reactive power in system. The output of automatic generation control is mainly effected by deviation in frequency and tie line power exchange[2]

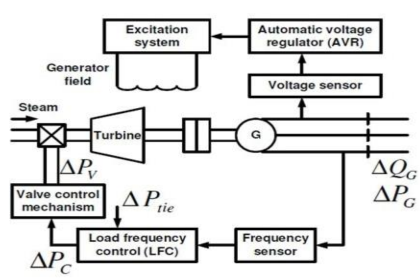

Fig 1.2 Schematic diagram of automatic generation control

1.1.2 Load frequency control

In large power system network, the several areas are interconnected through tie line. The change in load frequency in power system effect the system efficiency .so that the maintaining the load frequency in power system is major issue.it is necessary to maintain the frequency in power system. The power system state of equilibrium is achieve by maintaining the frequency and voltage in power system[3].Power system operation. Both active power and reactive power demand is vary it never steady.

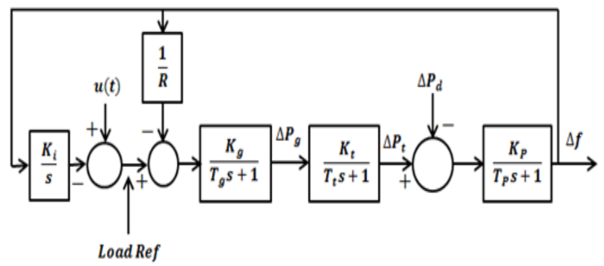

Fig 1.3 Block diagram of load frequency control in power system

$\frac{Kg}{Tgs+1}$ =Transfer function of speed governor

$\frac{Kt}{Tts+1}$ = Transfer function of turbine

$\frac{Kp}{Tps+1}$=Transfer function of power system

K= Gain
T= Time constant

Tg<< Tt <Tps

Time constant for speed governor is very less as compare power system. Time constant limit for turbine is in between 0.2 to 2.5

$\frac{1}{R}$ = Speed regulator
$\Delta f = chnage\ in\ frquency$
$\nabla Pg = generator\ output = turbine\ output$
$\frac{Ki}{s}$ = transfer function of PI controller

1.1.3 Load frequency characteristics of speed governor system

Steady state change in frequency is due to change in load demand.

$$\Delta f = \frac{1}{B+(\frac{1}{R})} \Delta P \quad (1.1)$$

In this equation gives change in load demand therefore change is frequency.As the load increase speed of governor decrease therefore frequency is also decrease. R is speed regulator which regulator the speed of governor by opening and closing the valve according our requirements.
The slope of this relationship is

$$\frac{1}{B+1/R} \quad (1.2)$$

Power system parameter B is much smaller as compare 1/R.
B=0.01 p.u.MW/Hz
1/R=1/3
So B is neglect as compare 1/R

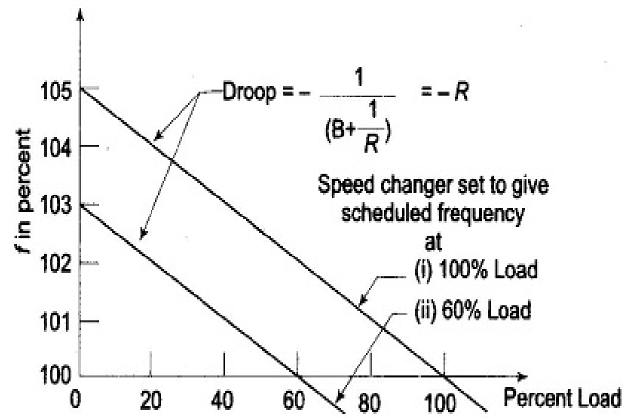

Fig 1.4 Steady state load frequency characteristic

1.1.4 Literature Review

In this paper for load frequency control or frequency and tie line deviation reduce within the minimum time by using the linear quadratic Gaussian controller. The performance of controller is evaluated by changing the load. In this paper result that performance of LQG controller is better stable then PID controller. [4] Load frequency control,maintain the frequency and tie line power of three area interconnected system PID controller and SMES device. The purpose of superconducting energy storage device is improve the transient and faster settling time. The performance of controller and SMES device is simulate using MATLAB software.[13]. Literature survey on load frequency control on conventional and distribution power system. In this paper discussed about the storage devices like photovoltaic cell and facts devices.[11]In this paper fuzzy adaptive MPC is apply for load frequency control of a micro grid. The performance result of fuzzy adaptive MPC is better and fast as compare the PI controller. Proposed fuzzy adaptive MPC can be used for effective frequency regulation in micro grid applications.[7]In automatic generation control ,for load frequency control here apply genetic algorithm technique and PI controller. Result show that performance with less settling time, overshoot and zero frequency deviation after a disturbance. The deviation was also less prominent in the DWT-GA than that of the GA-PI [8]

1.1.5 Simulation Models

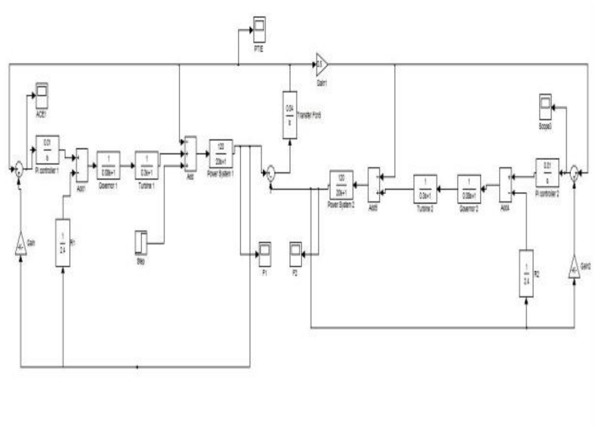

Fig 1.5 Simulink model of load frequency control on two area system with PI controller

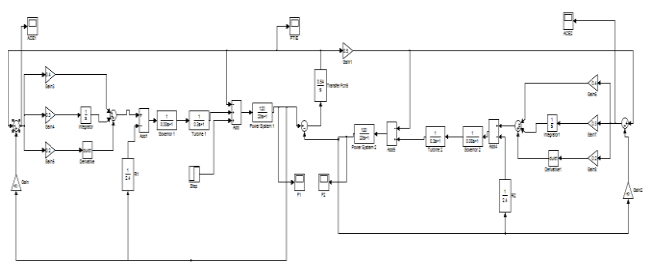

Fig 1.6simulation model of load frequency control with PID controller

1.1.6. Conclusion

In this paper, a power system model is proposed to improve the dynamic performance of two area interconnected power system. Firstly the system was controlled by PI controller and then with PID controller and its feasibility is studied by varying system parameters. It has been observed that responses of the system with PID controller is better in terms of dynamic parameters such as peak overshoot and settling time when it is tuned with PI controller.

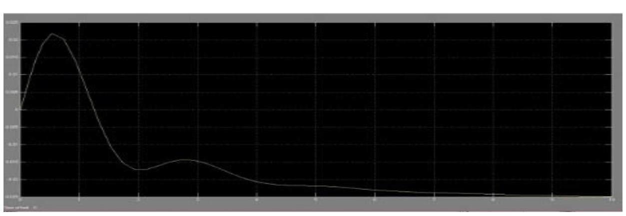

Fig.1.7. Deviation in frequency in area 1

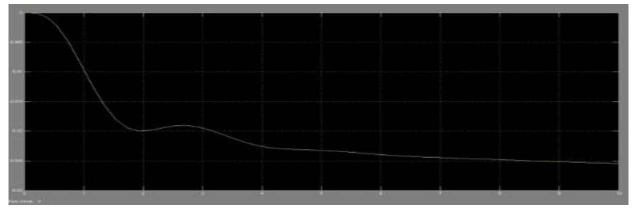

Fig.1.8. Deviation in frequency in area 2

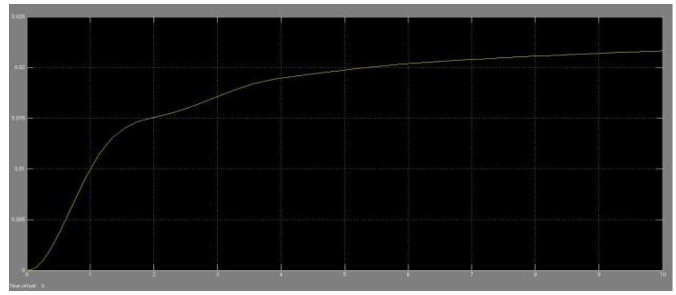

Fig.1.9. Tieline power deviation of area 1-2 with PI controller

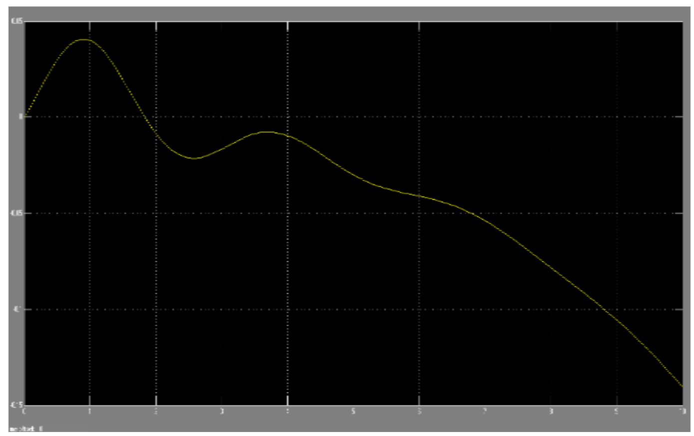

Fig 1.10 Frequency deviation of area 1 and area 2 with PID controller

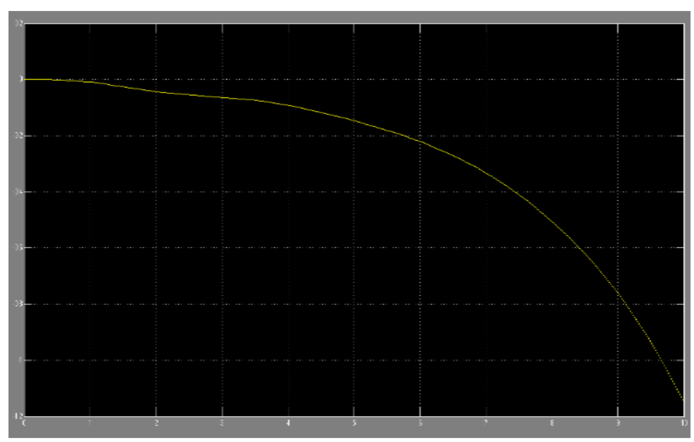

Fig 1.11 Frequency deviation of area 1 and area 2 with PID controller

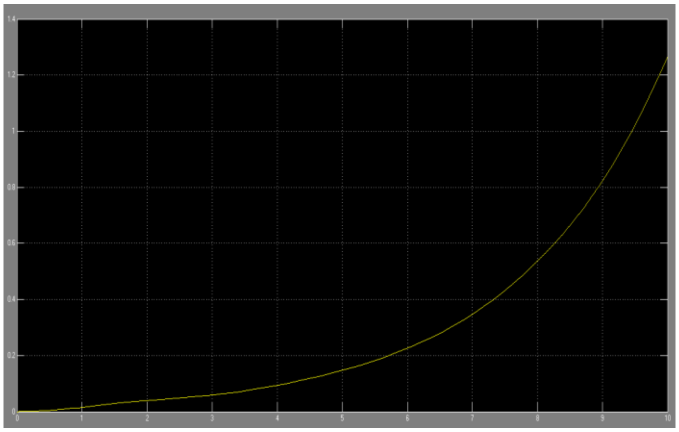

Fig 1.12 Tie line power deviation with PID controller

Table 1.1- change in frequency in area 1

	With PI	With PID
Maximum overshoot	0.0227	0.04049
Minimum overshoot	-0.0211	-0.0213
Settling time	9.54	_

Table 1.2- change in frequency in area 2

	With PI	With PID
Maximum overshoot	-0/0190	0
Minimum overshoot	-0.0230	0
Settling time	9.544	_

Table 1.3- change in tie line power of interconnected system

	With PI	With PID
Maximum overshoot	0.0205	0
Minimum overshoot	0.0146	0
Settling time	_	_

REFERENCES

[1] A.H.M.A Rahim and A.M.Mohamad; “Superconducting Magnetic Energy Storage System for Power System.Stabilization", 28th Universities Power Engineering Conference, Staffordshire, UK, September, 1993**.**

[2] Dong, X., Wang, C., Yun, Z., Wang, Y., Zhao, P., Ding, Y., … Sun, H. (2017). Power Flow Analysis Considering Automatic Generation Control for Multi-Area Interconnection Power Networks. *IEEE Transactions on Industry Applications*, *9994*(c). https://doi.org/10.1109/TIA.2017.2738618

[3] Fagna, R. (2017). A novel Elephant Herding Optimization based PID controller design for Load frequency control in power system - IEEE Xplore Document, 595–600. Retrieved from http://ieeexplore.ieee.org/document/8004039/

[4] Hassen, S. Z. S., &Jahmeerbacus, M. I. (n.d.). Optimal Frequency Regulation of a Two-area Power System, 140–145.

[5] https://www.mathworks.com/products/matlab.html#overview

[6] Jaleeli, N. (1992). Understanding automatic generation control. IEEE Transactions on Power Systems, 7(3), 1106–1122.

[7] Kayalvizhi, S., & Kumar, D. M. V. (2017). Load Frequency Control of an Isolated Micro grid using Fuzzy Adaptive Model Predictive control. IEEE Access, 3536(c), 1–1. https://doi.org/10.1109/ACCESS.2017.2735545

[8] Otchere, I. K., &Ampofo, D. O. (2017). Adaptive Discrete Wavelet Transform Based Technique for Load Frequency Control, 589–594.

[9] Panda G., Panda S. and Ardil C. , *2009.* ”Automatic Generation Control of Interconnected Power System with Generation Rate Constraints by Hybrid Neuro Fuzzy Approach”, *International Journal of Electrical and Electronics Engineering, Vol.52, pp. 532-537.*

[10] Pandey, S. K., Mohanty, S. R., &Kishor, N. (2013). A literature survey on load-frequency control for conventional and distribution generation power systems. Renewable and Sustainable Energy Reviews, 25, 318–334. https://doi.org/10.1016/j.rser.2013.04.029.

[11] Pandey, Shashi Kant, SoumyaR. Mohanty, and NandKishor. "Aliterature survey on load–frequency control for conventional anddistribution generation power systems." *Renewable and SustainableEnergy Reviews* 25, pp.318-334, 2013.

[12] Rana, K., &Kakran, S. (2016). Improvement in dynamic performance of an interconnected power system in Load Frequency Control using SMES. 2016 IEEE Students’ Conference on Electrical, Electronics and Computer Science (SCEECS), 1–6. https://doi.org/10.1109/SCEECS.2016.7509338.

[13] Robert Herschel Miller, James H. Malinowski, Power system operation, McGraw-Hill Professional, 1994 ISBN0-07-041977-9, page 86-87

[14] SachinKhajuriaJaspreet Kaur **“**Load Frequency Control of Interconnected Hydro-Thermal Power System Using Fuzzy and Conventional PI Controller” International Journal of Advanced Research in Computer Engineering & Technology(IJARCET)Volume 1, Issue 8, October 2012