FEATURE EXTRACTION OF POWER SIGNAL

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ABSTRACT

Our work provides an effective feature extraction of a power signal disturbances for analyzing both steady state and short duration non-stationary signals. Power signal is a non-stationary signal in which statiscal characteristics change with time. If u look at such a signal for a few moments and then wait for a period and look at again it would not essentially be the same i.e. its amplitude distribution and standard deviation would be different. In this project we investigate the features of different power signal disturbances like energy, entropy, standard deviation etc. By using these features we can easily analyze the power signal disturbances.

Key words: Non-stationary power signal, feature extraction, 3-D feature plots, analyzing power signal disturbances

I. INTRODUCTION

1.1 Non-Stationary Signals

A non-stationary signal is the one in which statistical characteristics change with time. If you look at such a signal for a few moments and then wait for a period and look it again, it would not essentially the same, i.e. its amplitude distribution and standard deviation would be different. Non – stationary signals can be divided into two types:

1.Mommentarily transient

2.Persistent

A momentarily transient signal has a brief finite duration of time –varying behaviour . Where as in case of persistent signal has continous time varying behavoiur.To process such signals digitally they are to be sampled . The Nyquist criterion gives us a theoretical limit to what rate we have to periodically sample a signal that contains data ata certain maximum frequency .A dilemma concering the choice of sampling of sampling rate araises:on one hand the maximum signal frequency defines sampling frequncy according to Nyquist , while on the other hand the narrow instantaneous bandwidth of signal at each time moment allows a considerably lower sampling density.

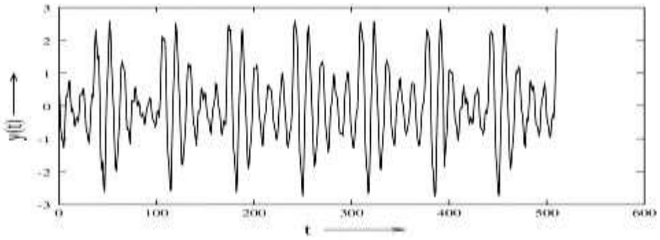

Fig 1.1 Non-stationary signal

One possible course of an action in such a case is to use a non-uniform sampling technique. The proper application of non-uniform sampling suppresses the frequency aliasing and allows the use of a sampling density below the Nyquist rate. It should be stated that non-uniformly taken signal require the focusing of more attention on the signal processing algorithm.

In communication systems accurate and quick measurement of signal frequency and amplitude in the presence of distortions and noise is a challenging problem encountered by communication engineers at present .Frequency and amplitude are important parameters for any communication signal quality monitoring, operation management and control using microprocessor. In the past various techniques were proposed that have been used in the estimation of signal frequency and amplitude perform well when the signal is sinusoidal in nature. But when random noise and harmonic distortions are present accuracy and convergence estimation are Discrete Fourier Transformation, Mean square Error, Kalman, adaptive notch filters etc.

II. GENERATION OF SYNTHETIC SIGNALS

2.1 Power Quality

Recently Power Quality (PQ) and related power supply issues have become quite a serious problem for both the end users as well as the utilities. According to established reports, the industry is losing huge amount of resources due to power outages and PQ problems. PQ may be defined as the continuous availability of electric power that confirms to accepted standards of phase, frequency, and voltage. Power System Disturbance is defined as a variation in these standards. The PQ issues and related phenomena can be attributed to the use of solid-state switching devices, unbalanced and non-linear loads, industrial grade rectifiers and inverters, computer and data processing equipments etc., which are being increasingly used in both the industry and home appliances.

These devices introduce distortions in the phase, frequency and amplitude of the power system signal thereby deteriorating PQ. Subsequent effects could range from overheating, motor failures, inoperative protective equipment to power inrush, quasistatic harmonic distortions and pulse type current disturbances. Therefore it is essential to monitor these disturbances. There are different types of disturbances which occur in power systems due to varied reasons. These disturbances can be broadly classified into two types.

- Steady state disturbances
- Short duration disturbances or transients

III. FEATURE EXTRACTION

In this work we have used two types of features i.e. time-domain and frequency-domain features. Out of the seven features used, spectral entropy is a frequency-domain feature and the rest, which includes energy, mean, standard deviation, variance, autocorrelation and maximum deviation, are time-domain features. From these features 5 statistics $f_{1\ldots}\ f_5$ are calculated which are fed to the network for classification task. All the time domain feature statistics calculated are normalized between the ranges zero to one. This is done by dividing the individual features obtained for all the training patterns or (disturbance signals) with the maximum value of the respective feature. This ensures better stability of the network weights during training. There after the entropy value is normalized by dividing it by the factor log (N) where N is the total number of frequency components in the range $[f_1,\ldots,f_N]$. It can be observed that the entropy value for low frequency disturbances like voltage sag, voltage swell, momentary interruption and the pure undistorted sinusoidal is minimum, which is zero. Harmonics including sag with harmonics and swell with harmonics have a comparatively higher value of entropy while disturbances like voltage flicker and flicker involving harmonics show maximum entropy value in the class of steady state PQ disturbances.

IV. SIMULATION RESULTS

Energy plot:

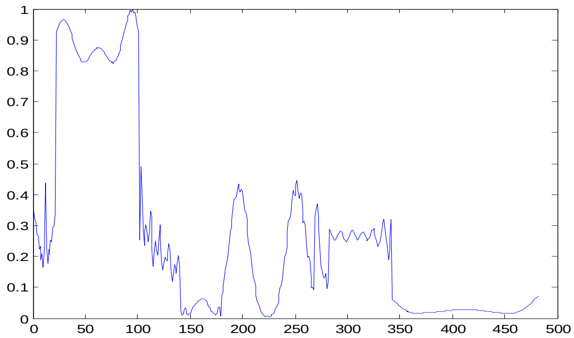

Figure 4.1 energy plot

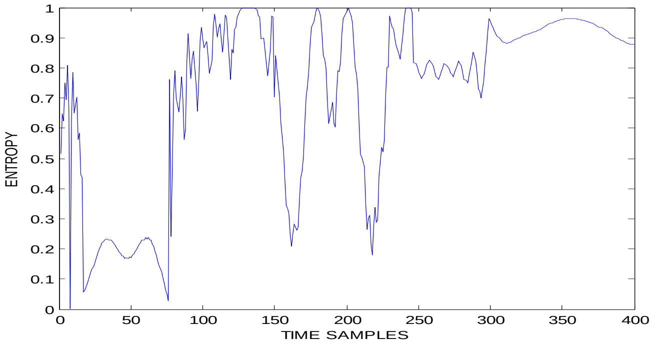

Figure 4.2 entropy plot

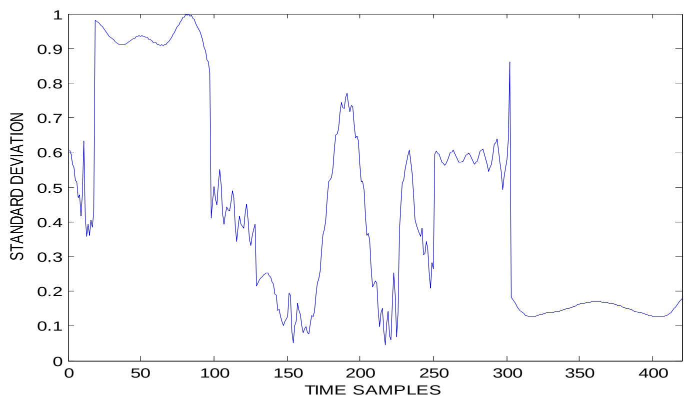

Figure 4.3 standard deviation

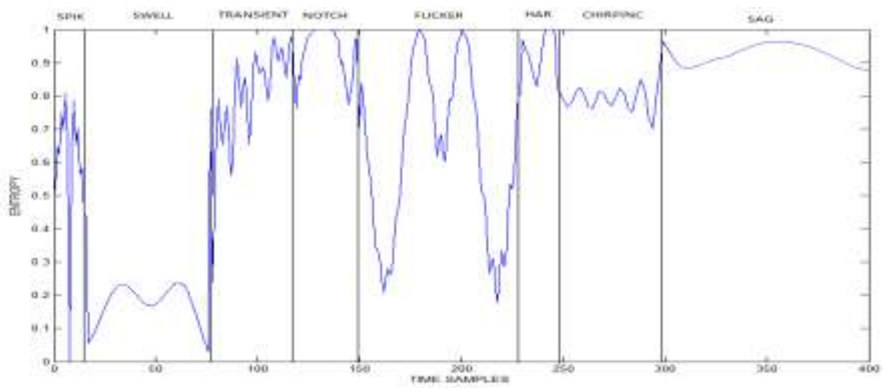

Figure 4.4 plotting the entropy plots for different disturbances

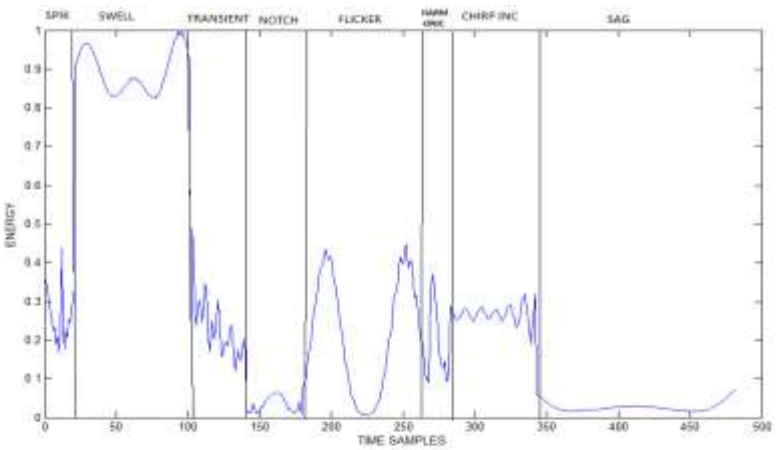

Figure4.5 Plotting the Energy Samples of the Different Disturbances signals

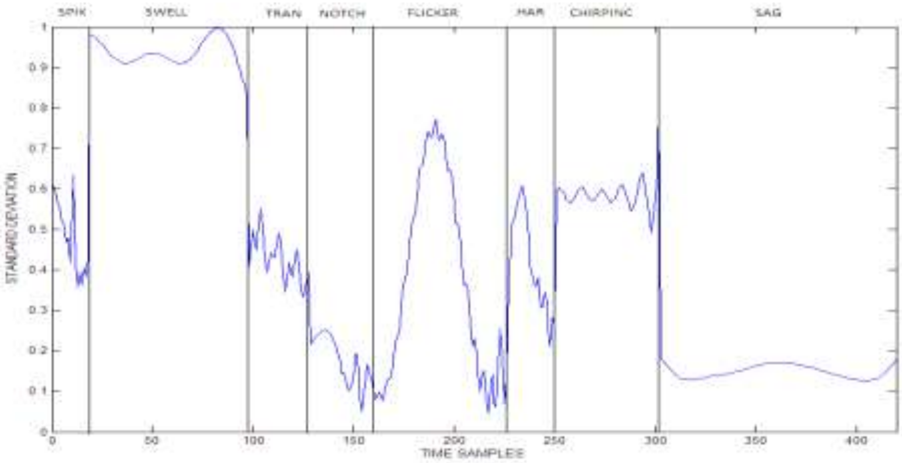

Figure 4.6 plotting the standard deviation of the different disturbance signals

5. CONCLUSION

In this paper, an attempt has been made for pattern recognition and classification of power quality disturbances. In this we analyzed the time domain features like energy, standard deviation, mean, variance and frequency domain features like entropy of different power signal disturbances like voltage sag, swell, harmonics, momentary interruption etc.From that we can observe the different power quality disturbance signals within very short duration. And in future finally time – time transform has been utilized to produce representative feature vector plot that can capture the unique and silent characteristics of each disturbance. And further these values are applied to neural networks.

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