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.

\[ p : \text{Dimension of the search space,} \]
\[ S : \text{Total number of bacteria in the population,} \]
\[ N_c : \text{The number of chemotactic steps,} \]
\[ N_s : \text{The swimming length.} \]
\[ N_{re} : \text{The number of reproduction steps,} \]
\[ N_{ed} : \text{The number of elimination-dispersal events,} \]
\[ Ped : \text{Elimination-dispersal probability,} \]
\[ C(i) : \text{The size of the step taken in the random direction specified by the tumble} \]

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 unit time 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, N_e, N_s, N_o, N_eo, ..., and c(i), i = 1, 2, ..., S

l = l + 1

j = j + 1

k = k + 1

i = 1; i <= S; ... minimum

Let m = 0

If m < N_s

m = m + 1

m = N_s

If j(i, j+1, k, l) < J_last

No

Yes

No

EA

D

C

B

J_last = J(i, j+1, k, l)

Compute J(i, j+1, k, l) using new (i, j+1, k, l)

If i = S

Yes

No

i + 1

If j < N_c

No

Yes

If l < N_e_d

No

Yes

If k < N_r_e

End

If i = S

Yes

No

Sort bacteria, C(i) in the ascending order of Jhealth

Split S-bacteria with best values

If k < N_e_s

No

Yes

If l < N_e_d

No

Yes

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 $f_1$, the second Area frequency deviation $f_2$, 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 $\Delta P_{\text{ref}}$ 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 $\Delta P_{\text{tie}}$ with 0.1 per unit variation in Area 1

Figure 5: Variation of $\Delta P_{\text{m}}$ with 0.1 per unit variation in Area 1
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;
Kᵢ₁ = Kᵢ₂ = 120 Hz/p.u MW/Hz; integral constant of controller;
Kᵢ₂ = 120 Hz/p.u MW/Hz; Proportionality constant of controller;

REFERENCES


