Economic Operation of Power Systems by Unit Commitment using PSO algorithm

Guide: [1] Siddarameshwar H. N ,

Authors: [2] Anusha A Shanbhag , [3] Daneshwari V Kooli , [4] Kavya Angadi, [5] Supriya M

[1]Faculty in EEE, BVBCET, Hubli, [2,3,4,5]Students, EEE, BVBCET, Hubli
Email: [1]shairani@gmail.com, [2]anushaashanbhag@gmal.com, [3]daneshwarikooli@gmail.com, [4]angadikavya@gmail.com, [5]supriyasuma41@gmail.com

Abstract: The growing electric network/ interconnections leads to the complexity of power system. The load demand on a power system doesn't remain constant; hence it is necessary to schedule the generating units according to the load demand for the economic operation of system. Unit commitment plays main role in the economic operation of a power system. There are number of conventional methods to solve above said problem such as priority list method, lagrangian relaxation,lamda iteration method ,dynamic programming methods etc and there are many more optimization methods like Genetic Algorithm, Particle Swarm Optimization(PSO), AI, Fuzzy Logic etc. Here the Unit Commitment based-Economic Load Dispatch(UC-ELD) problem is optimized using PSO; the proposed method tries to find a optimal production cost of the unit to meet the required load.

Keywords: Unit Commitment, Economic Operation, PSO

I. Introduction

Micro grids with minimum number of generating units can be handled manually but it becomes difficult to schedule those units every hour according to demand. It's necessary to use programming solutions to maintain and schedule the generating units of a power system.
The scheduling of generators according to varying load demand is called as Unit Commitment where as optimal dispatch of load demand among the scheduled generators at lower cost considering the constraints is called as Economic Load Dispatch.[1]
The project focuses on the economic dispatch of the demand on system using unit commitment . The AI techniques help the problem converge quickly and find a better solution Hence we considered one of the AI -Particle Swarm Optimization(PSO).This can be applied to thermal generating stations.
Hence project aims is to find optimal solution to the Economic dispatch including losses and generating limits by unit commitment .

II. Particle Swarm Optimization:

It is a population based search algorithm which is inspired by the behaviours of social system such as birds flocking.
In PSO each unit is considered as particle, group of particles constitute swarm. During the movement of particles and changing the velocity they refer to the previous position of their own and their neighbour particles.[3]
Each particle will track their all possible movements and the best one is termed as personal best (pbest) .The global best solution is find out by considering the best solution among pbest values.
In case of PSO based UC-ELD algorithm, each generating units are considered as dimensions of the problem .The positions of individuals /values of generating units are generated randomly between upper and lower limit of that generating unit.[6]

III. Why PSO?

- Formulation is easy.
- Faster convergence.
- Parameters tuning required is less.

IV. Particle Swarm Optimization algorithm:

This project presents a solution to the UC-ELD problem using the PSO algorithm to search for optimal generation quantity of each unit.

Step 1: initialise number of the generating units, maximum and minimum generation of each unit ,losses and other necessary data.

Step 2: Initialise population of particles and other variables randomly within the specified range.

Step 3: Parameters like size of population , initial weight and final weight of inertia ,value of lamda , etc are initialised.

Step 4: The fitness value of each individual are calculated using cost functions and then compare each values *pbest* and assign the best value as *gbest*.
$V_{id}^{(t+1)} = \omega.\ V_i^{(t)} + C1*rand\ ()*(pbest_{id} - Pg_{id}^{(t)}) + C2*Rand\ ()*(gbest_d - Pg_{id}^{(t)})$
Where i=1,2..m & d=1,2..n
V_{id} and P_{gid} are the velocity and Power generated at the i^{th} instant.
Step 5: Modify the velocity and position of each individual and evaluate individuals position and velocity to get *ppbest* value
$Pg_{id}^{(t+1)} = Pg_{id}^{(t)} + v_{id}^{(t+1)}$

If $V_{id}^{(t+1)} > V_{dmax}$, then $V_{id}^{(t+1)} = V_{dmax}$. If $V_{id}^{(t+1)} < V_{dmin}$ then $V_{id}^{(t+1)} = V_{dmin}$.
Step 6: The constraints are modified according to above equations and fitness function is optimized . Repeat the iteration from step 2 to 5 till it reaches maximum value.
Step 8: The total cost is calculated using the formula:
$F_i(P_{gi}) = 1/2\ ai{*}Pgi^2 + bi{*}Pgi + ci$

Step 7: Above steps are calculated for each combination of generators. Minimum operating cost is find out.

V. Flow chart:

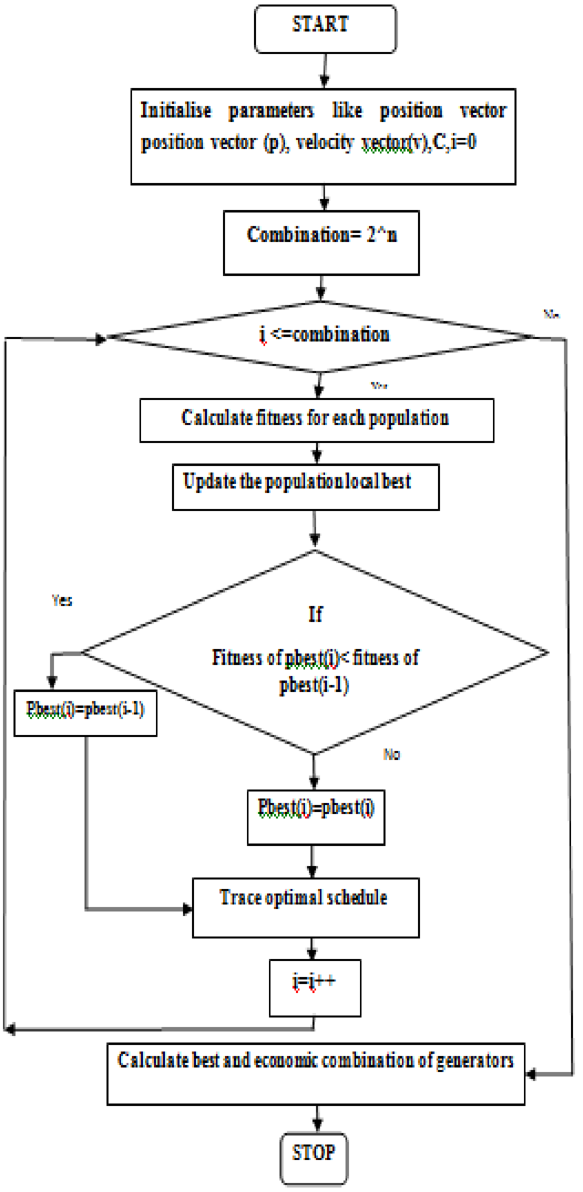

Figure 1:Flow chart of PSO based UC-ELD program

The flow chart shown above represents the simplified steps involved in the MATLAB code written in 'C' language , code is generated to solve the UC-ELD problem by using above algorithm. Solution obtained tells about how the dispatch and scheduling must be done among the generating units. It is done for only current hour i.e for an hour.

The program tends to converge based on the maximum iteration it is subjected to.As number of iteration increases, the convergence becomes more accurate but time required to converge is more.

VI. Result :

Input :

Simple power system with 6 generating units are taken whose data are entered as shown below

```
a=[240 200 300 150 200 120];
b=[7 10 8.5 11 10.5 12];
c=[0.0070 0.0095 0.0090 0.0090 0.0080 0.0075];
pmax=[500 200 300 150 200 120];
pmin=[100 50 80 50 50 50];
B=[ 0.000017 0.000012 0.000007 -0.000001 -0.000005 -0.000002
0.000012 0.000014 0.000009 0.000001 -0.000006 -0.000001
0.000007 0.000009 0.000031 0.000000 -0.000010 -0.000006
-0.000001 0.000001 0.000000 0.000024 -0.000006 -0.000008
-0.000005 -0.000006 -0.000010 -0.000006 0.000129 -0.000002
-0.000002 -0.000001 -0.000006 -0.000008 -0.000002 0.000150 ];
```

Figure 2 : Input data window

Required data Read are cost coefficients(a,b,c), B coefficients, Power limits(Pmax and Pmin) and power demand.

Output :

For Pd=250

```
minimum cost(in 1000*Rs/Hr) is:
176
for the iteration
   40

combination
100111
   100     0     0    50    50    50

  ------------for the current hour-------------

gen(1)  ->on->  generation of 100.000000 MW    fuel cost of 78.400000Xk rs
gen(2)  is off
gen(3)  is off
gen(4)  ->on->  generation of 50.000000 MW     fuel cost of 34.400000Xk rs
gen(5)  ->on->  generation of 50.000000 MW     fuel cost of 31.300000Xk rs
gen(6)  ->on->  generation of 50.000000 MW     fuel cost of 31.500000Xk rs
```

Figure 3 : Result of program for Pd = 250

For Pd = 450

```
minimum cost(in 1000*Rs/Hr) is:
417
for the iteration
    64

combination
111111
  172.3750   50.0000   80.0000   50.0000   50.0000   50.0000

  ------------for the current hour--------------

gen(1)  ->on->   generation of 172.374953 MW    fuel cost of 217.405121Xk rs
gen(2)  ->on->   generation of 50.000000 MW     fuel cost of 34.700000Xk rs
gen(3)  ->on->   generation of 80.000000 MW     fuel cost of 67.540000Xk rs
gen(4)  ->on->   generation of 50.000000 MW     fuel cost of 34.400000Xk rs
gen(5)  ->on->   generation of 50.000000 MW     fuel cost of 31.300000Xk rs
gen(6)  ->on->   generation of 50.000000 MW     fuel cost of 31.500000Xk rs
```

Figure 4:Result of program for Pd = 450

VII. Result Analysis:

For **Pd=250** :

minimum cost(in 1000*Rs/Hr) is: 176
for the iteration: 40
Generator combination:100111
100 0 0 50 50 50

For **Pd=450** :

minimum cost(in 1000*Rs/Hr) is: 409
for the iteration :64
combination:111111
169.3068 50.00 80.0 50.00 50.0 50.0

Here the fuel costs of each scheduled generators are calculated using cost coefficients. We can see that as the demand increases the generation of unit increases and the fuel cost also increases which results in increase of total production cost. Here only the transmission losses are considered.

During each run of the program the best combination of generators which meet the required load demand with minimum total production cost are selected.

VIII. Conclusion and Future Work:

The MATLAB program written according to the algorithm shown above, can be used for primary understanding of ELD by using UC. The program provides a solution about how the total demand must be dispatched among the generating units and which all units must be online for economic operation of system. PSO algorithm always provides converged solution which does not require initial value of lambda.

This can be extended by including constraints like ramp constraints, time, unit type , thermal constraints etc.

Further program can be improvised by using Hybrid AI methods like neuro-fuzzy algorithm, tuned differential evolution etc.

IX. References:

[1]. Damian Obioma Dike, Moses Izuchukwu Adinfono ,“Economic Dispatch of Generated Power Using Modified Lambd aIteration Method”, IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) e-ISSN: 2278-1676,p-ISSN: 2320 3331, Volume 7, Issue 1.

[2]. Susheel Kumar D, “A Traditional Approach to Solve Economic Load Dispatch Problem Considering the Generator Constraints”,IOSR-JEEE,e-ISSN: 2278-1676,p-ISSN: 2320-3331.

[3]. Ashish Dhamanda, Arunesh Dutt, “A Traditional Approach to Solve Economic Load Dispatch Problem of Thermal Generating Unit Using MATLAB Programming method”, International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 9, ISSN: 2278-0181

[4]. Zwe-Lee Gaing, “Particle Swarm Optimization to solving the EconomicDispatch Considering the Generator Constraints”, IEEE Trans. On Power Systems, Vol.18, No.3, pp. 1187-1195, August 2003

[5]. I.J. Nagrath, D.P. Kothari, “Modern Power System Analysis”, 2nd Edition, Tata McGraw-Hill Co

[6]. Surekha P, N. Archana ,“Solving Unit Commitment and Economic Load Dispatch Problems Using GA and PSO Algorithms” IJCSIE, Vol. 3, No. 1, June 2012, pp. 7-21

[7]. Y. Labbi, D. Ben Attous, “A Hybrid GA–PS Method To Solve The Economic Load Dispatch Problem”, Journal of Theoretical and Applied Information Technology, pp.

[8]. M.Basu, “Particle swarm optimization based goal-attainment method for dynamic economic emission dispatch of system load”, Elect. Power Syst. 34 (2006) 1015–1025.