Load Margin Enhancement in Power System Considering Contingency

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Abstract— **This paper presents the load margin enhancement in power system considering contingency. The contingency is consider at line outage. Basically, this paper is to determine system load margin by improve system load margin with control of RPD utilizing EP technique . This paper divided by two optimization which are normal condition and outage. This paper to present the comparison between pre and post optimization at the normal and outage condition. In this paper, it improve/increase a load margin at 26 buses (IEEE) of EP. By using the Evolutionary programming (EP) technique are used to optimization technique in load margin of power system.**

Keywords—**power system problems, increase power, reactive power dispatch(RPD),evolutionary programming (EP) and line outage.**

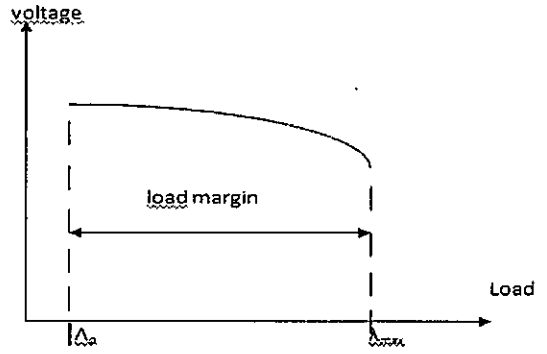
I. INTRODUCTION

The power system networking is getting more complex and stressed due to global warming phenomenon, increasing population size and rapid infrastructure development which contribute to continuous changes in supply and demand patterns, increased interconnection and stringent environment constraints. This will make voltage instability in the transmission lines and that also will make many losses and voltage drop are happen. The purpose of this project is to maximize the loading value by using the EP technique for the OPF approach .EP are used to optimization the load margin at the normal and contingency condition.

A Load Margin

There are three basic load margin are discussed in this project which are load margin assessment, load margin analysis and load margin enhancement.

Figure 1: Load margin assesement obtained from voltage vs load graph



A.1) Load margin assessment

Load margin assessment is a fundamental measure of proximity to voltage collapse. The computation of load margin is crucial since it is capable to measure how close the system operation to its stability limit; or in other perspective ,it also can be used to determine the maximum load that the particular system can sustain before it is entering unstable operating point [1].

A.2) Load margin analysis

In load margin analysis, the maximum load that the system can be withstand before it enters instability condition is called maximum loading point(MLP).Generally, the study involving load margin can be divided into two categories, one is to predict the value of MLP and the other one is to improve or extend the value of MLP[1].

A.3) Load margin enhancement

System load margin can be improved using various ways. Among the approaches are by implementation of reactive power management[1],installation of flexible AC transmission system (FACTS) devices [1],reconfiguration of distribution system [1], load shedding and proper generation scheduling [1].

B.Contingency

Contingency is one or more events occurring simultaneously or at different instants of time ,with each events resulting in a change in the state of one or more power system elements. A contingency may be initiated by a small disturbance, a fault or a switching action[6]. Type of switching actions supported in the contingency which are breaker opening/close, shunt capacitor/reactor insertion and/or removal, series capacitor insertion or bypass, generator tripping, load shedding, transformer tap changing, facts devices connectivity and operation, automatic transfer tripping[6].Contingency analysis has the basic functions which are contingency selection and screening, voltage security(stability) evaluation and voltage security (stability) enhancement[6]. Contingency selection and screening is contingencies might impose immediate threat to voltage stability. It is required therefore, to define a credible list of contingencies[6]. Hence, contingencies selection and screening will select the most likely contingencies whish will cause voltage stability problem so they will be assessed in detailed[6]. Voltage security evaluation is conducted to further analysis

in term of voltage stability criteria has to be evaluated[6]. The voltage stability criteria may specify how far the system should be from the voltage stability limit in terms load increase, transfer increase, or other form of stress[6]. It is also necessary to know the voltage secure region around this operating point. Voltage security enhancement is to take the preventive control actions before any contingency happen[6].

C. Optimization technique

There are many optimization technique that have been applied in power system problem solution to accelerate the research direction as well as to fine tune the result. In this project, the optimization are used is Evolutionary Programming (EP).

D. Evolutionary programming (EP)

Evolutionary programming (EP) optimization technique is used to optimize of the load margin by using in MATLAB software. Evolutionary Programming was one of the main avenues of research in evolutionary computation in the early 1990s, including Genetic Algorithms along with Genetic Programming, and Evolution Strategies. At this time, the term "Evolutionary Computation" was invented to describe the entire field of study[3]. Whereas some members of the genetic algorithm and evolution strategies communities have opted to retain these terms, virtually all of the researchers active in Evolutionary Programming recognize the value of a single encompassing term for the entire field and have adopted this term to describe their work[3]. This is particularly true because in the modern version of Evolutionary Programming, it can employ any data representation, any variation operators, and any selection procedure.

E. Reactive power dispatch (RPD)

Reactive Power Dispatch (RPD) is one of the important tasks in the operation and control of the power system. RPD problem can be formulated as a non-linear constrained optimization problem. The proposed algorithm has been applied to find the optimal reactive power control variables in IEEE 30 and IEEE 118-bus systems[2]. The purpose of Reactive Power Dispatch is mainly to improve the voltage profile in the system and to minimize the real power transmission loss while satisfying the unit and system constraints. It is achieved by proper adjustment of reactive power control variables like Generator bus voltage magnitudes (V_{gi}), transformer tap settings (t_i), reactive power generation of the capacitor bank (Q_{ci})[2]. To solve the RPD problem, a number of conventional optimization techniques have been proposed[2]. These include the Gradient method, Non-linear Programming (NLP), Quadratic Programming (QP), Linear programming (LP) and Interior point method[2]. Though these techniques have been successfully applied for solving the reactive power dispatch problem, still some difficulties are associated with them. One of the difficulties is the multimodal characteristic of the problems to be handled. Also, due to the non-differential, non-linearity and non-convex nature of the RPD problem, majority of the techniques converge to a local optimum. Recently, Evolutionary Computation techniques like Genetic Algorithm (GA) , Evolutionary Programming (EP) and Evolutionary Strategy have been applied to solve the optimal dispatch problem[2]. In this paper, EP based approach has been proposed to solve the RPD problem.

F. Optimal power flow (OPF)

In power system analysis, the OPF technique is applied to determine the optimal control parameter setting based on its objective function while satisfying a set of system constraint. In general, the OPF is divided into three which are reactive power planning(RPP), reactive power dispatch(RPD), and allocation of reactive power generator or capacitor placement(CP).Each approach is different control. In RPP, the transformer tap setting ,injection of reactive power at generator and load bus were optimized to fulfill the objective function. In RPD injection of reactive power at generator and CP is injection of reactive power at load bus was optimized.

II. METHODOLOGY

The methodology and approach for the project represented by the following process flowchart given in Figure 1:

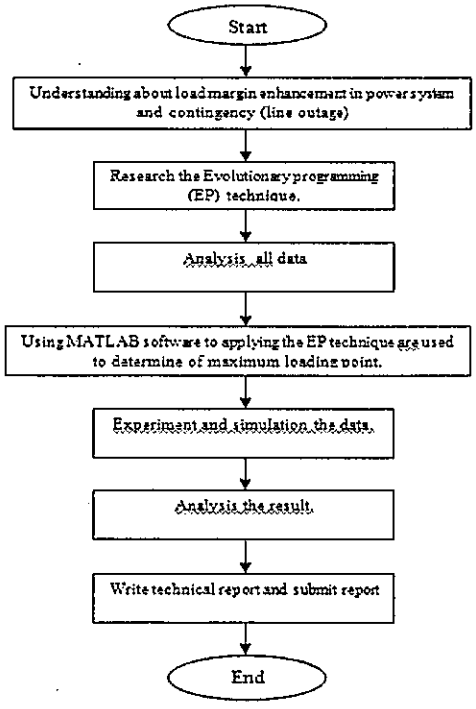


Figure 2: Flow Chart of Methodology Project Phases

In load margin assesement, the maximum loading point or the maximum load that the system can sustain before entering collapse point is crucial to be determined to ensure that system's operation is secured and stable. The determination of the MLP is basically comprises of the step as illustrated in figure 2.

Flow chart of calculation maximum loading point:

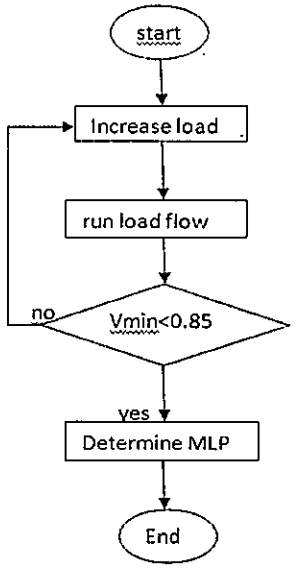


Figure 3 : Flow chart for the calculation of maximum loading point.

The methodology of basic EP is summarized as follow:

Step 1:initialization:

– the initial population of μ individuals consists of (x_i, η_i), $\epsilon\{1,2,...\mu\}$ are generated based on its limit.The fitness is calculated for each individual based on its objective function,$f(Xi)$.

Step 2:mutation,formula for mutation-

$$x'_i(j)=x_i(j) + \eta'_i(j)N_j(0,1)$$
$$\eta'_i(j)= \eta_i(j)\exp(\tau'N(0,1) + \tau N_j(0,1))$$

and

$$\tau = ((2(n)^{1/2})^{1/2})^{-1}$$
$$\tau = ((2(n)^{1/2})^{-1}$$

$x_i(j)$, $x'_i(j)$, $\eta_i(j)$, *and* $\eta'_i(j)$ are the j-th component of the vectors x_i, x'_1,η_i and η'_i. N(0,1) are represent a normally distributed one-dimensional random number with mean zero and standard deviation. $N_j(0,1)$ denotes that the random number is generated new for each value of *j*. Then, the fitness is calculated.

Maximizing loading point as the objective function
In this section, the methodology of EP based OPF technique with maximizing loading point as the objective function is discussed. A step procedure technique is given below:

Step 1: Control variables are generated randomly according to which OPF technique is considered at one particular time.

Step 2:Each set of control variable pattern are replaced into bus sytem and the load flow is executed using Newton Raphson method.

Step 3:The initial condition is checked :

- Bus voltage violation
- System's loss compared to pre optimization loss

Step 4:Maximum loading value sustainable by the system based on each set of generated control variable is calculated according to the steps in figure 2.

Step 5:The results are stored in program memory. Each results represents a parent in EP technique.Steps 1 to 5 repeated until total parents reach 20 candidates.

Step 6:Each component of parent is mutated by random amount and the new value of control variables are generated.These control variables are control variables for offspring.

Step 7:Steps 2 to 4 reapplied However , if the system constraints are violated as described in step 3, the process is repeated to step 6 instead of steap 1.

Step 8:Store the offsprings results in program memory. Steps 6 and 7 are repeated until all parents are mutated.

Step 9:Results for generated parents and offsprings are recalled from system memory. Both population are combined and ranked in descending according to maximum loading value carried by each individual

Step 10:The best 20 results which have the highest loading value are selected to be parents for next iteration.Step 6 to 9 repeated until the solution converges.

Flow chart for evolutionary programming (EP):

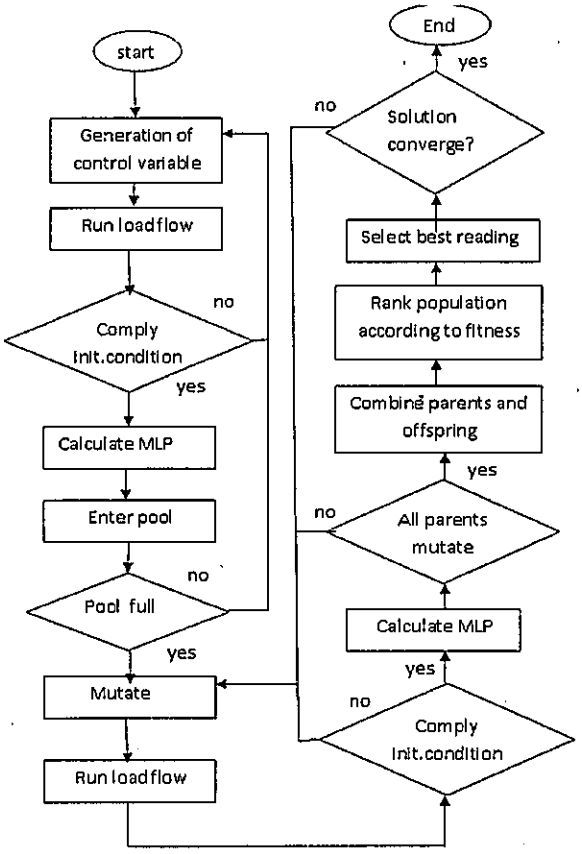


Figure 4: Flow chart of evolutionary programming (EP) with maximizing loading value.

This paper are consider contingency, the contingency may be initiated by a small disturbance, a fault or a switching action. Type of switching actions supported in the contingency which are breaker opening/close, shunt capacitor/reactor insertion and/or removal, series capacitor insertion or bypass, generator tripping, load shedding, transformer tap changing, facts devices connectivity and operation, automatic transfer tripping[6]..For this project ,it focus on the line outage. The line outage that are chooses is line 25 which at line 11 to 25.That because ,this line are critical than other line.

III. RESULTS AND DISCUSSIONS

In this paper, it have a result for pre and post optimization during normal and outage condition. A result represent in the table below:

Table 1:Pre and post optimization results at the normal Condition for critical bus(Bus 25).

Optimization technique	MLP(MW)	Vmin(p.u)	Vmax(p.u)	Computation time(second)
Pre optimization	219.0000	0.8500	1.0500	
Post optimization	229.91	0.8530	1.0700	53.3391

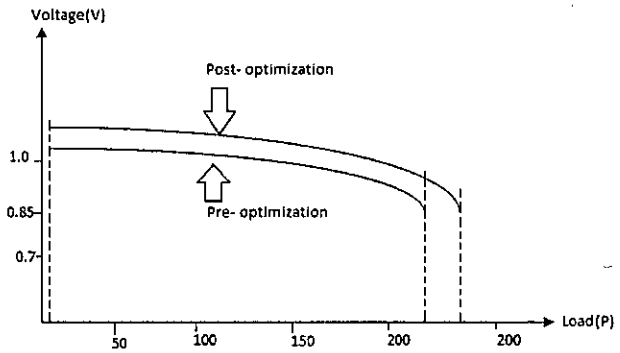


Figure 5: Pre and post optimization result of MLP at the normal condition for critical bus(Bus 25).

Consider (contingency) line outage

Table 2:Pre and post optimization results consider Contingency for critical bus(Bus 25).

Optimization technique	MLP(MW)	Vmin(p.u)	Vmax(p.u)	Computation time(second)
Pre optimization	138.0000	0.8500	1.0500	
Post optimization	151.844	0.8530	1.0700	100.1389

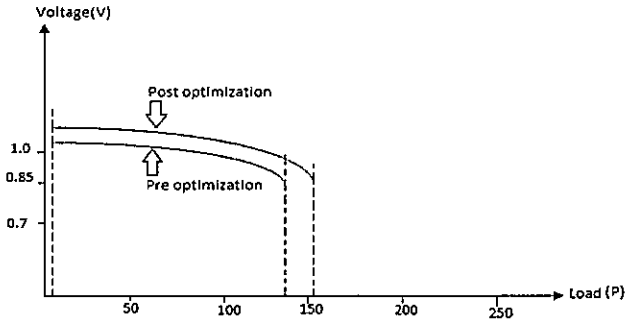


Figure 6: Pre and post optimization result of MLP consider Contingency for critical bus(Bus 25).

This result show detailed about at the pre and post optimization. It can be divided by two categories which are not consider and consider contingency.

Normal condition:

For the pre optimization ,it only consider increase p. However at the post optimization ,it use a evolutionary programming technique (EP).The maximum loading point (MLP) at pre and post optimization are different which are at the post optimization, the value of maximum loading point (MLP) are more high than pre optimization. The value for the voltage still stable for all the technique which are between 0.85 to 1.05 p.u.

Consider (contingency) line outage:

When consider line outage, the value of maximum loading point (MLP) are decrease than not consider line outage for the both technique pre and post optimization. . The value for the voltage also still stable for all the technique which are between 0.85 to 1.05 p.u.

IV. Conclusion

As a conclusion, this paper has shown optimization power flow of the power system. It is important to maximize the total loading which called the load margin. For this project, it consider on line outage which increase the load margin. For the result are expected is by analyzing the Evolutionary programming (EP) technique to increase the power of load margin are maximize the total loading . By using MATLAB software , it is able to analyze the data in using the EP technique. By improve system load margin with control of RPD utilizing EP during normal and contingency condition. When increase the load margin of the system, the voltage must in stability. For the last conclude, through this project it will study about the EP technique with more accurate. Also, it can improvement the system loading that the stability of voltage before the collapsed occur.

V. Future Development

Development in the future, the EP programming technique is proposed to run with bigger system such as IEEE 57-bus and more complex system, smaller range of voltage limit and smaller accuracy limit in order to obtain more optimum results. It also recommended that the EP technique can be implementing with solving the various optimization problems in the power system.

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