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THE COMPARISONSTUDY AMONG OPTIMIZATION TECHNIQUES IN OPTMIZING A DISTRIBUTION SYSTEM STATE ESTIMATION

HAZIM IMAD HAZIM

Master of Electrical Engineering (Industrial power)

2017

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HAZIM IMAD HAZIM

A dissertation submitted
In partial fulfillment of the requirements for the degree of Master of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017

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DECLARATION

I declare that this dissertation entitle “The Comparison StudyAmong Optimization Techniques InOptimizing A DistributionSystem State Estimation” is the result of my own research except as cited in the references. The dissertation has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	:	………………………….
Name	:	HAZIM IMAD HAZIM.
Date	:	………………………….

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APPROVAL

I hereby declare that I have read this dissertation and in my opinion, this dissertation is sufficient in terms of scope and quality for the award of Master of Electrical Engineering (Industrial Power).

Signature : ……………...............................

Supervisor Name : PROF.MADYA.IR.DR.ROSLI BIN OMAR

Date : ……………………….....................

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DEDICATION

To my father

For earning an honest living for us and for supporting and encouraging me to believe

In myself

To my mother

A strong and gentle soul who taught me to trust in Allah, believe in hard work and that

So much could be done with little

To my brother and sister

I am really grateful to my family

The reason of what I become today

Thanks for your great support and continuous care.

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ABSTRACT

State estimation considered the main core of the Energy Management System and plays an important role in stability analysis, control and monitoring of electric power systems. The state estimator actually depends on many factors, such as data sensitive regarding the sensors accuracy, the availability of raw data, the network database accuracy, and the time skew of data. Many researchers already been studied multi-area power system state estimation and most of them investigation of state estimation schemes including different state estimators for each a central coordinator and control area. Therefore, accurate and timely efficient state estimation algorithm is a prerequisite for a stable operation of modern power grids. This thesis introduce an intelligent decentralized State Estimation method based on Firefly algorithm for distribution power systems. The mathematical procedure of distribution system state estimation which utilizing the information collected from available measurement devices in real-time. A consensus based static state estimation strategy for radial power distribution systems is proposed in this research. This thesis concentrates on the balanced systems. There are buses acting as agents using which we can evaluate the local estimates of the entire system. Therefore each measurement model reduces to an underdetermined nonlinear system and in radial distribution systems, the state elements associated with an agent may overlap with neighboring agents. The states of these systems are first estimated through centralized approach using the proposed algorithm to compare with weighted least squares technique. At the end, the result will presented the application of the developed approach to a network based on IEEE 13 bus, 14 bus and 33 bus test System. The result a proved to be computational efficient and accurately evaluated the impact of distributed generation on the power system.From the result, it can observe that for decentralized is faster and less error for both WLS and FA. In addition, FA show faster and less error than WLS for both centralized and decentralized. In addition, the proposed FA show faster with increasing the number of buses.

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ABSTRAK

Anggaran taraf dianggap sebagai teras utama Sistem Pengurusan Tenaga dan memainkan peranan yang penting dalam analisis kestabilan, kawalan, dan pemantauan sistem tenaga elektrik. Penaksir keadaan sebenarnya bergantung kepada banyak faktor seperti peka data terhadap ketepatan sensor, adanya data mentah, ketepatan pangkalan data rangkaian, dan kecondongan masa data. Ramai penyelidik telahpun mengkaji anggaran taraf sistem tenaga pelbagai kawasan, dan sebilangan besar di antara mereka telah menyiasat skim anggaran taraf termasuk penaksir taraf yang berbeza untuk setiap penyelaras pusat dan kawasan kawalan. Oleh itu, algoritma anggaran taraf yang tepat dan yang menepati masa dengan berkesan adalah pra-syarat untuk operasi stabil grid kuasa moden. Tesis ini memperkenalkan suatu algoritma Anggaran Taraf pintar yang tidak berpusat yang berdasarkan algoritma kelip-kelip untuk sistem pengedaran kuasa. Prosedur matematik untuk sistem pengedaran anggaran taraf menggunakan maklumat yang dikumpul daripada peranti pengukuran yang terdapat dalam masa nyata. Satu strategi anggaran taraf statik yang berdasarkan konsensus untuk kuasa jejarian telah dicadangkan dalam kajian ini. Tesis ini tertumpu pada sistem seimbang. Dengan menggunakan beberapa buah bas yang bertindak sebagai agen, kami dapat menilai anggaran tempatan untuk keseluruhan sistem. Oleh itu, setiap model pengukuran dikurangkan menjadi sistem tak linear yang kurang ditentukan, dan dalam sistem pengedaran jejarian, unsur-unsur taraf yang dikaitkan dengan sesuatu agen mungkin bertindih dengan agen bersebelahan. Taraf sistem-sistem ini dianggarkan pada mulanya melalui pendekatan berpusat dengan menggunakan algoritma yang dicadangkan untuk membuat perbandingan dengan teknik wajaran kuasa dua terkecil.Akhirnya, kami membentangkan keputusan yang diperolehi daripada aplikasi pendekatan yang dibangunkan terhadap rangkaian yang berdasarkan IEEE 13 bas,14 basdan 33 sistem ujian bas. Hasilnya terbukti bahawa pengiraan tersebut adalah cekap dan telah menilai dengan tepatnya kesan pengedaran penjanaan pada sistem kuasa.Dari hasilnya, ia dapat melihat bahawa untuk desentralisasi adalah lebih cepat dan kurang kesilapan untuk kedua-dua WLS dan FA. Di samping itu, FA menunjukkan lebih cepat dan kurang ralat daripada WLS untuk kedua-dua berpusat dan berpusat. Di samping itu, cadangan yang dicadangkan FA lebih cepat dengan meningkatkan bilangan bas.

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LIST OF ABBREVIATIONS

DSE	dynamic state estimation
EMS	energy management system
FA	firefly Algorithm
GA	Genetic Algorithm
GPS	Global Positioning System
ISO	independent system operator
LAV	Least Absolute Value
LNR	Largest Normalized Residual
NRPF	Newton Raphson Power Flow
PF	Power Flow
PMUs	Phasor Measurement Units
PSO	Particle Swarm Optimization
RTU	Remote Terminal Units
SCADA	supervisory control and data acquisition
SE	state estimation
SSE	Static State Estimation
WLS	Weighted Least Squares

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LIST OF PUBLICATIONS

Journal Papers

1. **Hazim Imad Hazim,** Rosli Bin Omar, Marizan Bin Sulaiman,Ahmed N Abdalla, Mohammed Rasheed, Imad Hazim Mohammed,(2017). A Novel Firefly Algorithm for Distribution System State Estimation. Journal of Engineering and Applied Sciences, **Scopus,Accepted, printing process.**

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CHAPTER 1

INTRODUCTION

1.1 Introduction

State estimation plays a key role in secure operation of power systems. Using the state estimation solution operators can determine if the current operating state of the system belongs to a normal, emergency or restorative state. State estimation also provide efficient and accurate monitoring of operational constraints on quantities such asbus voltages and power angle (Bar-Shalom and Chen, 2005; Duanet.al., 2008).

State estimation is a tool that is widely used in power network control centres to improve the quality of directly telemetered data, to provide a way for direct monitoring of network conditions. The state estimation also provide the best available estimate of network model that can be used as a starting point for further real-time power system application such as Voltage Automatic Regulation (VAR) optimization, contingency analysis, congestion management, and constrained re-dispatch. State estimation and it's subordinate applications such as parameter estimation, bad data identification, breaker status estimation, and external model estimation are widely used in industry with different degrees of success.

In power system state estimation, a measurement may contain gross error because of communication noise, incorrect sign convention or measurement device failure. These measurements are called bad measurements (data) and can lead to biased estimates.

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Therefore it is important to implement robust state estimators. Estimators with high breakdown points, which are the smallest amount of contamination that can cause an estimator to give an arbitrarily incorrect solution (Donoho, 1982), have been investigated and developed by researchers (Hampel et.al., 1986; Rousseeuw and Leroy, 1987). Some of these have also been applied to power system state estimation ((Mili et.al., 1996; Baldick et.al., 1997; Irwing et.al., 1987). Among these robust estimators, the Least Absolute Value (LAV) estimator was shown to have desirable properties where its implementation can be made computationally efficient by taking advantage of power system's properties (Celik and Abur, 1992; Abur and Celik, 1993).

In this thesis a novel framework to perform Firefly algorithm based dynamic state estimation in a distributed way is proposed considering increasing complexity associated with large-scale power system. According to (Du et.al., 2011), Dynamic State Estimation (DSE) can be implemented in a distributed environment by decomposing the systems into subsystems to increase the computational speed of DSE process in large scale power systems.

1.2 Related Work

Power System Configuration Sectors

The world today is more dependent on electrical energy than any other form of energy. A power system consists of three major components: power generation, transmission networks and distribution systems.Figure 1.1shows the power systems basic sectors from generation to consumers (Resk Ebrahim Uosef, 2011).

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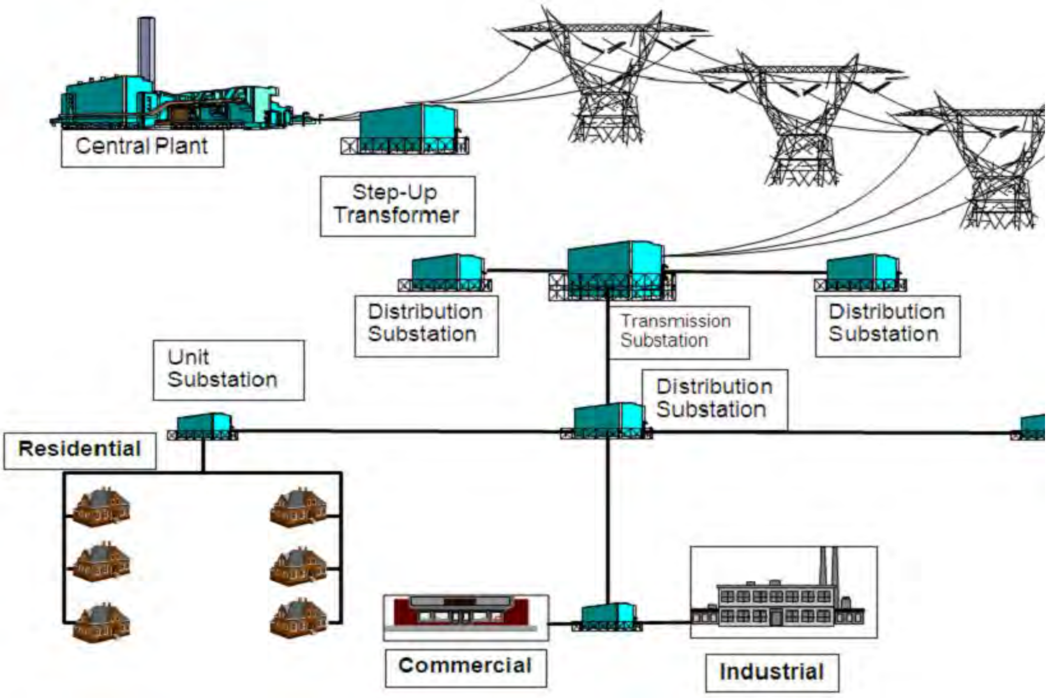

Figure 1.1: Powersystem components (Resk Ebrahim Uosef, 2011).

The power system consists of three major components: power generation, transmission and distribution systems. The power generation plants convert energy stored in the water position, gas, oil, coal, wind, nuclear fuel and other resources to electric energy. The voltage of the generator is relatively low, and if the electric energy is transmitted at this voltage over a long distance, there will be great voltage drop and energy losses. So, the step up transformer is used to increase the voltage and reduce the current.

The power transmission systems are a network of power lines and devices that can deliver the energy to the users over a long distance. The voltage of transmission systems is very high, so the energy can be transmitted with small losses. There are also some sub-transmission lines that connect the transmission substations with distribution substations within a city.

The power distribution systems directly deliver the power to the end users. The distribution systems are the systems between the distribution substations and the end users.

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A typical distribution system consists of one distribution substation with one or more primary feeders and many laterals. Figure 1.2 shows the concept of typical distribution systems.

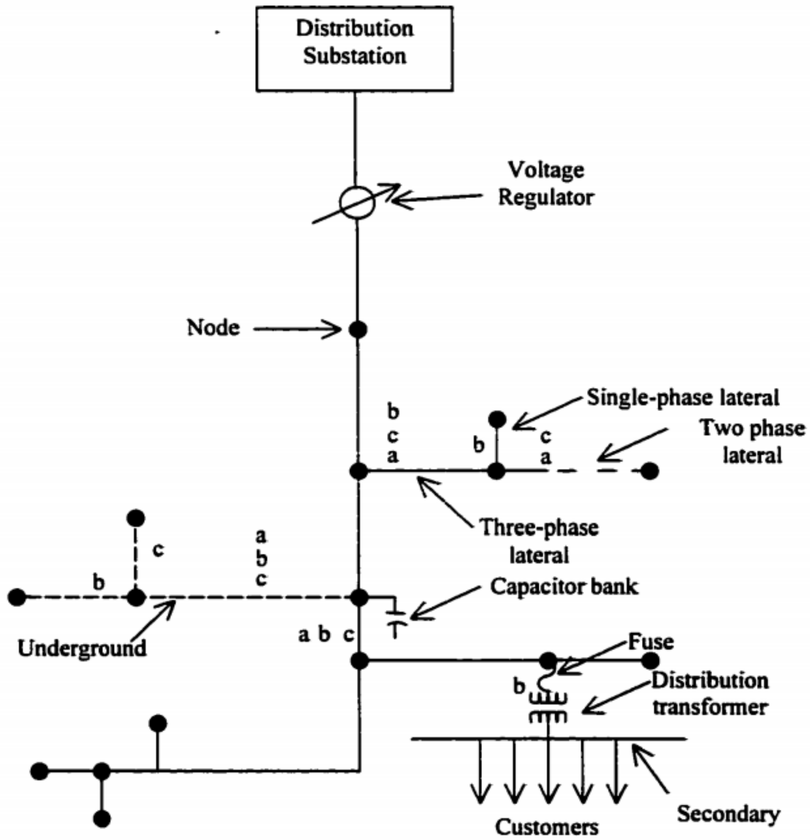

Figure 1.2: Concept of typical distribution systems (Kersting, 2002).

Power State Estimation

There has been a considerable progress in the field of power system state estimation since it is firstly introduced by Fred Schweppe in the late 1960s (Schweppe and Wildes, 1970; Schweppe and Rom, 1970; Schweppe, 1970). The State Estimation (SE) tool has benefited from large number of theoretical developments and practical improvements (Gomez et.al., 2011). Various methodologies have been offered regarding the mathematical formulation, numerical solution, computational procedure, realtime implementation, measurement types, and calculation of the state estimates and identification of the

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modeling errors in the literature concerning both static and dynamic power system state estimation process.

Figure 1.3, show the basic concept of 'Static State Estimation (SSE)' is defined and several numerical approaches are offered as a solution in (Schweppe and Wildes, 1970; Schweppe and Rom, 1970; Schweppe, 1970; Larson et.al., 1970). The general structure and main functions of the static state estimator are listed in (Schweppe and Handschin, 1974). One of the most widely used methods to solve the power system static state estimation problem appears to be the Weighted Least Squares (WLS) approach. The WLS estimators have been studied extensively and their numerical stability as well as computational efficiency have been greatly improved by various techniques (Abur and Celik, 1991; Abur and Exposito, 2004).

Traditionally, the power systems are collected by low updating rate Supervisory Control And Data Acquisition(SCADA) systems via Remote Terminal Units (RTU) as shown inFigure 1.4. The widely used measurement types in the common state estimation process can be listed as power injections, power flows, voltage and current magnitudes. More recently, the PharosMeasurement Units (PMUs), which provide Global Positioning System (GPS)-synchronized measurements, among which are voltage and current phasor magnitude and phase angles, are expected to introduce major improvements in state estimation SE performance and capabilities (Gol et.al., 2012). The impact of synchronized phasor measurements on the SE function is well described by (Abur, 2009).

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