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Designing and Implementation High Performance FIR Filter Architecture using Distributive Arithmetic Technique:- A Review

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Abstract— An efficient and economic power generation has always held an important position in the electric power industry. Operational Economics involving power generation and delivery can be subdivided as – Economic Load Dispatch and Unit Commitment. The main objective of Economic Load Dispatch is the process of allocating the required load demand between the available generation units such that the cost of generation is. Furthermore, Unit Commitment is an optimization technique that determines the units that are feasible and should be committed over a period of time to serve the load demand at minimum operating cost, satisfying all plant and system constraints. The test system is also analyzed under 3- phase symmetrical fault with its effect on generation. There exist various UC scheduling algorithms among which my research work is based on Dynamic Programming method which is robust in nature, takes less computation time and includes plant constraints like start-up cost, fuel cost etc. The performance of Dynamic Programming method is further enhanced by adopting Sequential Combination – DP method which involves reduction in the dimensionality state of the solution space and faster computation speed. The effectiveness of the proposed technique is investigated on 26-Bus Multi Machine system consisting of six thermal generating units and is carried out using MATLAB.

Keywords: Unit Commitment, Dynamic Programming, Fuel Cost, Voltage Stability and Economic Dispatch

I. INTRODUCTION

Signal processing is very important in many of the system Economic operation and planning of electric energy generating systems have always been given proper attention in the power system industry. A saving in the cost of generation represents a significant reduction in the operating cost and hence this area has warranted a great deal of attention from operating and planning engineers. The factors influencing power generation at minimum cost are operating efficiencies of generators, fuel cost and transmission losses. The most efficient generator in the system does not guarantee minimum cost as it may be located in an area where fuel cost is high. Also, if the plant is located far from the load centre, transmission losses may be considerably higher and hence the plant may be uneconomical. Hence, the problem is to determine the generation of different plants such that the total operating cost is minimum. Thus, the operating cost plays an important role in economic scheduling [1]. The solution to the above problem has a potential to save millions of rupees per year in terms of fuel and related cost. Thus, it leads to the emergence of "Optimal load dispatch with Unit Commitment" which is the basis of my research work that involves the inclusion of three vital research applications - Optimum Power Flow method, Economic Load Dispatch and Unit Commitment.

Electric power utilization must be improved in present scenario while taking into account the security and reliability of power flow. Over all voltage profiles are deteriorated and system stability and security are decreased due to the reason that, transmission line power flows are not uniform. In some lines it"s below the standard value whereas in some it"s way above the normal power flow values. Due to this the low voltage condition comes into picture and hence most of the electrical loads are connected to low voltage power distribution system. Thus, there exist an urgent need of optimum power flow (OPF) solution which provide a systematic mathematical approach for determination of various bus voltages, active and reactive power flows through different branches, generators and loads under steady state condition [2]. Power flow analysis is used to determine the steady state operating condition of a power system. It is widely used by power distribution

professional during the planning and operation of power distribution system. The optimum power flow analysis can be achieved through various mathematical iterative algorithms like –

- Gauss – Seidal
- Newton – Raphson
- Fast – Decoupled

In terms of convergence and reliability, the Newton – Raphson method is much more superior and accurate when compared to gauss- siedal and fast-decoupled and that‟s why it‟s been widely used for power system analysis and design [3]. In the present modern era, where the population is rapidly increasing, so is increasing the consumption and need, and as a result has led to an increase and unpredictability in the demand and generation. In the existing power system the load is not stable and it keeps varying depending on our requirement and consumption from hour to hour, day to day and reaches different peak values from one day to other day. Thus, it‟s not possible to run all the units simultaneously as it leads to increase in fuel and generation cost. Thus, to tackle the above problem unit commitment method is used.

Unit Commitment (UC) is a non-linear, mixed integer combinatorial optimization problem in which the number of generators is being scheduled satisfying number of load and other equality and inequality constraints such that the total system production cost over the scheduled time horizon is minimized i.e. unit commitment is turning on and turning off the generators over the time horizon. In solving the unit commitment problem, generally two basic decisions are involved, namely, the "Unit Commitment" decision and the "Economic Load Dispatch" decision. The "Unit Commitment" decision involves determining the units that are feasible and should be committed over a period of time to serve the load demand at minimum operating cost, satisfying all plant and system constraints. The "Economic Load Dispatch" decision involves in determining the optimum allocation of load among the committed generating units subject to satisfaction of power balance and capacity constraints, such that the total cost of operation is kept at a minimum. There exist various methods for solving a unit commitment problem like.

- Branch and Bound method
- Benders decomposition method
- Priority List method
- Lagrange Relaxation method
- Dynamic Programming method

Among all these methods the dynamic programming method is much more flexible, faster, supports all system constraints and can forecast the scheduling of generating units on a hourly basis. That‟s why it has been widely used and is the area of my research analysis [5]

II. LITERATURE REVIEW

W.F Tinney, C.E.Hart in their research paper has shown the effectiveness of Newton method which is faster, more accurate and more reliable than any other known method for any size or kind of power system problem [1].

Federico Milano in his research paper describe the application of the continuous Newton method to the power flow problem based on a 1254 – bus model. The paper also shows that the Newton Raphson method is the most robust power flow algorithm [2].

Adejumobi et.al in his research paper has compared the performance of Gauss, Newton and Fast Decoupled power flow algorithm. Test cases resulted that Newton-Raphson appeared to be the best power flow algorithm in terms of convergence and reliability [3].

David I. Sun et.al the classical optimal power flow problem with a nonseparable objective function can be solved by an unambiguous Newton-Raphson approach. Well-organized, healthy solutions can be obtained for problems of any practical size or kind. Solution effort is approximately proportional to network size, and is relatively independent of the number of controls or binding inequalities. For any given set of binding constraints the process converges to the Kuhn-Tucker conditions in a few iterations [4].

F.L.Alvardo the method for solving the active and reactive optimal power flow problem is based on non-linear programming techniques with the merging dual and penalty approaches. Actually according to them it is a dual amplified Lagrangian approach for optimal power flow. The classical Lagrangian is defined for both equality and inequality constraint. This function is then enlarged by penalty terms for all constraints and it is minimized by Newton-Raphson method [5].

Leandro D.S. Coelho and C.S. Lee has formulated an optimizing technique which solves economic load dispatch problem in power system using chaotic and particle swarm optimization approaches that minimizes the operating cost satisfying all system constraints [6].

Sanjay Vyas et.al has discussed various method of optimizing generation cost by using load dispatch schedule under varying load demands [7].

Hadi Saadat in his book has discussed the lambda iteration method of solving economic load dispatch problem. It is one of the methods used in solving the system lambda and optimal power dispatch of the generators. In lambda iteration method, the unknown variable, lambda, gets its next value based on intuition. That is, there is no equation that computes the next iteration of lambda. It is projected by interpolating the best possible value until a specified mismatch has been reached [8].

Martin C.Rodriguez analyzes the effect of fault on power system under symmetric and asymmetric case. It discusses

the occurrence of voltage dip and system unbalance by the variation of fault impedance [9].

Sayeed Salam has given a complete overview of various methods of solving Unit Commitment problem in his research paper [10].

Tim T. Maifeld and G.B. Sheble in their research paper has solved the Unit Commitment problem using Genetic Algorithm which is biologically inspired computational search algorithm which results in generation cost minimization [11].

U. Leeton et al describe optimal power flow based on particle swarm optimization (PSO) in which the power transmission loss function is used as the problem objective. PSO is well-known and widely accepted as a potential intelligent search methods for solving such a problem. Therefore, PSO-based optimal power flow is formulated and tested in comparison with quasi-Newton method (BFGS), genetic-based (GA-based) optimal power flow [12].

A.J. Wood and B.F. Wollenberg in his book discusses various optimizing techniques for solving Unit Commitment problem among which Dynamic Programming is the most robust method. It satisfies all system constraints and can be implemented on any size of the system [13].

Shoults, Chang, Helmick and Grady in their research paper discussed about the application of Unit Commitment to multiple integrated power system satisfying all the constraints and minimizing operation cost [14].

III. OPTIMUM POWER FLOW METHOD

In power engineering, the power flow studies also referred as load flow studies forms the backbone of power system analysis and design. It is the most important and vital part of any power system problem. They are necessary for planning, operation, economic scheduling and exchange of power between utilities. In addition, power flow analysis is required for many other analyses such as fault study and transient stability.

It is a significant tool involving mathematical analysis applied to an integrated power system. In fact, it can be said as the pulse of the system which determines the characteristics of power system under steady state operating mode by providing the magnitude and phase angle of voltage at each bus and the real and reactive power flowing in each transmission line of bus networks. It solves the static load flow equations obtained within the specified constraints. A power flow study normally uses simplified notations such as one-line diagram and per-unit system, and does focus on various forms of AC power (i.e.: bus voltages, phase angle, real power and reactive power).

It analyses the power system in normal steady-state operation. Many software implementations of power flow studies exist. The main information obtained from the power flow study is the magnitude and the phase angle of the voltage at each and every bus, and the active and reactive power flowing in each transmission line [17].

A. Objective of Power Flow Study

- Power flow analysis is very important in planning stages of new networks or addition to existing ones like adding new generator sites, meeting increase load demand and locating new transmission sites.
- The load flow solution gives the nodal voltages and phase angles and hence the power injection at all the buses and power flows through interconnecting power channels.
- It is helpful in determining the best location as well as optimal capacity of proposed generating station, substation and new lines.
- To determine power loss in the system and its minimization.
- Economic system operation with minimization of fuel cost.

IV. ECONOMIC LOAD DISPATCH

Economic operation is very important for a power system to get profits on the capital invested. Operational economics involving power generation and delivery can be subdivided in to two parts: minimization of power production cost, called economic load dispatch and minimization of transmission losses. Thus in general, economic dispatch is the method of determining the most efficient, low cost and reliable operation of a power system by dispatching the available electricity generation resources to supply the load on the system. The primary objective of economic dispatch is to minimize the total cost of generation while satisfying the total operational constraints of the available generation resources.

Usually, it will also consider functionally optimum power flow problem that combines the power flow with Economic load dispatch problem. The objective of OPF is to find the optimal setting of a given power system network that optimize a certain objective function such as power loss, reactive power voltage and so on while system security, and all operating constraints are satisfied. The most commonly used objective is the minimization of the overall fuel cost function along with minimization of active power loss, bus voltage variation, emission of power generating units, and scheduling [22].

A. Economic Load Dispatch Formulation

As it has been mentioned before, the objective of Economic load dispatch problem is to minimize the total generation cost within a specific period of operation so as to accomplish optimal generation units while simultaneously meeting the system load demand and other generator optimal constraints [19]. The objective function to the generation cost can be approximated described as quadratic function as follows:

$$F_T = \sum_{i=1}^{n} F_i(P_i) = \sum_{i=1}^{n} (a_i P_i^2 + b_i P_i + c_i)$$

Where
FT= total fuel cost generation in the system (Rs/hr),
$, bi\ and ci$= cost coefficient of the it generator,
Pi= the power generated by the it unit
n = the number of generator.

V. UNIT COMMITMENT

Unit commitment is an optimization technique used to schedule the feasible generation units in order to serve the load demand at the minimum operating cost while meeting all plant and system constraints during a given interval of time.In the existing power system the load is not stable and it keeps varying depending on our requirement and consumption from hour to hour, day to day and reaches different peak values from one day to other day. At each period there will be distinct isolated load levels. So it is not worthwhile to run all the existing units all the time. Therefore, it is essential to forecast the starting up of the units, connection of the units to the network, the order for shutting down the units and the time period for the units to be in off state. Thus, determining which unit must be kept online and which ones should not constitutes a difficult problem for the operators seeking to minimize the system operational cost. And this has led to the emergence of Unit Commitment solution.

VI. CONCLUSION AND FUTURE WORK

For energy conservation and economic aspects, allocation of load demand along with proper scheduling of feasible generating units is necessary. This gives arise to the concept of Optimal Load Dispatch with Unit Commitment using Dynamic Programming method which has been discussed and investigated for 26-bus multi-machine system consisting of six thermal generating units using MATLAB. The following conclusions have been drawn through the research work and are presented below as follows –

- The Optimum Power Flow solution techniques consisting of Gauss-Seidal, Newton-Raphson and Fast-Decoupled method has been discussed. Among these, Newton-Raphson method has emerged to be the best Power Flow iterative method due to its faster convergence speed and reliability and therefore has been used for carrying out Economic Load Dispatch for the considered system.
- Economic Load Dispatch using Newton-Raphson power flow method has been carried out considering with or without losses as case study. The simulation result revealed that losses and generation cost are minimized by the use of shunt capacitors that injects reactive power in the system.
- The system has been analyzed for 3-phase symmetrical fault and its effect on generation has been observed. Test cases shows that the during-fault voltages, currents and generation cost are greatly affected by the system unbalance and the fault impedance. The increase of the fault impedance reduces the fault current and therefore the effect of the system unbalance on during-fault voltages and current diminishes. Larger fault impedance values produce fault currents similar to nominal load currents and therefore the effect of these faults in terms of duringfault voltages and currents cannot be differentiate from nominal operation conditions. Therefore, it has been observed that the faulty unbalance system returns to its steady-state normal condition at larger fault impedance.
- Economic power generation has been achieved through Unit Commitment using Dynamic Programming method which commits only the feasible generating units thus minimizing the total generation cost and saving millions of rupees which has been observed in comparison to Economic Load Dispatch. The proposed algorithm for solving Unit Commitment problem has the advantage that its 64 practical in nature, satisfies all the system constraints and can be implemented for any size of the system.
- The performance of Dynamic Programming method has been further enhanced by adopting Sequential Combination Dynamic Programming method (SC-DP)which involves reduction in the dimensionality state of the solution space and faster computation speed when compared to Conventional Dynamic Programming method.

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