

Analysis through mathematical model of power quality disturbances to improvement

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Abstract

Power quality studies have developed to analyses power quality data as the use of delicate electronic equipment has increased. The wavelet transformation method was developed to be more useful for analyzing different kinds of power quality events. In this research, we analyses the utilization of several wavelet types at various sizes and decomposition level of the system analyzing actual value of the power quality disturbances events in the transmission system. Signal created using MATLAB backdrop. Testing has been done on voltage sag, voltage swell, and transient events. This technique makes use of Wavelet transform and Artificial Neural Network (ANN) to identify and categories power quality disturbances in the power system. Comparing the suggested method to the standard approach, fewer characteristics are needed for identification. Artificial neural networks are taught to classify events using the feature that the wavelet extracts. The weight gained after neural network training is used to categories PQ concerns between the quantity demand and the price.

Subject Classification: 00A05.

Keywords: Disturbances power quality, Wavelet transforms techniques, and Artificial neural network.

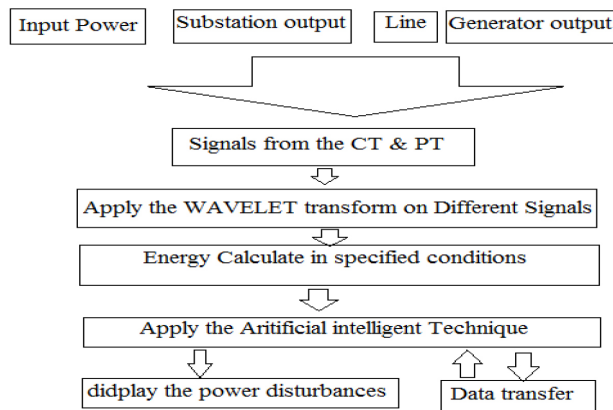
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1. Introduction

Due to their exposure to the environment, transmission lines have one of the highest fault incidence rates of all the parts of the power system. Man cannot prevent line faults caused by lightning, storms, foliage falling from the sky, fog or salt spray on soiled insulators. Three phase shunt and three phases to ground circuit faults are balanced transmission line faults. Any aberrant flow of electric current in an electric power system is referred to as a fault. As an illustration, a short circuit is a defect in which current flow skips the usual load. If a failure causes the circuit to be interrupted, an open-circuit fault occurs. In three phase (3P) systems, a defect can develop simply between phases or between one or more phases and the ground. The current in "Ground Fault" travels along the earth's surface [1].

The protective devices in power systems will identify fault situations and activate relays and the CB (circuit breakers) and some other important devices to reduce the amount of service that is lost as a result of a breakdown. A "symmetrical fault" is one that can affect all phases of a poly phase system equally. The "asymmetrical fault" that results when only some phases are impacted is more difficult to analyze since the simplistic presumption of equal current size in all phases is no longer valid. Using techniques like symmetrical components helps to simplify the analysis of this sort of defect more frequently. Symmetrically faults affect all phases equally and the value of these type fault not more than 5% of all the faults. About 5% of the defects in transmission lines are symmetric. This, as compared to an asymmetric fault that does not have equal impact at all the phases of the system as compared to the symmetrical faults. Power systems commonly experience imbalance issues in practice. The three phases are not equally impacted by an asymmetric or unbalanced fault [3]. Conjugate gradient method use for sampling and solving the large scale problem for optimization [2]. This study discusses numerous wavelet-based strategies for transmission line protection with an emphasis on the many ways to accomplish fault isolation, classification, and detection in transmission lines. Among them is the Wavelet transform function [4]. In the modern system resolving the high speed faults is very crucial and a number of methods are proposed to achieve this purpose. In this series adaptive wavelet networks (AWNs), the method of power-quality detection for power system disruptions was suggested [1]. An AWN is divided into two different network (sub-network) design made up of an adaptive probabilistic network and a wavelet layer. An adaptive

**Figure 1****Flow chart of apply method**

probabilistic network analyses the significant characteristics and carries out discriminating tasks after feature can be extracted by the Morlet wavelet transform function at the different disturbances and faults, fluctuations. With add-in and delete-off capabilities that use automated target modification and parameter tweaking, AWN models are appropriate for use in a dynamic context. Power-quality issues, such as those brought on by harmonics, voltage sag, voltage swell, and voltage interruption, have been tested for in the planned AWN. CWT is properly applied to the sampled signal, the disturbance's detection and duration may be determined [2]. The Discrete Time Wavelet Transform (DTWT) apply at the data for decomposing signals into the frequency signals or sub bands in order to determine disturbance amplitude. Figure 1 suggested approach is intended for an agile disturbance classification and has a strong noise can be rejected that is produce for the measurement of data for the real time and the off- time line period and tested the date.

2. Transform using Wavelet

One of the most significant and potent tools for signal representation is the wavelet transform. It is being utilized in signal processing, data compression, and picture processing. Due to its powerful temporal and frequency capabilities, discrete wavelet transform analysis is a very important and specified domain signal processing technology, is already being used by many academics in the field of power systems. In relation to a mother is wavelet (t), the CWT definition for a given signal $x(t)$ is analysis

of the domain [3], [4]. Uncertainty problem can be solve with the implementation of the optimal control [11].

Events of the quality of the power and their protection of the system are large two sectors with the largest applications [5], [8]. Where the translation factor is and the scaling factor is

$$CWT(a, b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} x(t) \psi\left(\frac{t-b}{a}\right) dt \quad (1)$$

T, a, and b are all continuous for CWT. Instead of the wavelet transform function necessitates the choice of a mother wavelet for a variety of uses Wavelet transform use in engineering fields Typically, a DWT is required, which indicates t (time), a and b (constant) in (1) have a discrete form. The DWT representation is expressed as

$$DWT(m, n) = \frac{1}{\sqrt{a_0 m}} \sum_k x(k) \psi\left(\frac{k - nb_0 b_0^m}{a_0^m}\right) \quad (2)$$

In the above equation (1) different parameters and the original data can be modified from n to m integer function with the variables function refer k to input signal.

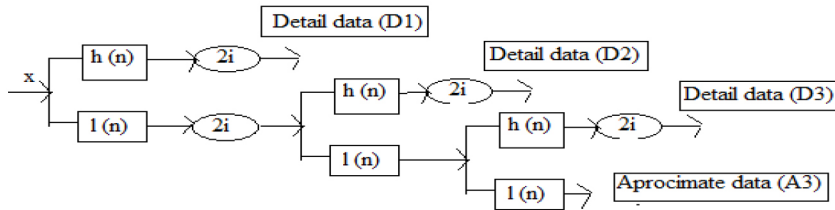


Figure 2

Multi-resolution analysis by the wavelet transforms

In the above Figure 2 for multi-resolution analysis by the wavelet transforms, a highly helpful DWT applicable for the system. In this system two type of the filter like low pass filter and high pass filter respectively $l(n)$ and $h(n)$ are applied to the original sampled signal $x(n)$. In this system two type of the signal coefficient level have required in which for the approximate data approximation level denoted by A1 and for the detail data detail level is required which is denoted by D1. The second step then repeats the process using the approximation coefficients [15-18]. The data is finally decentralized at the level of particular level of details level and the approximate level. If the initial sample frequency in the scenario depicted in Figure 2 is F, the signal data that D1 has recorded falls within

the range of $F/4$ and $F/2$ of the frequency band. D2 records the data between $F/8$ and $F/4$, whereas D3 records the information between information between $F/16$ and $F/8$, whereas A3 keeps the remaining original signal information between 0 and $F/16$. the data into several band of frequency while also matching the information to the relevant time period [6]. Haar wavelet transform implemented for the finding the absolute power quality and efficiency of the system [11].

The information is kept after decomposition to a greater or lesser extent depending on the wavelet energy. The $X[n]$ is defining for the total energy denotation and the average signals of the power that provided by given Eqs. (3) and (4) as follows.

$$E = \sum_{-\infty}^{\infty} x^2(n) \quad (3)$$

$$P = \lim_{x \rightarrow \infty} \frac{1}{2N} \sum_{-N}^N xn(n) \quad (4)$$

Following a successful decomposition procedure, we obtained the energy gradient of each signal that travels to the classification of the different faults in term of the internal and external. The wavelet transform is a type of comparative analysis that assesses how closely a provided data resembles a shifting data on the axis and scaling of the fundamental signals in the form of the input parameters and output parameters with the help of a fundamental function. Through changes in scale factor, the wavelet transform's data window length is flexible. We obtained the energy coefficient of each signal after a successful decomposition operation, which we then sent to the neural network for categorization of internal and external defect [10]. We choose the number of decomposition levels for Multiresolution analysis and the kind of Mother Wavelet based on the best results found in the proposed study. This decision was made entirely using MATLAB research.

3. Artificial Neural Network

In this paper a neural system is essentially a grouping of artificial neurons network of the system. A simulation model of the system in artificial neuron system have been created in its most basic form is an artificial neuron. According to our knowledge, biological neurons are thought of as the basic components for any nervous system's information

processing. Basic mathematical model of the system is depending on the following parameters in neural network.

The basic building blocks of a neurological system at which information processing takes place are called neurons.

Signals are the kind of incoming data that are sent between neurons via connecting pathways.

Network has the data to be transmitted from each link with amplifying for the transmission in the system [14].

Each neuron has an internal action that based on a bias or fringe threshold, produces an output signal by applying summation of the input signals for the activated function can be given by $\sum_{i=1}^n W_i X_i$.

The resultant input data of the for the neural network is achieved and known as the weight of sum of them signals like $X_1, X_2, \dots, X_n$ with respect to the certain neuron associated weight like $W_1, W_2, \dots, W_n$ respectively with the input data or signal.

$$y = f \left(\sum_{i=1}^n W_i X_i \right) \quad (5)$$

3. Implementation of the wavelet transforms

3 phase output data of the in term of the current can be measure through the current transformer. Current transformers (C.T.) are used use to measure the data of the different equipment's in the power system like transformer, transmission line, generator, distribution line and the load center of the substation. In order to extract the signal, this current signal is sent to the wavelet block. Using wavelet transform methods, the spectral energy of each individual phase current signal was computed in this block. The neural network is given the coordinates of the current spectral energy [12]. The neural network is previously trained for various conditions of PQ Figure 3. Neural networks make decisions on the different types of Power quality disturbances in accordance with the training data set.

$$y = f \left(\sum_{i=1}^n W_i X_i - b \right) \quad (6)$$

Neural network defined in the form of representation as

$$f(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ 0 & \text{if } x < 0 \end{cases} \quad (7)$$

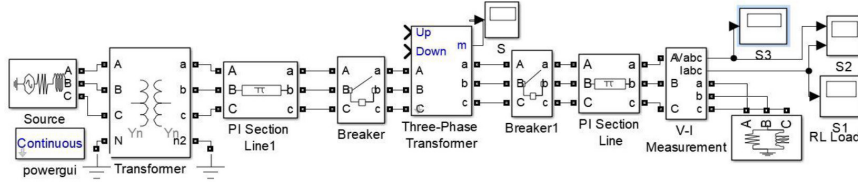


Figure 3

Simulation circuit for determination of disturbances in system

So that the activation of the network can be achieved by the

$$f\left(\sum_{i=1}^n (W_i X_i - b)\right) = \begin{cases} 1 & \text{if } \sum_{i=1}^n W_i X_i \geq b \\ 0 & \text{if } \sum_{i=1}^n W_i X_i < b \end{cases} \quad (8)$$

5. Voltage sag

In this model take into account a 34.5 KV gearbox model with 440 Volts, 30 KVAR of 50Hz inductive load, and 10W of active load to generate sag voltage. In between 0.1 and 0.4 seconds, sag is formed. The simulation lasts one second in total. The sag waveform was subjected to wavelet transform analysis using the analysis mother wavelet as a debachies-1 for up to five level decomposition. Five detail coefficients are obtained from the five level decomposition. For each and every power quality disturbance, there exist various standard deviations of the detail coefficients [5].

6. Voltage Swell

In this analysis model of the system has taken with the apply voltage of 34.5 KV including three phase system at 440 Voltage and frequency of

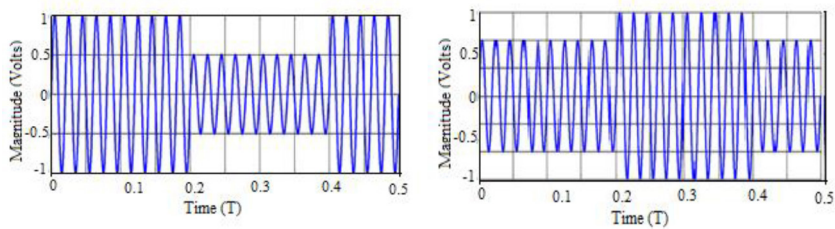


Figure 4

(A) Voltage sag (B) Voltage Swell

50Hz. Here load is inductive with 30 KVAR including 10 Watts active load for detection of the interruption in the system. Figure 4 simulation lasts one second in total. Swell voltage signal and energy calculations utilizing wavelet multiresolution analysis using the wavelet toolkit [13].

6. Voltage interruption

In this analysis model of the system has taken with the apply voltage of 34.5 KV including three phase system at 440 Voltage and frequency of 50Hz. Here load is inductive with 30 KVAR including 30 Watts active load for detection of the interruption in the system [9]. Figure 5 interruption was present in the system between 0.4 to 0.1 second. The simulation lasts one second in total. For the estimation of energy and momentary interruption of the voltage signal, wavelet multiresolution analysis is used.

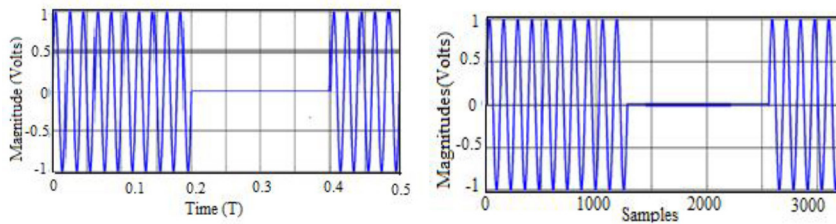


Figure 5
Voltage interruption

Table 1
Different level of data interruption in neural network [7]

PQ Disturbances	P 5(A)	P 5 (D)	P 4 (D)	P 3 (D)	P 2 (D)	P 1 (D)
General Voltage Level	98.01	1.60	0.40	0.15	0.250	0.015
Sag	98.02	1.59	0.39	0.12	0.027	0.017
Swell	97.99	1.60	0.41	0.14	0.018	0.009
Interruption	98.01	1.58	0.38	0.13	0.019	0.014
Harmonics	97.98	1.57	0.39	0.14	0.020	0.013
Transient	97.15	1.50	0.25	0.11	0.011	0.012

Where

P (A)5 _ Approximate coordinate at level 5 and

P 5 (D) to P 1 (D) Detail coordinate at level 5 to detail coordinate at level 7].

7. Conclusion

In this paper we can say the 15 number of disturbances apply on the system then some of the disturbances approximate 10 disturbances are remove with the 69% of accuracy. Remaining about 5 disturbances apply methodology cannot have proper investigation with the neural network and wavelet transform. For the determination of more accurate data for remaining disturbances new approach will be presence. This technique makes use of Wavelet transform and ANN to identify and categories PQD in the supporting system. Table 1 the suggested approach to the standard approach, fewer characteristics are needed for identification. Artificial neural networks are taught to classify events using the feature that the wavelet extracts. The weight gained after neural network training is effective of categories PQ concerns. The ANN total effectiveness for analyzing Power Quality Disturbance is 69%.

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