Experimental Study on Generation Scheduling using Genetic Algorithm, PSO and Improved PSO technique

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ABSTRACT

In this paper, the author has perform an experimental study on provides a literature review on generation scheduling and prediction issues in power system. Unit commitment in power systems refers to the problem of determining the on/off states of generating units that minimize the operating cost for a given time horizon. Economic dispatch is the short-term determination of the optimal output of a number of electricity generation facilities, to meet the system load, at the lowest possible cost, subject to transmission and operational constraints. The economic load dispatch means that the generator's actual and reactive power are acceptable to change within certain limits so as to meet a load demand within minimum fuel cost.
Keywords: Generation scheduling, Unit commitment, short term.

I. INTRODUCTION

In power system, Unit commitment problem is a complex decision-making process which involves the scheduling of generators over a set of time periods to satisfy system load demand, water demand, system reliability, operational, and security constraints. Mathematically, this is a nonlinear, non-convex, high dimensional and large-scale optimization problem over mixed integer variables. for a short-term unit commitment problem such as hourly or daily scheduling of generators, the operator needs to run the model in real-time. The operator should have immediate access to information concerning which units should be operated when emergency situations arise or how to schedule around planned maintenance of units. Modern Soft Computing Techniques is developed to solve the unit commitment problem.

The scheduling of the units together with the allocation of the generation quantities which must be scheduled to meet the demand for a specific period represents the Unit Commitment Problem. Economic Load Dispatch (ELD) seeks the best generation schedule for the generating plants to supply the required demand plus transmission loss with the minimum generation cost. Significant economical benefits can be achieved by finding a better solution to the ELD problem.

Necessity of generation scheduling

In a practical power system, the power plants are not located at the same distance from the centre of loads and there fuel costs are different. Also under normal operating, the generation capacity is more than the total load demand and losses. Thus, there are many options for scheduling generation. In interconnected power system, the objective is to find out the actual and reactive power scheduling of each power generation plant in such a way so as to reduce the operating cost. This mean that generators real and reactive powers are allowed to vary within certain limits so as to meet a particular load demand with minimum fuel cost. This is called the “Economic load dispatch”(ELD) problem. The objective functions, also known as cost functions may present economic cost system security or other objectives. The transmission loss formula can be derived and the economic load dispatch of generation based on the loss formula can also be obtained. The Loss coefficients are known as B-coefficients. A major challenge for all power utilities is not only to satisfy the consumer demand for power, but to do so at minimal cost. Any given power system can be comprised of multiple generating stations having number of generators and the cost of operating these generators does not usually correlate proportionally with their outputs; therefore the challenge for power utilities is to try to balance the total load among generators that are running as efficiently as possible.

SHORT TERM UNIT COMMITMENT PROBLEM

The unit commitment problem determines both the hourly start-up and shut down schedule as well as the power output for the generating units over a certain time period. the resultant schedule minimizes the total operational cost while satisfying the system demand as well as generating units constraints. In a Unit Commitment Problem (UCP), the objective is to achieve the minimum total operating cost by a precise scheduling of the ON/OFF status of the generating units subject to the system and physical constraints.

Unit commitment (UC) is the problem of scheduling of generating units over a given time period so that the total operational cost is minimized and all operational constraints are satisfied. UC involves two decision processes; first, the "economic dispatch" decision involves the allocation of the system demand and reserve capacity among the operating units in each specified hour second, the "unit scheduling" that determines on/off status of generating units in each hour of planning horizon subject to system capacity requirements, including the spinning reserve and the constrained on start-up and shut-down of units.. In power system, Unit commitment problem is a complex decision-making process which involves the scheduling of generators over a set of time periods to satisfy system load demand, water demand, system reliability, operational, and security constraints. Mathematically, this is a nonlinear, non-convex, high dimensional and large-scale optimization problem over mixed integer variables.

For a Short-Term Unit Commitment Problem such as hourly or daily scheduling of generators, the operator needs to run the model in real-time. The operator should have immediate access to information concerning which units should be operated when emergency situations arise or how to schedule around planned maintenance of units. Modern Soft Computing Techniques is developed to solve the unit commitment problem.

Problem Formulation

Unit commitment is a complex decision making process because of the multiple constraints that must not be violated when finding optimal or near optimal commitment schedules. Mathematically, the Unit Commitment Problem is a non-linear, mixed-integer combinatorial optimization problem. The optimal solution to the above complex combinatorial optimization problem in power system can be obtained by global search techniques.
the objective function of the short term thermal Unit Commitment Problem is composed of the fuel cost, start-up cost and shut-down cost of the generating units and mathematically can be expressed as below:

$$Cost_{NH} = \sum_{h=1}^{H}\sum_{i=1}^{NG}[FC_i(P_{ih})*U_{ih} + STUC_{ih}*(1-U_{i(h-1)})*U_{ih} + SDC_{ih}*(1-U_{ih})*U_{i(h-1)}]$$

Where,

$Cost_{NH}$ is the total operating cost over the scheduled horizon

$FC_i(P_{ih})$ is the fuel cost function

$U_{i(h-1)}$ is the ON/OFF status of of ith unit at $(h-1)^{th}$ hour.

U_{ih} is the ON/OFF status of ith unit at hth hour.

U is the decision matrix of the U_{ih} variable. for i=1,2,3,....... NG.

P_{ih} is the generation output of ith unit at hth hour.

$STUC_{ih}$ is the start-up cost of the ith generating unit at hth hour.

SDC_{ih} is the shut-down cost of the ith generating unit at the hth hour.

NG is the number of thermal generating units

$U_{ih} \in \{0,1\}$ and $U_{i(h-1)} \in \{0,1\}$

H is the number of hours in the study horizon.

For Short-Term unit Commitment, H is generally taken as 8-12 Hours. For general unit commitment scheduling H is taken as 24 hours (i.e. one day) and for long term unit commitment, H may be taken as one week, one month, three month, six month or one year duration.

(a) Fuel Cost, $FC_i(P_{ih})$

The fuel cost function of the thermal unit $FC_i(P_{ih})$ is expressed as a quadratic equation:

$$FC(P_{ih}) = \sum_{i=1}^{NG} (a_i P_{ih}^2 + b_i P_{ih} + c_i) \quad \text{Rs.}/\,Hour$$

Where, a_i (\$/MW²h), b_i (\$/MWh) and c_i (\$/h) are fuel consumption coefficients of i^{th} unit.

(b) **Start up cost,** $STUC_{ih}$

Start up cost is warmth-dependent. Start up cost is the cost involved in bringing the thermal unit online. Start up cost is expressed as a function of the number of hours the units has been shut down. Mathematically, the start-up cost can be represented as a step function:

$$STUC_{ih} = \begin{cases} HSC_i, & if \quad MDT_i \le DT_i < (MDT_i + CSH_i) \\ CSC_i, & if \; DT_i > (MDT_i + CSH_i) \end{cases}$$

where, DTi is shut down duration, MDTi is Minimum down time, HSCi is Hot start up cost, CSCi is Cold start up cost and CSHi is Cold start hour of ith unit.

(c) **Shut down cost ,** SDC_{ih}

Shut down costs are defined as a fixed amount for each unit/shutdown. The typical value of the shut down cost is zero in the standard systems. This cost is considered as a fixed cost.

RESULTS AND DISCUSSION

In this section, the results of economic load dispatch are discussed after the implementation of PSO. The programs are implemented in MATLAB R2010a. The developed algorithms for economic load dispatch problem based have been discussed. The main objective is to minimize the total fuel cost of generation of plants using PSO methods. The performance is evaluated without considering losses using two generator test systems, i.e. five generator test system and six generator test system. Multi-objective Economic Load Dispatch Problem of Thermal Electric Power System consisting of six Generating Units using Particle Swarm Optimization (PSO) Technique. In which fuel cost cofficients and emisssion cofficients are mention with real power genration capacity for obtanig multi- objective.

The coefficients of fuel cost and maximum and minimum power limits are given in Table 1. The short term load demand (8hrs.) is considered as 166 MW to 213 MW. The results of economic load dispatch using PSO are detailed in figure 1 and the comparison of results is shown in table 1.

Table 1: Generating unit characteristics-6 unit model

UNITS	P_{max}	P_{min}	A	B	C	MU_i	MD_i	H_{cost}	C_{cost}	C_{hour}	IniState
Unit1	200	50	0.00375	2	0	1	1	70	176	2	1
Unit2	80	20	0.0175	1.7	0	2	2	74	187	1	-3
Unit3	50	15	0.0625	1	0	1	1	50	113	1	-2
Unit4	35	10	0.00834	3.25	0	1	2	110	267	1	-3
Unit5	30	10	0.025	3	0	2	1	72	180	1	-2
Unit6	40	12	0.025	3	0	1	1	40	113	1	-2

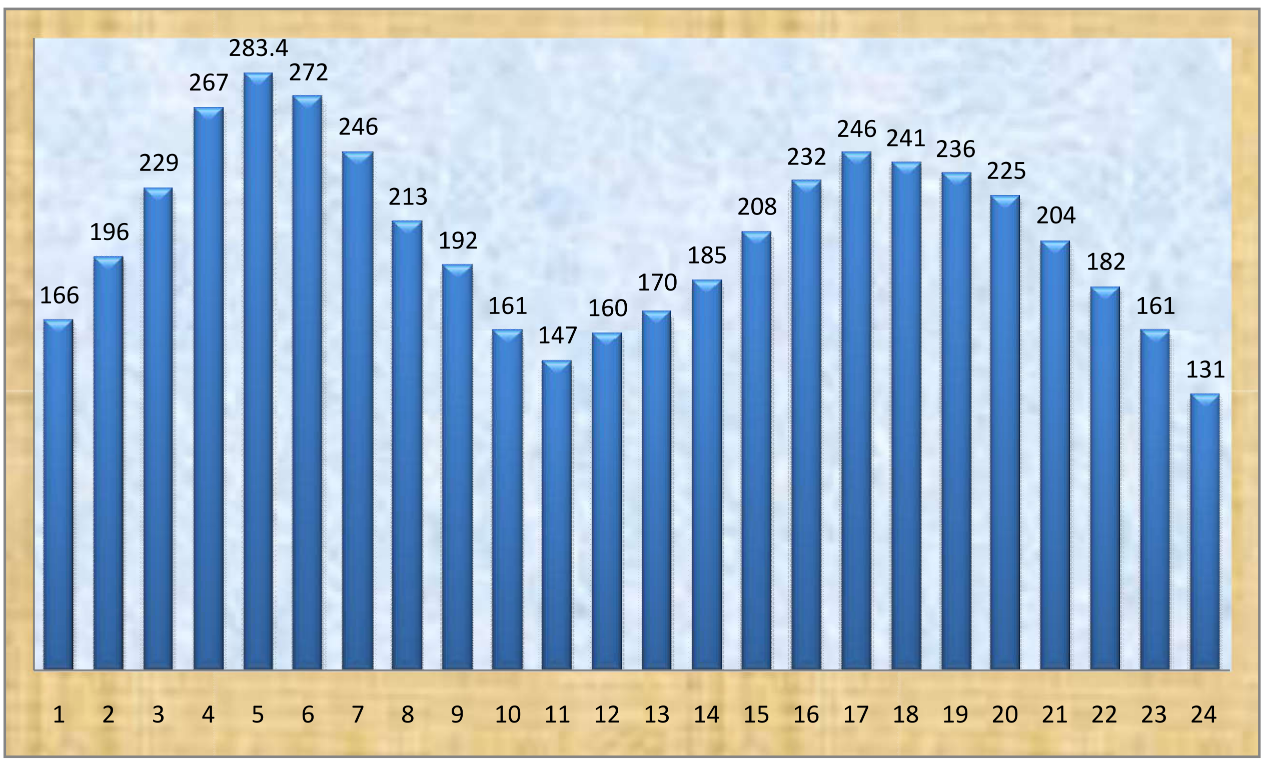

Figure 1: load demand curve

Table 2: Optimal result of UCP 6 unit system using PSO

Load Demand (MW)	U1	U2	U3	U4	U5	U6
166	166	0	0	0	0	0
196	116	80	0	0	0	0
229	149	80	0	0	0	0
267	197	20	50	0	0	0
283.4	153	80	50	0	0	0
272	142	80	50	0	0	0
246	166	80	0	0	0	0
213	143	20	50	0	0	0
192	112	80	0	0	0	0
161	161	0	0	0	0	0
147	147	0	0	0	0	0
160	160	0	0	0	0	0
170	170	0	0	0	0	0
185	105	80	0	0	0	0
208	128	80	0	0	0	0
232	152	80	0	0	0	0
246	166	80	0	0	0	0
241	161	80	0	0	0	0
236	156	80	0	0	0	0
225	145	80	0	0	0	0
204	124	80	0	0	0	0
182	102	80	0	0	0	0
161	161	0	0	0	0	0
131	131	0	0	0	0	0
Total cost ($)					**13423**	

Table 3: Comparison of Results For ACO And UCP

S.NO	10 unit	PSO [19]	DE [19]	ACO [24]	FUZZY [24]	Proposed PSO [our Method]
1	**Fuel Cost**	573378.1	568262.6	N/A	N/A	567330.00
2	**STC**	4780	4780	N/A	N/A	3950
3	**Overall Cost**	578158.1	573042.6	568815.4	571893	571280.00

CONCLUSION

This paper provides the experimental study on generation scheduling and short term unit commitment problems in electric power system. In the unit commitment phase, the start up and shut down times of the units over the whole scheduling period must be specified. Following points have been concluded.

1. By proposed PSO algorithm Fuel cost (FC) is 5,67,330 and by Differential Evoluation technique FC is 5,68,262.6
2. By proposed PSO algorithm start up cost (STC) is 3950 and by Differential Evoluation technique STC is 4780
3. Over all cost by proposed PSO algorithm is 5,71,280 and by Differential Evoluation technique is 5,73,042 , by Fuzzy 5,71,893
4. Simple implementation, less computational time.
5. Very few algorithm parameters

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