LOCATION OF VOLTAGE SAG SOURCE BY USING ARTIFICIAL NEURAL NETWORK

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To my beloved mother, wife, daughters and son

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ABSTRACT

Power quality (PQ) is a major concern for number of electrical equipment such as of sophisticated electronics equipment, high efficiency variable speed drive (VSD) and power electronic controller. The most common power quality event is the voltage sag. The objectives are to analyse the voltage sag and to estimate the voltage sag source location using artificial neural network (ANN). In this project, the multi-monitor based method was used. Based on the simulation results, the voltage deviation (VD) index of voltage sag was calculated and assigned as a training data for ANN. The Radial Basis Function Network (RBFN) was used due to its superior performances (lower training time and errors). The three types of performance analysis considered are coefficient of determination (R^2), root mean square error (RMSE) and sum of square error (SSE). The RBFN was developed by using MATLAB software. The proposed method was tested on the CIVANLAR distribution test system and the Permas Jaya distribution network. The voltage sags were simulated using Power World software which is a common simulation tool for power system analysis. The asymmetrical fault namely line to ground (LG) fault, double line to ground (LLG) fault and line to line (LL) fault were applied in the simulation. Based on the simulation results of VD for CIVANLAR distribution test system and the Permas Jaya distribution network, the highest VD was contributed by LLG which were 0.491 and 0.751, respectively. Based on the proposed RBFN results, the best performance analysis were R^2, RMSE and SSE of 0.9999, 5.24E-04 and 3.90E-05, respectively. Based on the results, the highest VD showed the location of voltage sag source in the system. The proposed RBFN accurately identified the location of voltage sag source for both test systems.

ABSTRAK

Kualiti kuasa adalah perkara yang amat dititikberatkan bagi bilangan peralatan-peralatan elektronik yang canggih, pemacu halajubolehubah berkecekapan tinggi dan pengawal elektronik kuasa. Kebanyakan peristiwa daripada kualiti kuasa disebabkan oleh voltan lendut. Tujuan projek ini adalah untuk analisa voltan lendut dan menganggar lokasi berlakunya voltan lendut dengan menggunakan rangkaian neural buatan (RNB). Di dalam projek ini, kaedah berdasarkan paparan pelbagai akan digunakan. Berdasarkan keputusan simulasi, indek perbezaan voltan bagi voltan lendut akan dikira dan akan dijadikan sebagai data latihan untuk RNB. Rangkaian fungsi asas jejarian (RFAS) digunakan disebabkan prestasi yang tinggi (rendah masa latihan dan kesilapan). Tiga jenis analisis prestasi digunakan ialah pekali penentuan (R^2), ralat punca min kuasa dua (RMPKD) and hasil tambah ralat kuasa dua (HTRKD). RFAS telah dibangunkan dengan menggunakan perisian MATLAB. Kaedah cadangan ini akan diuji pada sistem ujian pengagihan CIVANLAR dan rangkaian pengagihan Permas Jaya. Voltan lendut telah disimulasi menggunakan perisian Power World yang mana perisian ini adalah perisian yang biasa digunakan untuk analisis sistem kuasa. Kerosakan tidak simetri yang akan diaplikasi ialah talian ke bumi, talian ke talian dan dua talian ke bumi. Berdasarkan keputusan simulasi indek perbezaan voltan daripada sistem ujian pengagihan CIVANLAR dan rangkaian pengagihan Permas Jaya, indek perbezaan voltan yang tertinggi disumbangkan oleh LLG iaitu 0.491 dan 0.751. Berdasarkan keputusan RFAS, analisis prestasi terbaik adalah R^2, RMSE dan SSE adalah 0.9999, 5.24E-04 dan 3.90E-05. Berdasarkan keputusan tersebut, indek perbezaan voltan yang paling tinggi menunjukkan lokasi berlakunya voltan lendut pada sistem. RFAS telah dapat mengenalpasti secara tepat lokasi sumber voltan lendut pada kedua-dua sistem.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANN	-	artificial neural network
DS	-	downstream
IEEE	-	Institute of Electrical and Electronics Engineers
kV	-	kilovolt
LG	-	line to ground
LL	-	line to line
LLG	-	double line to ground
MW	-	mega watt
MVA	-	mega volt ampere
MVar	-	mega volt ampere reactive
PQM	-	power quality monitor
p.u	-	per unit
RBFN	-	radial basis function network
rms	-	root mean square
RMSE	-	root mean square error
SSE	-	sum of square error
US	-	upstream
VD	-	voltage deviation

LIST OF SYMBOLS

B	-	Susceptance
C	-	Capacitance
f	-	Frequency
F	-	Farad
Ω	-	Ohms
R	-	Resistance
R^2	-	coefficient of determination
R_f	-	fault resistance
S	-	Siemens
S_{base}	-	Apparent power base
X	-	Reactance
Y	-	Admittance
Y_{base}	-	Admittance base
Z	-	Impedance
Z_{base}	-	Impedance base

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of the Project

The increasing numbers of sophisticated electronics equipments, high efficiency variable speed drive (VSD) and power electronic controller which can cause electromagnetic interference has heightened interest in power quality (PQ). Many utilities and consumers have increased their concerns about power quality. Power quality problems occur when the 50 or 60 Hertz sine wave alternating-voltage power sources is distorted. The characteristics of power quality problems are variation of voltage, current and also frequency from nominal rating. The effects of power quality problem which are motors overheating, adjustable-speed drives (ASDs) tripping off, computers shutting down, flickering lights and stopped production [1]. The types of power quality problems which are voltage sag, voltage swell, undervoltage, overvoltages, harmonics distortion, flickers and transients [2]. The voltage sag is the most common disturbance of power quality issue at power frequency [3].

Figure 1.1 describes the demarcation of the various power quality issues based on the magnitude and duration [4].

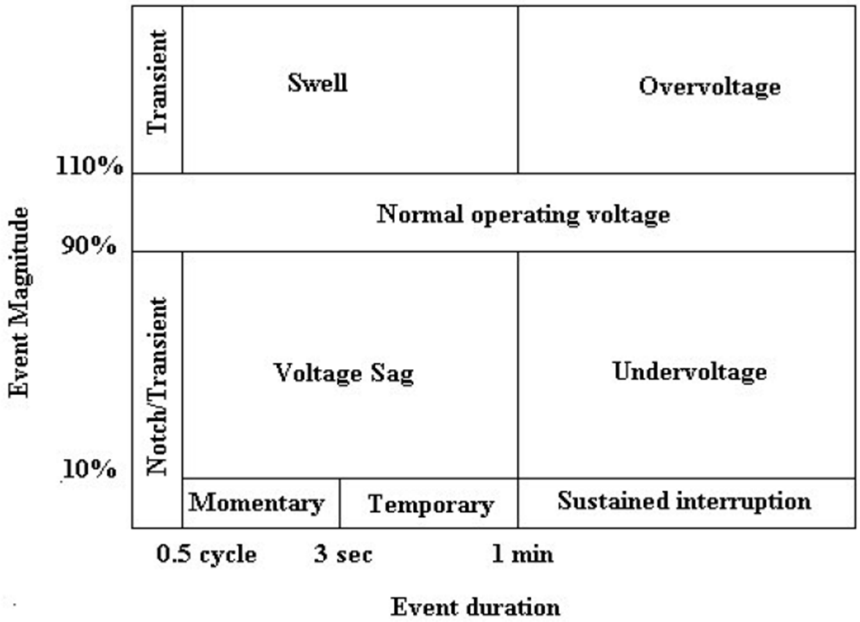

Figure 1.1 Demarcation of the various power quality events

Generally, voltage sag is reduction of voltage magnitude of rms voltage in between 10 to 90 percent of nominal voltage around 0.5 cycles to 1 minute. Voltage sag can cause by utility and end users. The utility consists of transmission and distribution systems. The most common cause of voltage sag is faults in the system [4].

The estimation of the voltage sag source location is the most important method for the feature study of the power system. After the location of the sag source is identified, the diagnosis and mitigation can be applied to improve the power quality in the power system [5]. There are two categories of voltage sag source location method, namely single monitor and multi monitor methods.

Recently, most researchers focus on the application of multi monitor method due to its accuracy in getting the data needed.

Artificial intelligence (AI) is an area of computer science which is emphasizes the creation of intelligent machines that work and reacts like humans. AI such as artificial neuron network (ANN), expert systems (ES) and fuzzy logic (FL) are widely used in electrical applications. The ANN has been applied widely in the power system such as fault diagnosis/fault location, load forecasting, economic dispatch, security assessment and transient stability [6]. The main advantage of ANN is to solve problems related to classification and optimization [7]. It is very suitable to be used in the voltage sag source location as it has the ability to recognize complex patterns in the power system.

1.2 Objectives of the Project

The objectives of this project are:

- To analyse voltage sag characteristic for asymmetrical fault in power distribution networks
- To estimate voltage sag source location using artificial neural network (ANN)

1.3 Scopes of the Project

The scopes of this project are:

- The analysis of voltage sag characteristic which is magnitude
- The asymmetrical fault will be generated in a simulation at the bus in the system
- The RBFN will be used to estimate the bus location in the system

1.4 Problem Statement

The voltage sag causes motor to stall, computer and ASDs to shut down and production halt which translates to losses of money. The power quality monitor (PQM) is essential to be installed for all buses in distribution network to identify the cause and source location of the voltage sag. In real life, not all buses are installed with PQM due to expensive equipment cost.

The proposed method will be able to estimate the location of voltage sag source using ANN to overcome the problem.

1.5 Project Report Outline

This project report consists of five main chapters which are introduction, literature review, methodology, results and discussion and conclusion.

Chapter 1 of this project report will be focused on the general briefing about voltage sag, voltage sag source location methods and artificial neural network (ANN). This chapter also explains the objectives, scopes of the project, problem statement and project report outline.

Chapter 2 will be more on the discussion about literature review on the voltage sag, voltage sag source location methods which are single and multi-monitor methods. This chapter also discusses on the related works on voltage sag source location methods.

Chapter 3 is the methodology for this project. In this chapter, the method proposed will be explained in further details on how to model and simulate the test systems using software. This chapter also discusses on the development of ANN using software.

Chapter 4 will be focussing on the results obtained in the chapter 3. The results will be analysed using appropriate tools. The analysis comprises of load flow analysis, voltage sag magnitude, voltage deviation (VD) index, performances analysis of ANN, analysis of error and voltage sag source location.

Chapter 5 is the main conclusion of this project, which will further discuss about the results of this project. This chapter also provides suggestion of future works.

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