

Chapter 24

Intelligent Techniques for the Analysis of Power Quality Data in Electrical Power Distribution System

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ABSTRACT

This chapter is about the intelligent techniques for the analysis of power quality problems in electrical power distribution system. The problems related with electrical power industry are becoming more widespread, complex, and diversified. The behaviour of power distribution systems can be monitored effectively using artificial intelligence techniques and methodologies. There is a need of understanding the power system operations from power utility perspectives and application of computational intelligence methods to solve the problems of the power industry. The real power quality (PQ) data is taken from a power utility in Victoria Australia. Principal Component Analysis Technique (PCAT) is used to reduce the large number of PQ data attributes of the power distribution system. After the pre-processing of PQ data using PCAT, intelligent computational techniques will be used for the analysis of power quality data. Neural network techniques will be employed to estimate the values of PQ parameters of the power distribution system. The Feed Forward Back Propagation (FFBP) neural network and Recurrent Neural Networks (RNN) are used for intelligent estimation of PQ data. The results obtained through these intelligent techniques are compared with the real data of power utility in Victoria, Australia for stability, reliability and enhanced power systems performance.

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INTRODUCTION

The annual consumption of electricity has been increasing rapidly through out the world. The increased usage of electricity in the modern day world challenges the economic operations of a power system with a greater focus on Power Quality (PQ). The optimum utilization of energy leads us to management of load, which is defined as the set of objectives designed to control and modify the patterns of demands of various consumers of a power utility. This deliberate effort to modify the patterns of demands of consumer gives rise to the issue of PQ which has been acknowledged as the most important area of research in power industry. The proper analysis of power quality problems requires a high level of engineering expertise and is not restricted to a specific area of electric power, which makes the problem more complex and diversified.

Today we find power quality issues in transformers, electric drives, rotating machines, power electronics, power supplies, capacitor switching, protection, power system faults, harmonics, signal analysis, measuring instruments and general power system operations. In electrical power system the monitoring and management of power quality data has become immensely important because of demand of continuous availability of quality power supply to consumers on sustainable basis. The main problem faced by modern power utilities today is the unpredictability of the power system behaviour due to unexpected power quality problems. The common PQ problems faced by power industry are sag, swell, harmonics, and interruptions in supply of power for short and long durations or sometimes the complete outage. These PQ problems can lead to severe losses for industrial consumers including costly equipment damage.

POWER DISTRIBUTION NETWORK

Power distribution network holds a pivotal position in entire electrical power system. An electrical power system consists of mainly three components:

1. Generating stations
2. Transmission systems
3. Distribution systems

These three components of electrical power systems are integrated together to supply electricity to consumers (Paracha & Doulai, 1998).

The typical power distribution system consists of power distribution networks which consist of high voltage distribution lines having a rating of 11kV, 22kV or 33kV. The traditional power distribution network will have these high voltage lines as overhead lines coming out of the substation. With the modern power distribution network the overhead high voltage distribution lines are being replaced by underground lines to ensure safety, reliability and considering the environmental impact of the power distribution network. In addition to high voltage distribution lines power distribution network consists of transformers and other auxiliary equipment in substations to ensure smooth availability of quality supply power to consumers. The most important requirement to run power system operation in advanced global world is to have sustained availability of quality and reliable supply of electric power. Power utilities around the world are focused on delivering a greater quality of power delivery due to increased customer competition in modern day challenging environment. There is an on-going demand for more reliable and inexpensive supply of power. PQ has become widely important and is a matter of concern to all of its stakeholders as it directly affects the running of their smooth operations.

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