FREQUENCY VARIATIONS MEASUREMENT TECHNIQUES IN POWER QUALITY MONITORING

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ABSTRACT

Power quality is a term used to describe electric power that motivates an electrical load and the load's ability to function properly with that electric power. Without the proper power, an electrical device load may malfunction, fail prematurely or not operate at all. There are many ways in which electric power can be of poor quality and many more causes of such poor quality power. The aim of this thesis is to study measurement techniques available in monitoring power system frequency particularly using the Least Square Error (LSE) method and neural network approach (ADALINE). The algorithms for the various measurement methods in this thesis were implemented using MATLAB. Results concluded that the neural network approach (ADALINE) is much better for frequency approximation although the LES algorithm provides an easier measurement method. The LES technique was found to be not accurate in the presence of noise and harmonics. Further studies could be done on recursive LES which may compensate the drawbacks of non-recursive LES algorithm which was studied in this work.

ABSTRAK

Kualiti kuasa membawa maksud kuasa elektrik yang membolehkan muatan elektrik berfungsi dengan sempurna. Tanpa kuasa elektrik, muatan elektrik mungkin tidak akan befungsi dengan sempurna, rosak sebelum tamat tempoh hayatnya atau langsung tidak dapat beroperasi. Terdapat banyak sebab yang menyebabkan kualiti kuasa eletrik menjadi rendah. Tujuan utama tesis ini adalah untuk mengkaji kaedah-kaedah menentukan frekuensi sistem kuasa terutamanya menggunakan teknik Least Square Error (LSE) dan neural network approach (ADALINE). Algoritma untuk kaedah tersebut telah dilaksanakan menggunakan MATLAB. Keputusan yang diperolehi menunjukkan bahawa neural network approach (ADALINE) lebih sesuai unuk menganggarkan frekuensi meskipun kaedah LES lebih mudah diukur. Kaedah LES didapati kurang tepat disebabakan mudah terganggu dengan kebisingan dan harmonik. Kajian seterusnya dapat dilakukan terhadap recursive LES yang mungkin dapat mengatasi kelemahan dalam non-recursive LES yang telah digunakan dalam kerja ini.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Power quality is the electrical power that enables an electrical load to function. The electric power industry is in the business of electricity generation (AC power), electric power transmission and ultimately electricity distribution to a point often located near the electricity meter of the end user of the electric power. The electricity then moves through the distribution and wiring system of the end user until it reaches the load. The complexity of the system to move electric energy from the point of production to the point of consumption combined with variations in weather, electricity demand and other factors provide many opportunities for the quality of power delivered to be compromised.

While "power quality" is a convenient term for many, it is actually the quality of the voltage, rather than power or electric current that is the actual topic described by the term. Power is simply the flow of energy and the current demanded by a load is largely uncontrollable.

In recent years, power quality has become an important issue and is receiving increasing attention by utility, facility and consulting engineers. Today's modern commercial and industrial facilities are installed with many electronics equipment and devices such as digital computer, power electronics devices and automated equipment that are sensitive to many types of power disturbances. Power disturbances such as the harmonics currents injected to the system arising within customer facilities have increased significantly due to the increasing use of energy efficient equipment [1]. Examples of these equipments are switch-mode power supplies, inverters for variables speed drives, etc. Therefore, the monitoring and data collection activities for power quality study have to be conducted at the users' premises in order to locate the source of disturbances.

1.2 Problem Statement

This work deals with the power quality problems caused by frequency variation. A frequency variation involves a change in frequency from the normally stable utility frequency of 50 or 60 Hz, depending on the geographic location. This may be caused by erratic operation of emergency generators or unstable frequency power sources. For sensitive equipment, the results can be data loss, program failure, equipment lock-up or complete shut down. To minimize frequency measurement errors, a very accurate measurement technique needs to be implemented on the related system to monitor the power quality. The challenge is to obtain a robust measurement technique that can precisely capture the true system distortion even in the presence of fast frequency variations, harmonics and noise [2]. From the results obtained, a suitable solution such as voltage regulators and power conditioners can be designed.

1.3 Objectives

The ultimate goals of this thesis are :

i. To study issues related to power quality and possible solutions.
ii. To study and evaluate various frequency variation measurement techniques and its application.
iii. To model, develop and test the effectiveness of frequency variation. measurement techniques available namely the Least Error Square, numerical, and ADALINE methods.
iv. To analyze and compare the performance of the three techniques studied.
v. To enhance the techniques used for future improvement and possible industrial application.

1.4 Scope of Work

Power quality monitoring involves several factors such as voltage, current and frequency effects on the overall power quality. The scope of work for this project only concentrates on power frequency variations measurement techniques.

This project incorporates the software implementation where various frequencies and their effects on power quality are studied for LES, numerical and ADALINE techniques. The development done for the software section involves simulations and analysis of the results obtained using the MATLAB software.

As this project focuses solely on software implementation, nevertheless a brief literature research of a possible hardware implementation is also included in Chapter 3.

1.5 Thesis Organization

The body of this report consists of six chapters. After this introductory Chapter 1, the following Chapter 2 will discuss in detail on power quality issues, its applications and challenges. Chapter 3 will elaborate on the frequency variation measurement techniques for power quality monitoring studied for this scope of work particularly the LES, numerical and ADALINE methods. Each method will cover the application using digital technique, the effects of harmonics and noise.

Chapter 4 will present the detailed equations and mathematical algorithms and parameters used for LES, numerical and ADALINE techniques. The equations used are inclusive of the basic measurement without distortion, measurement under the effect of noise and measurement under the effect of harmonics. The subsequent Chapter 5 presents the graphic MATLAB results for each equation or algorithm generated in the previous chapter. The results and comparisons are also discussed.

Chapter 6 is the final chapter which consists of the conclusion and recommendations of this study. The last sector of this thesis includes the references used and appendices on the MATBLAB source codes for each algorithm mentioned in Chapter 4 and Chapter 5.

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