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Optimized Frequency Control of Smart Grid Integrated with Electric Vehicles using Particle Swarm Optimization

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Abstract:- In recent years there is a substantial improvement in the development of technologies in electrical power generation and consumption strategies, involving more electric vehicles (EV's),smart loads ,renewable energy in smart grids. In this paper, a large number of EV aggregators are connected to the smart grid in order to improve the frequency response and an optimized control strategy is implemented including both the primary controller and the EV controller when power mismatch occurs. By operating the power plant ,frequency is stabilized by primary controller and frequency deviation is controlled by EV controller. Here both the controllers are PI controllers and the controller parameters are optimized using Particle Swarm Optimization.

I. INTRODUCTION

Electric vehicles plays vital role in renewable energy systems. Grid connected electric vehicles contribute certain large advantages in stability point of view by providing frequency control of power system. Number of connected electric vehicles to grid at certain period determines the stability of system and results will be desirable if optimized grid to vehicle and vehicle to grid schemes are applied. Particle Swarm Optimization is the one which is evolved from natural process has applied to the system and frequency control is obtained from that proposed model.

II. PROPOSED SYSTEM

In proposed system, PI controllers are used for both primary controller and EV controller. But due to dynamic load and power generation of smart grid the frequency instability occurs. To overcome the problem, identification of the optimal controller variable K_P—proportional gain, K_I—integral gain by using particle swarm optimization(PSO) is done.

III. EV-INTEGRATED BENCHMARK SMART GRID

Integration of electric vehicle is studied in smart grid with different loads,renewable energy sources and a conventional governer-turbine system and smart homes. Notations followed for the folowing figure as

U_P ,U_e=primary control signal,EV control signal.
U_{e1}, U_{e2}, and Uen = control signals of n EV aggregators. ΔP_{e1}, ΔP_{e2}, and ΔP_{en} = n EV aggregators power output change

Δf , ΔX_g = frequency deviation, change of governor position
ΔP_e,ΔP_t =change of output power of EV aggregators and the turbine
ΔP_d ,ΔP_{re} = power mismatches of wind and change in load

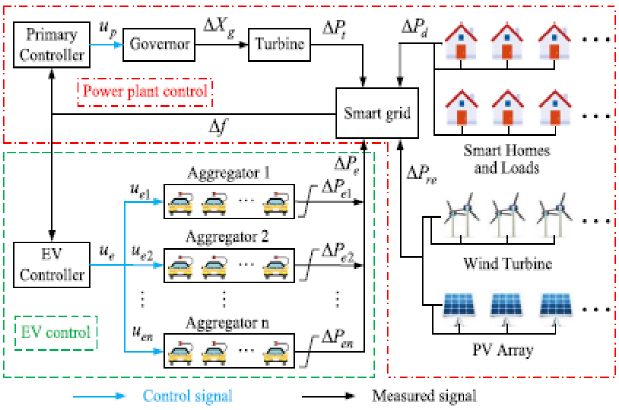

Fig1: EV integrated smart grid

The above block diagram represents the integration of electric vehicles with smart grid.
T_g, T_t, T_p = governor time constant, turbine time constant, power system time constant
R , Kp= speed regulation coefficient , gain of the power system.

Variations of discharging and charging coefficients are small defined as K_{A1}, K_{A2}, and K_{An} for n EVs.

For frequency control strategy, ξ_1, ξ_2 = primary and EV control distribution coefficients. $\xi_1 + \xi_2 = 1$.

T_{e1}, T_{e2}, T_{en} =EVs time constants of the respective EV aggregators.

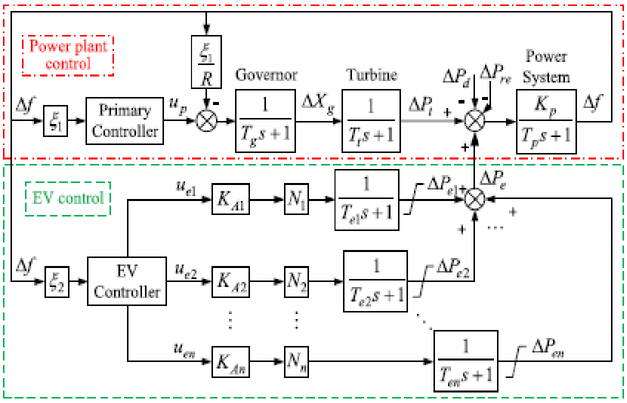

Fig2: smart grid control structure

IV. PI CONTROLLER MODEL

Proportional Integral control is applied to system and output is observed accordingly.

Block diagram of controller is as shown in fig

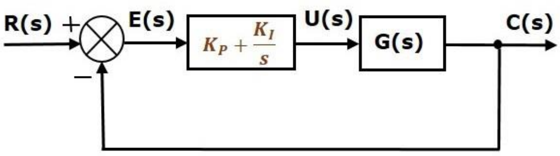

Fig3: PI controller closed loop system

As a result of this, there is reduction in steady state error and the same is observed through the simulation results.

V. PSO OPTIMIZATION

Particle swarm optimization is a robust technique studied on basis of movement and intelligence of swarms. Particle uses search directions(gradients) to communicate each other directly of indirectly. Particle swarm optimization algorithm is to locate global optimum by set of particles flying over a search space.updation of particles position is obtained for every iteration.

In general three vectors are studied for understanding the movements and behaviour of different particles.significane of those vectors are they records current position ,records location of best solution, contains gradient direction.Insearch of certain solutions such as local best ,global best each particle will have velocity which moves towards global best besides the local best.

VI. SIMULATION AND RESULTS

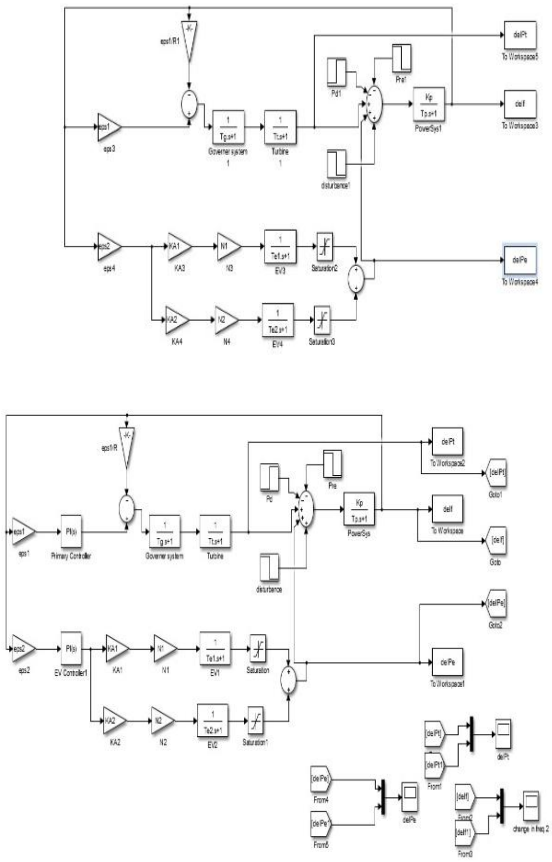

Fig4. Simulink Model for PI controller

Different parameters taken for study with smart grid as follows $T_t = 0.3$, $T_g = 0.1$, $T_p = 10$, $K_p = 1$, $R = 0.05$, $\xi_1 = 0.2$, $\xi_2 = 0.8$. $T_{e1} = T_{e2} = 0.035$,time constant of aggregators. Coefficients of charge and discharge as $K_{A1} = K_{A2} = 0.0024$ power constraints taken as [-0.5,0.5]. Pi controller parameters are as of primary controller $K_{PP} = 15$, $K_{IP} = 40$ and $K_{PE} = 0.2$ and $K_{IE} = 2$ for EV control.

PSO PARAMETERS

Max Iteration	15
Swarm Size	10
Inertia Weight(w)	1
Inertia Weight Damping Ratio(wdamp)	0.999
Personal Learning Coefficient(C_1)	1.5
Global Learning Coefficient(C_2)	0.5

Table1 :PSO parameters taken for optimization

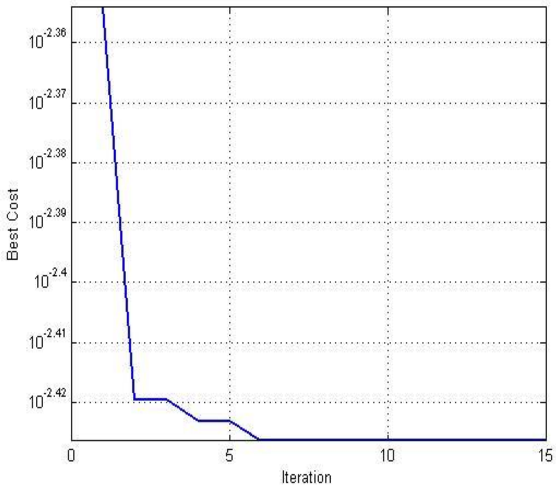

Fig5. Best cost vs iteration for PSO

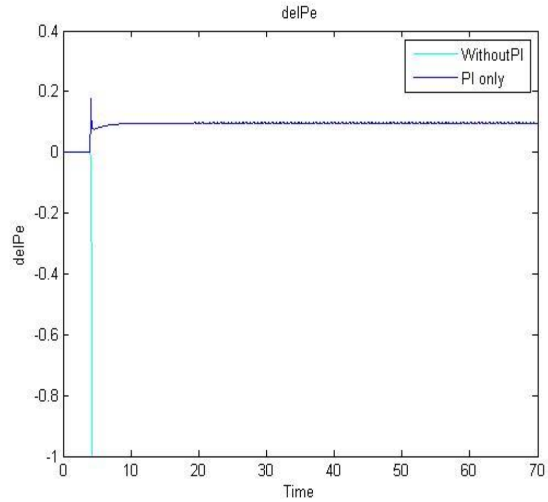

Fig 8 Time Vs ΔP_e

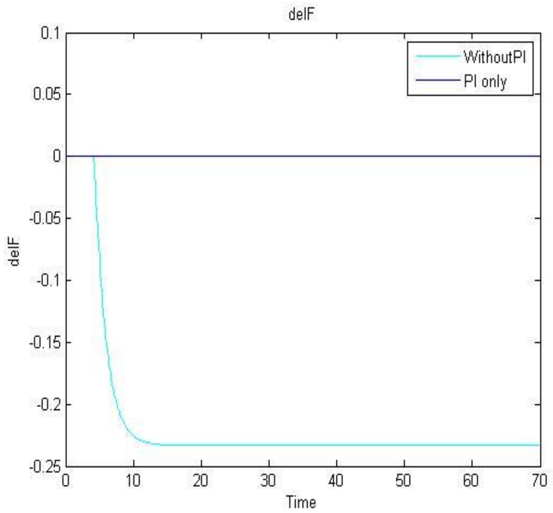

Fig 6 Time Vs Δf

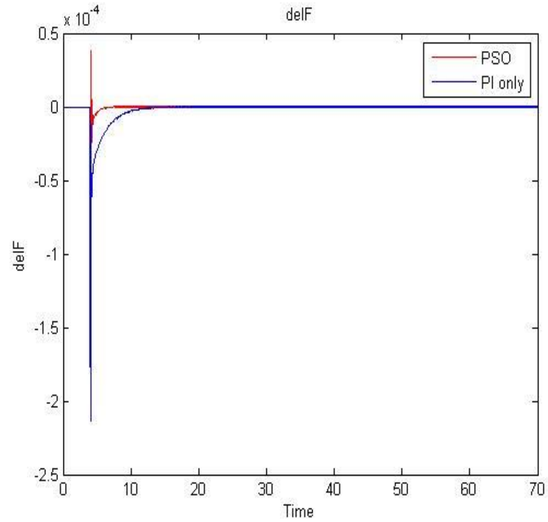

Fig 9 Time Vs Δf

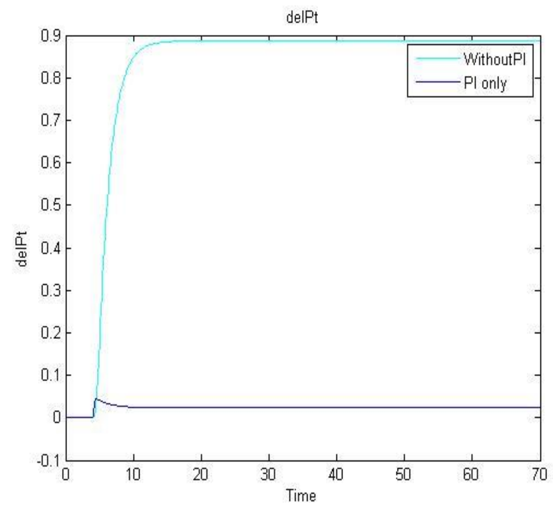

Fig 7 Time Vs ΔP_t

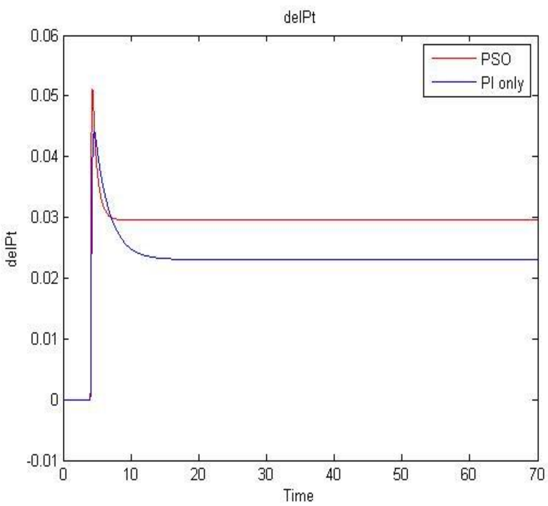

Fig 10 Time Vs ΔP_t

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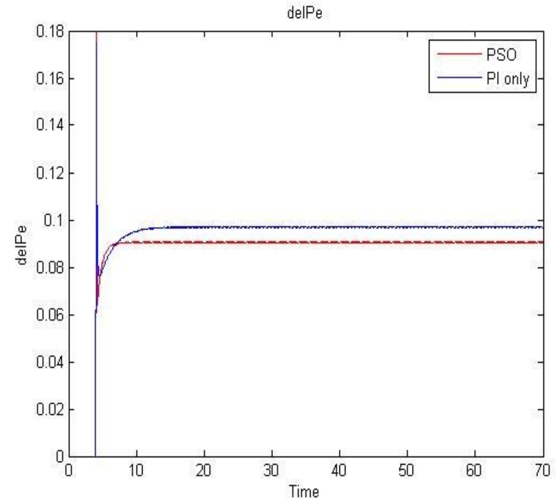

Fig 11 Time Vs ΔP_e

Results with 10% increase in K_P and K_I values :

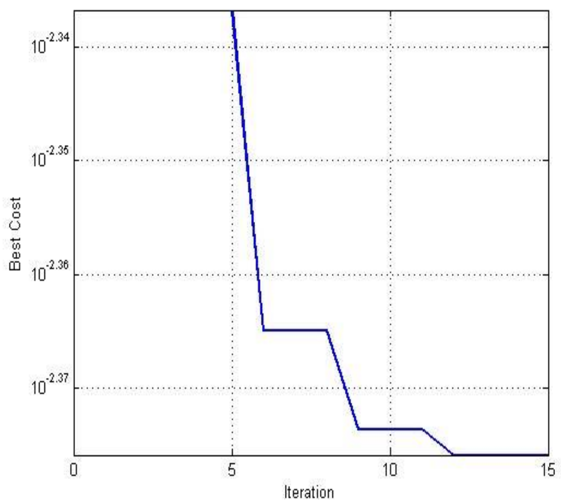

Fig12Best cost vs iteration for PSO

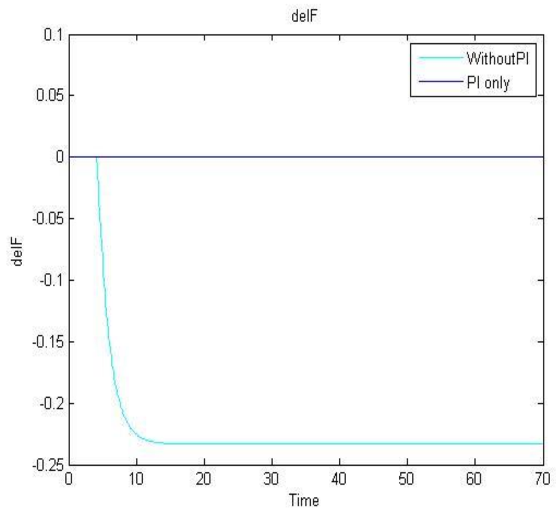

Fig 13 Time Vs Δf

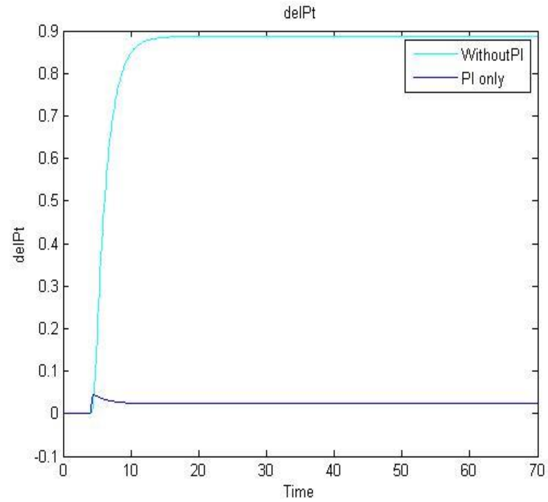

Fig 14 Time Vs ΔP_t

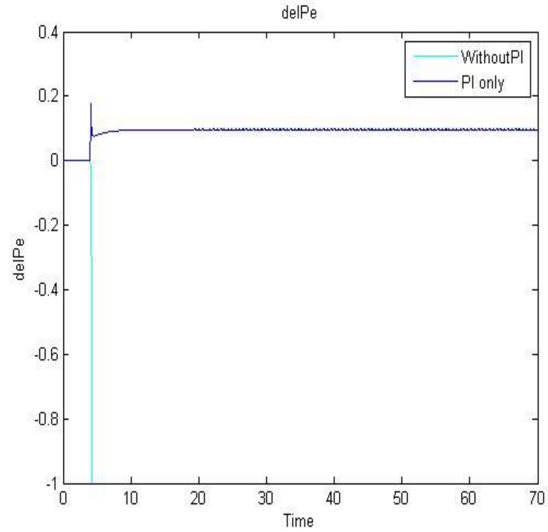

Fig 15 Time Vs ΔP_e

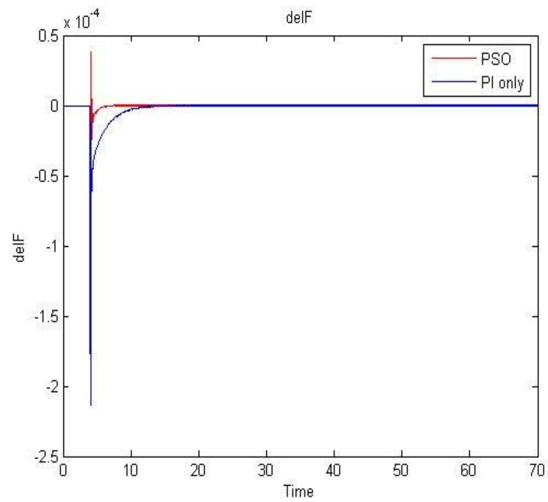

Fig 16Time Vs Δf

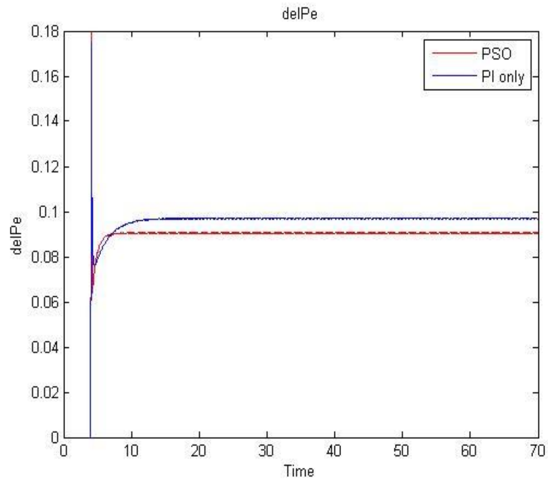

Fig 17 Time Vs ΔP_e

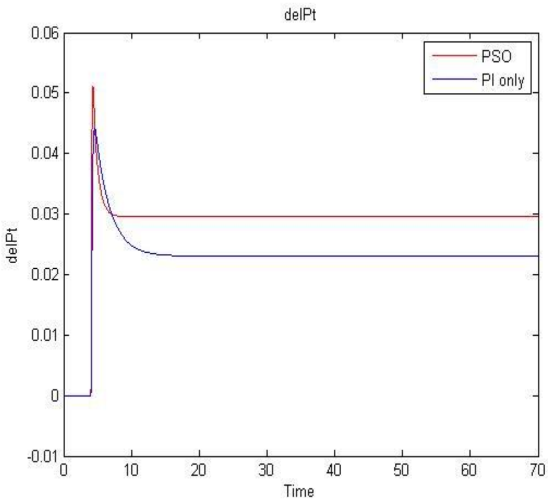

Fig 18 Time Vs ΔP_t

VIII. CONCLUSION AND FUTURE WORK

An optimized control strategy is developed including both the primary controller and the EV controller when power mismatches happen. In proposed system, PI controllers are used for both primary controller and EV controller. But due to dynamic load and power generation of smart grid the frequency instability occurs. To overcome the problem, identification of the optimal controller variable K_P—proportional gain, K_I—integral gain by using optimization methods is done. Particle swarm optimization is studied and results are obtained with PI controller and PSO and observed.

REFERENCES

[1]. S. K. Pandey, S. R. Mohanty, and N. Kishor, “A literature survey onload-frequency control for conventional and distribution generation powersystems,” Renew. Sustain. Energy Rev., vol. 25, pp. 318–334, 2013.
[2]. X. Yu and Y. Xue, “Smart grids: A cyber-physical systems perspective,”Proc. IEEE, vol. 104, no. 5, pp. 1058–1070, May 2016.
[3]. C. Li, Y. Xu, X. Yu, C. Ryan, and T. Huang, “Risk-averse energy tradingin multienergy microgrids: A two-stage stochastic game approach,” IEEETrans. Ind. Inform., vol. 13, no. 5, pp. 2620–2630, Oct. 2017.
[4]. S. Wu, Y. Wang, and S. Cheng, “Extreme learning machine based windspeed estimation and sensorless control for wind turbine power generationsystem,” Neurocomputing, vol. 102, pp. 163–175, 2013.
[5]. C. Li, C. Liu, K. Deng, X. Yu, and T. Huang, “Data-driven charging strategy of PEVs under transformer aging risk,” IEEE TransCont. Syst. Technol., vol. 26, no. 4, pp. 1386–1399, Jul. 2018, doi:10.1109/TCST.2017.2713321.
[6]. K. S. Parmar, S. Majhi, and D. Kothari, “Load frequency control of realistic power system with multi-source power generation,” Int. J. Elect.Power Energy Syst., vol. 42, no. 1, pp. 426–433, 2012
[7]. "Modern Power System Analysis” by D. P. Kothari,I. J. Nagrath
[8]. Book of “Electrical power systems” by C.L Wadhwa.