DISTRBUTION NETWORK RECONFIGURATION BY USING EVOLUTIONARY PROGRAMING (EP) FOR MINIMIZING POWER LOSSES

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June 2014

“I hereby declare that I have read through this report entitle “Distribution Network Reconfiguration by Using Evolutionary Programming (EP) for minimizing power losses” and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)”

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Date : 9 JUNE 2014

DISTRIBUTION NETWORK RECONFIGURATION BY USING EVOLUTIONARY PROGRAMMING (EP) FOR MINIMIZING POWER LOSSES

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A report submitted in partial fulfilment of the requirement for the degree of Bachelor of Electrical Engineering (Industrial Power)

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2014

I declare that this report entitle "Distribution Network Reconfiguration by Using Evolutionary Programming (EP) for Minimizing Power Losses" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	:	....
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Date	:	9 JUNE 2014

To my beloved mother and father

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ABSTRACT

In the worldwide trend toward restructuring the electricity network, there are a lot of problem. System power loss is one of the problems of distribution utilities. There are a lot of things affecting circuit loss such as sub-optimal configuration of the network, unbalance loading and unbalance line impedance. Currently, by the increasing the electricity demand, intelligence algorithm is one of the solutions that may help in minimizing the power losses in the power distribution network. This project presents a reconfiguration of the modern complex distribution network. The main objectives of this study are to minimize the power losses and improve the voltage profile while analysing the consistency and computing time effectively. The performance of Evolutionary Programming (EP) method for 16kV International Electronic Electrical Engineering (IEEE) test system has been compared with Genetic Algorithm (GA). While, EP achived 90% improvement better than GA respectively. From the result obtain, it can be concluded that EP algorithm is better in power loss reduction if to be compared to the GA algorithm. The results of this study is to help the power system engineers in Malaysia in order to solve the losses problem in the plant at the same time increasing the efficiency of the real 16-bus distribution system.

ABSTRAK

Dalam trend di seluruh dunia ke arah penyusunan semula rangkaian elektrik ; terdapat banyak masalah. Sistem kehilangan kuasa adalah salah satu masalah pengedaran utiliti. Terdapat banyak perkara yang memberi kesan kepada kehilangan litar antaranya adalah seperti sub- optimum konfigurasi rangkaian , beban tidak seimbang dan talian impedans tidak seimbang. Pada masa ini, berdasarkan peningkatan permintaan elektrik, algoritma kecerdasan adalah salah satu penyelesaian yang boleh membantu dalam mengurangkan kehilangan kuasa dalam rangkaian pengagihan kuasa. Projek ini membentangkan konfigurasi semula rangkaian pengedaran kompleks moden. Objektif utama kajian ini adalah untuk mengurangkan kehilangan kuasa dan meningkatkan profil voltan manakala menganalisis konsisten dan masa pengiraan berkesan. Prestasi kaedah “Evolutionary Programming” (EP) untuk 16kV “International Electronic Electrical Engineering” (IEEE) sistem ujian telah dibanding dengan “Genetic Algorithm” (GA). Di mana, EP mendapat peningkatan 90% lebih baik daripada GA. Daripada hasil yang diperolehi, ia boleh disimpulkan bahawa algoritma EP adalah lebih baik dalam pengurangan kehilangan kuasa jika boleh dibandingkan dengan algoritma GA . Hasil kajian ini diharap dapat membantu para jurutera sistem kuasa di Malaysia untuk menyelesaikan masalah kerugian dalam penjanaan pada masa yang sama meningkatkankecekapan sistem pengagihan 16- bas yang sebenar.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIXES

CHAPTER 1

INTRODUCTION

1.1 Research Motivation

A lot of interest in development and studies that can minimize energy cost and reducing transmission and distribution losses. Network reconfiguration is the best technique in order to minimize the losses in 11kV, 16kV, 33kV, 69kV and 129kV distribution system. Nevertheless, the reconfiguration for 16kV distribution network is critical and not frequent in Malaysia. So that, the research on 16kV distribution network by using Evolutionary Programming (EP) could be helpful in finding the optimal solution for this field of study. This study could be useful for Tenaga Nasional Berhad (TNB) or other large company as a reference for minimizing the power losses in the network system.

1.2 Problem Statement

Due to increasing the power system demand from the users, it will effect to the distribution network power losses. Distribution network failure will increase the operating cost and major in economic losses. The arrangement of open and close switches is one of the important role in order to reduce the power losses. In other word, the Evolutionary Programing may help to minimize the power losses in the distribution network system.

1.3 Objectives

There are two objectives of this project. They are:

- To minimize the power losses in the distribution network system.
- To improve the voltage profile in the distribution network system.

1.4 Scope of Research

Scopes of this project are to focus on minimizing power losses by using the Evolutionary Programming (EP) method. Other than that, is focuses on a research of 16kV distribution network using the 16-bus test system distribution network and while remain on the radial network.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The literature review is past studies related to EP method, GA method and DNR system which is about reducing the power losses, improving the voltage profile and research finding about the performance of the DNR which is using the mathematic and optimization methods for minimizing the power losses that applied on medium voltage. The comparison between EP and GA method are also be review in history to compared their best method. The detail function of EP, GA method and DNR also had been discussed in previous related work.

2.2 Distribution System

The distribution system is the part which contents the distribution substations to consumers' service-entrance equipment. The primary distribution lines are usually in the range of 4 to 34.5kV. The small industrial customers are served directly by primary feeders. The secondary distribution network reduces the voltage for utilitization by commercial and residential consumers. The secondary distribution serves most of the costomers at level of 240/120 V, single-phase, three wire; 208Y/120 V, three-phase, four-wire; or 480Y/277 V, three-phase, four-wire. The power for a typical home is derived from a transformer that reduces the primary feeder voltage to 240/120 V using three-wire line.

2.3 Types of Distribution Network

a. Radial

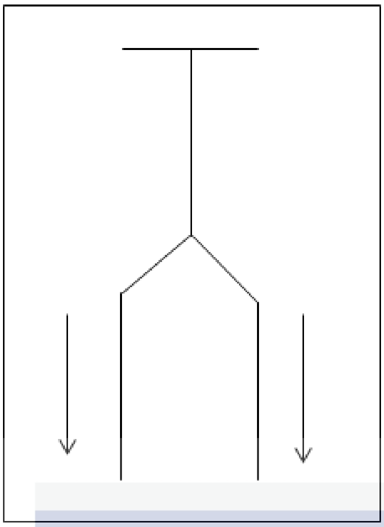

Figure 2.1: Radial system

- For radial, only one path between substation or servise transformer and customer. The power flow is from substation to customer along single path. Furthermore, radial is cheap and predictable to use and simple to analyse.

b. Loop

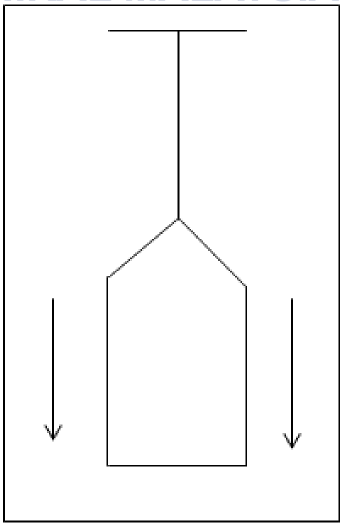

Figure 2.2: Loop system

- For loop, two path between substation transformer and customer. Power flow is usually from both sides to the middle. The equipment is rated so that service can be maintained if an open point occurs in the system.

- Mesh

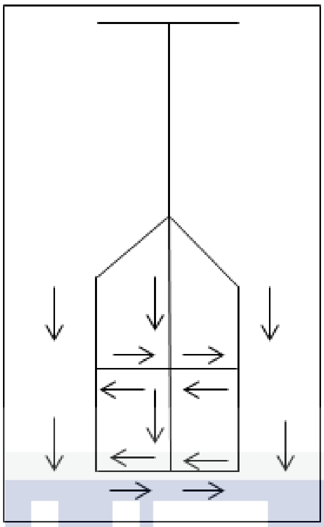

Figure 2.3: Mesh system

- For mesh, multiple path between all point in the network. Power flow between any two points is split along several paths. It is most realible method of distributing electricity. If failure occurs, power instantly reroutes itself. Other than that, it is usually used in high density urban area where maintenance and repairs are difficult and costly.

2.4 History of EP

Evolutionary computation started to receive significant attention during the last decade, although the origins can be detected back to the late 1950's [1]. This technique describe the purpose, the general structure, and the working principles of different approaches, including genetic algorithms (GA), evolution strategies (ES), and evolutionary programming (EP) by analysis and comparison of their most important constituents. In [2] the 1960s, Rechenberg (1965, 1973) introduced "evolution strategies" (Evolutions strategy in the original German), a method that used to optimize the parameters for devices such as airfoils. The idea then was further developed by Schwefel (1975, 1977). The field of evolutionary strategies has permanant an active area of research, mostly developing independently from the field of genetic algorithms (although recently the two communities have begun to interact). Fogel, Owens, and Walsh build "evolutionary programming," in 1966, a technique in which candidate solutions to given tasks were represented as finite−state machines, then by randomly mutating and after that selecting the fittest. Several other people working in the 1950s and the 1960s developed evolutionin ideas algorithms for optimization and machine learning. Box (1957), Friedman (1959), Bledsoe (1961), Bremermann (1962), and Reed, Toombs, and Baricelli (1967) all worked in this area, though their work has been given little or none of the kind of attention or follow up that evolution strategies, evolutionary programming, and genetic algorithms have seen.

2.5 History of GA

Genetic algorithms (GAs) were created by John Holland in the 1960s and were developed by Holland and his students and colleagues at the University of Michigan in the 1960s and the 1970s. Holland's original goal was to formally investigate the phenomenon of adaptation as it occurs in nature and to develop ways in which the mechanisms of natural adaptation might be imported into computer systems and not to design algorithm to solve problem which are differ from evolution strategies and evolutionary programming. Adaptation from Holland's book in Natural and Artificial Systems shown the genetic algorithm as an abstraction of biological evolution and gave a theoretical framework for adaptation under the GA. Holland's GA is a method for moving from one population of "chromosomes" to a new population by using a kind of "selection" together with the genetics inspired operators of crossover, mutation, and inversion [2].

2.6 Previous Related Work

Evolutionary programming from genetic mechanisms, is a random search algorithm. It has good dependabality and obvious superiority to solve nonlinear optimization problem with a non-differentiable objective function [3]. From this paper, the author has proposed multi-objective reconfiguration algorithm based on evolutionary programming and considered both objects of minimum power loss and branch load balancing with considering the economy and safety of distribution network which is the operator to select switch to close and to open is designed. So, the efficiency of algorithm is higher and can be applied to large-scale distribution. But, the report does not discuss accordingly in term of the small scale network as an example 16kV distribution network.

In the year 2006, the authors report the multiple objective approach that is considered for load balancing among the feeders and also to power loss minimizing, the deviation of node voltage, and branch current constraint violation. This four objective important to the a radial network structure in which all loads must be energized for the research [4]. From the author's conclusion, a heuristic-based fuzzy multiobjective algorithm is the best and has been proposed to solve the network reconfiguration problem in a radial distribution system. The simulation has proved and proposed on a medium-size distribution network and the results are impressive and encourage the implementation of the result in a large-size distribution network.

Another solution on distribution network reconfiguration is proposed the effect of distribution network reconfiguration in the power grid. This methods analyzed the features of these methods and to solve distribution network reconfiguration problem and applied to distribution network reconfiguration. The solution worked out using the algorithm based on the optimal flow pattern may not be optimal or near optimal. But the algorithm combined with heuristic rules can quickly obtain satisfactory results were in 2010 [5]. From the research, it shows the Genetic Algorithm is suitable for solving DNR problem and the application is wide use to solve the problem.

In the same year, the research on implementation of an improved genetic algorithm in the distribution system with feeder reconfiguration to minimize real power losses has been reported [6]. A genetic algorithm (GA) is a search technique used in computing to find exact or approximate solutions to optimization and search problems. Genetic algorithms are a particular class of evolutionary algorithms or also known as evolutionary computation that uses techniques inspired by evolutionary biology such as inheritance, mutation, selection, and crossover or also called recombination. This research on 33 bus distribution where the improvement in crossover and mutation and also shown that improved Genetic Algorithm is more efficient and satisfies the conditions of the global.

In [7], the analysis of sensitivity of evolutionary algorithms is to propose a new idea for solving the problem of the optimal reactive power dispatch. This report develops the Particle Swarm Optimization (PSO) and Genetic Algorithm (GA) for reduce real power loss and improve the voltage profile of giving interconnected power system. Then, the EP is method to run to make the iteration complete. Shunt capacitor is one of solution for loss sensitivity. The solution is compared with another method such as simulated annealing and simple quadratic programming.

On the other hand, the ideas of evolutionary programming are a good global optimization method. By introducing the improved adaptive mutation operation and improved selection [8]. This report verifies with the simulation experiment of typical optimization function. The experiment is compared between others algorithm such as evolution strategies, genetic algorithm, simulated annealing (SA), tabu search (TS) and other. Evolutionary programming disadvantages is its slow convergence to a good near optimum. The result after research shows that in new algorithm, evolution is performed with different mutation strategy and the simulation of new adaptive give the best performance in evolutionary programming especially in global convergence.

In the year 2012, "Radial network reconfiguration and load balancing for loss minimization using genetic algorithm" [9]. This paper is tested on 14-bus test system where to reduce load balancing. This paper also tests the result for the 123-bus test system. Then, the paper minimized losses for unbalanced radial three phase system the combined methods of phase load balancing and network reconfiguration. Phase load balancing and network reconfiguration in the distribution system is used to reduce circuit losses while satisfying electrical constraints and also can deleting overload condition, balance feeder loads, and improve the voltage profile simultaneously.

The reconfiguration of distribution networks is an important combinatorial problem [10]. This paper is tested on large scale network at area of Energy Australia. The objective of this paper is carried out over two domains simultaneously; there are re-switching strategies and transformer tap-changer adjustment by using the Evolutionary Programming (EP) method. It also implements two evolutionary algorithms in the research. There are, genetic algorithm, applied to re-switching strategies and tap-changer adjustment and the other one of the algorithm is memetic algorithm applied to the same problem with genetic algorithm. From the research, the results show memetic algorithm obtained the best result compared to a genetic algorithm with least the number buses uses with considering the re-switching strategies and tap-changer adjustment.

In [11], the paper has proposed technique determines the best combination of generator that should be dispatched in the system considering loss reducing or improving voltage stability. This paper discusses on generators for performance the reactive power that will lead to non-economical result which is rather unnecessary. So, the research presents a new approach for selecting generators perform optimally using evolutionary programming on IEEE 33-bus bar.

Back to the year 2010, research by Men-Shen Tsai, Member of IEEE, and Fu-Yuan Hsu have done in title “Application of Grey Correction Analysis in Evolutionary Programming for Distribution System Feeder Reconfiguration” [12]. During a feeder reconfiguration, many objective is considered by the distribution system operators. With the complexity of the reconfiguration problems, to solve it the system operators are finding for assistance from a computer program that can provide adequate switching plans to reconfigure the feeders so that the truth goal can be achieved. This author makes differentiation between two distribution system on application of grey correction analysis so it can choose the best and can help the Evolutionary Programming for choosing it feeder in the distribution system.

Research on "A comprehensive Power Restoration Approach Using Rule-Based Method for 11kV distribution network" had been done on 2008. The problem are to optimize power dispatch, achieve rapid restoration plan with lowest number of switching involved and to reduce technical loss (I^2R) without violating technical and operational constraints in the network [13]. This research done on 11kV underground cable distribution network and choose three test configuration that are one feedback, two feedback and three feedback respectively. Being tested on two conditions with are with and without technical and operational violation. Then, this method is able to perform the best solution restoration plan.

Line loss calculation data used in the previous distribution network reconfiguration was historical load data or real-time data. And that to minimize the realistic significance of distribution network reconfiguration. A new technique is presented in [14]. This research on the year 2008 which is applying the Genetic Programming on Load Forecasting also the distribution network reconfiguration used partheno-genetic algorithm (PGA) and it improved according the features of the distribution network. The research result was presented and the load forecasting adopted GA and also PGA and improved.

Other research is held in the year 1997 and the title is "Distribution Network Reconfiguration on energy loss reduction". The methods was combined with the heuristic rules developed to lead the iterative process and make the energy loss minimization method effective, robust and fast [15]. This method can be used to minimize the energy losses and by further improved heuristic rule used to lead the minimization process. The method is suitable to uses in this research for energy loss reduction.

On August 2004, the other research done by the title is "Voltage Regulation and Power Losses Minimization in Automated Distribution Networks by an Evolutionary Multiobjective Approach" [16]. This research on two different objectives they are the problem on voltage regulation and minimization the power losses then the heuristic strategy used based on fuzzy set theory.

In year 2009, the research on network reconfiguration to study the present of a new method that improved genetic algorithm for loss and reliability optimization in the distribution system. This research done on 69 bus radial distribution system (RDS) [17].

From the research, it shows that the efficiency of the distribution system is achieved through the improved genetic algorithm for losses and reliability optimization in the distribution system.

In [18], the paper is proposed on distribution network reconfiguration with modified the genetic algorithm. The objective is to minimize the system power loss with applied on 16-bus, 33-bus and real distribution network of Mauritius by changing the status of sectionalizing switches and is commonly done for loss reduction. From the result, genetic algorithm found that the system more likely to obtain the global optimal solution in less time than the exhaustive search and heuristic search methods. The genetic algorithm is improved by chromosome coding, fitness calculation, crossover and mutation pattern where there is problem in distribution network reconfiguration.

In year 2008, research on evolutionary algorithm but focus on the radial distribution network that specified for long interruption and voltage disruption costs [19]. The problem occurs in a radial distribution system under different load conditions and for voltage disruption cost where considers power quality indices such as long duration interruptions and customer process by using simulation method, Mento Carlo. Commonly, electric power distribution system should operate in radial configurations. Strategic point of normally open and normally closes is located along the network. In this research, the result finds that a new method to determine the best configuration by simply changing the status of some few network switches. So, can conclude that can give benefit to the utility and for the customer since aspect related to the network losses, voltage regulation, capacity loading and power quality.

In the other year, 2007. The author makes research on distribution network reconfiguration by using an efficient evolutionary algorithm [20]. This is done by renovation the network structure of distribution feeder by changing the open or close sectionalizing switching. The research can minimize the power losses and also reducing the overloading of the network components. Is test on 14-bus bar test system. This paper proposed different ways to implement the genetic operator which make the algorithm to take advantage of the problem characteristic in order to improve in efficiency, narrow the search space and speed up the process. Then, the combination with an efficient evolutionary algorithm is such as Che Beasley Genetic Algorithm, yield as result an efficient and very fast tool to network reconfiguration.

In [21], this paper proposed a title of improved evolutionary programming for reduce distribution feeder losses. The paper presents an evolutionary programming process to reach the optimum after reproduction, mutation, competition, and selection procedure. Then, the distribution system has normally open and normally closed switches. The author focuses on the minimization of the real power loss, on voltage and current constraint subjected to the radial network structure. The research test on 32 bus test system and 5 tie-switches. The results show, improve evolutionary programming can solve the problem of the feeder reconfiguration.

This paper present in the year of 2001, the title is for focusing on minimizing the power losses [22]. The objective of the paper proposed is to reduce active power losses without solving any load flow in the optimization process but ensuring the radial configuration and other realistic constraints. The method is used in this paper are based on two ideas. They are Piecewise linear approximation of power losses and the notion of path to model radially constraints. The research Distribution system that finds the each individual branch can be opened or closed switching with every line. By finding that the path which should be active for each node in the result, then the losses are reduced and loops are prevented.

2.6 Summary of the Review

From all of this related research work, it can be summarized that a lot of method and technique can use to minimize the power losses. There are test on 11, 33, and 69 bus bar system but fewer for 16 bus system. So that, this project will be use the 16-bus system while Evolutionary Programming(EP) is applied in order to reconfiger the network.

CHAPTER 3

METHODOLOGY

3.1 Project Methodology

The research project is undertaken by following stage of task and flow chart. On the previous related work, several papers are reviewed, evaluated, analysed and be as motivated to proceed with the research project. Meanwhile, the methodology step for this project consist of task (1), which is understanding the EP method, for task (2) is mathematical model, for task (3) is the load flow and line losses and for task (4) is implementation of EP method in distribution network reconfiguration. Task (1) including the flow chart of Gaussian based on EP approach. Task (2) including flow chart of implementation of EP.

3.2 Analytical Approach for Understanding of EP method

Task 1: Understanding of EP method

The power losses's problem in distribution network could be solved by using the EP. The network is optimized when the open and closed switches are positioned and it is considered as the basic fitness function. Tie switches are symbolized by using the integer such as 1, 2 or 3. Evolutionary Programming (EP) was originally conceived by Lawrence J. Fogel in 1960 [21]. In EP, mutation is done according the Gaussian or any other mathematical formulation.

The EP is an excellent method for searching optimal solution to a complex problem. Generally, there are several steps for developing EP. The steps are:

i. Random generation of initial population
ii. Fitness computation
iii. Mutation
iv. Combination
v. Tournament selection
vi. Transcription of next generation

Step 1: Random generation of initial population

The process for the optimal solution is done by determining a population of candidate solution over a number of generations randomly.

Step 2: Fitness computation

The strength of each candidate solution is determined by its fitness function which is evaluated based on the constraint in the objective function of the optimization process.

Step 3: Mutation

Others will combine through a process of mutation to breed a new population.

Step 4: Combination

Combination process will occur after the mutation that will combine the parent and offspring.

Step 5: Tournament Selection

Tournament selection is choosing the survival to next generation.

Step 6: Transcription of next generation

The new population is evaluated and the process is repeated.

Optimization in the EP can be summarized into two major steps:

a) Mutate the solution in the population- mutational transformations (β) play a crucial role in EP. It is the key search operator which generates new solutions (offspring) from the current one (parent).
b) Select the next generations from the matured and the current solutions.

Therefore, Figure 3.1 below shows the comparative flow chart of standard Gaussian based EP approach:

i. Gaussian based EP approach

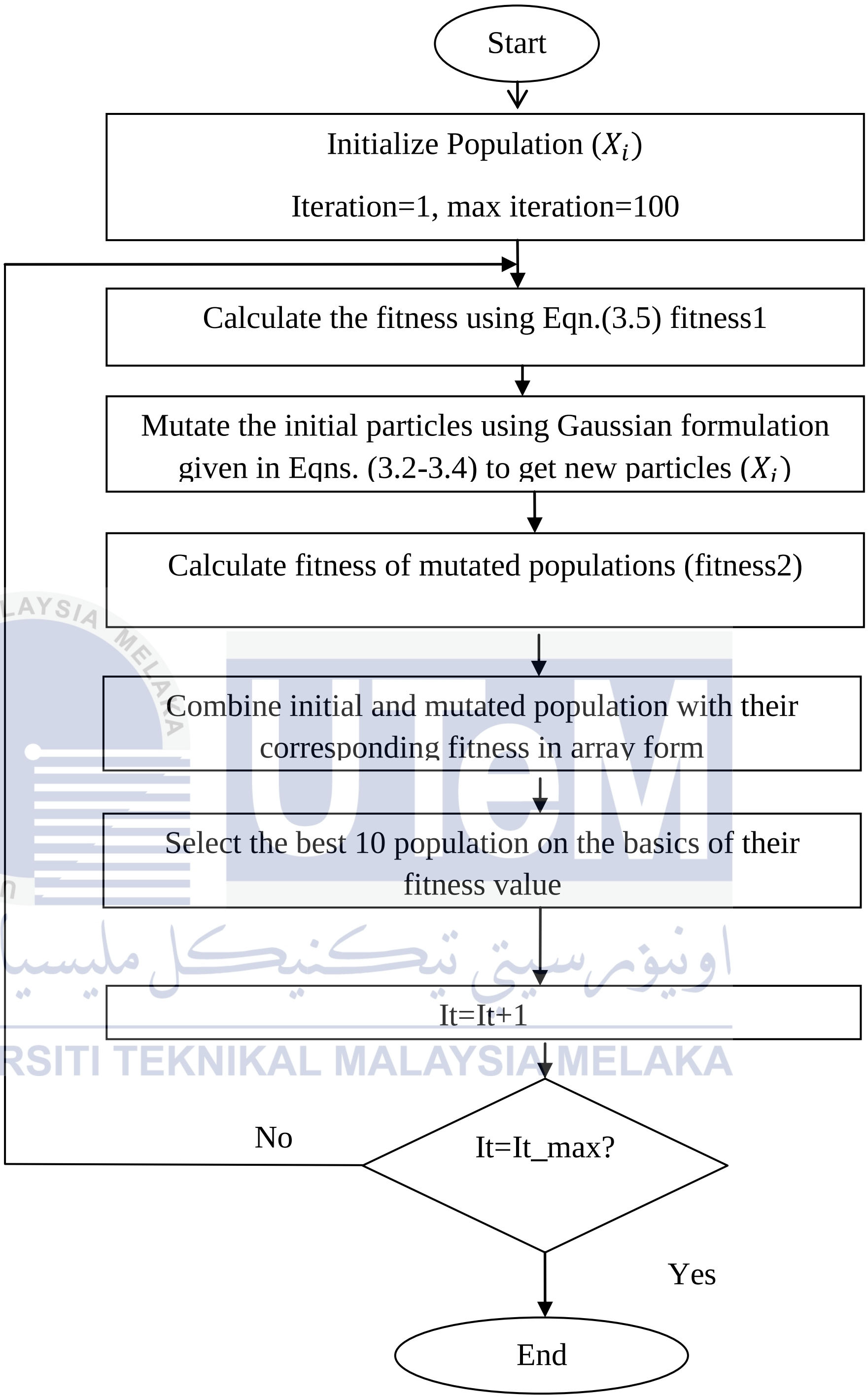

Figure 3.1 : Gaussian based EP approach

In EP different approaches have been stated to mutate the current parent particles X_i to get the off-spring particles $X_i{}'$, given by equation (3.1)

$$X_i'(j) = X_i(j) + N(\mu, \sigma^2) \tag{3.1}$$

Where j representing the component of xi, N(μ,σ2) is the Gaussian formulation with a mean (μ) and variance (σ2).Gaussian formulation is one of the most common strategies to mutate the current particle. A mutation operator is called mutation strategy, if the random variable *xi* satisfies the probability density function.

Updating Eq. (1) With truncated Gaussian parameter results in Eq. (3.2).

$$X_i'(j) = X_i(j) + \sigma_i'(j) \times n \tag{3.2}$$

Where, *σ'i(j)* is the approximate mutation scale of the *jth* component, given by Eq. (3).

$$\sigma_i' = \sigma_i(j) \times (1 + alpha^n) \tag{3.3}$$

Where, alpha is a constant (σ =2.198) and n is a pseudo random vector, given by Eq. (3.4).

$$\text{n=Truncated Gaussian (sigma, [Range])} \tag{3.4}$$

Here sigma is treated as 1 and range is -1 to +1.

Minimization of power losses is considered as fitness function, given by Eq. (3.5)

$$f = Min\{P_L = \{\sum_{i=1}^{n} |I_i|^2 R_i\} \tag{3.5}$$

Where,

I is the line current in branch *I*,

R is the resistance of branch *I*,

n is total number of branches.

3.3 Mathematical model for Distribution Network Reconfiguration

The most important of distribution network reconfiguration is to search a radial operating structure that minimizes the system power loss while satisfying operating constraints. Then, network reconfiguration for loss minimization can be formulated as follows:

Minimize:

$f_c = \sum_{i=1}^{n} Loss\ i \qquad i \in NL$

I.e $f_c = \sum_{i=1}^{n} |I_i|^2 k_i R_i \qquad i \in NL$ (3.6)

Where:

f_c is the loss function, I_i is the current in branch i, R_i is the resistance of branch, NL is the total number of branch and k_i is the variable that represents the topological status of the branch (0=open, 1=close).

From (3.6), the total power loss can be increased when the main source is sending the large amount if current, I_i through certain branch in the network to achieve the target demand at the end of feeder. But, with the reconfiguration network, it can be solved the problem to minimize the power losses by changing the closed and open switching in the network.

Subject to the following:

a. Radial network constraint

Distribution network should be composed of the radial structure considering operational point of view.

b. Node voltage constraint

Voltage magnitude at each node must lie within their permissible ranges to maintain power quality. The standard minimum voltage used is 0.95 and maximum voltage is 1.05(1±5%).

$V_{min} \leq V_{bus} \leq V_{max}$ (3.7)

c. Feeder capability limits

$|I_k| \leq I_k^{max} \in \{1,2,2 \dots \dots\}$ (3.8)

Where I_k^{max}= maximum current capability of branch k.

3.4 Load flow and line losses

In this report, the Newton Raphson load flow method has been used. Where, load flow studies are need in scheduling, economic planning, control of the existing system and planning its future expansion.

The Newton-Raphson load flow equation as follow:

$$P_i = \sum_{j=1}^{n} |Y_i||V_j||Y_{ij}| cos(\theta_{ij} - \delta_i + \delta_j) \tag{3.9}$$

$$Q_i = -\sum_{j=1}^{n} |Y_i||V_j||V_{ij}| sin(\theta_{ij} - \delta_i + \delta_j) \tag{4.0}$$

Where,

V_j, V_i: Voltage magnitude of bus *i* and *j* respectively

δ_i, δ_j: Voltage angle of bus *i* and *j* respectively

Y_{ij}, θ_{ij}: Magnitude and angle of *Yij* element in the bus admittance matrix respectively

The equations for the difference in real power (ΔP_i) and reactive power (ΔQ_i) are:

$$\Delta P_i = P_i^{sp} - P_i \tag{4.1}$$

$$\Delta Q_i = Q_i^{sp} - Q_i \tag{4.2}$$

P_i^{sp} and Q_i^{sp} are the specified real and reactive power at bus *i* respectively.

The rectangular Newton-Raphson power flow is expresses as:

$$\begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} = \begin{bmatrix} \frac{\partial P}{\partial \delta} & \frac{\partial P}{\partial V} \\ \frac{\partial Q}{\partial \delta} & \frac{\partial Q}{\partial V} \end{bmatrix} \begin{bmatrix} \Delta \delta \\ \Delta |V| \end{bmatrix} \tag{4.3}$$

Power loss equation as follow:

$$P_{loss} = \sum_{i=1}^{n} \sum_{i=1}^{n} A_{ij}(P_i P_j + Q_i Q_j) + B_{ij}(Q_i P_j - P_i Q_j) \tag{4.4}$$

$$A_{ij} = \frac{R_{ij} \cos(\delta_i - \delta_j)}{V_i V_j} \tag{4.5}$$

$$B_{ij} = \frac{R_{ij} \cos(\delta_i - \delta_j)}{V_i V_j} \tag{4.6}$$

Where,

P_i: Real power at bus *i* respectively

P_j: Real power at bus *j* respectively

Q_i: Reactive power at bus *i* respectively

Q_j: Reactive power at bus *j* respectively

R_{ij}: Line resistance between *i* and *j*

$V_i V_j$: Voltage magnitude of bus *i* and *j* respectively

δ_i δ_j: Voltage angle of bus *i* and *j* respectively

3.5 Analytical Approach for Implementing the Evolutionary Programming (EP) method in Distribution Network Reconfiguration (DNR)

Task 2: Implementation of EP in DNR for power loss minimization and voltage profile improvement.

The programming will be written and used the entire data network. The EP programming will be tested on MATLAB for result analysis. The EP will compared with Genetic Algorithm (GA) method to show the minimizing in power losses. This EP technique will compared with the existing references and journals of GA that fulfill the IEEE 16kV test system standard.

ii. The flow chart of implementing an EP algorithm by MATLAB programming is shown in Figure 3.2:

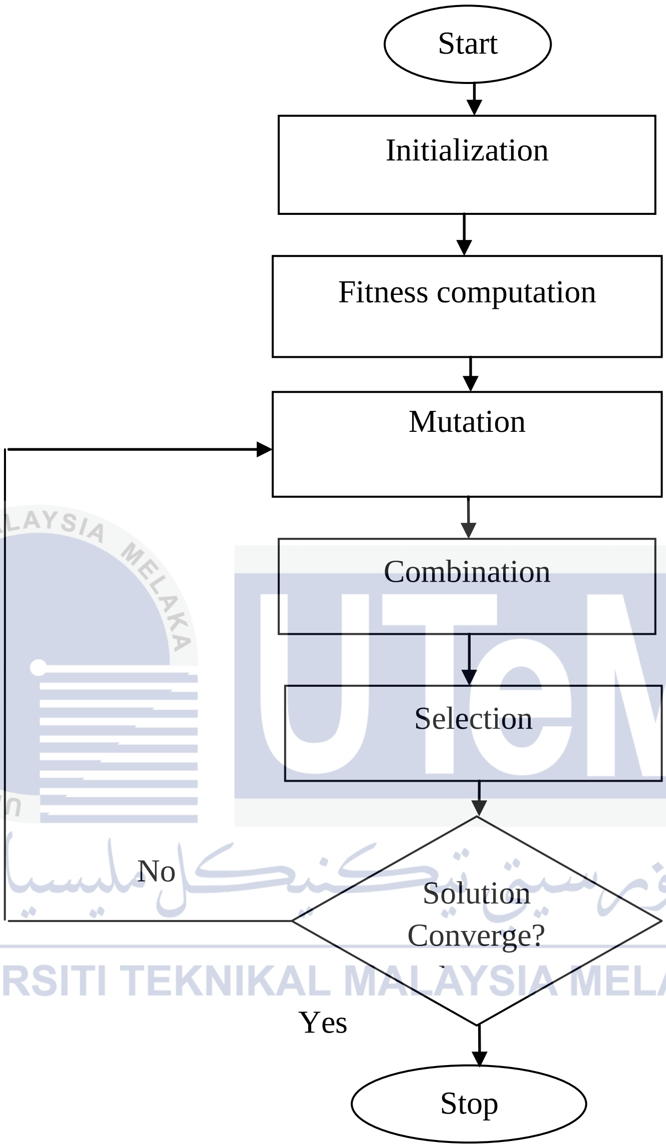

Figure 3.2: Flowchart of EP implemented in Network Reconfiguration

3.5.1 Initialization

Input system data includes network data, buses data, lines data, and data to run EP such as maximum iteration, population size and accuracy are inserted in the MATLAB program. The initialization population is determined by selecting tie switches from the set of original tie switches. After that, the variable will be generated by the system via a random generator available in the program and they will be utilized to compute the power losses in the next step. Equation of tie switches as shown:

$$X = [s_1, s_2, s_3 \dots \dots \dots .. s_\gamma] \qquad (4.7)$$

Where,

S= variable for tie switch

γ= number of tie switches

Furthermore, to ensure the radial network is maintained, several constraint needs to be considered in the system. There are several conditions have been adopted for the selection switches:

Condition1: All switches that do not belong to any loop are to be closed.

Condition 2: All switches are connected to the sources are to be closed.

Condition 3: All switches contributed to a meshed network need to be closed.

3.5.2 Fitness Calculation

For the fitness calculation is the type of objective function that need to optimized and solved for the power loss of the system. The power flow will be accomplished and the total power loss will be calculated using the Newton-Raphson load flow program for each particle that fulfills the constraint. Subsequently, evaluation of maximum, sum and average of fitness is carried out which will be utilized in the mutation process.

3.5.3 Mutation

Mutation is the process of generating the offspring of the random numbers. The Gaussian mutation technique has been used in this project. It has been implemented by using below equation:

$$X_i = X_{i,j} + N(0, \gamma^2) \tag{4.8}$$

$$\gamma^2 = \beta(X_{j\,max} - X_{j\,min}\left(\frac{f_i}{f_{max}}\right)) \tag{4.9}$$

Where:

$X_{i+m,j}$= Mutated parents (offspring)

X_{ij}= Parents

N= Gaussian random variable with mean μ and variance γ^2

β= Mutation scale, 0< β<1

$X_{j\,max}$= Maximum random number for every variable

$X_{j\,min}$= Minimum random number for every variable

f_i= Fitness for the i^{th} random number

f_{max}= Maximum fitness

The mutation scale or search step, β determine the convergence rate. Large value or β will cause slow convergence of the EP since it implies to a large search step. Thus it will lead to large computation time.

3.5.4 Fitness Calculation & Combination

At this stage, the fitness function (power losses) is recalculated in order to get new value based on the new generate state variables (new tie switch) during mutation process. Subsequently, the combination process will combine the parents and offspring (tie-switches) in cascade mode.

3.5.5 Tournament Selection

EP take a selection through the tournament scheme as to choose the survivals to the next generation. This selection is used to identify the tie-switches that can be transcribed into the next generation from the combined populations of the parent and offspring (tie-switches). The priority selection was done whereby the arrangement of tie-switches with optimal values were sorted in descending order according to their power losses in MW.

3.5.6 Convergence Test

Convergence test is required to determine the stopping criteria of the evolution. The convergence criteria are specified by the difference between maximum and minimum fitness≤ 0.0001. The mathematical equation is given as follow:

$$maximum_{fitness} - minimu_{fitness} \leq 0.0001 \qquad (5.0)$$

3.6 Summary

The method used in this project is EP method which are comparing with the GA method and initial configure. The most important part in the methodology is implementation EP method in DNR. There are the initialization, fitness calculation, mutation, fitness calculation and combination, tournament selection and convergence test to determine the stopping criteria of the evolution. Therefore, it is hoping to achieve the best result in improving voltage profile and also better in power losses with EP method.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Overview

This project has used the test system which consists of 16-bus radial distribution system as shown in Figure 4.1. The system consist of 3 feeders, 13 sectionalizing switches (normally close switches) and 3 tie switches (normally open switches with dotted line) and located on branch No. 14, 15, and 16. This system has 13 load centers and is assumed to be constant with initial load capacities for total real and reactive powers are 28.7MW and 16.3MVAr respectively. The base MWA for the system is set at 100MVA. In other word, the total optimization variable is represented by combination of 3 switches (X1, X2, and X3). After that, all the population will be evaluated by using load flow analysis. The power flow program, Evolutionary Programming and Genetic Algorithm are implemented in MATLAB environment. All calculation for this method are carried out in the per-unit system.

4.2 Test Simulation and Test system

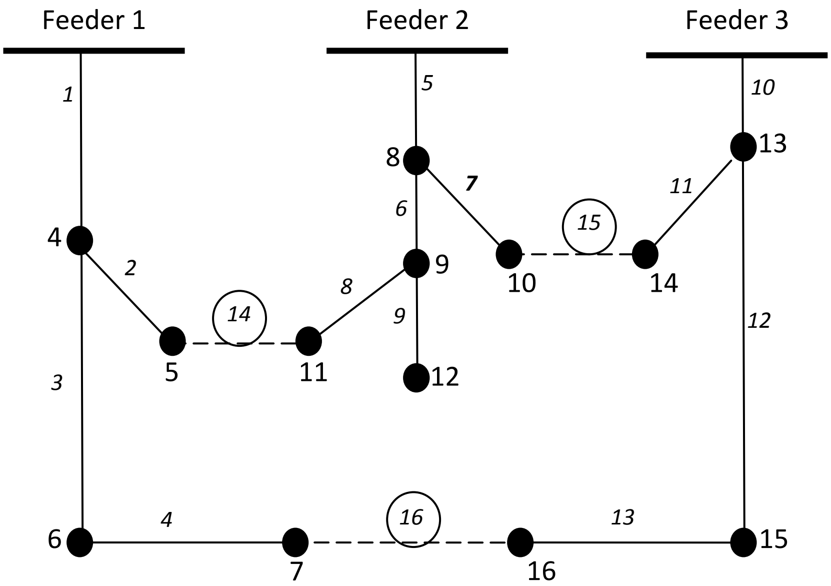

Figure 4.1: IEEE 16-bus distribution initial network

Three cases have been executed in determining their reliability of having EP and GA in the system to achieve best configuration.

1. *In the first case*

The system follows the original network distribution of 16-bus without any alteration done. All the switches in the network remain the same.

2. *In this second case*

The reconfiguration strategy is applied in the system is based on GA method.

3. *In this third case*

The reconfiguration strategy is applied in the system is based on EP method.

4.3 Analysis of EP

The proposed algorithm has been tested on radial 16-bus distribution test system. The numerical result of the three cases is summarized in the Table 4.1 while the Table 4.2 and Table 4.3 represent the consistency of Genetic Algorithm method and Evolutionary

Algorithm method respectively. Other than that, the Table 4.4 denote the improvement of voltage profile between GA and EP algorithm.

4.3.1 Power Loss, Performance Analysis and Consistency Analysis

Table 4.1: The performance analysis of the 16-bus systems by using GA and EP

Parameters	First case: Original Network	Second case:GA Simulation (after reconfiguration)	Third case: EP Simulation (after reconfiguration)
Tie lines	14, 15, 16	16,8,11	7,8,16
Power loss (MW)	0.5114	0.4707	0.4661
Loss Reduction (MW)	-	0.0407	0.0453
Loss Reduction (%)	-	7.95%	8.85%

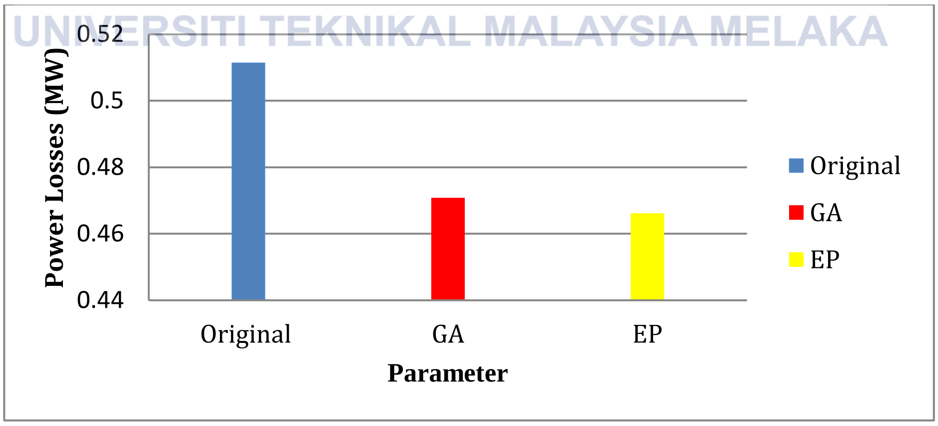

Figure 4.2: Total power losses for original, GA and EP

Table 4.1 shows the result obtained after distribution network reconfiguration from case 2 and case 3. The parameter that have been considered are switches opened, total power loss and loss reduction. There are significant difference in term of power loss reduction between both cases if to be compared with original network. In case 2, by using the GA method, the total power loss is 0.4707MW and 0.0407MW of loss reduction while percentage of reduction is approximately 7.95%. Other than that, the total power loss in case 3 is 0.4661MW while the loss reduction is 0.0453MW if to be compared to the original network. The percentage for loss reduction is 8.85%. From the result, it can be concluded that EP algorithm is superior in terms of power loss reduction compared to the GA algorithm. The Figure 4.2 review the total power losses plotted in the graph presentation.

Table 4.2**:** Table of Consistency GA

No.	**Power losses (MW)**	**Tie lines**	**Converges time (s)**
1	0.4773	3,15,8	0:0:2:30
2	0.4745	7,3.14	0:0:2:07
3	0.4887	13,15,8	0:0:1:97
4	0.4892	11,8,16	0:0:2:56
5	0.4707	8,11,16	0:0:1:80
6	0.4707	11,8,16	0:0:2:20
7	0.4773	3,15,8	0:0:1:93
8	0.4844	14,4,15	0:0:1:89
9	0.4745	3,14,7	0:0:1:98
10	0.4979	14,7,12	0:0:2:14
11	0.4707	8,11,16	0:0:2:61
12	0.4844	4,15,14	0:0:2:20
13	0.4667	8,15,4	0:0:2:30
14	0.5096	14,11,3	0:0:2:47
15	0.4773	8,15,3	0:0:2:00
16	0.4892	8,3,11	0:0:1:93
17	0.4773	3,15,8	0:0:2:07
18	0.4707	11,8,16	0:0:2:56
19	0.4707	11,16,8	0:0:2:16
20	0.4707	16,8,11	0:0:2:47

Table 4.3: Table Consistency of EP

No.	Power losses (MW)	Tie lines	Converges time (s)
1	0.4839	16,14,7	0:0:10:84
2	0.4661	7,8,16	0:0:10:30
3	0.4661	7,8,16	0:0:10:17
4	0.4661	7,8,16	0:0:09:54
5	0.4661	7,8,16	0:0:10:17
6	0.4661	7,8,16	0:0:09:36
7	0.4661	7,8,16	0:0:09:40
8	0.4661	7,8,16	0:0:09:40
9	0.4661	7,8,16	0:0:09:49
10	0.4661	7,8,16	0:0:09:54
11	0.4661	7,8,16	0:0:09:67
12	0.4661	7,8,16	0:0:09:58
13	0.4661	7,8,16	0:0:09:76
14	0.4661	7,8,16	0:0:09:90
15	0.4661	7,8,16	0:0:09:58
16	0.4661	7,8,16	0:0:09:76
17	0.4661	7,8,16	0:0:09:58
18	0.4661	7,8,16	0:0:10:00
19	0.4661	7,8,16	0:0:09:49
20	0.4661	7,8,16	0:0:09:54

Table 4.2 and Table 4.3 indicate the consistency of methods, GA and EP algorithm. It can see from the Table 4.2 show the consistency of converges time for GA method and Table 4.3 that the consistency of converges time for EP method. In other word, both tables show the consistency of time. Furthermore, the optimization results are better in longer runtime which is convergence time for EP method is longer than convergence time for GA method [8]. Meanwhile, for better understanding, the result of consistency have shown and explained in other graph.

The consistency of GA and EP techniques in term of power loss and convergence time has been shown in Figure 4.3 and Figure 4.4 concurently.

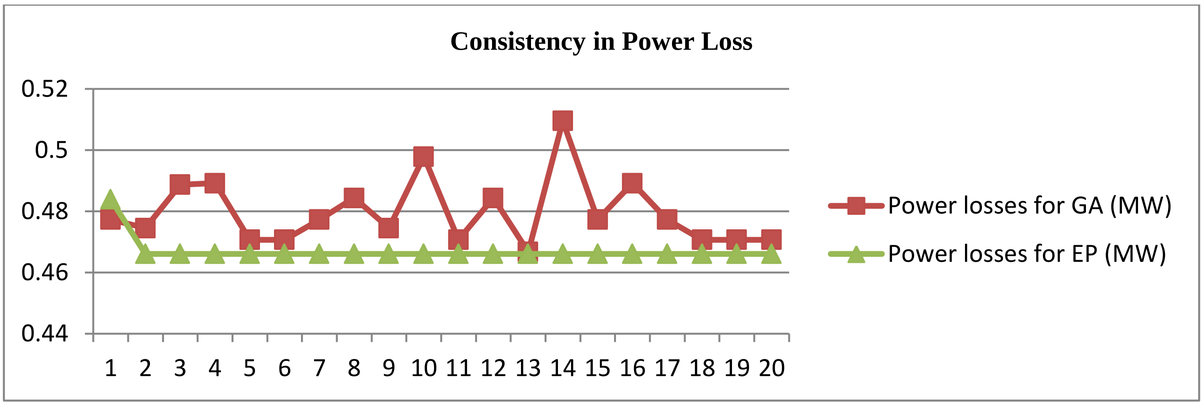

Figure 4.3: Consistency in Power Loss between GA and EP

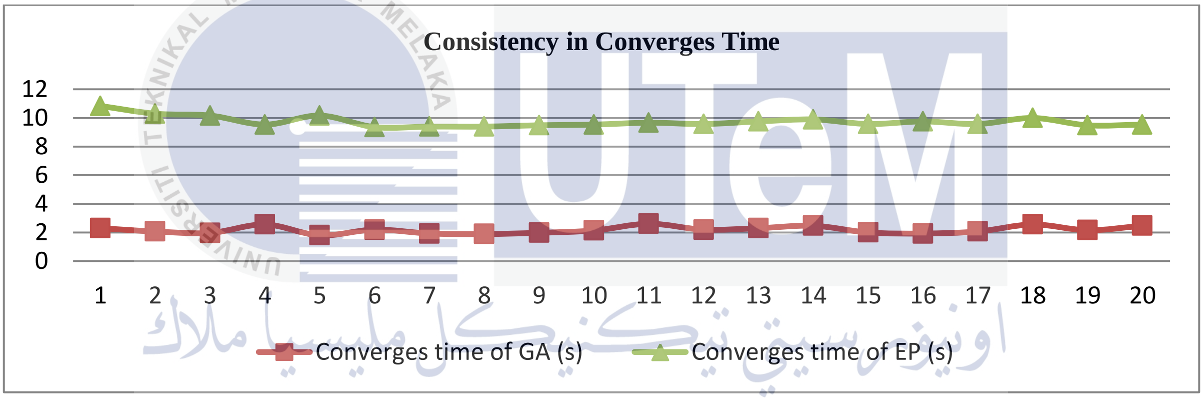

Figure 4.4: Consistency in Converges Time between GA and EP

In order to determine the robustness and the consistency for both algorithm method, the program has run for 20 times to veritfy the converges time and power loss for the test system. From Figure 4.3, the power loss for GA is not consistence. The graph shown increase and decrease in power losses. Nevertheless, for EP method, the graph is consistence and linear starting at 2nd until 20th program running. In other word, EP method has achieved the stabilize level so that the value of power losses are remain the same. In addition, the Figure 4.4 shows the consistency of converges time comparison between GA and EP method. From the observation both methods achieved virtous consistency simultaneously. However, the GA method get lower and fastest convergence time if to be compared to EP method. Where, in EP method the converges time get more longer. Optimization results are better in longer runtime.

4.3.2 Voltage Profile Analysis

Table 4.4: Voltage Profile Comparison between GA and EP

Bus no.	Voltage mag. for initial	Voltage mag. for EP	Voltage mag. for GA
1	1.000	1.000	1.000
2	1.000	1.000	1.000
3	1.000	1.000	1.000
4	0.990	0.991	1.000
5	0.916	0.998	0.927
6	0.983	0.986	1.000
7	0.985	0.985	0.999
8	0.980	0.981	0.944
9	0.971	0.973	0.933
10	0.975	0.990	0.968
11	0.927	0.988	0.929
12	0.968	0.972	0.931
13	0.992	0.992	1.000
14	0.990	0.991	0.977
15	0.990	0.990	0.998
16	0.990	0.989	0.998

The Table 4.4 is voltage profile comparison between GA and EP. The voltage profile from bus 8 until 12 shows the improvement of EP from GA and initial. From bus 8, EP gets 0.981 follow by 0.973, 0.990, 0.998 and 0.972. While, GA shows lower than EP at bus 8 until 12 and the difference are not effective value between the buses. It shows that EP method has a better value for the voltage profile if to be compared to initial configuration and GA method. The improvement of voltage profile has been plotted clearly in Figure 4.5.

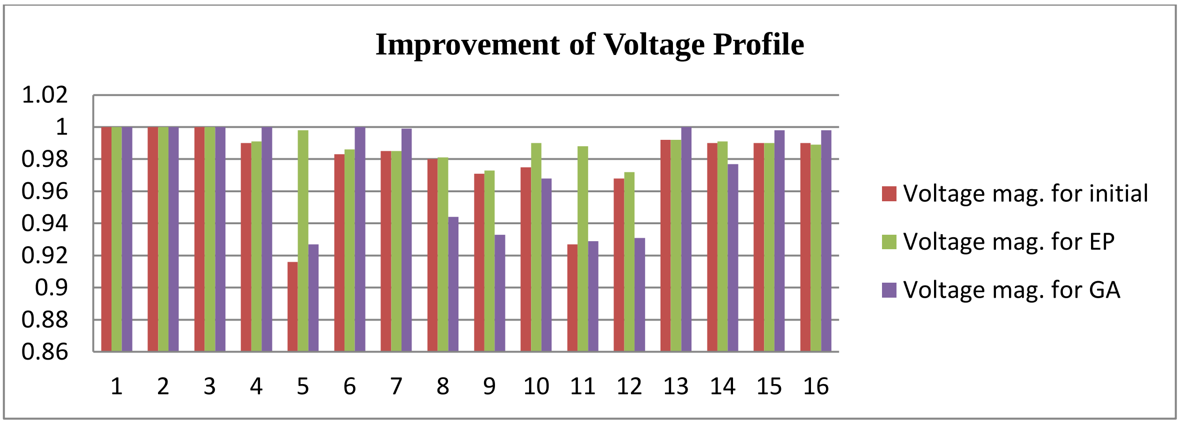

Figure 4.5: Voltage profile improvement comparison between initial configuratuion, GA and EP

The voltage profile for several nodes after reconfiguration at GA and EP method show some significant improvement compared to the initial configuration as shown in Figure 4.5. But, the result obtained is clearly shown the better improvement voltage profile for EP method from the bus 8 until 12. For the EP method, the system at nodes 8 has been increased to 0.981 p.u and follows with nodes 9, 10 and 11 for 0.973 p.u, 0.990 p.u and 0.988 p.u. While for GA method, the system at nodes 8 until 12 shows lower in voltage profile and the value in voltage profile for GA are not stabilize as shown in the graph. The other still remain within the acceptable value.

4.3.3 Feeder After Reconfiguration

The feeder after reconfiguration are presented in Figure 4.6 and Figure 4.7.

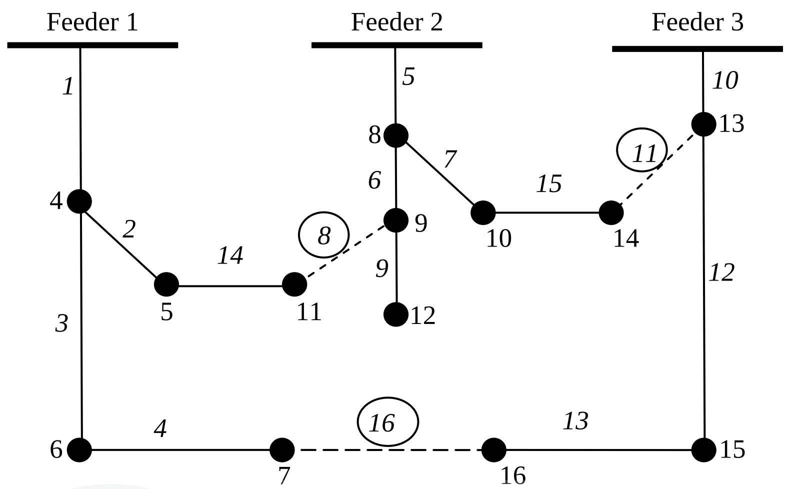

Figure 4.6: The radial network after reconfiguration GA

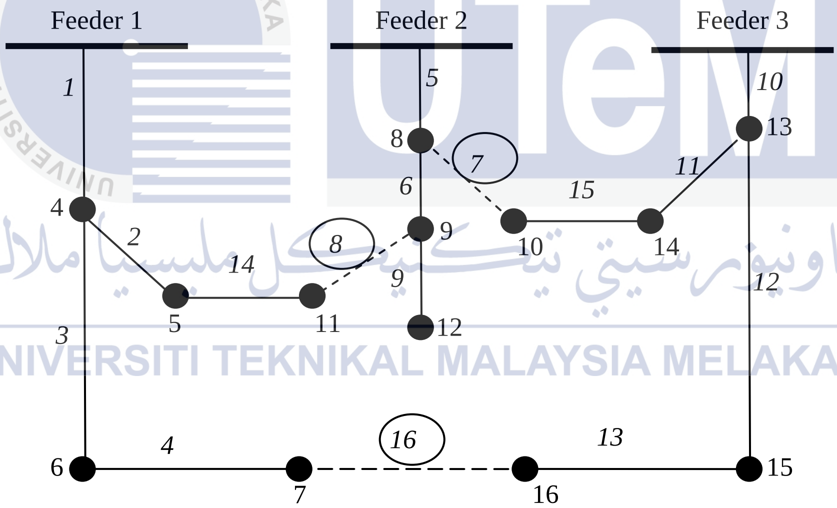

Figure 4.7: The radial network after reconfiguration EP

To get the optimal value of power losses for both cases the sectionalizing switches are contributed in getting the value. The original switches that are opened from original network are at 14, 15 and 16. In case 2, GA algorithm after reconfiguration, the sectionalizing switches opened are 8, 11 and 16 while for EP it is opened at 7, 8 and 16 respectively. The Figure 4.6 and Figure 4.7 show the network topology after the reconfiguration by using both methods accordingly.

On the analysis part, the power loss minimizing can be determined by using the 90% EP method. After simulation test conducted, the data obtained is insert in table and plotted in graph. This method is accepted with the result shown at 90%.

4.4 Summary

As shown in the analysis, all the methods used have been successfully implemented to the 16 radial distribution system test data for the purpose of reconfiguration. All the result obtains show the capabilities of EP method differ from initial network and GA method by improving and increasing the performance of the system. The implementation of EP method in getting the next generation (tie-switches) not only gives impact to voltage, but also power loss reduction.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, it can be summarized that a lot of method and technique can be use for loss minimizing. In this project, EP algorithm method have been developed for the distribution network reconfiguration to minimize line losses and improving voltage profile with get a set of normally closed and normally opened of switches tie line. The superior of the proposed method has shown with the comparison of the results. The performance of the algorithm method were presented and tested on radial distribution IEEE 16 bus test system to solve the losses problems. The algorithm has been implemented by using MATLAB software package and the result obtained shows an improvement if to be compared to GA method. Other than that, for the objective the power loss has positively been reduced and the improvement of voltage profile has been achieved. Furthermore, from the result and analysis, the EP method also produced a feasible and encouraging solution better than initial configuration and GA method. Thus, the implementation of EP method is proved to give a great impact for the 16kV network reconfiguration system.

5.2 Recommendation

The EP method is one of the algorithm that use for reducing the power loss and improving the voltage profile simultaneously. There are many idea for minimizing the power losses on distribution network system. Meanwhile, for improving the method of EP, the "Ranking" concept might be introduced in order to boost the convergence time while searching for the superior numbers of losses reduction. The proposed technique can use the frame of EP while rejuvenating the algorithm by introducing the ranking concept in the future.

REFERENCES

[1] Thomas Back, Ulrich Hammel, and Hans-Paul Schwefel, "*Evolutionary Computation: Comments on the History and Current State*", IEEE Transaction on Evolutionary Computation, Vol.1, No.1, pp 3-17. (1997).

[2] Mitchell Melanie, "*An Introduction to Genetic Algorithms*", A Bradford Book the MIT Cambridge, Massachusetts. (1999).

[3] Zhang Bingda and Liu Yan, "*A Novel Algorithm for Distribution Network Reconfiguration Based on Evolutionary Programming*," The International Conference on Advanced Power System Automation and Protection, Vol.1, No.1, pp 31-35. (2011).

[4] Debapriya Das, "*A fuzzy multiobjetive approach for network reconfiguration of distribution system*," IEEE Transaction on power delivery, vol.21, No.1, pp 202-209. (2006).

[5] Yitao Hui, Ning Hua, Chun Wang, Liao lang Gong and Xiangshuo Li, "*Research on distribution network reconfiguration*," International conference on computer, mechatronics, control and electronic engineering (CMCE), Vol.1, No.1, pp 176-180 (2010).

[6] P.Ravibabu, M.V.S.Ramya, R.Sandeep, M.V.Karthik and S.Harsha, "*Implementation of improved genetic algorithm in distribution system with feeder reconfiguration to minimize real power losses*," 2^{nd} international conference on computer engineering technology (ICCET), Vol.4, No.1, pp 320-323. (2010).

[7] B.Bhattacharyya and S.K.Goswami, "*Sensitivity based evolutionary algorithms for reactive power dispatch*," Third international conference on pwer system, Kharagpur, India, Vol.1, No.1, pp 1-7. (2010).

[8] Liu Fang, "*The new adaptive evolutionary programming*," Proceedings of the Ninth International Conference on Machine Learning and Cybernetics, Vol.5, pp 2341-2344, (2010).

[9] Bryan B.Navarro,Ivan Benedict Nilo C.cruz, Bienvenido M.Malquisto.Jr, "*Radial network reconfiguration and load balancing for loss minimization using genetic algorithm*", IEEE region 10 conference, pp 1-6. (2012).

[10] Alexandre Mendes, Natashia Boland, Patrick Guiney and Carlos Riveros, "*Switch and tap-changer reconfiguration of distribution network using evolutionary algorithms*," IEEE transactions on power system, Vol.28, No.1, pp 85-92 . (2013).

[11] Nor Rul Hasma Abdullah, Ismail Musirin and Muhammad Murtadha Othman, "*Operating generator selection applied for reactive power dispatched using evolutionary programming technique*," IEEE 7th international power engineering and optimization conference, pp 583-587 .(2013).

[12] Men-Shen Tsai, and Fu-Yuan Hsu, "*Application of Grey Correlation Analysis in Evolutionary Programming for Distribution System Feeder Reconfiguration*", IEEE transactions on Power System, Vol.25, No.2, pp 1126-1133. (2010).

[13] Abd Rahman Khalid, Sharifah Mumtazah Syed Ahmad , Asma Shakil, Nawar Nik Pa and Roslin Mohd Shafie, "*A Comprehensive Power Restoration Approach Using Rule-Based Method for 11kV Distribution Network*", 2nd IEEE International Conference on Power and Energy, pp 1179-1182. (2008).

[14] Limin Huo, Jinliang Yin, Yao Yu and Liguo Zhang, "*Distribution Network Reconfiguration Based on Load Forecasting*", International Conference on Intelligent Computation Technology and Automation, Vol.1, No.1, pp 1039-1043. (2008).

[15] Kubin Taleski and Dragoslav RajiCid, "*Distribution Network Reconfiguration for Energy Loss Reduction*",IEEE Transactions on Power Systems, Vol. 12, No. 1, pp398-406. (1997).

[16] Antonino Augugliaro, Luigi Dusonchet, Salvatore Favuzza, and Eleonora Riva Sanseverino, "*Voltage Regulation and Power Losses Minimization in Automated Distribution Networks by an Evolutionary Multiobjective Approach*", IEEE Transactions on Power System, Vol. 19, No. 3, pp 1516-1527. (2004).

[17] Romeu M. Vitorino, Humberto M. Jorge and Luís P. Neves, " *Network reconfiguration using an improved genetic algorithm for loss and reliability optimization in distribution systems*" International Conference on Power Engineering, pp 84-89. (2009).

[18] Bhoomesh Radha, Robert T. F. Ah King and Harry *C.* S. Rughooputh, "*A Modified Genetic Algorithm for Optimal Electrical Distribution Network Reconfiguration***",** IEEE The Congress on Evolutionary Computation, Vol.2, pp 1472-1479. (2003).

[19] J.C. Cebrian and N. Kagan, "*Evolutionary Algorithms for the Reconfiguration of Radial Distribution Networks considering Long Interruption and Voltage Sag Disruption Costs*", International Conference on Harmonic and Quality of Power, pp1-7. (2008).

[20] E. M. Carreno, N. Moreira, and R. Romero, "*Distribution network reconfiguration using an efficient evolutionary algorithm*", IEEE on Power Engineering Society General Meeting, pp 1-6. (2007).

[21] F.S. Cheng, M.T. Tsay, and W.M. Lin, "*An Improved Evolutionary Programming Approach for Distribution Loss Reduction by Feeder Switching*", Internal Conference on Power System, Vol.3, pp 1419-1424. (2000).

[22] E. Romero Ramos, J.L. Martinez-Ramos, A. Gdmez Expdsito, and A. J. Urbano Salado, "*Optimal Reconfiguration of Distribution Networks for Power Loss Reduction*", IEEE on Porto Power Tech Conference, Vol.3. (2001).

[23] L. J. Fogel, A. J. Owens, and M. J. Walsh, "*Artificial intelligence through simulated evolution*," IEEE on Evolutionary Computation, pp 227-296. (1966).

Appendix A

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A 16kV Distribution Network Reconfiguration by Using Evolutionaring Programming for Loss Minimizing

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ABSTRACT

In the worldwide trend toward restructuring the electricity network; there are a lot of problems. Where with the increasing of electricity demand, intelligence algorithm is one of the optimization search engine that may help in minimizing the power losses in the power distribution network. This paper presents a method of 16kV Distribution Network Reconfigurtion (DNR) by using Evolutionary Programming (EP). The main objectives of this study are to minimize the power losses and improve the voltage profile while analyzing the consistency and computing time effectively. The performance of the Evolutionary Programming method will be investigated and the impact to the 16kV distribution network will be analyzed. Thereal result will be compared with the conventional initial network and other optimization technique which is Genetic Algorithm (GA). The results of this study is hoped to help the power system engineers in Malaysia in order to solve the losses problem in the plant at the same time increasing the efficiency of the real 16-bus distribution system.

Keywords: Distribution network reconfiguration, evolutionary programming, power losses, genetic algorithm