Motivation

- The high proliferation of nonlinear loads, power electronic-based devices and renewable energy sources in the recent years are deteriorating the quality of power supply to quite severe levels.
- The PQ monitoring helps in the understanding of PQ disturbances, their causes and their impact on the power system and the end-user equipment.
- The analysis of time-varying practical voltage and current signals requires an adaptive tool to analyze the disturbances accurately and identify the transitions.

Objectives

In view of the importance of the accurate and fast PQ monitoring, and limitations of the existing techniques, the main objectives of this work are:

- To accurately estimate the PQ indices of distorted signals containing harmonics and interharmonics with less computational complexity.
- To analyze the time-varying signals having disturbances and visualize their instantaneous amplitude and frequency accurately.
- To extract the actual fundamental frequency component of any distorted voltage/current signal for the computation of time-varying PQ indices.
- To develop a novel online automatic recognition approach for accurate classification of single and combined disturbances under noisy conditions.

Power Quality Monitoring Outline

To define, measure, quantify & interpret the disturbances occurring in the system.

1. Estimation of PQ indices using EWT

Application of a modified EWT for an accurate estimation of 1-Ø & 3-Ø PQ indices.

2. Adaptive Filtering for continuous monitoring

Proposes an improved two-stage filtering technique utilizing a divide-to-conquer principle based frequency estimation and Hamming window.

3. GEWT to visualize time-varying PQ indices

This work proposes a Generalized Empirical Wavelet Transform (GEWT) tailored for assessment of all sort of PQ disturbances.

4. GEWT based Features for multiple PQDs

This work utilizes the GEWT for feature extraction and SVM for accurate classification of the most frequent 15 disturbances with only six features.

- The combined disturbance, which contains two or more single disturbances simultaneously will exhibit characteristics of all its individual disturbances.
- The proposed SVM model with RBF kernel has the highest classification accuracy of 97.44%.
- The overall classification time is approx. 50 ms.
- Tested on 6 real disturbance signals.

5. Detection of PQDs using TQWT & MSVM

The proposed approach first investigates the presence of low-frequency interharmonics and then tunes the wavelet for decomposition of signal into fundamental and distortion components.

- The overall accuracy of the dual MSVM and RBF kernel is found to be 97.286 %.
- The mean classification time is 80 ms.

6. DSP Implementation of the EWT for PQ

To investigate the practical applicability of the modified EWT, it is implemented on a DSP and verified on practical 1-Ø voltage and current signals.

Conclusions

- Developed adaptive and intelligent techniques for PQ monitoring with an objective of attaining high accuracy with less computational complexity.
- Successfully utilized the potentials of the EWT for PQ analysis.
- The GEWT shows excellent performance in case of PQ disturbances due to its complete adaptiveness.

Both the two new multiclass SVM classification models are suitable for quick detection of 15 PQ disturbances with an overall accuracy of 97 %.

- Finally, the practicality of the EWT-based PQ measurement is investigated and verified on the TMS820F28377S DSP.

Journal Papers out of The Thesis Work: