

# IDENTIFICATION OF POWER QUALITY PROBLEMS IN IEEE BUS SYSTEM BY USING NEURAL NETWORKS

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**ABSTRACT:** In power system, operation and fortification detection and classification of current and voltage conflict is a significant assignment. In this paper, a measurement system of some transient disturbances based on Artificial Neural Networks will be presented. This paper presents a new advance for classifying the proceedings that stand for or direct to the dreadful conditions of power quality. A probabilistic neural network structure proposed and it is chosen as the classifier.

**KEYWORDS:** power quality problems, artificial neural networks, IEE 30 bus system.

## INTRODUCTION

Now a day's making use of electronic controllers in electric power supply system has turned out to be exceptionally common. These electronic controllers act as nonlinear in nature and cause severe distortion in the distribution system and originate unwanted harmonics in the supply system, leading to less efficiency of the power system network and equipment connected in the system [1]. The general power monitoring systems are able to identifying the majority of the power quality problems as well as classification of harmonics and irregular waveforms. To further enhance robustness in monitoring and to increase performance during worst conditions, we propose the use of neural networks is another method for classification of different types of harmonics and irregular waveforms.

Power quality is more significant parameter in the power systems. The power to be supplied with no interruptions, but also the voltage and current are nominal values to ensure continuous equipment operation. Low power quality can cause severe problems for the affected loads, such as lifetime is shorter period, malfunctions, instability and interruptions of the system. The main cause for our step by step dedicated to interests in power quality lies in the enormous cost-effective value directly associated with those disturbances. Less power quality is normally considered as presence of disturbances such as harmonics distortion, switching of large capacitors, various faults, inrush currents in transformers and sudden starting of motor. In order to increase the quality of service, systems that are capable of identify the signatures of various actions and make appropriate decisions for switching and regular maintenance. Conventional techniques for recognition and sorting of power system disturbances are difficult, because they are basically depends on visual checking of waveforms [2].

An extensive variety of real time power qualities detecting systems are helping the power industry. A rapid review will show the most of the detecting systems are used to follow the quality of the power supply and for load flow studies. For monitoring the system to be more intelligent, so we propose the use of a probabilistic artificial neural network (ANN) for predicting the style of power factor, active and reactive power. By predicting the power factor and active power require it is probable to automate the control of reactive power load and to superior utilize the volt-amperes (VA) inflow. Efficient utilization of the VA loading will not only progress the overall grid condition but also diminish the consumer's industrial tariffs. Modern complex industrialized systems rely seriously on Computer Numerical Controlled (CNC) machines, variable speed drives and robotic devices which often require a high level of reliability from the grid. Due to the widespread usage of non-linear loads there has been a significant increase in the harmonic content of the 3-phase supply, raising serious power quality issues [3]. We attempted the usage of ANNs for classification of harmonics and abnormal waveforms. Among the commonly used neural network models, Self-Organizing Maps (SOM) are reputed for pattern

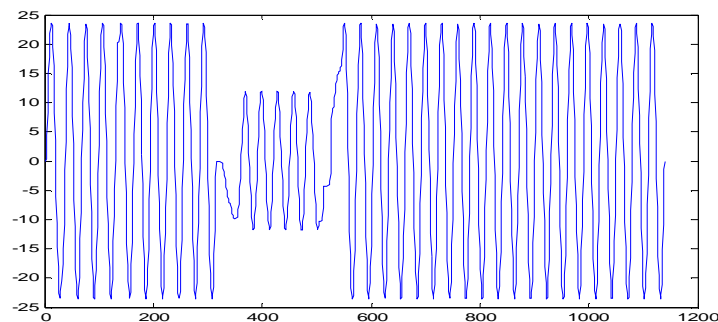
classification. We tried SOMs to classify harmonics and abnormal waveforms but the results were not encouraging. However, the probabilistic neural networks proved efficient and were able to classify different harmonics and abnormal waveforms with almost 100% accuracy.

## POWER QUALITY ISSUES

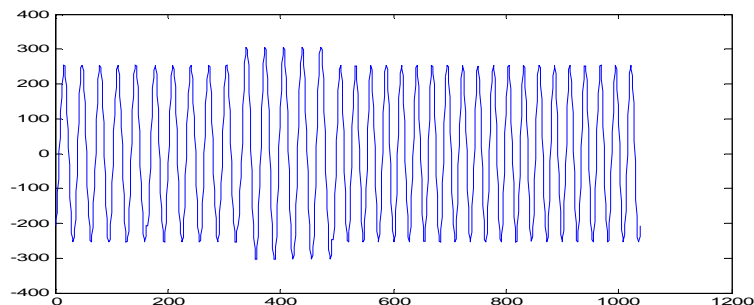
The awareness in power quality has increased during the recent years. A power quality problem can be defined as “a problem due to frequency, voltage regulation, voltage dips, flicker, transients, harmonics, and power factor and 3-phase imbalance”. All rotating machinery has affect the grid by the sources of harmonics, voltage variations or by their power factors. At the same time the performance of the machines is affected by the power quality on the distribution network. The operating machines in industries are increasing rapidly then power quality problems occur in the system. All industrial drives can be disturbed by transients or other irregularities in the feeding voltage. The Industrial drives may cause disturb the network voltage by the producing the harmonics, changes in load and unreliable power factor. The harmonic content and amplitude existing in any power system is highly changeable, and their effects will vary commonly in various parts of the same system due to varying effects of different frequencies. Since the indistinct wave is in the supply system, harmonic effects may happen at any point on the system where the indistinct wave exists. When power is converted to direct current or some other frequency, harmonics will exist in any indistinct alternating component of the converted power. Harmonics are transferred from one circuit or system to other by direct contact or by inductive or capacitive pairing. Harmonics of 50 Hz are in the less-frequency audio range, the transport of these frequencies into communication, signaling, and control circuits employing frequencies in the similar range can root unacceptable interference. In addition, harmonic currents circulating inside a power circuit decrease the capability of the current-carrying apparatus and enlarge losses without providing any functional work.

### Power Quality Disturbance Classes

There are different types of proceedings that can degrade power quality, which makes the detection problems often mysterious and hard. In this paper we can build up our classification algorithm based on disturbance proceedings from six major categories, which are harmonics, high switching frequency of capacitor, low switching frequency of capacitor, sudden voltage sag, gradual voltage sag, and voltage swell. Harmonics distortion is the most important power quality problem [4]. Because of the increased reputation of electronic and other non-linear loads, such as ASD'S, arc furnaces, and induction furnaces, perfect sinusoid waveforms quite often become distorted in this way. Current harmonics causes increased losses in the customer's and utility's power system equipment, while voltage harmonics affects not only sensitive loads but also electric motors and capacitor banks.



**Figure 1.** Voltage sag



**Figure 2.** Voltage Swell

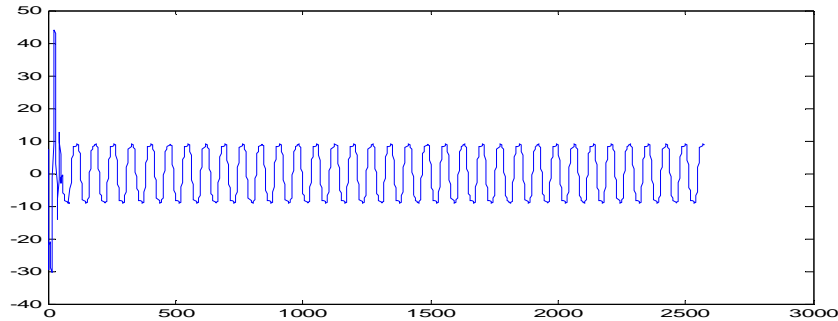


Figure 3. Harmonics

## IEEE-30 BUS SYSTEM

It consists of six generating units, 41-transmission lines, two VAR injecting sources, and four tap changing transformers. The base real power demand of the system is 281.43MW and the base reactive power demand of the system is 134.3 KVAR. The single line diagram of the IEEE 30 bus system is shown here.

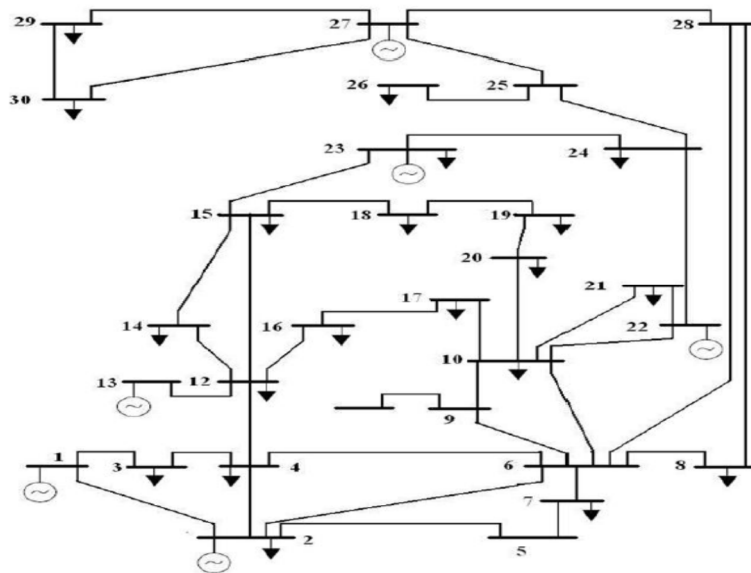


Figure 4. Single line diagram of 30 bus system

The line data and the bus data are given in reference. To study the dynamic behaviour of the neural network on the IEEE 30 bus system power quality analysis problems were carried out. The voltage profile, real power flow and reactive power flow at various buses are measured which was discussed in simulation results.

## PROBABILISTIC NEURAL NETWORK

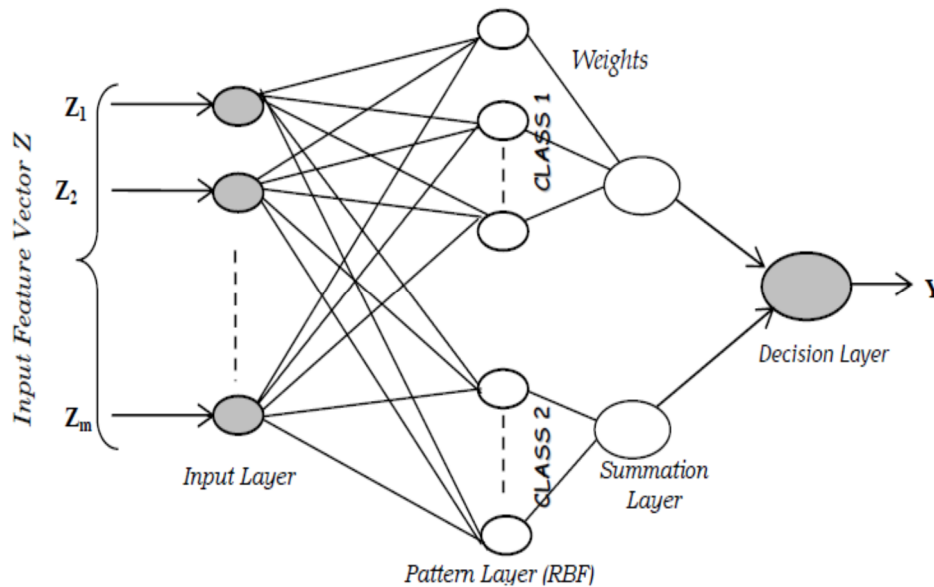
### Artificial Neural Networks

ANNs are the oldest AI techniques among them; they have been around the power research field for relatively some time. Neural networks have been applied broadly in power quality (PQ). Main applications include [5, 6]:

- ❖ Recognizing power quality issues ;
- ❖ Designing the path of harmonic production from illumination systems;
- ❖ Evaluate the harmonic distortions and power quality problems;
- ❖ Recognizing power quality issues using the wavelet transformer along with neural networks;
- ❖ Identifying large-impedance fault and standard load current paths;
- ❖ Estimating harmonic distortion at the same time neglecting the special effects of noise and sub harmonics;
- ❖ Developing a screening tool for the power system engineer to use in addressing power quality issues.

The Neural network models are planned and trained based on the train set and validated using test set samples. The presentation of these neural network models is evaluated in terms of classification precision and misclassification rate. The implementation of NN models is carried out in IEEE 14 bus, 30 bus and 57 bus IEEE standard test systems and the classification results are compared. In this probabilistic neural network model is proposed with IEEE 30 bus system for identification and detection of power quality problem like sag, swell and harmonics etc.

Probabilistic Neural Network (PNN) is a class of multilayer neural network, used in the field of pattern classification. The PNN is a non-linear, nonparametric pattern recognition algorithm that operates by defining a probability density function for each data class based on the train set and optimized kernel width parameter [7]. Figure 5 shows the architecture of probabilistic neural network, consisting of four layers. Radial Basis Function (RBF), an exponential kernel, is used as the activation function in the hidden layer.



**Figure 5.** Architecture of Probabilistic Neural Network (PNN) Model

The input layer has one neuron for each feature variable. The hidden layer (pattern layer) consists of one neuron for every train data sample. The hidden neurons accumulate the values of feature variables along with target class. The summation layer has one neuron for each category of target variable. The neurons in this layer compute the weighted vote for each class category. The final layer called the decision layer compares the weighted votes in the summation layer and uses the largest vote to predict target category (Y).

## MATLAB/SIMULINK RESULTS

The Power Quality assessment analysis has been done for IEEE 30 bus system using MATLAB/SIMULINK. The proposed algorithm has successfully identified the power quality issues like Voltage sag, Voltage swell, Harmonics. The below figure 6 shows the Simulink circuit of IEEE 30 bus system used in this case. In order to create voltage sag short circuit has been created in the system, a Non linear load has been used as a source of harmonics. A power electronics converter is used as Non linear load. By using controlled voltage source we have created voltage swell. Fig 7, Fig 8, Fig 9 shows the power quality problems such as harmonics, voltage sag, and voltage swell in an IEEE 30 bus system is shown.

## CONCLUSION

In this paper power quality problems such as Harmonics, Voltage Swell, and Voltage Sag have been identified in an IEEE 30 bus system. Neural Network based control algorithm has been used to detect the power quality problems. The results obtained from simulation studies have been shown and discussed.

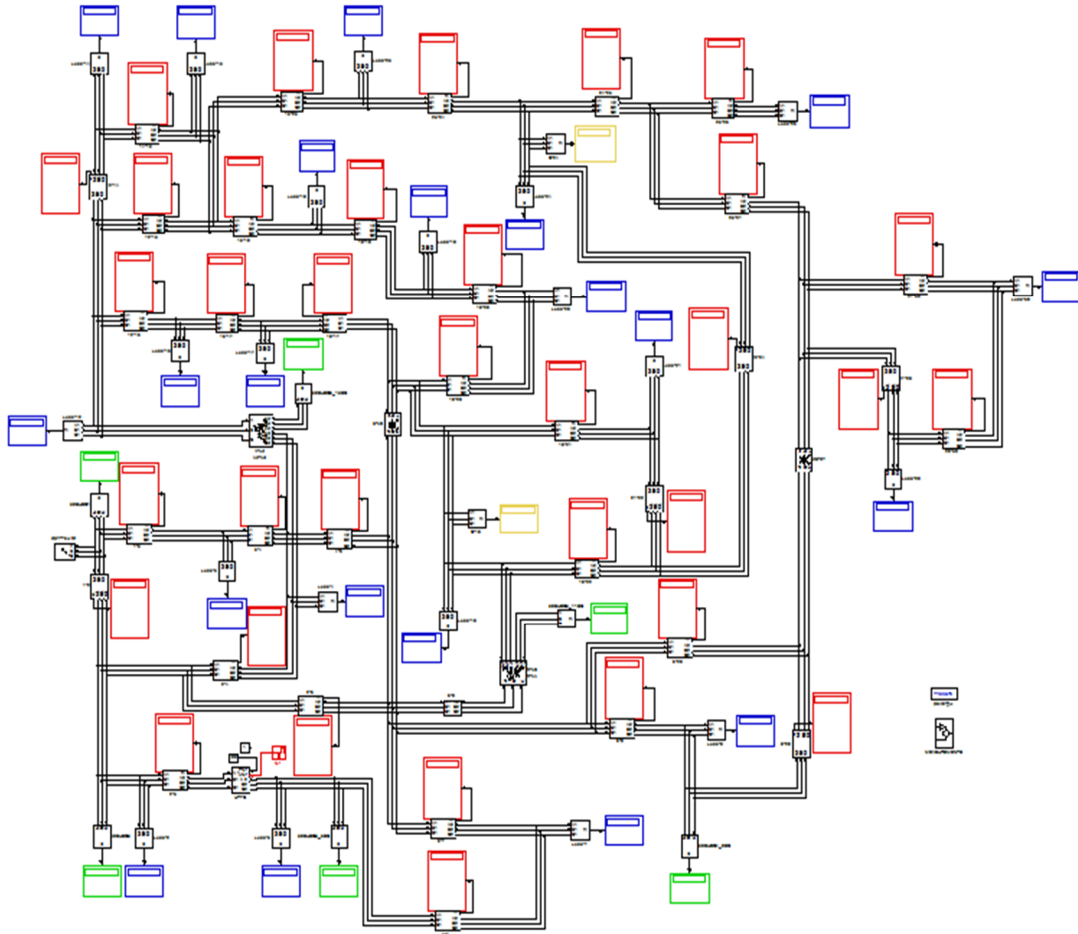


Figure 6. IEEE 30 bus system in Simulink

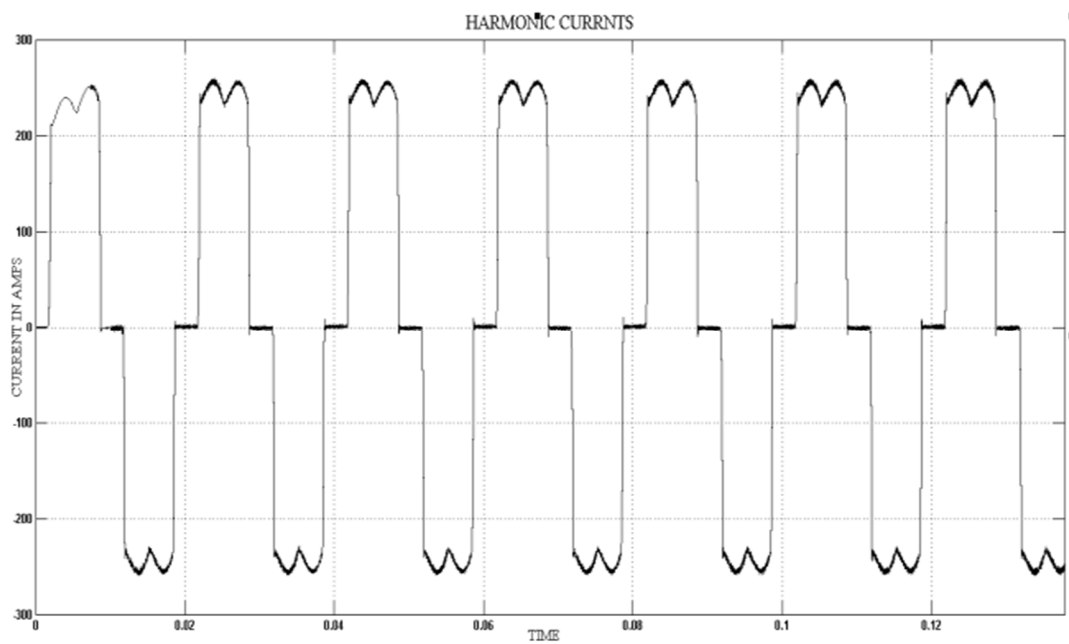
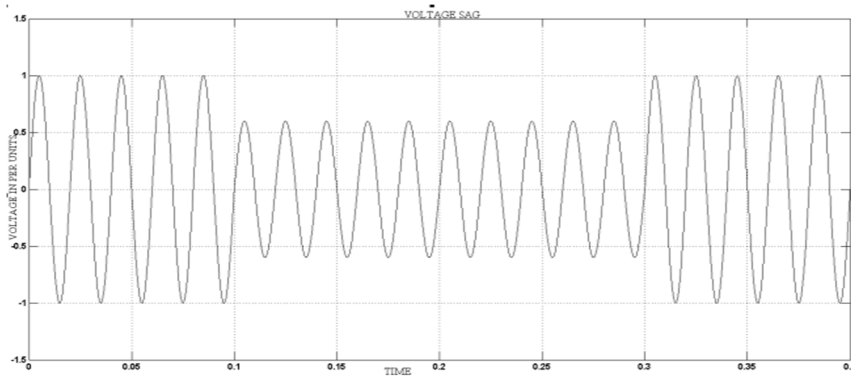
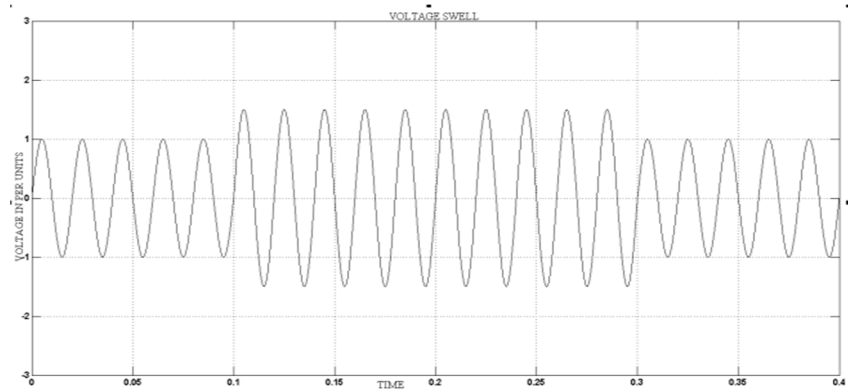


Figure 7. Harmonics Detection



**Figure 8.** Voltage sag detection



**Figure 9.** Voltage swell detection

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