Dynamic Programming Based Unit Commitment Methodology

S.Madhusudan¹ Dr.C.Nagarajan²

¹Muthayammal College of Engineering, Salem, Tamilnadu

Abstract—In dynamic programming–based power scheduling algorithms, thousands of hourly economic dispatches must be performed to consider every possible unit combination over all the stages of the optimization interval. If the unit commitment problem is constrained to observe a minimum system spinning reserve and an economic dispatch of a combination of units does not comply with this requirement, necessary and sufficient conditions have been established to guarantee that the dispatch of these units will meet the constraint. However, these conditions can only be checked after a dispatch is performed. In this paper, we present necessary and sufficient conditions for the feasibility of unit combinations that can be checked off-line. That is, before the start of the unit commitment algorithm, and thus before any economic dispatches are performed, thereby rendering a very efficient unit scheduling algorithm in terms of computer memory and execution time. Moreover, these feasibility conditions are independent of the problem formulation and thus can easily be applied to other unit commitment algorithms. Examples are provided to illustrate the efficiency attainable by the implementation of these conditions.

Key words: Scheduling algorithm, Networks

I. INTRODUCTION

Unit commitment is one of the decision-making levels in the hierarchy of power system operations management. The optimization problem is posed over time horizons that vary from 24 hours to one week. The objective is to determine the set of generating units, among those owned by a utility that should be connected to the power grid on an hourly basis to supply the demand at minimum operating cost over the scheduling horizon. This optimization problem is constrained by the unit characteristics and other operation limitations. Since the objective of the unit commitment is to determine a cyclic schedule that will meet the system constraints at minimum cost, the economic operation of a power system may be formulated as a dynamic optimization problem. The problem is dynamic in the sense that decisions to startup and/or shutdown units at any stage cannot be made without considering the states of the system at other stages. Generally, unit commitment is a computationally intensive algorithm, since thousands of hourly economic dispatches must be performed to consider every possible unit combination over all the stages in the optimization interval. Therefore, any effort toward the elimination of any unfeasible unit combinations performed off-line, that is before the start of the commitment algorithm and thus before any dispatches are considered, will handsomely the commitment problem is constrained to observe a minimum system spinning reserve and a dispatch of a unit combination does not comply with the requirement, the problem may still be solvable by the re-dispatch of these units, as long as the conditions prescribed by W.G. Wood10 are satisfied. However, these feasibility conditions can only be checked after a dispatch has been performed and, as a consequence, many dispatches that turn out to be unfeasible are needlessly computed in the process.

II. LITERATURE SURVEY

J, 1996; Navpreet Singh Tung, et al., 2012; Saravanan, B, et al, 2013; Pang, C. K, et al. 1981; Muralidharan, S, et al., 2011, Lagrangian Relaxation (Virmani, S, et al. 1989) and the Branch and Bound methods. Even though the autocratic methods are simple and fast, they suffer from mathematical convergence and way out eminence problems. The hypothetical search algorithms such as particle swarm optimization (Kennedy, J, et al. 1995; Valle, Y, et al, 2008; Yuan, X, et al. 2009; Rama Krishna, P. V, et al., 2012; Kwang Y. Lee, et al, 2010; Lala Raja Singh, R, et al, 2010; Andries P., et al, 2007), genetic algorithms, evolutionary programming, and ant colony optimization are able to triumph over the limitations of conventional optimization methods. The new optimization technique explicitly the particle swarm optimization technique is employed to get a way out to the unit commitment problem in sort of acquiring minimum operating cost. The amount of decision variables is enormously reduced by this formulation. PSO is a popular optimization method outstanding to its minimalism, stoutness and reduced consumption of computing time. Attribute over other methods and Particle swarm optimization is used for solving the unit commitment problem due to straightforwardness and less parameter modification. This paper provides a detailed analysis of the unit commitment problem solution using Dynamic Programming method. In this paper an algorithm using PSO was developed for finding a solution to unit commitment problem.

III. EXISTING SYSTEM

The Lagrangian Relaxation Method has been successfully applied in unit commitment scheduling of power systems. This can then be done through creation of the relaxed problem by including the constraints into the objective function. By multiplying the constraints with the Lagrange multipliers, λ and μ, respectively, and including them in the objective function; the primal problem is transformed into an unconstrained optimization problem, called the relaxed problem. Two basic models, one for the power production problem and one for the heat production problem, are used. The total system cost is minimized and the model includes start-up costs. For the heat production problem heat storage is included. Minimum operation and shut-down times are also considered.

IV. PROPOSED SYSTEM

The Dynamic algorithm for the conditions that a unit combination must satisfy to not only meet the minimum system spinning reserve constraint, but also the power balance constraint, the unit capacity limits, and all the other pertinent constraints as well. These conditions are shown to
be necessary. We further show that these conditions turn out to be both necessary and sufficient when the spinning reserve constraint is to be met by re-dispatch. Clearly then, when these conditions are not fulfilled by a unit combination, that combination can be discarded as unfeasible by the scheduling algorithm, thereby reducing drastically the number of decisions to be considered in the solution space.

The net result is a very efficient commitment algorithm as illustrated by examples. Furthermore, these feasibility conditions are independent of the problem formulation and thus can easily be implemented in other unit commitment algorithms. Advantages of Proposed System: Easy to Implement, Easy to Maintain. I develop many sub solutions: Exhibits overlapping and Easy to Reuse.

V. BLOCK DIAGRAM

Fig. 1: Block diagram of dynamic programming method

The Generation operators, transmission owners, and load serving entities must
- Provide accurate and current information to those performing the planning and dispatch functions.
- Those performing planning and dispatch must provide accurate and current dispatch instructions to generation operators, transmission operators, and load serving entities.
- Inadequate or incomplete communications affects the level of costs of the economic dispatch.
- Software tools for dispatch and information
- Reliable and secure computer software is essential for rapidly responding to system changes to maintain power system reliability, while selecting the lowest cost generators coordination of dispatch across regions

There are multiple, independently performed, dispatches in a region, the effectiveness of coordination agreements and their implementation affect the level of costs of the economic dispatch.

VI. SOFTWARE IMPLEMENTATION

MATLAB and Simulink for Model-Based Design provide signal, image, and video processing engineers with a development platform that spans design, modeling, simulation, code generation, and implementation. Engineers who use Model-Based Design to target FPGAs or ASICs can design and simulate systems with MATLAB, Simulink, and Stateflow and then generate bit-true, cycle-accurate, synthesizable Verilog and VHDL code using HDL Code. Alternatively, engineers who specifically target Xilinx FPGAs can use a Xilinx library of bit-true and cycle-true blocks to build a model in Simulink. They can then use Xilinx System Generator for DSP, a plug-in to Simulink code generation software, to automatically generate synthesizable hardware description language (HDL) code mapped to pre-optimized Xilinx algorithm and summarizes the complementary features and benefits of HDL Coder and System Generator. Used independently, each approach provides an effective FPGA design flow. Some projects, however, benefit from a mixture of approaches – a workflow that combines the native Simulink workflow,
device-independent code, and code readability offered by HDL Coder.

A. Simulation coding

function DP_v8()
clc
warning off

DP_input_data
GMIN = gen_data(:, 2);
GMAX = gen_data(:, 3);
GINC = gen_data(:, 4);
GNLC = gen_data(:, 5);
GSC = gen_data(:, 6);
GFC = gen_data(:, 7);

if (DISPATCH_METHOD == 2 | DISPATCH_METHOD == 3) & (any(isnan(GNLC)) | any(isnan(GFC)) | any(isnan(GINC))
    STR = ['To use linear cost model, you must provide data for NO LOAD COSTS,'...
           'FUEL COSTS and INCREMENTAL COSTS.';]
    % there are no data for quick dispatch method,
    msgbox(STR,'DATA AVAILABILITY CHECK FAILURE!', 'warn');
    return
else
    DISPATCH_METHOD == 1 &
    (any(isnan(COEF_A)) | any(isnan(COEF_B))) | any(isnan(COEF_C)))
    STR = ['To use quadratic cost model, you must provide data for the cost coefficients:,'...
           'COEFF_A (£), COEFF_B (£/MWh) and COEFF_C (£/MW^2h).';]
    % there are no data for quick dispatch method,
    msgbox(STR,'DATA AVAILABILITY CHECK FAILURE!', 'warn');
    return
end

if MIN_UP_DOWN_TIME_FLAG == 1 &
    (any(isnan(GMINUP)) | any(isnan(GMINDOWN)))
    STR = ['To use minimum up and down time constraints, you must provide data for GMINUP...'...
           'and GMINDOWN.'];
    msgbox(STR,'DATA AVAILABILITY CHECK FAILURE!', 'warn');
end

B. Simulation result

1) Hourly results:

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<tr>
<th>Hour</th>
<th>Demand</th>
<th>Tot.Gen</th>
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<th>Max MW</th>
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<td>F-Cost</td>
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<td>Units</td>
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VII. CONCLUSION

The optimal unit-commitment of thermal systems resulted in enormous saving for electrical utilities. We have derived the mathematical formulation for the unit commitment problem in power systems using dynamic programming techniques. Two conditions were presented, which can be checked offline to eliminate unit combinations that are guaranteed a priori to be infeasible combinations since they are both necessary for a successful solution. Furthermore, we have presented a theorem with necessary and sufficient conditions for unit feasibility that require re-dispatch to meet the system spinning reserve requirement. Detailed examples on a 20-unit system showed specifically how the computationalefficiency was attained. Therefore when these conditions are checked as prescribed, they will always render very efficient solutions to unit commitment algorithms. Efficiency was attained.

REFERENCES


