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Student's Name : MOHAMAD FANI BIN SULAIMA

Date : 31 MAY 2016

MULTI-OBJECTIVE OF OPTIMAL DISTRIBUTION NETWORK RECONFIGURATION BY USING MODIFIED ARTIFICIAL BEE COLONY ALORITHM

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

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA Melaka

2016

"I declare that this report entitle "Multi-Objective of Optimal Distribution Network Reconfiguration By Using Modified Artificial Bee Colony Algorithm" 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 : .....

Student's Name : NURUL SYAZWANI BINTI IDRIS

Date : 31 MAY 2016

Dedicated, in thankful application for support, encouragement and understandings to my beloved parents and family

Idris Bin Husin

HalimahBintiDrauh

NurulHidayah

Mohammad Syafiq

NurulNajihah

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ABSTRACT

Electric power distribution loss and reliability are major concerns in power system as the demand of electrical energy by customers keep increasing day by day. One of the suggested methods to minimize these problems is by doing reconfiguration process to existing distribution network. A reconfiguration is performed by opening or closing the sectionalizing switches and need to maintain the feeder in radial network. This study presents Distribution Network Reconfiguration (DNR) by using Modified Artificial Bee Colony Algorithm (IABC). The main objectives of this study are to minimize the power losses, enhance load balancing index, and improve the voltage profile simultaneously. The performance of the proposed method will be investigated and the impact to the distribution network will be analyzed. The algorithm (IABC) will be applied on IEEE 33 bus radial distribution systems network. The real result will be compared with the conventional initial network and other optimization techniques which are Genetic Algorithm (GA) and Particle Swarm Optimization (PSO). The results of this study is hoped to help the electrical engineers (Power System) in Malaysia in order to solve the losses problem in the distribution network reconfiguration and at the same time increasing the efficiency of the real distribution system.

ABSTRAK

Kehilangan pengagihan kuasa elektrik dan keboleh percayaan adalah kebimbangan utama dalam sistem kuasa kerana permintaan tenaga elektrik oleh pelanggan terus meningkat hari demi hari. Salah satu kaedah yang disyorkan untuk mengurangkan masalah-masalah ini adalah dengan melakukan proses konfigurasi semula untuk rangkaian pengedaran yang sedia ada. Konfigurasi semula dilakukan dengan membuka atau menutup suis sectionalizing dan perlu mengekalkan feeder dalam satu jaringan radial. Kajian ini membentangkan konfigurasi semula rangkaian (DNR) dengan menggunakan Modified Artificial Bee Colony Algoritma (IABC). Objektif utama kajian ini adalah untuk mengurangkan kehilangan kuasa, meningkatkan indeks pengimbangan beban, dan meningkatkan profil voltan pada masa yang sama. Prestasi DNR akan disiasat dan impak kepada rangkaian pengedaran akan dianalisis. Algoritma (IABC) akan digunakan pada IEEE 33 bas jejarian sistem rangkaian pengedaran. Keputusan sebenar akan dibandingkan dengan rangkaian awal konvensional dan teknik-teknik pengoptimuman yang lain yang merupakan algoritma genetik (GA) dan Zarah Swarm Optimization (PSO). Hasil kajian ini diharap dapat membantu para jurutera elektrik (Sistem Kuasa) di Malaysia dalam usaha untuk menyelesaikan masalah kerugian dalam konfigurasi semula rangkaian pengedaran dan pada masa yang sama meningkatkan kecekapan sistem pengagihan yang sebenar.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Motivation

1.1.1 TNB Statistics of Supply Interruptions

TNB has disturbances of supply to a single consumer for more than 1 minute from September 2004. In Peninsular Malaysia, the number of supply disturbance per 1000 customer had recorded in TNB‟s distribution system which is from 4.9 to 9.1 interruptions in year 2003, it is increased by 85.7%. The number of supply disturbances per 1000 customer of TNB in the year from 2000 to the year of 2004 is shown in Figure 1.1. It is 96.6% was unscheduled interruptions whereas the remaining 3.3% was scheduled interruptions.

In the year 2004, the average number of supply disturbances of TNB in monthly increased by 91.5% from 2,365 to 4,529 in the year 2003 as shown in Figure 1.2. The highest number of supply interruptions in the year 2004 is Kedah, Wilayah Persekutuan, Johor and Selangor compared with the other states.

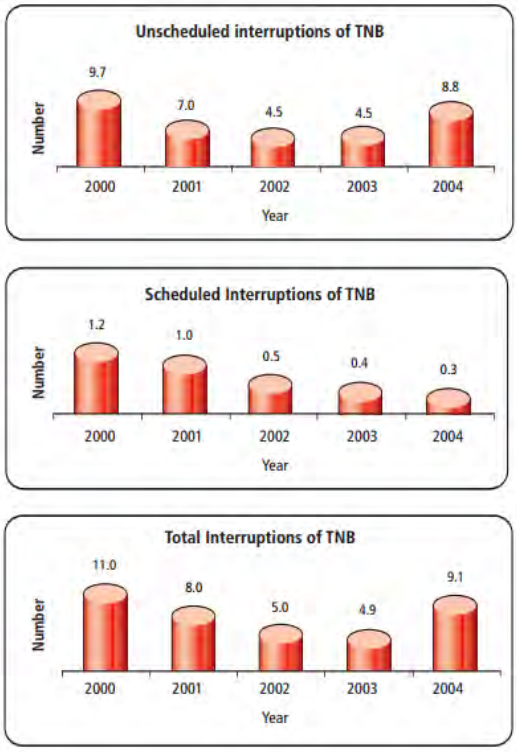

Figure 1.1: TNB"s Number of Electricity Supply Interruptions per 1000 Customers from Year2000 to 2004

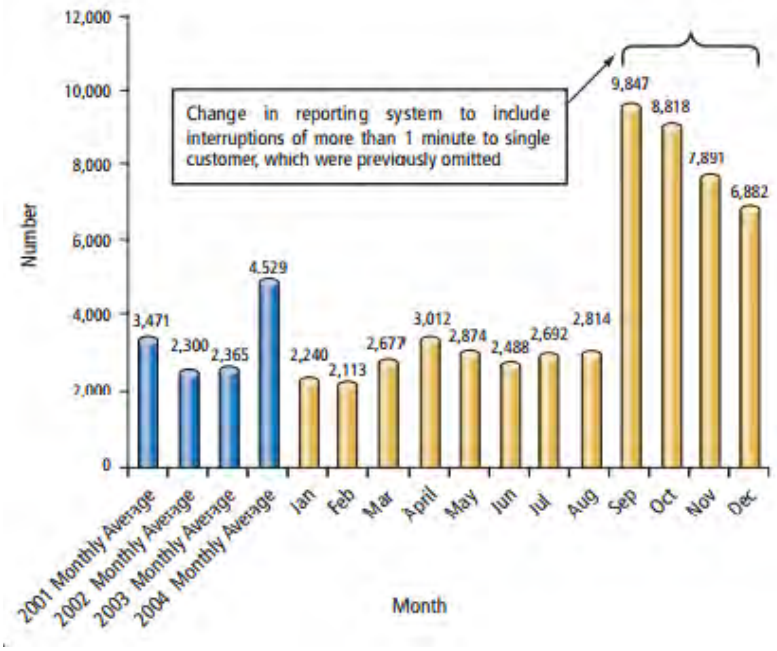

Figure 1.2: TNB"s Monthly supply interruptions in 2004

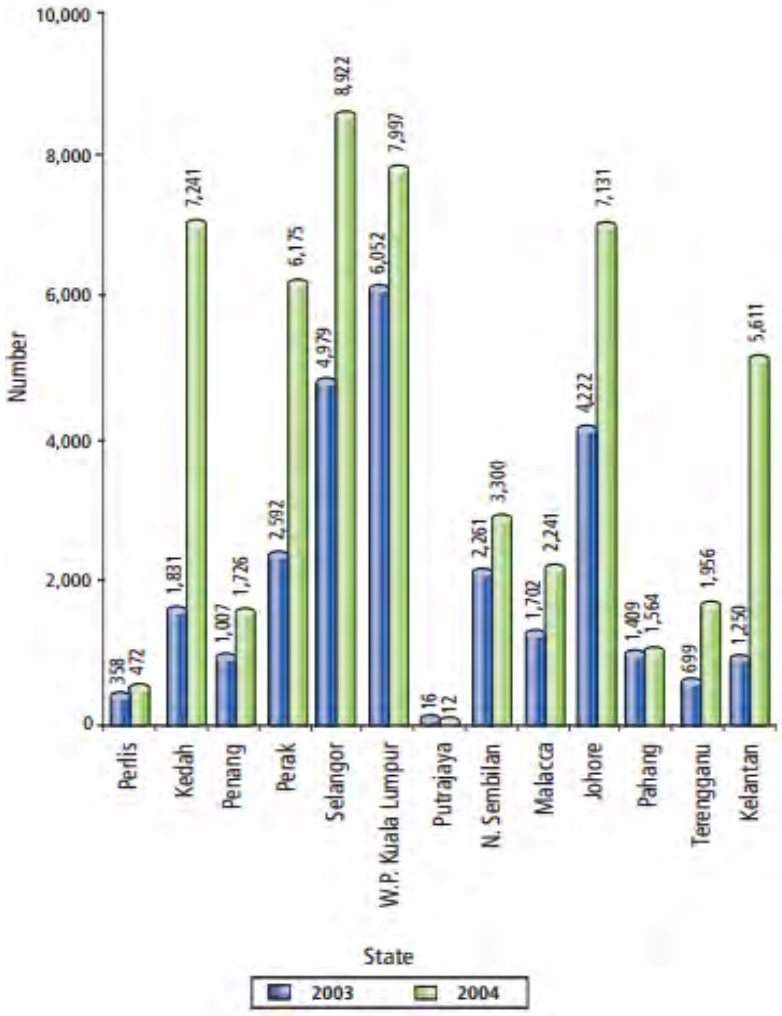

Figure 1.3: Various States of Total Number of Supply Interruptions in Peninsular Malaysia inyear 2003 and 2004

TNB conducted several efforts to improve the reliability of the distribution system such as:

(a) Enhancing preventive maintenance programmes which include:

- preventive testing of cables by very low frequency (VLF) test method
- condition monitoring of substation equipment, lines and cables
- scheduled preventive maintenance of substations on a continuous basis

(b) Reviewing manuals on operation and asset maintenance to enhance the quality of work.

(c) implementing various projects to strengthen the distributions network such as:

- injecting new feeders
- construction new substation
- changing bare conductors to insulated aerial bundled cable

1.1.2 Distribution System of TNB

The duration and the frequency of interruptions of supply experienced by consumers normally as reference to measures the reliability of electricity supply. System Average Interruption Duration Index (SAIDI) is one of the aspects that used to access the performance of the distribution systems in TNB and it is signifies the total duration in minutes on average that consumer is without supply in a certain period, usually a year. The SAIDI of TNB in different states in Peninsular Malaysia year from 2002 to 2004 shown in Figure 1.4. In the year 2004 the SAIDI had reduced if compared with the year 2003 (exception of Johor, Terengganu and Kedah). By referring in the year of 2004, overall TNB‟s SAIDI decreased from 167.6 (year 2003) minutes to 129.0 minutes, it is reduced by 22.8%. This address that the performance of the supply system of TNB having an improvement in the year 2004.

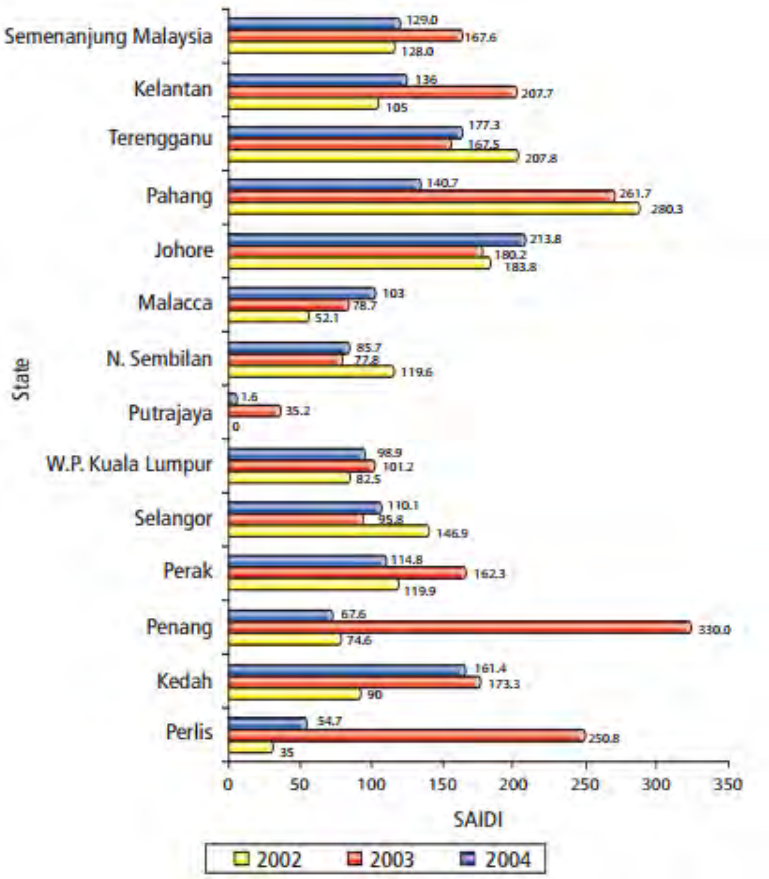

Figure 1.4: SAIDI (Consumers/Year/Minutes) in the Various States for Peninsular Malaysia inthe year 2002 to 2004.

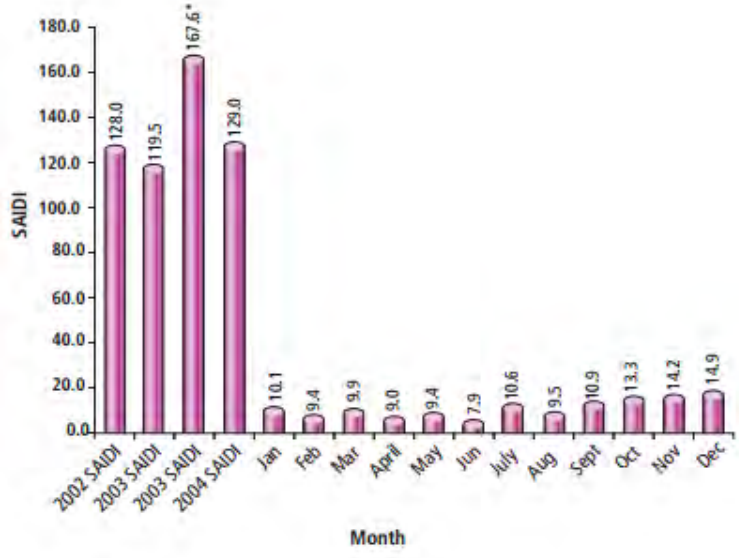

Figure 1.5: The monthly SAIDI in Peninsular Malaysia in the year 2004.

1.1.3 Distribution Network Configuration

Distribution System is the final segment of power system, bridging the gap between power supply system and user facilities. The major responsibility of the distribution system would be proper electric power distribution and guaranteeing users‟ normal power consumption.

Correspondingly, as a crucial part of the Distribution Management System, distribution network reconfiguration has great impact on the power quality. Network reconfiguration means changing network structure through operations of sectionalizing and loop switches to minimize power loss and keep the balance of power supply and consumption, meanwhile on satisfying capacity and voltage restraints. Currently, the distribution power grid construction in our country still remains to be modified. Equipment depreciation and inappropriate structure have led to low reliability and highly cost during the power transformation process. Considering the complicity of power distribution grid‟s mathematical model, the pursuit of optimal algorithm of network reconfiguration becomes inevitable and urgent [1] [2].

Theoretically, network reconfiguration is a complicated multi-objective nonlinear integral combinational optimization problem, which has characters of discontinuity, non-differentiability, multi-constraints and nonlinearity [1].

1.2 Problem Statement

Distribution Industry always wants to give consumer a good quality in electrical power network. The distribution industry tries to minimize the losses, balancing the load and improve voltage profile after network is reconfiguration, but at each panel of distribution network it will have losses and unbalance of load. Each unbalance system not just increases power losses into an advanced stage however could affect all the system and distribution generating sections. Losses could reduce the quality and the reliability of distribution networks. This will not just impact to distribution industry but including energy resources, money and cost. However to reach non interrupt in distribution network is almost impossible to get it. Therefore, this project is one of solution to distribution industry want to achieve a maximum stableness and reliability of an electrical power network to distribute to consumer.

From this, the method that can use is by applying the reconfiguration feeder distribution on 33-bus network system. By reconfiguration the feeder that means by changing the topology switch of feeder distribution, it can be used to balance the load on each bus in distribution network. Balancing the load is significant factor to minimize power reduction as well as increase voltage profile at the same time. In other words, accomplish those objectives; minimizing loss reduction, balancing the load and improve the voltage profile in simultaneously after reconfiguration by using modified Artificial Bee Colony (IABC) Algorithm will solve in distribution industry.

This algorithm is based on swarm bees that have been proposed to overcome the optimization problem in power system as an overall but, not specific to DNR. Therefore, new technique by using an Improved ABC algorithm has to be made for better system in distribution network reconfiguration.

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1.3 Objective

In order to solve the network reconfiguration for this project, the modified Artificial Bee Colony (IABC) Algorithm method is implemented as the optimization algorithm. The objectives are:

1. To minimize total power loss in IEEE 33-bus network test system.
2. To enhance the load balancing index during distribution network reconfiguration.
3. To improve voltage profile after network is reconfigurated.

1.4 Scope

This project focuses on the implementation of IABC algorithm to solve optimization problems. This algorithm was developed to determine the best configuration of tie switches to optimize the networks while satisfying with several operating constraint, for instance power flow constraint, voltage constraint, enhance load balancing and to minimize the real power loss of the network. Moreover, this technique should maintain the radiality of the network. This algorithm was tested on IEEE 33-bus radial distribution networks and was performed using MATLAB softwareversion 2010b software package.

CHAPTER 2

LITERATURE REVIEW

2.1 Theory

2.1.1 Electric Power System

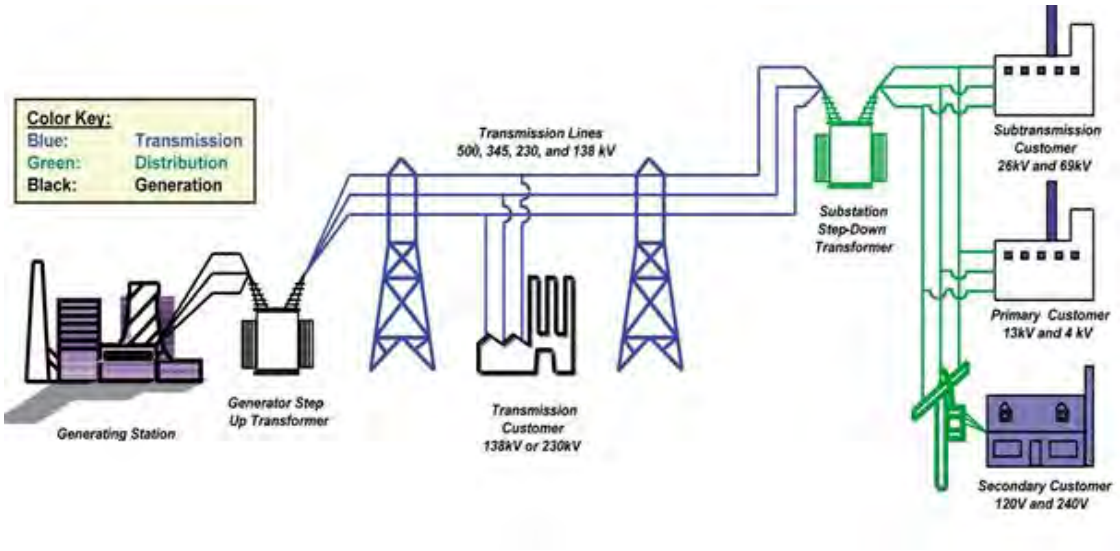

Figure 2.1: Electrical Power System of Basic Structure [31]

Power system is the network that related with the generation, distribution, transmission and consumption of electric power and electrical devices connected to the system including generators, motors and transformers. Network of electrical devices that used to supply,

transfer and use electric power is an electric power system. Network supplies a region"s homes and industry with power is an example of an electric power system. Power system that known as the grid is for sizable regions and it is can be commonly divided into the generators that supply the power, the transmission system that transmit the power from the generating centers to the load centers and the distribution system that supply the power to nearby homes and industries.

The final stage in the delivery of electric power is an electric power distribution system. It transmits electricity from the transmission line to individual consumers. Distribution substations connect to the transmission system and lower the transmission voltage to medium voltage with the usage of transformers. Primary distribution lines carry this medium voltage power to distribution transformers located near the consumer's locations. Distribution transformers again lower the voltage to the utilization voltage of household appliances and typically feed several customers through secondary distribution lines at this voltage. Commercial and residential customers are connected to the secondary distribution lines through service drop. Customers demanding a much larger amount of power may be connected directly to the primary distribution level or the sub transmission level.

2.1.2 Distribution Network Reconfiguration

Distribution networks have two types which is radial or network. [3] A radial system as shown in figure 2.2 is organized like a tree where each consumer has one source of supply while a network system has several sources of supply functioning in parallel. The secondary network is normally found in big cities and is the most consistent system. For concentrated loads is used spot network while in rural or residential areas usually used radial system and radial systems commonly contain emergency connections where the system can be reconfigured as shown in figure 2.3 in case of problems, such as a fault or required replacement. This can be complete by opening and closing switches. It may be acceptable to close a loop for a short time. Within these networks there may be a mix of overhead line construction utilizing traditional utility poles and wires and, increasingly, underground construction with cables and indoor or cabinet substations. However, underground distribution

is significantly more expensive than overhead construction. In order to reduce this cost, underground power lines are sometimes share location with other utility lines known as common utility ducts. Distribution feeders coming from a substation are generally controlled by a circuit breaker which will open when a fault is spotted. Automatic circuit recloses may be installed to further separate the feeder thus minimizing the impact of faults. Long feeders experience voltage requiring capacitors or voltage regulators to be installed.

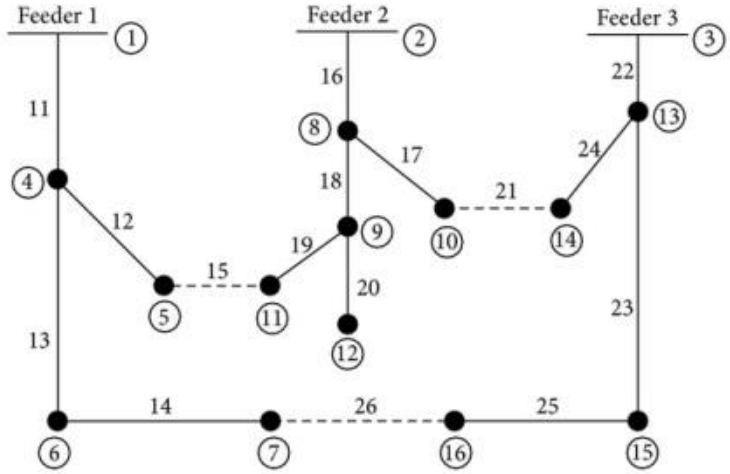

Figure 2.2: Example of 16 radial distribution bus system (original configuration) [32]

Exchanging the functional links between the elements of the system also called reconfiguration is the one of the most important measure which can increase the operational performance of a distribution system. In terms of its definition, the problem of optimization through the reconfiguration of a power distribution system is a historical single objective problem with constraints. In 1975, Merlin and Back[4] was introduced the idea of distribution system reconfiguration for active power loss reduction, until nowadays, a lot of researchers have planned various methods and algorithms to solve the reconfiguration problem as a single objective problem. For this purpose, different artificial intelligence based methods have been used such as microgenetic, [5] branch exchange, [6] particle swarm optimization[7] and non-dominated sorting genetic algorithm [8].