A Research Paper on Analysis and Solution of Single Area Unit Commitment Problem in Electrical Power System

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ABSTRACT

This paper addresses the Unit Commitment (UC) problem, which is a well-known combinatorial optimization problem arising in operation planning of power systems. In the UC issue, the numerical detailing of Unit Commitment Problem has been produced. The calculation for Unit responsibility issue has been produced utilizing Dynamic Programming Approach and Quadratic Programming based Particle Swarm Optimization (QP-PSO) Approach. The result of QP-PSO calculation is an apparent result of the work. The aftereffects of different IEEE Bus frameworks have been appeared. Additionally, the execution of proposed calculation is contrasted and Heuristic PSO Algorithm, Dynamic programming Algorithm and Genetic Algorithm.

Keywords: unit commitment, scheduling, generation, genetic algorithm, quadratic programming.

I. INTRODUCTION

Electrical power plays a pivotal role in the modern world to satisfy various needs. It is therefore very important that the electrical power generated is transmitted and distributed efficiently in order to satisfy the power requirement. The Economic Load Dispatch (ELD) issue is the most noteworthy issue of streamlining in estimating the age among warm creating units in control framework. The ELD issue is to design the yield control for each committed producing unit to such an extent that the cost of task is limited alongside coordinating force working cutoff points, stack request and satisfying different framework constraints. The ELD issue is a noteworthy issue in the activity of warm/hydro creating station. It is viewed as an advancement issue, and is characterized for limited aggregate age cost, subject to different non-direct and straight imperatives, keeping in mind the end goal to take care of the power demand.

The ELD issue is characterized in two diverse courses, as raised ELD issue and non-curved ELD issue. The raised ELD issue is demonstrated by considering the target work as limiting the generator cost capacities thinking about straight confinements/limitations. In the nonconvex ELD issue the non-straight confinements/imperatives are considered next to direct constraints while lessening cost work. The direct imperatives, that is the age limit and power adjust drives the ELD issue as rough, rearranged issue and the qualities bend is thought to be piecewise straight. A more exact and precise issue is displayed by having the non-straight imperatives, for example, precluded working zones, valve point impacts and slope rate limits. The issue of ELD is typically multimodal, broken and exceedingly nonlinear.

In spite of the fact that the cost bend of warm creating units are by and large displayed as a smooth bend, the inputoutput qualities are nonlinear by nature in light of valve-point stacking impacts, Prohibited Operating Zones (POZ), incline rate breaking points et cetera. Huge steam turbine generators regularly have different valves in steam turbines. These valves are opened and shut to keep the genuine power adjust. Be that as it may, this impact delivers the swells in the cost work. This impact is known as valve-point stacking impact. Disregarding of valve-point impacts prompts erroneous age dispatch. Other than this, the producing units may have positive range where task is relinquished because of the physical constraints of mechanical parts. Such confined districts of stacking are commonly known as POZ.

At the point when a producing unit has POZ, its working area breaks into remote sub-areas, in this manner framing a non-curved choice space. Besides, the working reach for online units is confined by their incline rate limits. To keep warm changes in the turbine inside safe restricts and to abstain from shortening of life, the rate of increment or abatement of energy yield of producing units is constrained inside a range. Such slope rate imperative makes the
ordinary ED issue as a Dynamic Economic Dispatch (DED) issue. The nearness of these nonlinearities in useful generator task makes taking care of the ED issue all the more difficult.

II. PROBLEM FORMULATION

Single Area Unit Commitment Problem

The fundamental goal of unit responsibility is to locate the ideal timetable for working the accessible creating units with a specific end goal to limit the aggregate working expense of the power age. Add up to working expense of energy age incorporates fuel cost, start up and close down expenses. The fuel costs are figured utilizing the information of unit warm rate and fuel value data which is ordinarily a quadratic condition of energy yield of every generator at every hour dictated by Economic Dispatch (ED).

\[ F_i\left(P_i\right) = a_i + b_i P_i + c_i P_i^2 \]

where, \(a_i, b_i, c_i\) are the cost coefficients.

The total fuel cost over the given time period ‘T’ is

\[ TFC = \sum_{i=1}^{n} \sum_{t=1}^{T} F_i P_i \times X_i(t) \]

where, \(X_i(t)\) is the position or status of \(i^{th}\) unit at \(t^{th}\) hour.

Start up cost is that cost which occurs while bringing the thermal generating unit online. It is expressed in terms of the time (in hours) for which the units have been shut down. On the other hand, shut down cost is a fixed amount for each unit which is shut down. A start up cost can be expressed as :

\[ SUC_i = \begin{cases} HSC_i, & \text{if } MDT_i \leq DT_i < MDT_i + CSH_i \\ CSC_i, & \text{if } DT_i > MDT_i + CSH_i \end{cases} \]

where,

\(DT_i\) - shut down time,

\(MDT_i\) - Minimum down time,

\(HSC_i\) - Hot start up cost,

\(CSC_i\) - Cold start up cost,

\(CSH_i\) - Cold start hour of \(i^{th}\) unit.

Algorithm of Proposed Hybrid Particle Swarm Optimization :

The Proposed Algorithm consists of Hybrid combination of Quadratic Programming and Particle Swarm optimization (QP-PSO). The procedure of the proposed hybrid algorithm is as follows:

Step-1: Initialize the Generating Units parameters i.e. Pmin, Pmax, MDT, MUT, a, b, c, SUC, SUH, Tcold, Init State, NG, T, Pload etc.

Step-2: Initialize the PSO parameters i.e NP, ITERmax, Zmax, Zmin etc.

Step-3: Initialize the swarm and sort Pmax in descending order w.r.t. time.

Step-4: Satisfy the load demand constraints and Reserve constraints using the equation () and () respectively. The Pseudo Code for constraints is mentioned below.

Step-5: Satisfy Minimum Up Time and Down Time constraints using the equation () and () respectively.
Step-6: Again Check the load demand constraints and Reserve constraints for updated population using the equation () and () respectively.

Step-7. Solve the Economic load Dispatch Problem without considering valve-point effects incorporating wind power using Quadratic Programming.

Step-8: Update the Swarm Position and Velocity using equation () and () respectively.

Step-9: Calculate the updated constraints using ( ) and randomly generate initial population around the solution obtained from Quadratic Programming for PSO.

Step-10. Again Solve the Economic Load Dispatch problem with valve-point effects and calculate Gfitness using Particle Swarm optimization. The Pseudo code for updating the status of swarm is mentioned below.

Step-12: Display the final status of the Generating units and Minimum Cost.

Step-13: Save the final results.

III. RESULTS AND DISCUSSIONS

Modern Soft Computing Technique: QP-PSO Algorithm

The Hybrid QP-PSO calculation has been produced as Modern enhancement calculation to explain the Single Area Unit Commitment issue. The comparing consequences of previously mentioned IEEE Bus frameworks utilizing Hybrid QP-PSO calculation are demonstrated as follows:

![Fig. 1: Load Demand pattern for 24-hours for 14-Bus System](image)

Table 1: Results for 14-Bus System Using QP-PSO

<table>
<thead>
<tr>
<th>Time</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<tr>
<td>TOTAL COST = 13733</td>
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**Table 3: Compared Results**

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<tr>
<th>Optimization Algorithm</th>
<th>No. of Generating Units</th>
<th>Total Operating Cost</th>
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<td>Shuffled Frog Leaping Algorithm</td>
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<td>Hybrid QP-PSO Algorithm [Proposed Algorithm]</td>
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</table>

**CONCLUSIONS**

In this work, the detailing and usage of arrangements techniques to acquire the ideal arrangement of Single Area unit Commitment Problem utilizing Dynamic Programming Approach and Hybrid QP-PSO calculation is completed. The accompanying critical focuses have been watched all through the work:

- Particle Swarm streamlining calculation can be utilized to illuminate a significant number of an indistinguishable sorts of issues from Genetic Algorithms.
- Particle Swarm framework has memory which the Dynamic Programming calculation and Lagrangian Relaxation Algorithm does not have.
- In molecule Swarm enhancement, person that fly past optima are pulled to return toward them, learning of good arrangements is held by all particles.
- Particle Swarm Optimization has likewise been exhibited to perform well on Heuristics PSO calculation test capacities and it has all the earmarks of being a promising methodology for robot undertaking learning.
The viability of the created model is tried for IEEE-14 Bus System, IEEE-30 System, IEEE-56 Bus System and IEEE Bus framework comprising of 10 Generating Units. The outcomes got by QP-PSO calculation is additionally contrasted and Dynamic Programming calculation, Heuristics PSO calculation and Shuffled Frog Leaping Algorithm. It is discovered that QP-PSO is giving better outcomes when contrasted with Heuristics PSO calculation. Working Cost utilizing Dynamic Programming calculation is superior to Classical PSO calculation.

REFERENCES


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