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INVESTIGATION OF POWER QUALITY EVENTS IN DISTRIBUTION SYSTEM

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ABSTRACT

The investigation of power quality measures in power systems are important work in monitoring and security of power system network. Most of the power system turbulences are non-stationary and transitory in nature and new tools are being used currently for the analysis of power quality troubles. This paper presents a wavelet based feature abstraction method for the finding of power quality problem. The disturbance waveforms obtained from simulation are decomposed by (DWT) discrete wavelet transform. The energy distribution pattern of the distorted signals has been taken for feature abstraction. Voltage sag, Transient and under voltage have been tested for investigation.

Keywords: *Sag, transients, under voltage, Discrete Wavelet Transform, Energy Distribution, Power Quality, PSCAD.*

I. INTRODUCTION

Power quality study has become an important issue in recent years because poor power quality may cause many problems for the sensitive loads such as malfunctions, instabilities, short life time etc. Hence detection of power quality disturbances is a challenging task for the power system engineers. The disturbance waveforms contain serious data and directly provide very little information for identification of power quality problems. Hence power quality experts are needed for the development of expert systems which can detect power quality problems. Discrete Wavelet transform with MATLAB software can extract unique features from voltage and current waveforms that characterize power quality events. To abstract power quality disturbance features the energy distribution at different levels of decomposition has been considered.

In this paper a wavelet based method for power quality disturbance recognition and identification has been proposed. To extract power quality problems features the energy distribution at each decomposition level has been considered.

II. PROPOSED METHODOLOGY

In this paper a single bus distribution network is considered for examination. First power quality disturbances created on the bus and simulated using PSCAD software, then discrete wavelet transform (DWT) with MATLAB used for abstraction of energies and different constraints. Wavelet transform is one of the signal processing method which has the ability to examine the signal in both time and frequency domain. It can be used on both stationary as well as non-stationary signal. The signal can be precisely reproduced with the wavelet analysis using small number of mechanisms. The wavelet energy is the sum of square of detailed wavelet transform constants. The energy of wavelet coefficient is varying over diverse scales depending on the input signals. The energy of the distorted signal can be segregated at different resolution levels in different ways depending on the power quality problem. Hence the coefficient of the detailed version at each determination level has been examined to extract features of the distorted signal for classifying different power quality problems.

The investigating wavelets are called as Mother Wavelet and the transformed version are called as Daughter wavelet. The “mother wavelet” governs the shape of the components of the decomposed signals. There are many kinds of wavelets such as Harr (H), Daubechies4 (D4), Daubechies 8 (D8), Coiflet 3 (C3), Symmlet 8 (S8), and so on. A particular type of wavelet is selected depending on the specific type of application. It has been proved that

Daubechies family of mother wavelet has good efficiency in power quality events.In this work decomposition level five is selected.

III. DETECTION OF POWER QUALITY DISTURBANCES

- **Network study**

Fig. 1 shows the distribution network which feeds load. Table.1shows the parameters for the same network.

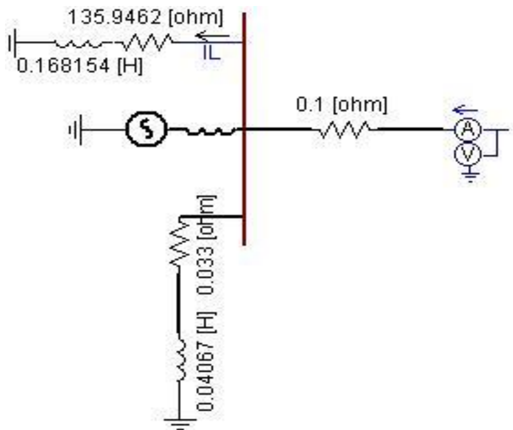

Fig.1.Distribution network under analysis

The waveforms of events were loaded to the wavelet toolbox. Daubechies 5 was used as mother wavelet. Five level decomposition of Db5 wavelet was used for examination. The following results were observed.

Three phase to ground fault produced (for time t=1.0to t=2.0sec) on load bus for empathy of voltage sag and capacitor switching done (for time t=1.0to t=2.0sec) to the bus for identification of transient. Heavy load on system maintained for identification of under voltage. The voltage waveforms for sag, transient and over voltage are as shown in fig.2, fig.3and fig.4 respectively. Then data of voltages is given to DWT for extraction of features for above events. Energy distribution and statistical parameters for sag, transient and over voltage are tabulated in Table.2,Table.3 and Table.4 correspondingly. Fig.5 shows the comparison graph between energy distribution and decomposition level for all the above said events. Voltage magnitude is compact to 20% in sag with the rated value. All the signals are of 60 Hz. frequency and amplitude 1 p.u.. The sampling frequency is 2KHz.

Table1. Parameters For Given Network

Source	**Inductive(L),115KV,60Hz**
Load	Load1:(R=0.033ohm/ph,L=0.04067H/ph) Load:(R=135.9462ohm/ph,L=0.168154)

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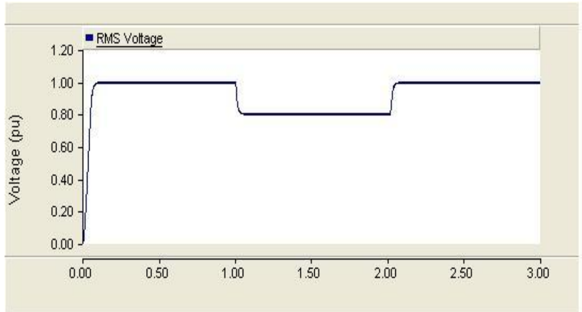

Fig.2.voltage sag waveform

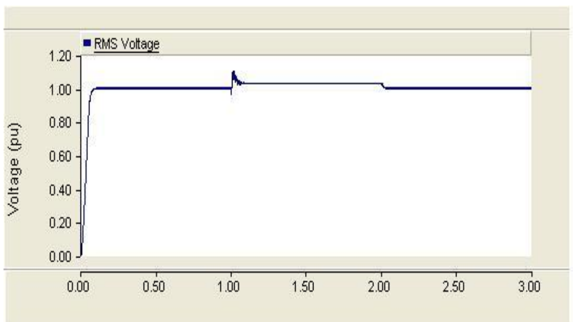

Fig.3.Transient waveform

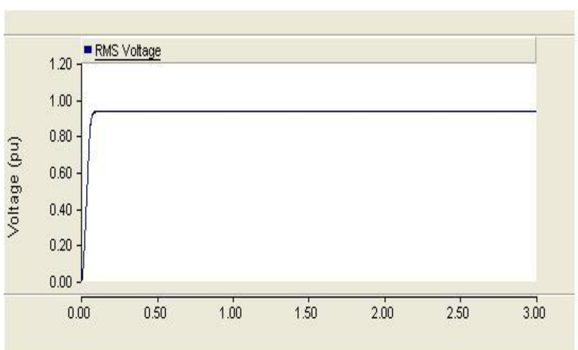

Fig.4.Under voltage waveform

Table2.Statistic Parameters For Sag

Time	E1	E2	E3	E4	E5	MEAN(E1+E2)	AVG	STDEV
t1	0	0	0	0	0	0	0	0
t2	5.13E-08	8.75E-07	9.94E-06	2.37011E-05	7E-05	4.63329E-07	2.2E-05	3.1E-05
t3	4962.238	1531.106	193562	9870252.921	1E+07	3246.671937	4617990	6331297
t4	4093.904	1635.898	192478.9	9864497.167	1E+07	2864.901075	4598598	6300836
t5	4093.904	1635.898	192478.9	9870983.053	1E+07	2864.901086	4598584	6300026
t6	4093.904	1635.898	192478.9	9864497.167	1E+07	2864.901051	4598627	6300883

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Table3. Statistic Parameters For Transient

Time	E1	E2	E3	E4	E5	MEAN(E1+E2)	AVG	STDEV
t1	0	0	0	0	0	0	0	0
t2	5.13E-08	8.75E-07	9.94E-06	2.3701E-05	7.5E-05	4.63329E-07	2.2E-05	3.1E-05
t3	46.47621	1083.648	144917.4	7439084.91	9738094	565.0622308	3464645	4747963
t4	2059.869	10159.42	144976	7439769.87	9746099	6109.645639	3468613	4748720
t5	2059.869	10159.42	144976	7438271.58	9747597	6109.645601	3468613	4748902
t6	2059.869	10159.42	144976	7439769.87	9746099	6109.645546	3468613	4748720

Table4. Statistic Parameters For Under Voltage

Time	E1	E2	E3	E4	E5	MEAN(E1+E2)	AVG	STDEV
t1	69.2714	1624.4	216861	1.1E+07	1.5E+07	846.8353541	5183584	6122748

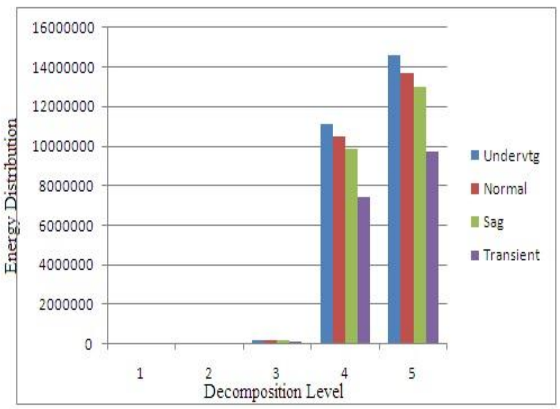

Fig.5.Energy distribution comparison for all events

Fig.5 shows the distribution of energies for power quality events at different decomposition levels.
In this scheme the power quality problems such as voltage sag, Transients and under voltage created for different sample instants and energy is calculated for each instant. Also calculated the different statistical parameters such as average mean and standard deviation for analysis purpose.

IV. CONCLUSION

In this paper we have proposed energy based wavelet scheme for identification of power quality events. The energy distribution patterns in the frequency domain are used as power quality disturbance features. It has been found that energy distribution for above events is distinguished. Using the energy distribution pattern system can be developed which can accurately classify the type of stationary and non stationary disturbances present in the signal.

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