Load Frequency Control in Two Area System Using Bacterial Foraging Optimization Algorithm

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Abstract- **As far as our power system is concerned there has been increase in the interconnected system. load and power flow is dynamically varying so there is a need for robust and efficient control and this is achieved by Bacterial Foraging Optimization Algorithm (BFOA).In this paper we use (BFOA) in place of conventional Proportional, PI, PID for better control in load frequency control in two area system and the results are compared conventional controllers.**

I. INTRODUCTION

LFC is one of the control problems in the electric power system design and operation. Any deviation in frequency can impact power system operation and system reliability. A large frequency deviation can cause an unstable condition for the power systems. Maintaining frequency and tie line power are the two main objectives of the load frequency control.

Bacterial Foraging Optimization Algorithm (BFOA) is proposed by Kevin Passino, is a new comer to the family of nature inspired optimization algorithms. Application of group foraging strategy of a swarm of E. coli bacteria in multi-optimal function optimization is the key idea of this new algorithm. Bacteria search for nutrients is a manner to maximize energy Obtained per unit time. Individual bacterium also communicates with others by sending signals. A bacterium takes foraging decisions after considering two previous factors. The process, in which a bacterium moves by taking small steps while searching for nutrients, is called chemotaxis. The key idea of BFOA is mimicking chemotactic movement of virtual bacteria in the problem search space.

p : Dimension of the search space,
S : Total number of bacteria in the population,
Nc : The number of chemotactic steps,
Ns : The swimming length.
NreThe number of reproduction steps,
Ned : The number of elimination-dispersal events,
Ped : Elimination-dispersal probability,
C(i): The size of the step taken in the random direction specified by the tumble

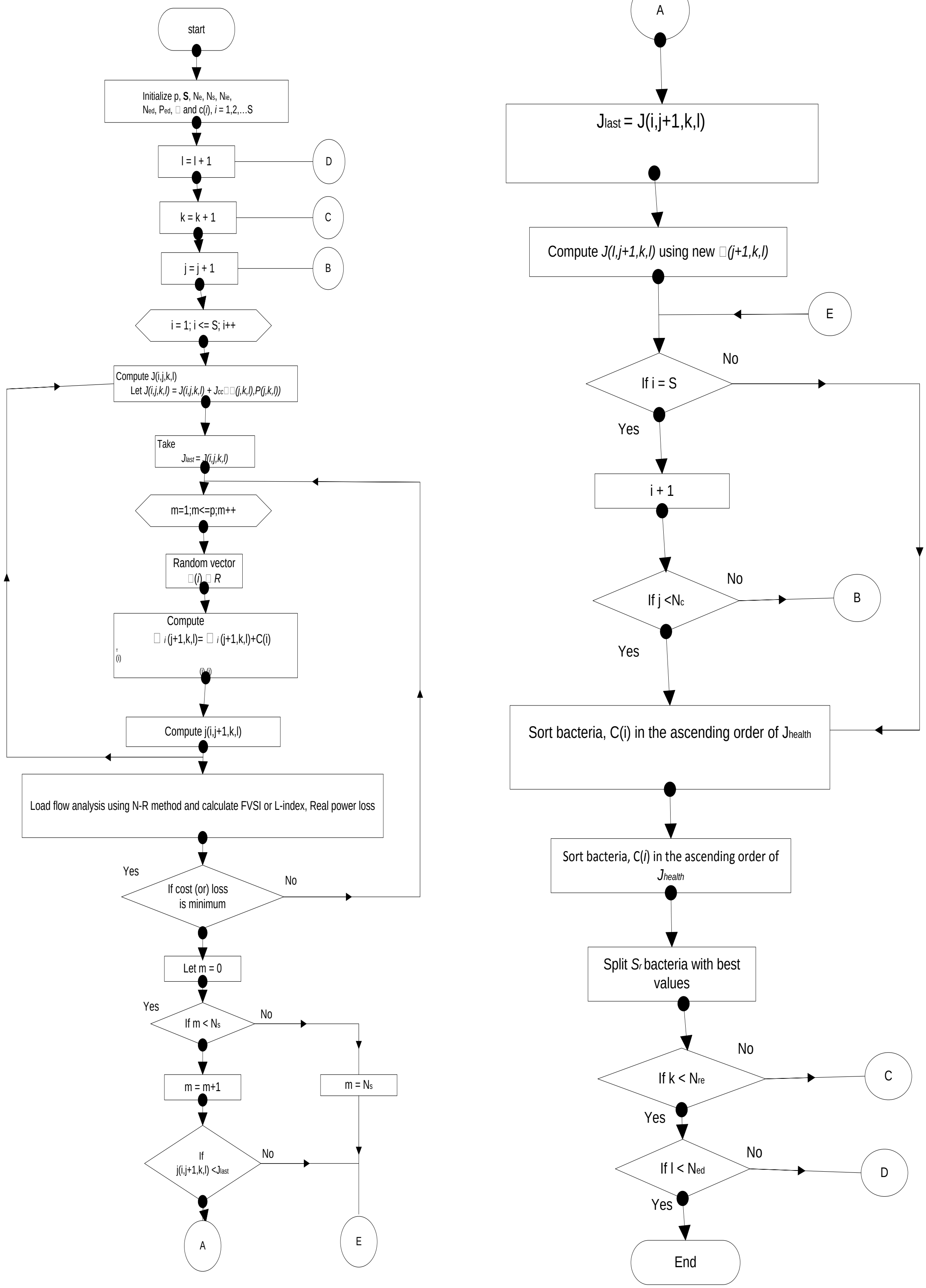
Bacterial Foraging Optimization Algorithm

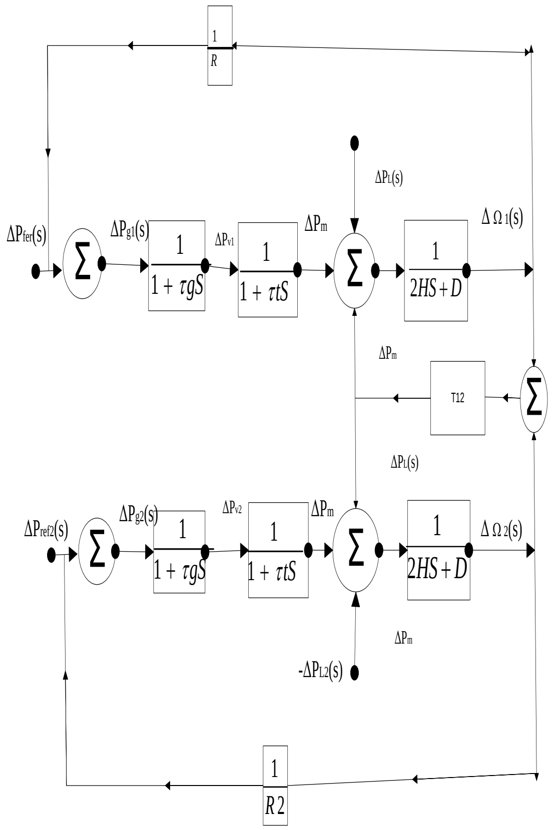
Foraging theory is based on the assumption that animals search for and obtain nutrients in a way that maximizes their energy intake E per unittime T spent foraging. Hence, they try to maximize a function like E/T (or they maximize their long-term average rate of energy intake). Maximization of such a function provides nutrient sources to survive and additional time for other important activities (e.g., fighting, fleeing, mating, reproducing, sleeping, or shelter building). Shelter building and mate finding activities sometimes bear similarities to foraging. Clearly, foraging is very different for different species. Herbivores generally find food easily but must eat a lot of it. Carnivores generally find it difficult to locate food but do not have to eat as much since their food is of high energy value.

The "environment" establishes the pattern of nutrients that are available (e.g., via what other organisms are nutrients available, geological constraints such as rivers and mountains and weather patterns) and it places constraints on obtaining that food (e.g., small portions of food may be separated by large distances). During foraging there can be risks due to predators, the prey may be mobile so it must be chased and the physiological characteristics of the forager constrain its capabilities and ultimate success. Bacterial Foraging optimization theory is explained by following steps

1 Chemotaxis
2 Swarming
3 Reproduction and
4 Eliminational-Dispersal

FLOW CHART


start
Initialize p, S, Ne, Ns, Nre, Ned, Ped, and c(i), i = 1,2,…S
l = l + 1
k = k + 1
j = j + 1
i = 1; i <= S; i++
Compute J(i,j,k,l)
Let J(i,j,k,l) = J(i,j,k,l) + Jcc(j,k,l),P(j,k,l))
Take Jlast = J(i,j,k,l)
m=1;m<=p;m++
Random vector
Compute
Compute j(i,j+1,k,l)
Load flow analysis using N-R method and calculate FVSI or L-index, Real power loss
If cost (or) loss is minimum
Yes
No
Let m = 0
If m < Ns
m = m+1
m = Ns
If j(i,j+1,k,l) <Jlast
A
E
D
C
B
Jlast = J(i,j+1,k,l)
Compute J(I,j+1,k,l) using new (j+1,k,l)
If i = S
i + 1
If j <Nc
Sort bacteria, C(i) in the ascending order of Jhealth
Split Sr bacteria with best values
If k < Nre
If l < Ned
End



Load frequency control of two area system

SIMULATION

FOR STEP INCREASE IN THE LOAD DEMAND IN AREA 1:-

As the first test case, at Area 1 a step increase in load is applied. Then the first Area frequency deviation f1, the second Area frequency deviation f2, tie line power and ACE deviation are shown in Fig. 3, Fig. 4, Fig. 5, Fig. 6, Fig. 7. In these Figures, it is quite evident that the performance of conventional PI controller is not satisfactory; the main problem arises due to its high settling time. To improve the system characteristic the proposed method is more suitable.

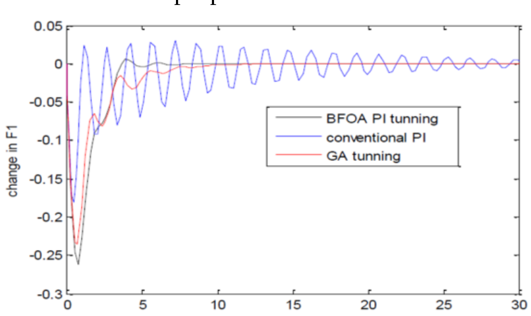


Figure 1 : Variation in frequency of Area 1 with 0.1 per unit variation in Area 1

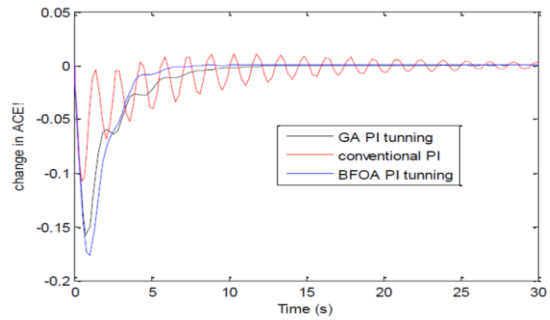


Figure 2: Variation of ACE1 with 0.1 per unit variation in Area 1

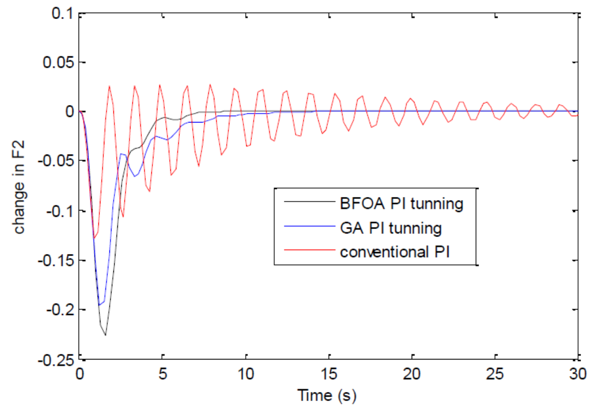


Figure 3: Frequency variation of Area 2 with 0.1 per unit variation in Area 1

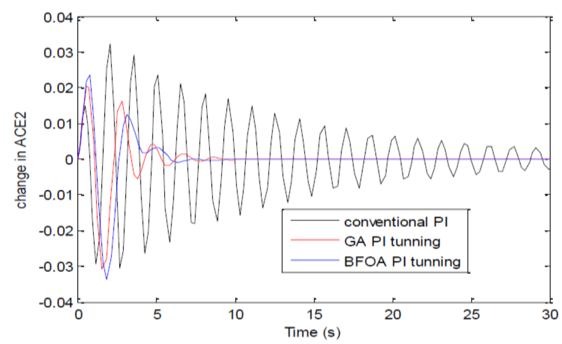


Figure 4: Variation of ACE2 with 0.1per unit variation in Area 1

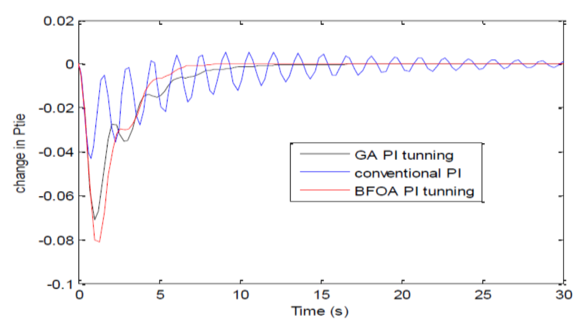


Figure 5: Variation of Ptie with 0.1per unit variation in Area 1

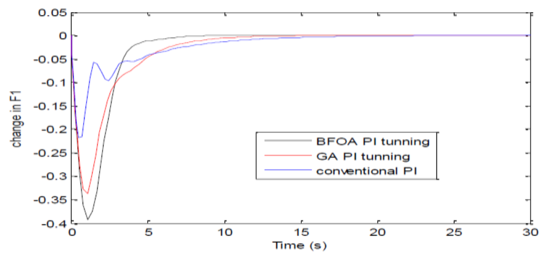


Figure 6: Effect on frequency of Area 1 with 0.1 per unit variation in all the Areas

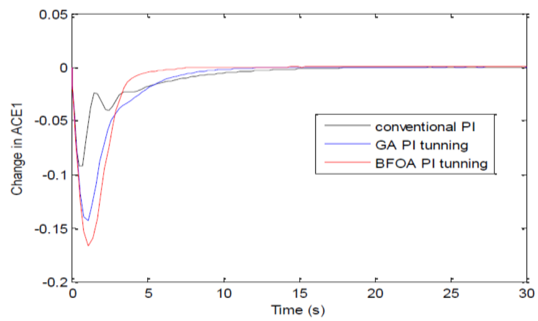


Figure 7: Effect on ACE of Area 1 with 0.1 per unit variation in all the Areas

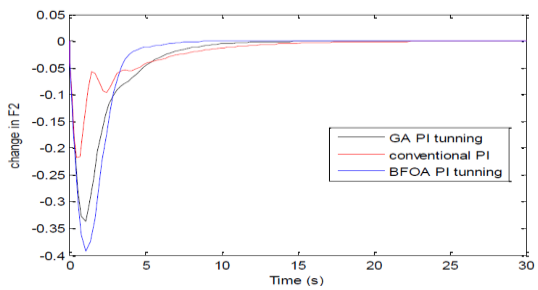


Figure 8: Effect on frequency of Area 2 with 0.1 per unit variation in all the Areas

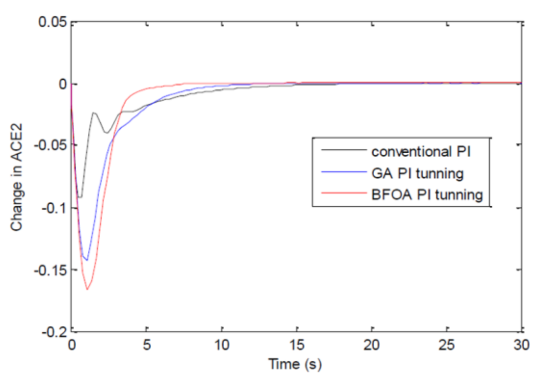


Figure 9: Effect on ACE of Area 2 with 0.1 per unit variation in all the Areas

CONCLUSION

In instance of the uncontrolled studies it has been witnessed that as the load fluctuation is increased the area control errors are also aggregated. The effect of FLC when placed in both the areas for a step load change in Area 1 is that the variations in Δf1 , Δf2 and ΔPtie are completely nonoscillatory. Comparable deductions can be drawn for equal step load changes in both the areas having FLC in area 1. The retorts are generated with FLC placed in both Areas. When FLC are placed in both the areas the abnormalities are small and the oscillations die out easily.. Altogether implementation of the BFOA controller gives an improved result compared to conventional and GA PI controller. The settling time, rise time has decreased significantly. The transient is settling quite easily. It has been given away that the projected controller is effective and provides significant improvement in system performance

NOMENCLATURE

The values for the system parameters is listed below :

TP1 = TP2 = 20 s, power system time constant;

TT1 = TT2 = 0.3 s, turbine time constant;

T12 = 0.545 p.u; tie line time constant;

TG1 = TG2 = 0.08 s; governor time constant;

Kp1 = Kp2 = 120 Hz/p.u MW; gain of power system;

R1 = R2 = 2.4 Hz/p.u MW; speed regulation constant;

B1 = B2 = 0.425 p.u MW/Hz; feedback bias control;

KP = Proportionality constant of controller;

KI= integral constant of controller;

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