Research Paper Engineering

Genetic Algorithm for Plant Generation Schedule in Electrical Power System

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ABSTRACT

In this paper, related to multi-objective generation scheduling using genetic algorithm i have tried to optimize the cost of generation and also reduce emission of the gases like oxides of carbon (CO2), oxides of sulpher (SO2), and oxides of nitrogen (NOx) which cause detrimental effects on human beings. As the thermal power plants are mainly sources for emission of gases. I consider only thermal power plants for generation scheduling in this paper. Conventionally Newton-Raphson method is using for generation scheduling. Using genetic algorithm we can get more accurate and different results which can help in to make the better decision at the time of planning by the decision maker.By using genetic algorithm, get fittest result among all the output result which can help not only to reduce overall operation time but also to get optimize future generation scheduling.

Keywords: Generation Scheduling, Multi Objective Optimization Technique, Genetic Algorithm

I. Introduction

Electric power today plays an important role in the life of the community and in the development of various sectors of economy. This in turn has lead to increasing number of power stations and their capacities. Conventionally, electric energy is obtained by conversion from fossil fuels, namely coal, oil, natural gas and also from nuclear and hydro sources. The combustion of fossil fuels gives rise to particulate material and gaseous pollutants apart from discharge of heat to water courses. The three principal gaseous pollutants, oxides of carbon(COx), oxides of sulphur (SOx) and oxides of nitrogen(NOx) cause detrimental effects on human beings. The usual control practice is to reduce offensive emissions through post-combustion cleaning systems such as electrostatic precipitators, stack gas scrubbers, or switching permanently to fuels with low emission potentials, i.e. from coal to oil; oil is however extremely expensive and supplies are uncertain. Thus there is a need for sheer optimum strategy, which can ensure minimum pollution level at minimum operating cost.

It has been found that power sector is the major contributor to CO2 emissions in 1995, the share of power sector in total carbon emissions was estimated to be 45% in India, 33% in China and 31% in Thailand. These higher ratios of carbon emissions are due to larger share of thermal power plants in the total electrocity generation for this region. The present study concerns the determination of least cost technological options for achieving a range of mitigation targets on GHG through optimal generation scheduling study.The objective of the study is to found out the following:

1. Optimal generation scheduling plan under the conventional lease cost planning strategy.
2. Change in optimal generation expansion plan with respect to emission reduction targets. Target on only SO2, NOx and CO2 reduction options.
3. Role in efficient/clean supply side options to mitigate green house gases and other harmful emissions.

II. Methodology

In recent years there has been an increase in research on multi-objective military, industry and other organizations. Researchers from wide variety of disciplines such as mathematics, management, science, economics, engineering and others have contributed to the solution methods for multi-objective optimization problems. The situation is formulated as a multi-objective optimization problem (also called multi-performance, multi-criterion or vector optimization) in which the engineer's goal is to maximize or minimize not a single objective but several objective functions simultaneously. The purpose of multi-objective problems in the mathematical programming framework is to optimize the different objective functions.

Wallonia's made a comparative evaluation of some interactive methods by using such measures of performance with ease of use, ease of understanding , and DM's confidence in the solution etc. He revealed that a simple trial and error type unstructured approach competed successfully with more sophisticated methods. Since DM is involved in the entire solution process, interactive methods have been accepted in practice. The primary objective of the MOP solution methods is to find the best compromise solution.

Economy objective

The fuel cost of a thermal unit is regarded as an essential condition for economic feasibility. The fuel cost (F1)curve is assumed to be approximated by a quadratic function of generator power Pgi as

$$F1 = \sum_{i=1}^{NG} \left(a_i Pg_i^2 + b_i Pg_i + c_i\right) \quad q\ldots1$$

where ai, bi and ci are cost coefficients and NG is the number of generators.

Environmental objectives

The emission curves can be directly related to the cost curve through emission rate which is a constant factor for a given type of fuel. Therefore, the amount of NOx emission is given as a quadratic function of generator output Pgi, i.e.

$$F2= \sum_{i=1}^{NG} \left(d_{1i} Pg_i^2 + e_{1i} Pg_i + f_{1i}\right) \quad q\ldots2$$

where d1i, e1i, and f1i are NOx emission coefficients. Similarly the amount of SO2 emission is given as a quadratic function of generator output Pgi, i.e.

$$F3= \sum_{i=1}^{NG} \left(d_{2i} Pg_i^2 + e_{2i} Pg_i + g_{2i}\right) \quad q\ldots3$$

where d2i, e2i and f2i are SO2 emission coefficients. The amount of CO2 emission is also represented as a quadratic function of generator output Pgi, i.e.

$$F4=\sum_{i=1}^{NG}\left(d_{3i}Pg_i^2+e_{3i}Pg_i+f_{3i}\right)...4$$

where d3i, e3i and f3i are CO2 emission coefficients.

III. Problem formulation

Genetic algorithms were first presented systematically by professor john Holland of university of Michigan, the basic ideas of analysis and design based on the concept of biological evolution can be found in the work of Goldberg[1989]. Philosophically, genetic algorithms are based on the darwin's theory of survival of the fittest. A global optimization technique known an genetic algorithm (GA) has emerged as a candidate due to flexibility and efficiency for many optimization applications. It combines an artificial , i.e. the Darwinian survival of the fittest principal with genetic operation, abstracted from nature to form a robust mechanism that is very effective at finding optimal solutions to complex-real world problems.

Genetic algorithms differ from more traditional optimization techniques as: GAs work with a coding of the parameter set, not the parameter themselves, GAs search from a population of points, not a single point, GAs use payoff (objective function) information, not derivates or oilier auxiliary knowledge, GAs use probabilistic transition rules, not deterministic rules. A genetic algorithm is composed of three basic operators namely, Reproduction, Crossover, Mutation

Reproduction: -Reproduction is a process in which the individual strings presented w, written in the binary digits 1 and 0 are converted into the perfect decimal and then we evaluate the function f(x) at that value.

e.g 1 0 0 1 1 now getting decimal value
F(x) = x3 at x = 19 i.e. F(19) = (19)3 = 6589

We shall consider an offspring with a maximum value and with the help of the other two operators; we shall contribute from a better set of population in the next generation.

Crossover: This operator randomly chooses a locus end exchanges the subsequences before and after that locus between two chromosomes to create two offspring.

e.g parent1 = 1000 / 0100, parent2 = 1111 / 1111
could be crossed over after the third locus in each to produce the two offspring children1 = 1001 / 1111
children2 = 1110 / 0100

Mutation: This operator randomly flips some of the bits in a chromosome. e.g 000001 00 might be mutated in its second position to yield 01000100 Mutation can occur at each bit position in a string with some probability, usually very small(e.g., 0.001).

IV. Algorithm

- Increment the population counter.
- Decode the string using
- Find Pji for 1to Ng.
- Calculate the transmission loss PL.
- Find the equal incremental cost criterion.
- Find the fitness function.
- If (j < L) then GOTO for increment the population counter.
- If (BIG ≤ error) then stop
- Find population with maximum fitness and average fitness of the population .
- Select the parents for crossover using stochastic remainder roulette wheel selection using algorithm of roulette wheel selection.
- Perform single point crossover for the selected parents.
- Perform the mutation.
- If (k<ITMAX) then GOTO increment the generation counter and repeat.
- Stop.

V. Case study

Generator's operating costs in P/h with Pi in MW are as follow.

C1 = 240 + 7.0P1 + 0.0070P12
C2 = 200 + 10.0P2 + 0.0095P22
C3 = 220 + 8.5P3 + 0.0090P32
C4 = 200 + 11.0P4 + 0.0090P42
C5= 220 + 10.5P5 + 0.0080P52
C6 = 190 + 12.0P6 + 0.0075P62
NOx coefficient
[0.006, -0.381, 80.901;
0.006, -0.790, 28.824;
0.003, -1.360, 324.177;
0.007, -2.399, 610.253;
0.003, -1.360, 324.177;
0.006, -0.390, 50.381]
CO2 coefficient
[0.265, -61.019 ,5080.148
0.140, -29.952 ,3824.770
0.106, -9.552, 1342.851
0.106, -12.736, 1819.625
0.106, -9.553, 1342.851
0.403, -121.981, 11381.070]
SO2 coefficient
[0.001206, 5.05928, 51.3778
0.002320, 3.84624, 182.2605
0.001284, 4.45647, 508.5207
0.000813, 4.97641, 165.3433
0.001284, 4.45647, 508.5207
0.003578, 4.14938, 121.2133]

VI. Results

For the load of 710 MW

Table 1:- Generator output

Method	Generator outputs MW					
Output	P1 MW	P2 MW	P3 MW	P4 MW	P5 MW	P6 MW
Proposed Ga prog.	310	51	156	55	79	51
Iterative program	318	51	160	52	67	53

Table 2:- Cost for generation

Method	Load MW	Fuel Cost Rs/h	Power loss MW
Proposed Ga prog.	710	8370.20	7.92
Iterative program	710	8381.70	8.95

Table3 :- Emission for generation

Emission	Nox Kg/h	So2 Kg/h	Co2 Kg/h
Proposed Ga prog.	985	4580	24780
Iterative program	1012	5112	27542

VII. Conclusion

By using genetic algorithm we get accurate and optimum result related to generation of the power. As shown above result data we can judge easily that other method gives higher fuel cost for generating the same power. Also doing modifications in the programming we can evaluate the value of Sox, NOx and CO2 etc.

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