UNIVERSITI TEKNOLOGI MARA

POWER QUALITY DIAGNOSIS TECHNIQUE USING CONTINUOUS S-TRANSFORM BASED ANALYSIS OF VARIANCE AND SUPPORT VECTOR MACHINE

KAMARULAZHAR BIN DAUD

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ABSTRACT

Power quality (PQ) has been an important issue in power systems in recent years. The demand for clean power has been increasing in the past several years. The reason is mainly due to the increasing usage of microelectronic processors in various types of equipment such as computer terminals, programmable logic controller, diagnostic systems, etc. Poor power quality may cause many problems for affected loads such as malfunction, instabilities, short lifetime, and so on. Poor quality is attributed due to the various power line disturbances like voltage sag, swell, impulse, and oscillatory transients, multiple notches, momentary interruptions, harmonics, and voltage flicker, etc. The objective of this work is to detect and classify the power quality disturbances (PQDs) that use the advances in signal processing and classification intelligence. In this research, a new application method of feature extraction, detection and classification the pattern or waveform shape of PQDs has been introduced. In the first stage, voltage waveforms with multiple power disturbances were simulated using the PSCAD and MATLAB software. Multi disturbance types generated from Power System Aided Design (PSCAD) and MATLAB software simulation were utilized for feature extraction purpose by deploying the Continuous S-Transform (CST). The feature selection and detection approach of feature extraction for these disturbances were employed by one and half-cycle Windowing Technique (WT) and Analysis of Variance (ANOVA). Then, the classification method for a different type of power disturbances was developed using the Neural Network (NN) including Probabilistic Neural Network (PNN), and Support Vector Machine (SVM). Consequently, the One-Cycle Windowing Technique (OCWT) was used to provide the smooth detection on PQ disturbances compared to Half-Cycle Windowing Technique (HCWT) in order to get better accuracy of classification. The significance results from OCWT produced good recognition rate as compared to HCWT. Finally, a comparison of classification using PNN and SVM were compared for the PQ diagnosis system to verify the accuracy rate of classification performance for voltage sag, swell, and transient. In overall, the significance result of SVM classifier was found more efficient as compared to PNN.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Power quality (PQ) can be defined as "any power problem manifested in the voltage, current, or frequency deviations that result in failure or mal-operation of consumers' equipment" [3]. PQ has become very important for utility, facility managers and consulting engineers in recent years [4]. End user equipment is more sensitive to various power quality problems that arise both in the power supply system and within customer facilities [5]. Electrical power supply requires the ability to provide a reliable and continues supply to consumers. Poor quality of electrical power supply could result in huge economic losses [6]. Consumers with sensitive electronic equipment such as computers, variable speed drives, robots, electronic controllers, and automated industrial production lines are very susceptible to power quality disturbances. A report from Electrical Power Research Institute (EPRI) shows that the US economy is losing between USD104 billion and USD164 billion a year to outages and another USD15 billion to USD24 billion to the PQ phenomena [7]. Meanwhile, a report from Tenaga Nasional Berhad (TNB) on Power Quality: Issues and Mitigation shows that their estimated loses are around RM1.85 billion a year due to the PQ phenomena especially through voltage sag [8].

The PQ monitoring system is actually meant to improve system performance and identify problems before they lead to equipment failures or extended outages as well as reducing the life span of power plant electrical equipment [10]. Most PQ monitoring systems use reactive mode to characterize specific PQ problems. Many power quality service departments or plant managers solve problems by performing short-term monitoring at specific consumers [9]. This is reactive mode of power quality monitoring but it frequently identifies the cause of equipment incompatibility which is the first step to any PQ solution. In reactive mode system, monitoring results are used to review disturbance characteristics before a problem occur, or they are used to provide summaries of system conditions such as power quality and reliability indices. However, there are opportunities to use these monitoring systems in a proactive mode. Proactive