SHORT-TERM VARIABLE HYDROPOWER GENERATION SCHEDULING FOR HEURISTIC METHOD

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ABSTRACT

This paper based on Heuristic method to solve the short-term variable hydropower generation scheduling problem. It uses Heuristic search method to find the result of all thermal and hydro power plants optimization. Numerical experiment show, this method to solve the non-linear problem with its available of constraints in acceptable time.

Keyewords: Variable HeadHydro-power generation system, Heuristic method and maximumiterations.

1. INTRODUCTION

The optimum hydro generation scheduling of an electric power system is the find of the generation for every generating station such that the total system optimum generation cost is minimum while satisfying the constrains. However due to insignificant operating cost of hydro plants the scheduling problem essentially reduces to minimizing the fuel cost of thermal plants constrained by the generation limits, available water, and the energy balance condition for the given period of time.

This paper is based on hybrid based on a Heuristic search method which finds the optimization schedules of all hydroelectric power plants optimization without decomposition.

2. HEURISTIC SEARCH METHOD

This method is not found the best solution but guaranteed the find good solution in reasonable time, and increases the efficiency, useful in solve the problems which,Could not be solved any other way, and Solutions take an infinite time or very long time to compute.

2. PROBLEM FORMULATION

Thisproblem formulates and solve in mathematically.

$Fi(P_{ik})$ Thecost of a fuel function of thermal power generating in the Interval k.
S_j –Reservoir surface area of j^{th}reservoir.
t_k - Duration of the k^{th} sub –interval.
P_{Dk} -Load demand during the k^{th} sub-interval.
V_j- Available water for whole period for j^{th} hydro unit.
P_{ik}- Power plant of i^{th} thermal generation in k^{th}interval.
P_i^{max}- Maximum energy of i^{th}generatingthermal and hydro unit in MW.
P_i^{min}- Maximum energy of i^{th}generatingthermal and hydro unit in MW.
a_i, b_i, c –Coefficients of cost the i^{th} thermal units.
x_j, y_j, z_j- Coefficients of Discharge the j^{th} hydro plant.
$\alpha_j, \beta_j, \gamma_j$-Discharge coefficients of head of the j^{th} hydro plant.
F_i-Thermal cost of the i^{th}unit.
q_{jk}-the discharge rate from the j^{th} hydro in the k^{th}interval.
h_{jk}-Head of j^{th} hydro unit during k^{th}sub interval.
I_{jk} -Inflow in j^{th} hydro plant in k^{th} interval.
P_{Lk}-Transmission losses during the k^{th} interval.
r_k - Penalty parameter.
j-Index for hydro units.
i-Index for thermal units.
k-Index of time period.
B-Coefficients of transmission losses.

Y- Mutation factor.
M- Number of hydro plants.
T- All period for generation scheduling.
N- Number of thermal units

$$Minimize J = \sum_{k-1}^{T} \sum_{i-1}^{N} t_k F(P_{ik}) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

1. Energy continuity equation

$$\sum_{i=1}^{N+M} P_{ik} = P_{Dk} + P_{Lk} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (2)$$

2. Water continuity equation

$\sum_{k=1}^{I} t_k q_{jk} = V_j$.. (3)(j = 1,2.....M) ....(3)

3. Minimum and maximum limit on discharge

$$q_{min} \le q \le q_{max} \ldots \ldots \ldots \ldots \ldots \ldots (4)$$

4. Maximum and minimum limit on hydrothermal generation

$$P_i^{max} \le P \le P_i^{min} \ldots \ldots \ldots \ldots (5)$$

3. APPLICATION OF ALGORITHM TO THE variable head hydro thermal scheduling

Parent function is generating by use random numbers is given below.

$$P_{ik} = P_i^{min} + rand_{ik}[0,1](P_i^{max} - P_i^{min})$$

$$i = 1,2, \ldots N + M; \quad k = 1,2, \ldots, T)$$

4. COMPUTER IMPLEMENTATION

Implementation of program written in Matlab version 2013JB Institute of Technology Dehradun, to run on Acer Pc compatible.

5. PROBLEM

The system test consists of hydro and thermal generation plant as
The operating cost is given by-

$$(P_{1k}) = aP_{1k}^2 + bP_{1k} + C1 \qquad Rs/h$$

$$F_2(P_{2k}) = aP_{2k}^2 + bP_{2k} + C_2 \qquad Rs/h$$

The variation rates of discharge of hydro generating station are given by quadratic function of effective head and active hydro power.

$$\phi(W_{3k}) = x_1 W_{3k}^2 + y_1 W + z_1 Mft^3/h$$

$$\phi(W_{4k}) = x_2 W_{4k}^2 + y_2 W_{4k} + z_2 Mft^3/h$$

$$\psi(h_{1k}) = \alpha_1 h_{1k}^2 + \beta_1 h_{1k} + \gamma_1 \qquad ft$$

$$\psi(h_{2k}) = \alpha_2 h_{2k}^2 + \beta_2 h_{2k} + \gamma_2 \qquad ft$$

The reservoirs have small capacity and vertical sides. The coefficients of fuel cost, discharge coefficients of hydro plants, constant of proportionality, water available, surface area, initial height of the head, maximum and minimum power limits, load demand and water inflow are given in respectively. The Bcoefficients of the power system network are given by

$$B=\begin{bmatrix} 0.000140 & 0.000010 & 0.000015 & 0.000015 \\ 0.000010 & 0.000060 & 0.000010 & 0.000013 \\ 0.000015 & 0.000010 & 0.000068 & 0.000065 \\ 0.000015 & 0.000013 & 0.000065 & 0.000070 \end{bmatrix} MW^{-1}$$

Table 5.1 Thermal unit cost functioncoefficient

Unit	a_i (Rs/MW^2h)	b_i (Rs/MWh)	c_i (Rs/h)
1	0.0025	3.20	25.0
2	0.0008	3.40	30.0

Table 5.2Water discharge rate hydro generation function

Unit	x_i (Mft^3/MW^2h)	y_i (Mft^3/MWh)
1	0.000216	0.306
2	0.000360	0.612

Table 5.3 Water discharge rate head function

Unit	α_i (ft/h^3)	β_i (ft/h^2)
1	0.00001	-0.0030
2	0.00002	-0.0025

Table 5.4 Reservoir data

Unit	Constant of proportionality K_j	Volume of water V_j (Mft^3)	Surface area S_j (Mft^2)	Initial height h_{j0} (ft)
1	1	2850	1000	300
2	1	2450	400	250

Table 5.5 Power generation limits

Unit	Minimum Limit (MW)	Maximum Limit (MW)
1	135	281
2	316	759
3	252	439
4	11	184

Table 5.6 Load demand and water inflows

Interval (hrs)	Load demand W_D (MW)	Water inflow I_1 (Mft^3/h)	Water inflow I_2 (Mft^3/h)
1	800	1	0.1
2	750	2	1.3
3	700	2.75	1.75
4	700	2.9	1.95
5	700	3	2
6	750	3.25	2.25
7	800	3.4	2.4
8	1000	3.75	3
9	1330	2	2.95
10	1350	3.5	3
11	1450	4.2	3.25
12	1500	3	3

5. OPTIMAL SOLUTION FOR TEST SYSTEM

The solution of hydrothermal generation scheduling of power systems presented here. The various parameters like population size is taken 20, variable-head hydro and thermal scheduling problem having two hydro unit and two thermal units has been solved using heuristic search method. Other different parameters maximum iterations are set to 200, the obtained value of objective function using heuristic search method algorithm is Rs 69588.9087

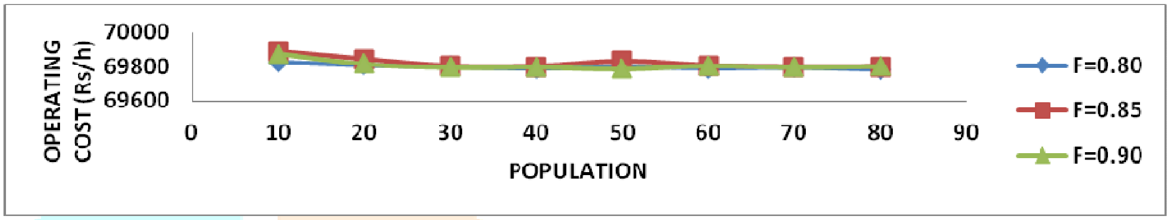

Fig. 6.1 Operating cost over the population at different mutation factors

Table 6.10 Total system operating cost w.r.t maximum iteration

POPULATION	TOTAL SYSTEM OPERATING COST (Rs)		
	Generation (Iterations) is 100	Generation (Iterations) is 150	Generation (Iterations) is 200
10	69824.04	69824.04	69824.04
20	69808.22	69808.22	69808.22
30	69801.53	69801.53	69801.53
40	69792.07	69792.07	69792.07
50	69802.09	69802.05	69802.04

XI=39 ZETA=0.26 F=0.8

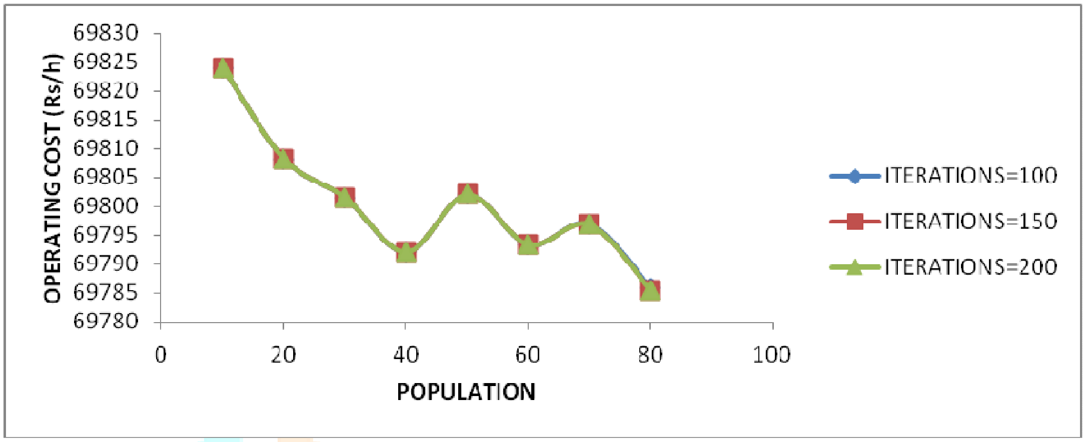

Fig. 6.2 Operating cost over the population at different maximum iterations

Table 6.11 Comparisons of results

Method	Operating cost (Rs)
Newton-Raphson	69801.08/-
Heuristic search method	69785.88/-

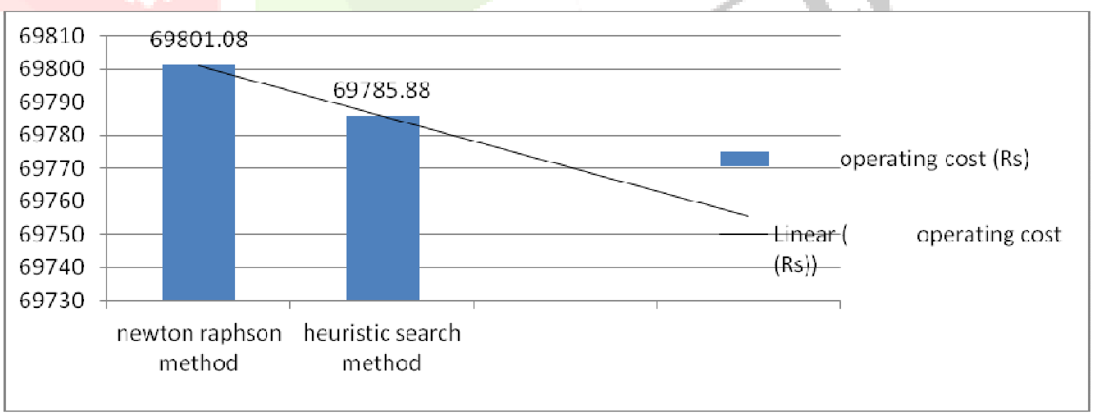

Fig 6.3 Comparison Chart

The total cost obtained from the heuristic search method is less as that of newton-rapson method [6].

Thus it can be concluded that heuristic search method technique provides optimum results the newton-rapson method. It is better to use heuristic search method because newton-rapson method cannot be applied to the hydrothermal scheduling problem having prohibited zone constraints.. While implementing heuristic search method there is no need of initial guess of power and water discharge. Hence it is better to use heuristic search method.

6. CONCLUSION

The heuristic method is based and used to solve the variable-head hydropower scheduling problem. A hydrothermal model has been implemented to find the optimum power generation schedule considering the transmission power losses. The heuristic search technique is having dynamic characteristics function utilized to update the solution vector and improves the convergence properties of the algorithm.

8. REFERENCES

1. rajendraprajapati and SandhuArun "Differential Evolutionary Search Method for Hydrothermal Scheduling", proc. JECAS., vol 4, No 6, June 2015

2. H. T. Kahraman, M. K. Dosoglu, U. Guvenc, S. Duman and Y. Sonmez, "Optimal scheduling of short-term hydrothermal generation using symbiotic organisms search algorithm," *2016 4th International Istanbul Smart Grid Congress and Fair (ICSG)*, Istanbul, 2016, pp. 1-5.

3. SandhuArun, SainiOmbeer and Shalini "Steepest decent method for economic load dispatch using matlab", proc. JECAS. vol 4, No 6, June 2015.

4. E.B.Dahlin and D.W.Shen,
"Application of Dynamic Programming to Optimization Of Hydro-Steam Power System Operation", Proc. IEE., vol 112, No 12, 1965.

5. T.G.Werner and J.F.Verstege "An Evolution Strategy For Short- Term Operation Planning Of Hydro Thermal Power Systems", Proc. IEEE., Vol 14, No 4, November1999.

6. M.E.El-Hawary and K.M.Ravindranath "Combining Loss and Cost Objective In Daily Hydro- Thermal Economic Scheduling" Proc IEEE. Transactions of Power Systems,Vol 6, No 3.1991.

7. M.FaridZaghlool and F. C. Troot, "Efficient Methods for Optimal Scheduling Of

Fixed Head Hydro Thermal power System", IEEE Trans of PWRS, vol 3, No.1, pp.24-30. Feb 1988.

8. J. Wood and B.F. Wollenberg, "Power Generation, Operation and Control ", John Wiley and sons, New York, 1984.