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Project Proposal for CS357

Economic emission dispatch problem

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Abstract

- The challenge of Economic Load Dispatch (ELD), which arises as a result of the increased energy needs, is brought on by the need to operate thermal power plants as inexpensively as possible.
- The challenge of ELD in the power system is to plan the power output for each committed generating unit in such a way that operating costs are reduced while load fulfilling demand and power operational restrictions.
- Power system designers are primarily concerned with the environment in the current situation since a rise in power generation has led to an increase in emissions.
- In addition to lowering operating costs, pollution management has grown to be a crucial operational goal for obtaining sustainable energy.
- The Economic Emission Dispatch (EED) problem is a multi-dimensional power system optimization problem that is the consequence of combining both the economic dispatch and emission dispatch objectives.In this paper, the Lambda Iteration Method and the Particle Swarm Optimization (PSO) technique have been used to solve the EED problem.
- On three generator systems and five generator systems, respectively, both solution techniques have been validated. A comparison of the outcomes from the two approaches has been carried out.

Introduction

EED: (Economic Emission Dispatch)

The major objective of today's huge, interconnected power systems is to distribute the load demand among participating generators as quickly as feasible.

Economic dispatch is the process of determining how much power each generator in a power system will produce while minimizing fuel costs and ensuring that different system constraints are met.

The system restrictions include ensuring system stability, running the generators within allowable parameters, and matching the power generation with the load.

When fossil fuels are burnt, toxic gasses are released, such as oxides of carbon, oxides of sulfur and oxides of nitrogen.

These gases pollute the atmosphere, which disturbs the ecological balance and causes global warming.

The environment has become inappropriate for the survival of living things as a result of the increased pollution caused by the increased energy production to fulfill the rising demand.

It is necessary to reduce emissions and fuel costs, a process known as emission dispatch, in order to meet the demand for clean energy.

While minimizing the emissions, there is a need to satisfy the system constraints. When economic dispatch and emission dispatch problems are combined together it becomes as EED problem.

Problem formulation

Consider a system of *N* thermal-generating units connected to a single bus-bar serving the electrical load. The input for each unit is F_i. The output of each unit is P_{gi}. The problem can be divided into two phases:

a) Economic dispatch:
Transmission losses are neglected. The objective function F_T is equal to the total cost of all units. The problem is to minimize this function while satisfying constraints(given later).

$$F_T = F_1 + F_2 + \ldots + F_N \qquad (1)$$

$$F_T = \Sigma_{i=1}^{N} F_i(P_{gi}) \qquad (2)$$

The fuel cost for each unit(without valve point loading) is given as a second order polynomial:

$$F_i(P_{gi}) = a_i P_{gi}^2 + b_i P_{gi} + c_i \qquad \text{Rs/hr} \quad (3)$$

Hence the problem can be summarized as:

$Min\ F_T$ (4)

(b) Emission Dispatch:

The objective E_T for the total emission from all units is given as:

$E_T = E_1 + E_2 + \ldots + E_N$ (5)

$E_T = \Sigma_{i=1}^{N} E_i(P_{gi})$ (6)

The emission from each unit can be given as a second order polynomial as:

$E_i(P_{gi}) = \alpha_i P_{gi}^{2} + \beta_i P_{gi} + \gamma_i$ Kg/hr (7)

Hence the problem can be summarized as:

$Min\ E_T$ (8)

System constraints:

The constraints considered in the case of minimizing economic and emission dispatch functions are:

(a) Equality constraints:

Total power generation must cover both power demand and power loss. This helps us formulate the equality constraint as:

$\Sigma_{i=1}^{N} P_{gi} = P_D + P_{LOSS}$ (9)

(b) Inequality constraints:

Each generator unit would have a lower and upper limit on the amount of power it can generate. These make up our inequality constraints. The constraints can be formulated as:

$P_{gi}^{min} \le P_{gi} \le P_{gi}^{max}$ (for i = 1 to N) (10)

Algorithms

This problem can be tackled using many algorithms. For the purpose of our project we will try to focus on two algorithms:

- Lambda-iteration algorithm
- Particle Swarm Optimization algorithm

We will try to implement both of these algorithms with examples and compare the results for both. If possible we will try to look for and implement more algorithms to solve this problem.

References

[Comparative Analysis of Lambda Iteration Method and Particle Swarm Optimization for Economic Emission Dispatch Problem - Vipandeep Kour, Lakhwinder Singh]