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Optimized Frequency Control for an EV-Integrated Smart Grid Using Artificial Bee Colony Optimization

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Abstract:- Saving the non-renewable energy electrical vehicle is a step ahead. Adopting electrical vehicle is encouraged due to the strength crisis, environmental problems. Electrical vehicle is the opportunity transportation method for the traditional internal combustion engine vehicle. Electric Vehicle to grid or else Grid to Electric vehicle the generation is permitted. This is known as Bidirectional exchange. This electricity exchange takes place between the powered electric cars and power grid. Which offers numerous offerings to power grid, like load levelling, reimbursement of reactive power, spinning reserve and grid regulation. Electric vehicle to grid generation is complicated to implement. Unit dedication with unusual different targets and constraints, optimization techniques are used.

I. INTRODUCTION

Smart grids play a vital role compared to the conventional electricity. Smart grids with load have the promising technology of energy saving. Due to the stochastic energy the system is hard to maintain steadiness, mainly when the system is going into operating mode. The power mismatch occurs, when the demanded power of load is higher than the grid power and the demanded power of load is lesser than the grid power. The frequency of the system fluctuates which results to the instability of the system, and the fault cannot be effectively eliminated in time. Artificial bee colony is applied to the system to control the frequency.

II. PROPOSED SYSTEM

In a system, we use PI controller for primary controller and EV controller. Identified the optimal controller variable KP—proportional gain, KI—integral gain via the usage of Artificial bee colonymodel.

III. EV-INCORPORATEDBENCHMARK SMART GRID

The EV-incorporated smart grid consists of Electric vehicles, governor, turbine, renewable energy, smart homes and loads. The smart homes and loads are uncertain load change.
Notations:
U_p= control signals of the primary controller
U_e= EV control signal
U_{e1}, U_{e2}, and U_{en}= n EV aggregators control signals
ΔP_{e1}, ΔP_{e2}, and ΔP_{en}= change in power ofaggregators
Δf=frequency deviation
ΔX_g= change of governor position
ΔP_e= Aggregators output power change
ΔP_t=turbine power change
ΔP_d= the power mismatches from the load change
ΔP_{re}=mismatch power of system

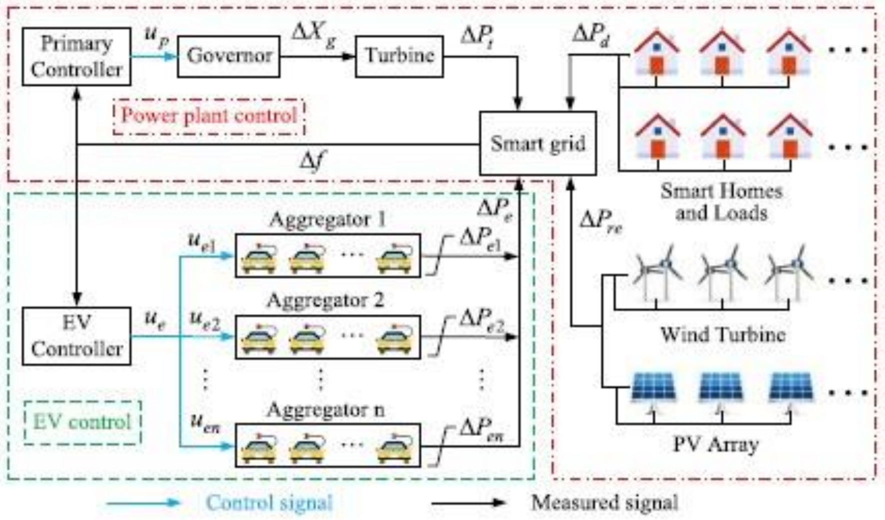


Fig1: EV incorporated smart grid

Smart grid with EV as shown in figure below
T_g =Time constants of the governor
T_t = Time constants of the turbine
T_p= power system constant for time
R= Speed regulation co-efficient
Kp= Gain of the electricity system

Distinction of coefficients of charging and discharging is very small. K_{A1}, K_{A2}, and $K_{An}$for n EV aggregators

ξ_1 and ξ_2 =coefficients of distribution for primary and ev control
$\xi_1+\xi_2=1$
T_{e1}, T_{e2}, and Ten=Time constants of EVs

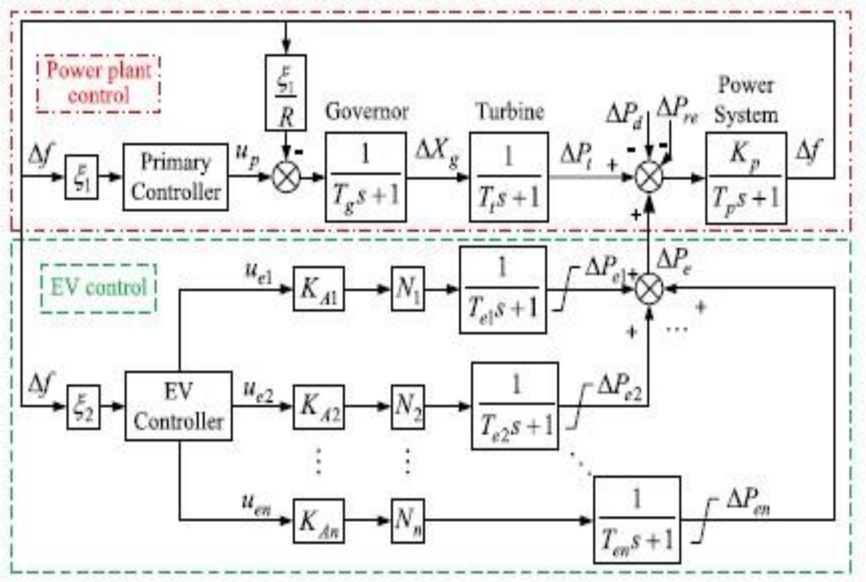


Fig2:Hierarchical control of smart grid

IV. PI CONTROLLER MODEL

PI controller is applied to the system and results are observed
$U(t) = K_P e(t)+K_I \int e(t)dt$
Apply Laplace transform on L.H.S and R.H.S
$U(s)= (K_P+K_I/s)E(s)$
$U(s)/E(s)= (K_P+K_I/s)E(s)$

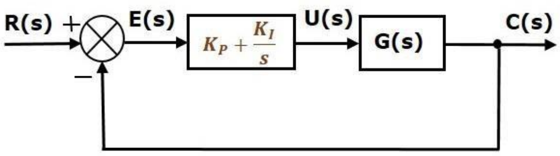


Fig3: Closed loop control system with PI controller

V. ABC OPTIMIZATION

Artificial Bee colony algorithm is the one which is evolved on basis of natural process of evolution. It converges the best possible solution by the following procedure given below;

Procedures of ABC:

a. Initialization
b. Moving of onlookers
c. Move only if employed bees reach limit
d. Memory updation
e. Checking of final condition for end

Movement of the Onlookers:
Nectar source selection probability is

$$P_i = \frac{F(\theta_i)}{\sum_{k=1}^{S} F(\theta_k)}$$

P_i=ithbee selection probability
S= employed bee number
θ_i= The position of the ithemployed bee
= value of fitness
$F(\theta_i)$

new position is updated as

$$x_{ij}(t+1)=\theta_{ij}(t)+\phi(\theta_{ij}(t)-\theta_{kj}(t))$$

x_{ij}: onlooker bee position
t : The iteration number
Θ_{ij}: The randomly chosen employed bee.
j:solution dimension
Θ_{kj}: A series of random variable in the range
The movement of scout bees as follows

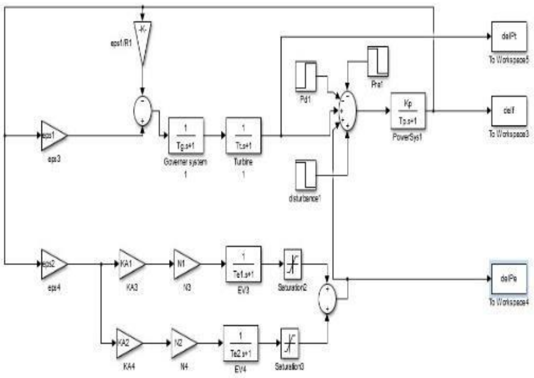
$$\theta_{ij} = \theta_{j\min} + r \cdot (\theta_{j\max} - \theta_{j\min})$$

ABC parameters:

Max Iteration	15
Colony size	10
Number of Onlooker Bees	10
Abandonment Limit Parameter Acceleration Coefficient UpperBound	0.6 1

Table1: ABC parameters

VI. SIMULATION AND RESULTS



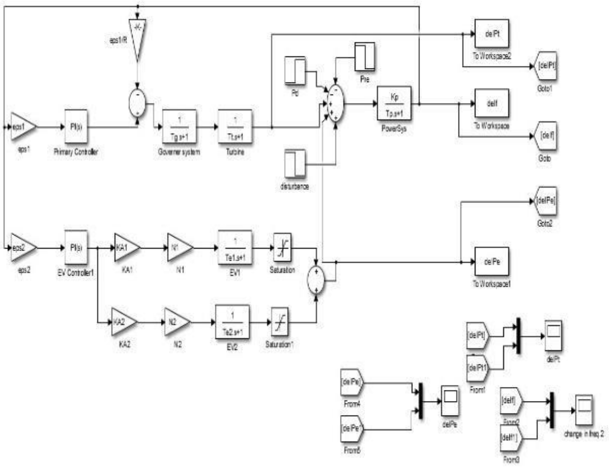


Fig4. Simulink Model for PI controller

First, we assumed with EVs and without EVs in a smart grid. parameters: Tt = 0.3, Tg = 0.1, Tp =10, Kp =1,R = 0.05. The distribution coefficients are ξ2 = 0.2, ξ2 = 0.8, Te1 =0.035, Te2 = 0.035, KA1 = KA2 = 2.4 ×10⁻³, power constrains [-0.5,0.5] for all EVs, For primary controller here PI controller is used K_{PP} = 15, K_{IP} =40, K_{PE} = 0.2 ,K_{IE} = 2 for the EV controller.

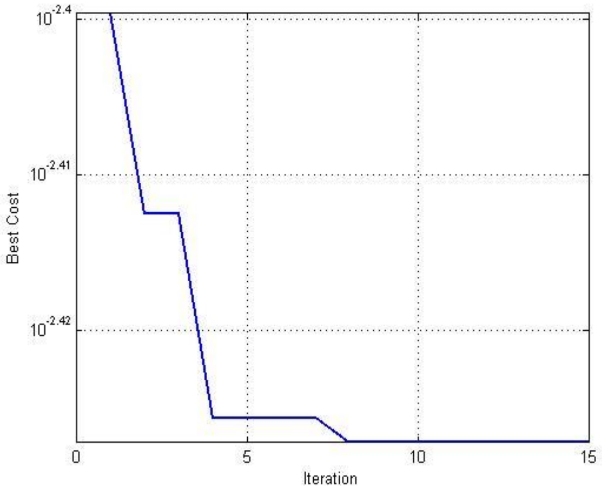


Fig5: Best cost vs iteration for ABC

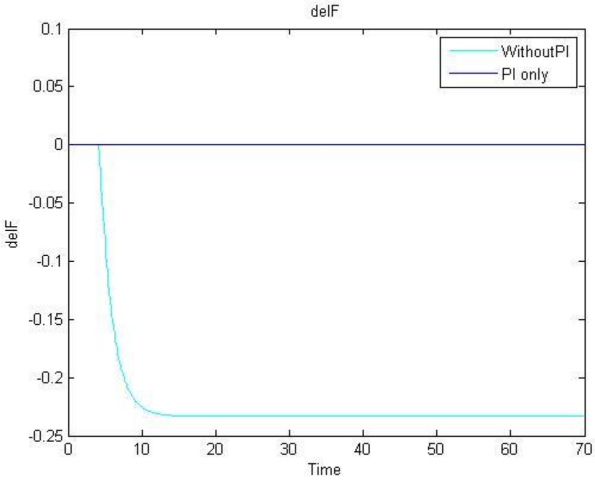


Fig6: Time Vs ΔF

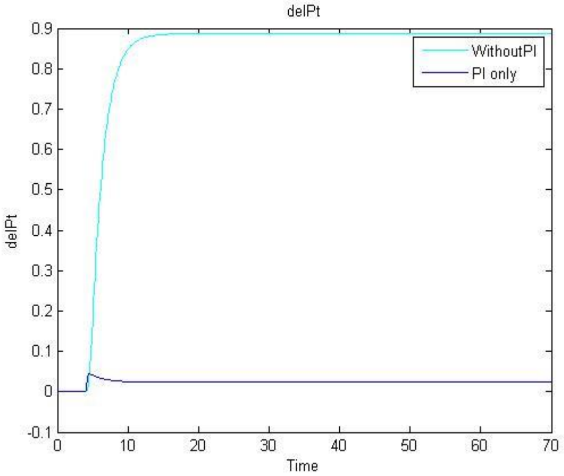


Fig7: Time Vs ΔPt

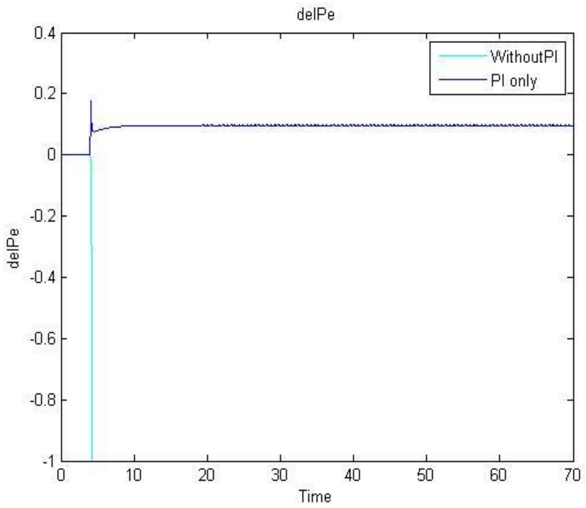


Fig8: Time Vs ΔPe

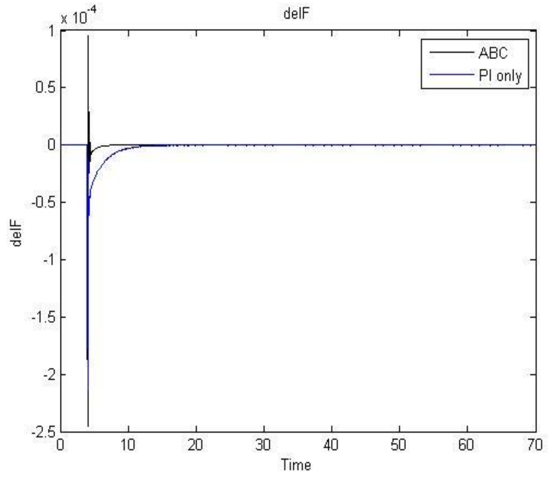


Fig9: Time Vs ΔF

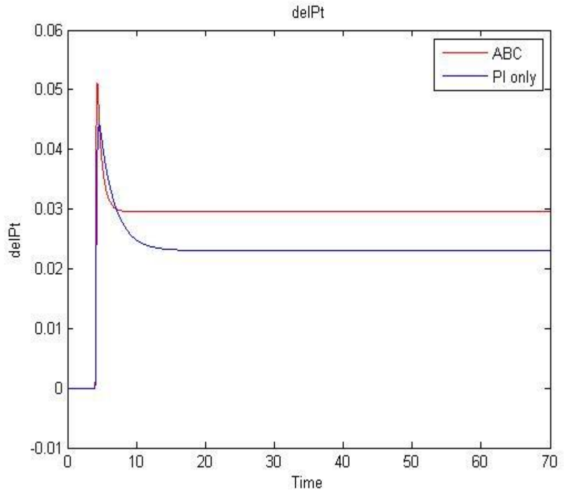


Fig10: Time Vs ΔPt

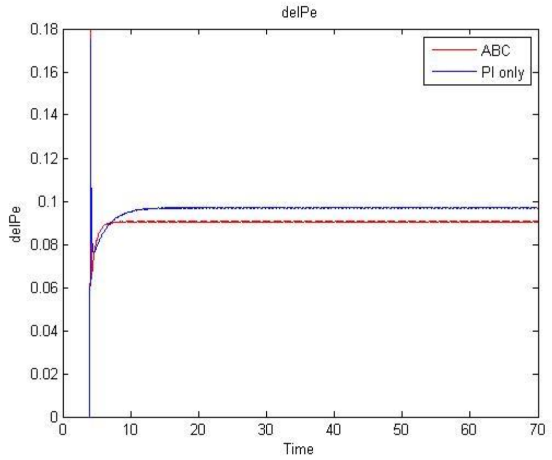


Fig11: Time Vs ΔPe

Observations of 20% increase in K_p and K_i

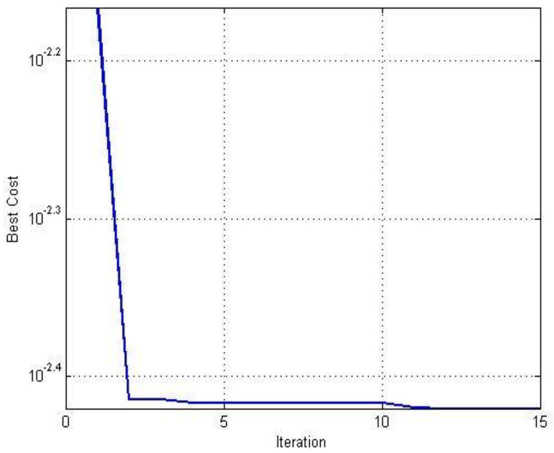


Fig12: Best cost vs iteration for ABC

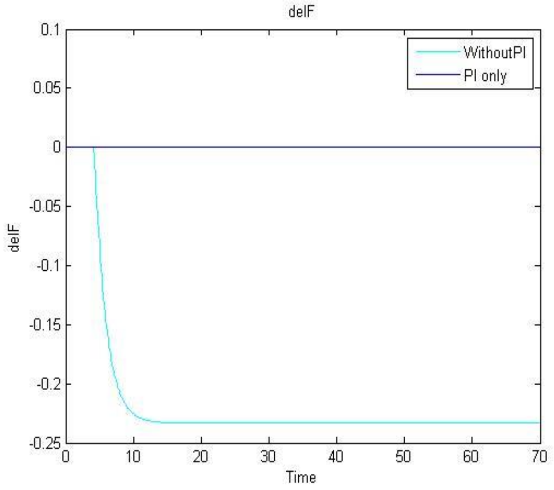


Fig13:Time Vs ΔF

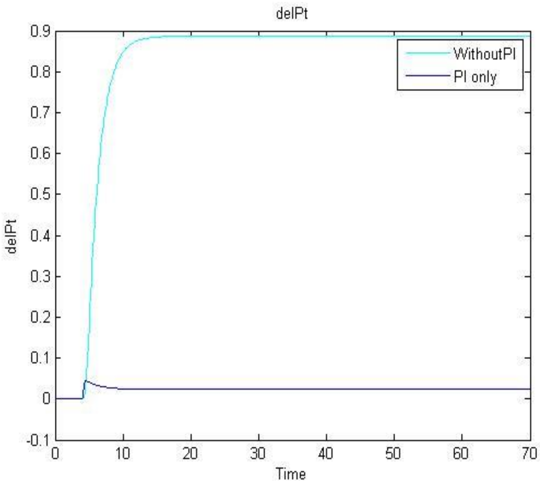


Fig14:Time Vs ΔPt

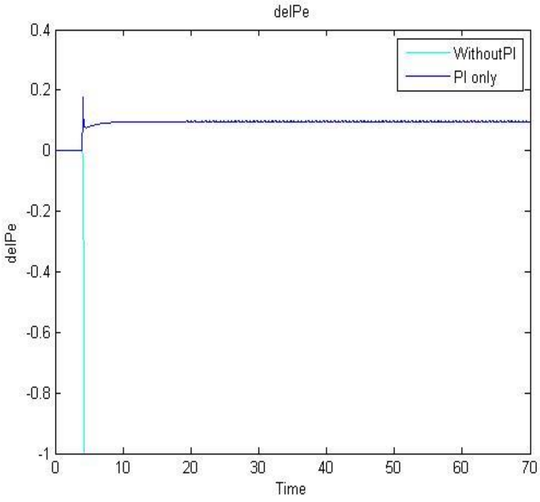


Fig15: Time Vs ΔPe

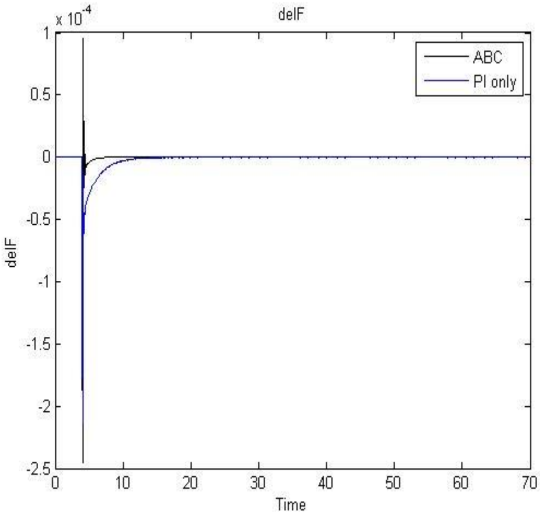


Fig16:Time Vs ΔF

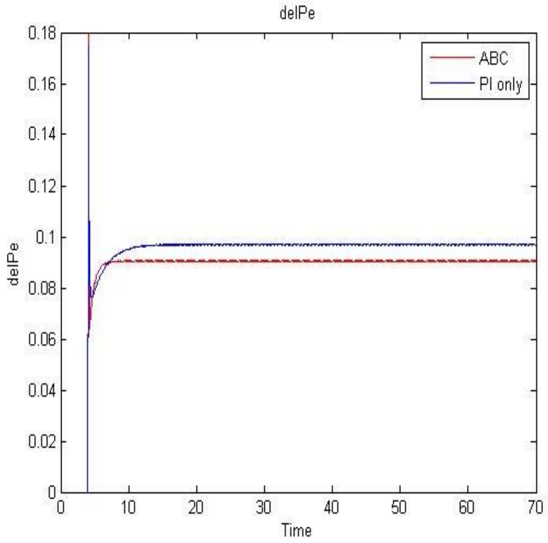


Fig17: Time Vs ΔPe

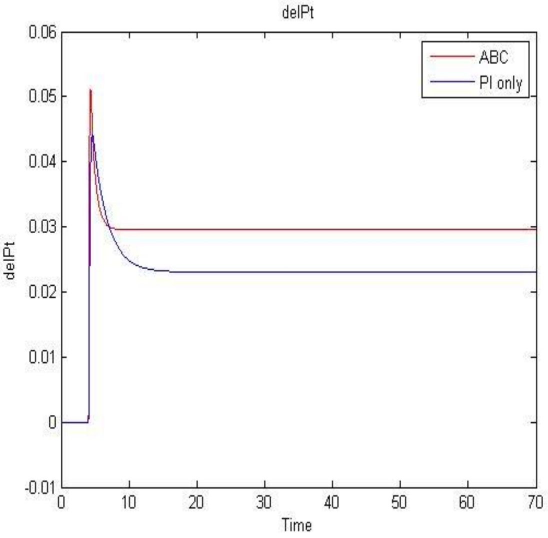


Fig18:Time Vs ΔPt

VII. CONCLUSION AND FUTURE WORK

A novel optimized control method is advanced which includes primary and EV controller while power incompatibility occurs. Bothcontrollers are designed using PI controller. However, because of dynamic load and power generation of smart grid,frequency instability happens. To overcome the problem, we have discovered the optimum controller variable Kp—proportional gain,Ki—integral gain by the usage of optimization techniques. Here we proposed artificial bee colony.

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