VOLTAGE SAG WAVEFORM FEATURES EXTRACTION USING MATLAB

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VOLTAGE SAG WAVEFORM FEATURES EXTRACTION USING MATLAB

FARIDAH HANIM BINTI MOHD NOH

A project report submitted in partial fulfillment of the requirements for the award of Master of Electrical Engineering

Faculty of Electrical and Electronic Engineering
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APRIL 2008

I declare that this report on "Voltage Sag Waveform Features Extraction Using Matlab" is the result of my own research except for works which have been cited in the references. The report has not been accepted any degree and not concurrently submitted in candidature of any other degree.

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To my beloved husband, Muhamad Faizal bin Yaakub and to my dearest daughter, Nur Amnah Fasihah

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ABSTRACT

In this project a software tool to extract characteristic parameters from a voltage sag waveform has been successfully developed and tested. The real recorded voltage sag waveform was acquired from IEEE Working Group P1159.2 Power Quality Event Characterisation webpage. The development of this software tool was done using Matlab environment. Theories and methods on voltage sag characterization was studied and analyzed. The characteristic parameters extraction is done on two conditions of sag, which are voltage sag in single phase condition and voltage in for three phase condition. Two signal processing methods have been applied in order to extract the characteristic of voltage sag in these two conditions. The applied methods are the rms sequence and Discrete Fourier Transform. The extracted parameters or indices of voltage sag in this project are the sag's magnitude, duration, phase angle jump, energy, and severity, type of sag, PN factor and the characteristic voltage. These parameters are the indices which characterize the voltage sag in single phase and three phase condition. The values of these parameters are displayed in the Graphical User Interface of the software tool that has been developed. These values has been compared with the results obtain from the manual calculation and from the simulation results on the Matlab rms and Discrete Fourier block set.

ABSTRAK

Satu perisian khas untuk mengekstrak parameter ciri-ciri lendut voltan daripada bentuk gelombang lendut voltan telah berjaya dibina dan diuji di dalam projek ini. Rakaman data bentuk gelombang lendut voltan sebenar telah diambil dari laman web Kumpulan Pencirian Gangguan Kualiti Kuasa IEEE1159.2. Pembangunan perisian ini dibuat dalam persekitaran Matlab. Teori-teori dan kaedah untuk pencirian lendut voltan telah dikaji dan dianalisis. Parameter ciri-ciri lendut voltan diekstrak dalam dua keadaan, iaitu parameter lendut voltan satu fasa dan parameter lendut voltan tiga fasa. Dua kaedah pemprosesan signal digunakan untuk pengektrakan parameter-parameter ini. Kaedah pemprosesan yang digunakan ialah jujukan rms dan jelmaan Fourier diskret. Parameter atau indeks lendut voltan yang diekstrak di dalam projek ini adalah magnitud, tempoh, anjakan sudut fasa, tenaga, keterukan, jenis lendut voltan, faktor PN dan voltan ciri. Kesemua parameter ini adalah indeks yang mencirikan lendut voltan satu fasa dan lendut voltan tiga fasa. Nilai kesemua parameter ini dipaparkan pada perantara pengguna grafik bagi perisian yang telah dibina dalam projek ini. Kesemua nilai ini kemudiannya dibandingkan dengan nilai yang diperolehi melalui pengiraan manual dan melalui simulasi set blok rms dan diskret Fourier Matlab.

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LIST OF ABBREVIATIONS

PN	-	Positive Negative
IEEE	-	Institutes of Electrical and Electronics Engineers
GUIDE	-	Graphical user interface development environment
IEC	-	International Electrotechnical Comission
rms	-	Root mean square
CBEMA	-	Computer Business Equipment Manufacturers Association
SEMI	-	Semiconductor Equipment and Materials International
THD	-	Total Harmonic Distortion
FFT	-	Fast Fourier Transform
DFT	-	Discrete Fourier Transform
GUI	-	Graphical User Interface

LIST OF SYMBOLS

$V(t)$	-	Voltage or current sample
N	-	Size of sliding window
U_{rms}	-	rms Voltage
U_{fund}	-	Fundamental voltage component
V_{fund}	-	Fundamental voltage component
E_{dip}	-	Energy
U_{nom}	-	Nominal Voltage
f_0	-	Power system frequency
T	-	Duration
V	-	Residual voltage of sag
S_e	-	Severity
f_s	-	Sampling frequency
f_{system}	-	Frequency of power system
e	-	Exponential
φ	-	Phase angle
$\overline{V}_1$	-	Positive sequence voltage
$\overline{V}_2$	-	Negative sequence voltage
$\overline{V}_0$	-	Zero sequence voltage
F	-	PN factor
V	-	Characteristic voltage

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Power quality is a term which broadly refers to maintaining near sinusoidal waveform of power distribution bus voltage at rated voltage and frequency [1], or in other words, providing a clean sinusoidal waveform without any power disturbances. Power quality problems or disturbances generally appear in the form of voltage sags, swells, harmonics, flickers and voltage imbalance. Since a large portion of power supply systems experiences a voltage sag whenever a fault occurs, voltage sags are much more common than actual interruptions in the power system network, but yet they are least avoidable power quality problem faced by utilities all over the world [2]. Voltage sag can be defined as the reduction of the rms voltage to a value below a given threshold for duration between 0.5 cycles to 1 minute [3] [4].

Recent years, utilities have been faced with rising numbers of complaints about voltage sags [2]. This is because more loads are sensitive to voltage sag today rather than they were just a few years ago. Many applications utilize the sensitive electronics circuitry and microprocessors. The industries are now relying more and more on the automated equipment. Voltage sag may reset controllers and the controlled process may take significant time to restart again. In semiconductor device fabrication, a reset in the process will cause a significant loss in terms of productivity, time and material [2]. For many other industrial users, a single voltage sag can cause losses equal to that caused by a power supply interruption [3]. Ironically, research carried out by [5] shows that the number of severe sags per year is higher than the number of interruptions per year. Due to this fact, voltage sag has become a major concern to industries worldwide.

Many engineering efforts [27] [28], researches [1] [23] and studies [26] [5], have been done on voltage sags. Basically, the study on voltage sags can be classified into the following categories:

1. Characterization and detection of voltage sag.
2. Equipment immunity.
3. Stochastic assessment.
4. Mitigation.

These four categories of studies are quite dependent on each other. But most of the times, all these studies are needed to solve a specific voltage sag problem [25]. The basic platform of other voltage sag studies is the characterization of the voltage sag. This study aim at acquiring knowledge of the voltage sags characteristics. Both fault propagation studies and measured data are being used for this. Voltage sag is normally characterized by its magnitude and duration. But some researches have shown that other parameters such as phase angle jump, point on wave, waveform distortion and phase imbalance could also affect the performance of some sensitive equipments.

Many researchers are characterizing and detecting voltage sags by using the latest signal processing algorithm such as [6], [7] had proposed