An analysis of economic load dispatch using conventional and artificial intelligence methods.

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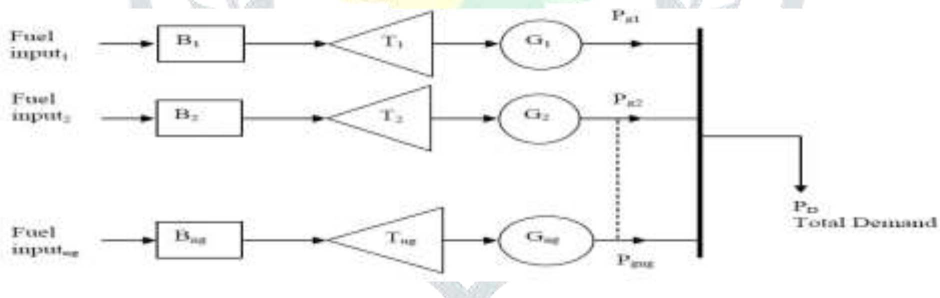
Abstract—Electrical power systems, as for cost effectiveness, need to be operated economically for constantly increasing fuel prices, wages, etc. such that the continuous variation of power demand would be met. Scheduling of the power generator outputs with respect to the load demands is achieved by the economic load dispatch method. The main objective of the economic load dispatch is to allocate the optimal power generation from different units at the lowest cost possible. The generation of different plants is determined by the economic load scheduling to minimize the operating cost, i.e. fuel cost and is expressed as the function of generation and is define as a non-linear function of power generation. The quantity of fuel consumed and the operating cost can be significantly reduced by the saving in the operating of the power system. The MATLAB environment is used to design a graphical layout for calculating the cost to generation for thermal power plants. It is easier to learn and use, Since the person using the application does not need to know what commands are available or however they work. The action that results from a specific user action are often created clear from the look of the interface.

***Index Terms*—Economic Load Dispatch,Artificial Intelligence, Genetic Algorithm**

I. INTRODUCTION

The economic load dispatch (ELD) issue is one of the essential improvement issues in the electric power system. The goal of the economic load dispatch problem (ELD) of electric power era is to plan the conferred creating unit output in order to take care of the required load demand at least working expense while fulfilling all unit and framework uniformity and imbalance imperatives. This makes the ELD issue a huge scale very nonlinear obliged streamlining issue. Enhancements in planning the unit yields can prompt huge cost funds. In this manner, numerous endeavors have been made to take care of the issue throughout the years.



This framework comprises of "Ng" thermal generating units associated with a single busbar serving a electrical load Pd. The contribution to every unit, appeared in Figure as Fi speaks to the cost rate of the ith unit. The yield of every unit, Pgi is the electrical power created by a specific unit. Along these lines, the objective function is characterized as

$$F_t = \min\sum_{i=1}^{Ng}(\,Fi(Pgi)) = \ min\sum_{i=1}^{Ng}(ai\,Pgi2 + bi\,Pgi + Ci\,)$$

Where ai, bi, and ci are the cost co-efficient of the ith unit, Pgi output active power of ith generating unit.

II. LAMBDA ITERATION METHOD

By monitoring the demand versus the incremental cost, we can quickly locate the coveted working point. In the event that we wished, we could make an entire arrangement of tables that would demonstrate the aggregate power provided for various incremental cost levels and blends of units. This same strategy can be received for a PC usage as appeared in Figure. That is, we will now build up an arrangement of legitimate tenets that would empower us to fulfill an indistinguishable target from we have quite recently finished with ruler and diagram paper.

Algorithm for Lambda Method

Stepwise procedure is outlined below.

1) Read data of Thermal generator cost coefficient a_i, b_i, c_i forith generator,
2) Assume the starting value λ and Δλ
3) Calculate total minimum and maximum load of power station.
4) Calculation of λ, in this step first value of λ and Δλ are assumed.
5) Calculate Pgi for each generator using below equation

$$Pgi = \frac{\lambda - bi}{2ai}$$

6) Find $\Delta P = P_d - \sum_{i=1}^{Ng} Pgi$
7) Find the new value of lambda by
   If ΔP > 1 then new value of λ is given by
   λ = λ + Δλ
   If ΔP < 0 then new value of λ is given by
   λ = λ - Δλ
8) Now repeat iteration for i=Ng and calculate Pgi for all generators.
9) Check the inequality constraint
   If $Pgi < Pgi^{min}$ than $Pgi = Pgi^{min}$
   If $Pgi > Pgi^{max}$ than $Pgi = Pgi^{max}$
10) Final Calculate optimal total cost of generation.

III. GRADIENT METHOD OF ECONOMIC DISPATCH

The lambda-emphasis seek procedure dependably requires that one have the capacity to discover the power yield of a generator, given an incremental cost for that generator. On account of a quadratic capacity for the cost work, or for the situation where the incremental cost capacity is spoken to by a piecewise direct capacity is a great deal more perplexing, for example, the one underneath:

$$F(P) = A + BP + CP^2$$

In this case, we shall propose that a more basic method of solution for the optimum be found.

This technique takes a shot at the rule that the base of a capacity, f(x), can be found by a progression of steps that dependably take us in a descending heading. From any beginning point x^0, we may discover the heading of "steepest drop" by taking note of that the inclination of i.e. Always focuses toward most extreme climb. Subsequently, on the off chance that we need to move toward greatest plunge, we invalidate the inclination. Then we should go from x^0 to x^1 using:

$$x^1 = x^0 - \Delta f \alpha$$

Where α is a scalar to allow us to guarantee that the process converges. The best value of α must be determined by experiment.

In the case of power system economic dispatch this becomes:

$$F = \sum_{i=1}^{N} F_i(P_i)$$

And the object to drive the function to its minimum. However, we have to be concerned with the constraint function:

$$\phi = (P_{load} - \sum_{i=1}^{N} P_i)$$

To solve the economic dispatch problem which involves minimizing the objective function and keeping the equality constraint, we must apply the gradient technique directly to the Lagrange function itself.

The Lagrange function is:

$$= \sum_{i=1}^{N} F_i(P_i) + \lambda\,(P_{load} - \sum_{i=1}^{N} P_i)$$

Algorithm for gradient method

The solution steps of the gradient method:

1) Given a set of fixed parameter p, assume a starting set of control variables 'u'
2) Solve for power flow. This guarantees is satisfied.
3) Solve eq. for λ
4) Substitute λ from eq. into compute the gradient.
5) If Δ equals zero within the prescribed tolerance, the minimum has been reached other wise:
6) Find a new set of control variables.

$x^{new} = x^{old} + \Delta x$

Where $\Delta x = -\alpha \nabla \Lambda$

Here Δu is a step in negative direction of the gradient. The step size is adjusted by the positive scalar α.

IV. GENETIC ALGORITHM METHOD

GAs are the search algorithms which uses the mechanism of natural genetics and selection process, which is different form the conventional techniques which are starts with initial set of random solutions , which is known as populations, which satisfying system boundaries or constraints of the problems.

Individual also known as a chromosome, which is nothing but solution of the problem in system. Chromosome contains the symbols in form of binary bit string, but it is not necessary to represent as a binary coding only. After evaluation each generation using fitness function in GAs.

Crossover and the mutation operators are used to create the new generation which is called offspring. In the offspring the selection is based on the fitness values of parents and offspring, in which some are rejecting by others as to keep the population constant. Offspring are selected by its fitness and after several generation it founds the best chromosome which is the optimum solution.

1. Genetic presentation of problem
2. Initial Population
3. Fitness function of the problem by which offspring is selected.
4. Genetic operators, which alters the parameter from parents and make new offspring (Crossover, mutation, selection, etc.).
5. Parameters value that been used to operate the GA algorithm. (Population size, probabilities of applying genetic operators, etc.)

V. Case Study

Table 1- Six Generator System Data

Pi Min (MW)	Pi Max (MW)	ai $/MWh^2	bi $/MWh	ci
50	200	0.00375	2	0
20	80	0.0175	1.75	0
15	50	0.0625	1	0
10	35	0.00834	3.25	0
10	30	0.025	3	0
12	40	0.025	3	0

Parameters of Genetic Algorithm	
Population Size	50
Fitnes Scaling Function	Proportion
Selection Function	Uniform
Cross over Fraction	0.7358
Mutation	Constraint Dependent
Crossover Function	Arithmetic
Migration Direction	Forward
Migration Fraction	0.2
Migration Interval	20
Initial Penalty	10
Penalty Factor	100

Table 2 – Result Table

Generator (Pi)	Pi Min	Pi Max	Lambda Iteration	Gradient Search	GA
P1	50	200	50	113.31	76.59
P2	20	80	36.6	39.74	50.35
P3	15	50	50	17.91	16.32
P4	10	35	19.71	10	16.54
P5	10	30	21.35	11.63	18.43
P6	12	40	21.35	14.45	20.98
Load Demand			200	200	200
Optimum Load Calculated by respective Method			199.01	199.9	199.21
Error			0.99	0.1	0.79
Fuel Cost in $/Hr			621.31	540.5	534
Fuel Cost in $/MW			3.12	2.7	2.68

VI. CONCLUSION

This paper is based on comparative study of conventional and artificial intelligent technics for economic load dispatch.

Compare to other convention methods GA provide better results. Here only generator constants are only considered but other inequality constraints like valve point effect and emission control also can be consider for the same problem.

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