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LOCALIZING POWER QUALITY DISTURBANCES USING HILBERT TRANSFORM IN LABVIEW

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Abstract- *This paper presents an intelligent approach for the analysis of the Power Quality Disturbances both qualitatively and quantitatively. The phase shifting property of Hilbert Transform was used to produce an accurate detection and computation of the characteristic magnitudes of the power quality disturbances along with their occurrence of time. The Power quality disturbances such as short duration variations (momentary interruption, voltage sag, voltage swell), transients, notches, harmonics and voltage fluctuation are simulated on LabVIEW .The proposed method facilitates for the real time detection and characterization of non stationary PQ signal accurately.*

Keywords: Power Quality (PQ), Hilbert Transform (HT), Fourier Transform (FT), Short Time Fourier Transform (STFT)

I. INTRODUCTION

The introduction of Power Electronics devices in power systems and also the increased usage of various time varying and typical loads at the consumer end have resulted in contamination of Power. The detection and categorizing the poor Power Quality are significant task. The disturbances broadly fall in the category of voltage swells, voltage sags, voltage fluctuation, harmonics, inter-harmonics and transient oscillation. The research undertaken in power quality till date was successful in providing tools to detect and monitor each of the disturbances individually and discretely, but there is no effective common technique has been formulated to accurately/precisely detect and classify the disturbances in real time [1]-[2].

The typical detection methods involved are based on time domain methods or frequency domain methods making them suitable to detect only a characteristic type of disturbance at a given instant. The proposed method of application of phase shifting property of Hilbert transform is inherently a steady inter-convertible from time and frequency domain making it an efficient technique for the detection of disturbances of a wide range with uncharacteristic properties. The method even provides with the time of occurrence of the disturbance making it suitable for real time application. Coupling the same with LabVIEW platform and executing the method has given satisfactory results.

Many automatic PQ disturbance detection methods are proposed [3-5].Fourier transform (FT) used to analyze frequency domain for stationary signal. Short time Fourier transform (STFT) which gives the information in time domain as well as frequency domain but width of the window is limited/fixed, and it doesn't cope-up for most of the PQ disturbance signals which are non-stationary in nature and posses unique feature hence the FT and STFT techniques cannot track the signal dynamics. [6-8]

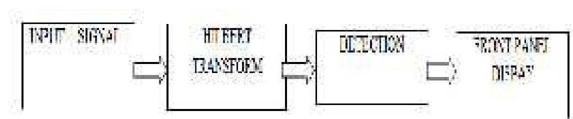

Fig.1.1 Block diagram of the proposed system

The functional description of the block diagram is as follows: The power quality disturbances is modeled using table.1 is taken as input, which was stationary and non-stationary signals by simulation using the Math script block in the LabVIEW software. The generated signals are passed through the Hilbert transform which detects and characterize the contaminated PQ signal accurately which was displayed virtually in the front panel of the LabVIEW platform.

II. HILBERT TRANSFORM

The Hilbert transform of u can be thought of as the convolution of $u(t)$ with the function $h(t) = 1/(\pi t)$. The Hilbert transform is used to generate a complex signal from a real signal. Instead, the Hilbert transform is defined using the Cauchy principal value (p.v.). Explicitly, the Hilbert transform of a function (or signal) $u(t)$ is given by:

$$H(u)(t) = p.v. \int_{-\infty}^{\infty} u(\tau)h(t-\tau)\,d\tau = \frac{1}{\pi} p.v. \int_{-\infty}^{\infty} \frac{u(\tau)}{t-\tau}\,d\tau$$

The Hilbert transform is a multiplier operator. Unlike other transform techniques, the HT of time-domain function is still in time domain, the HT in frequency domain can be portrayed as

$$X^h(f)=X(f).H(f)$$

Because the Fourier Transform of

$h(t)=F[h(t)] = H(f) = -j\text{sgn}(f)$

$= -j$ (1 if $f>0$ or -1 if $f<0$)

So we can obtain Hilbert Transform on frequency domain, if we multiply the negative frequency part of X(f) by j and multiply positive frequency part of the X(f) by -j.

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The Hilbert Transform result can be expressed from Fourier Transform,So

$$\hat{x}(t)=x(t)*h(t)=F^{-1}[X(f).H(f)]$$

As input signal

$$x(t) = \sin(2\pi f t)$$

its FT is

$$X(f) = \frac{j}{2}[\delta(f+f_i)-\delta(f-f_i)]$$

now multiplying the negative frequency of the X(f) by j and multiplying positive frequency part of the X(f) by

$$\hat{X}(f) = \frac{1}{2}[\delta(f+f_i)-\delta(f-f_i)] = F[-\cos(2\pi f_i t)]$$

Taking Fourier inverse to both sides of the formula, we get

$$H\sin(2\pi f_1 t) = \cos(2\pi f_1 t)$$

Formula shows negative of cosine function results by HT of the sine function, the result also depicts that it contributes to –j phase- shift of the input signal. The HT of an input cosine signal is the sine function, showing that it makes –j phase- shift to the input signal too. So the HT can provide 90 phase-shift and not influence the amplitude of the input wave component.

III. DETECTION OF DISTURBANCES USING HILBERT TRANSFORM

The ideal signal of power system is a pure sinusoidal waveform

$$u(t) = A\sin(2\pi f t + \emptyset) = A\sin(\omega t + \emptyset)$$

In ideal conditions, the properties of u(t) are :

$$u^2(t)+u^2(t-\pi/2)=[A\sin(\omega t+\emptyset)]^2+[A\sin\left(\omega\left(t-\frac{\pi}{2}\right)+\emptyset\right)]^2=A^2$$

Then the detection output y(t) would be :

$$y(t) = u^2(t) + u^2\left(t-\frac{\pi}{2}\right) - A^2$$

Hence if input signal is the ideal sinusoidal waveform, the detected output y(t) is zero. However when the input signal has characteristic disturbances, the expression for input signal After 90 phase- shifting to the u(t):

$$u_2(t) = u\left(t-\frac{\pi}{2}\right) = A\sin(\omega t + \emptyset - 90) + e(t-90)$$

$$y(t) = c(e(t))$$

So, when the disturbances contained in the input signal are predominant, the detection output certainly cannot be equal to zero. The disturbance e(t) will have different sets of values when the disturbances inputs are different and detection output will have different varied waveform characteristics, as it corresponds to the time when disturbances take place, it can assure the detection's real-time characteristic. Figure 6 shows the modeling of power quality disturbance and detection using Hilbert transform. The hilbert transform is used to obtain instantaneous frequency and instantaneous phase. The HHT is one of the best methods for analyzing non linear and non stationary signals in a time-frequency domain.

The HHT is a powerful and reliabe method for analyzing nonlinear and nonstationary signals because it is based on an adaptive basis. Instantaneous frequency is obtained by differentiation instead of convolution. Thus, there is no limitation because of the uncertainty principle.

TABLE1 :MODELING OF POWER QUALITY DISTURBANCE

PQ disturbance	Equation of Modeling	Value of Parameters
Sinusoidal wave	x(t) = Asin(ωt)	A=1.0 ; f=50Hz ; ω=2πf
Voltage Sag	x(t) = A(1−α(u(t −t1) −u(t −t2))) sin(ωt); t1 < t2 ,u(t) =1,t ≥ 0	0.1 ≤ α ≤ 0.9 , T ≤ t2 − t1 ≤ 8T
Voltage Swell	x(t) = A(1+α(u(t −t1) − u(t −t2))) sin(ωt); t1 < t2 ,u(t) =1,t ≥ 0	0.1 ≤ α ≤ 0.8 , T ≤ t2 − t1 ≤ 8T
Momentary Interruption	x(t) = A(1+α(u(t −t1) − u(t − t2))) sin(ωt); t1 < t2 ,u(t) =1,t ≥ 0	0 ≤ α ≤ 0.09 , T ≤ t2 − t1 ≤ 8T
Harmonics	x(t)=A(sin(2πift))+A(sin(2πi fta))	a=integer; i=1:1400
Transient	x(t)=sin(ωt)+(s(sin(aωt)))	S=d*y;y=exp(-k); a=55;k=(t/λ); (t>0.02&t<0.06)

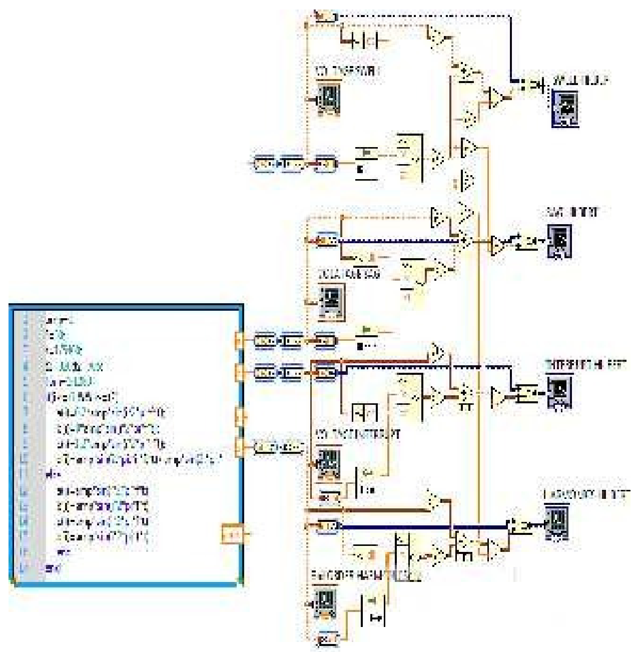

Fig. 3.1 Modeling Power quality disturbances and HT detection

II.SIMULATION RESULTS

An ideal waveform is generated in Labveiw which is shown in Fig.3 whose fundamental frequency is 50 Hz, amplitude is 1v, sampling frequency is 6400 Hz and number of samples are 1280. The output of Hilbert transform detects that there is no contamination in the signal and the waveform shows normal smooth straight line.

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Fig.4 Shows the Voltage sag signal whose typical values of voltage drop are 10-90% of the rated voltage lasting for half a cycle to less than 1 min. The voltage sag caused due to system faults and energization of heavy loads. For 80% of voltage sag are simulated for three cycles are shown. The HT localize the disturbance present in the signal over the duration 250millsec to750millsec in the downward direction.

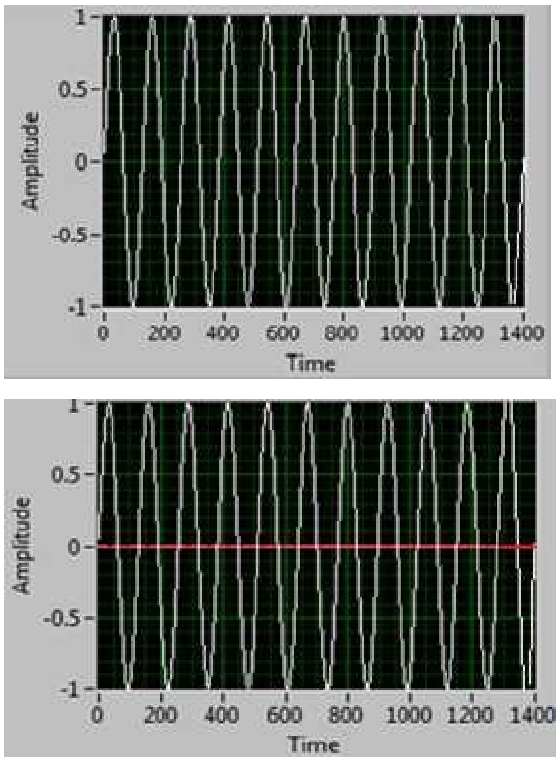
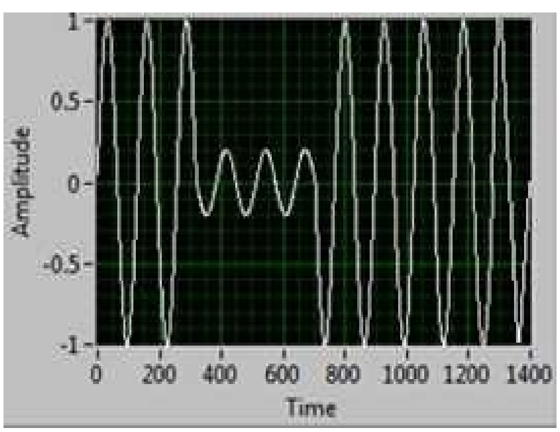


Fig. 3 Pure sine wave and HT output



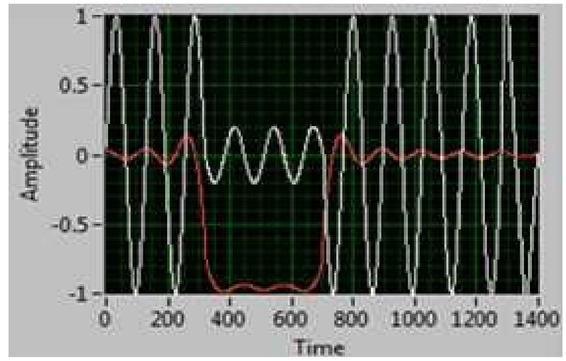


Fig. 4 Voltage Sag and HT output

Fig. 5 Shows the typical values of Voltage swell signal are 110-180% of the rated voltage. A 50% of voltage swell disturbance signal lasting for three cycles are simulated and shown. The duration of Voltage swell is detected clearly by HT output showing upward over the period of time when the signal is contaminated.

Fig.6 shows Interruption of signal which describes a drop of voltage less than 1% of the rated voltage for a period of time not exceeding 1 min. The Interruption is caused by system faults ,equipment failures and control malfunctions .The HT detects the disturbance time of occurrence correctly.

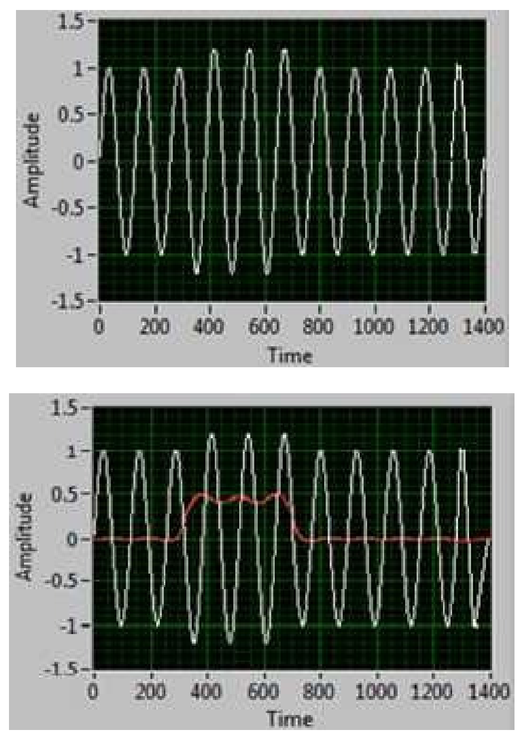


Fig. 5 Voltage Swell and HT detection

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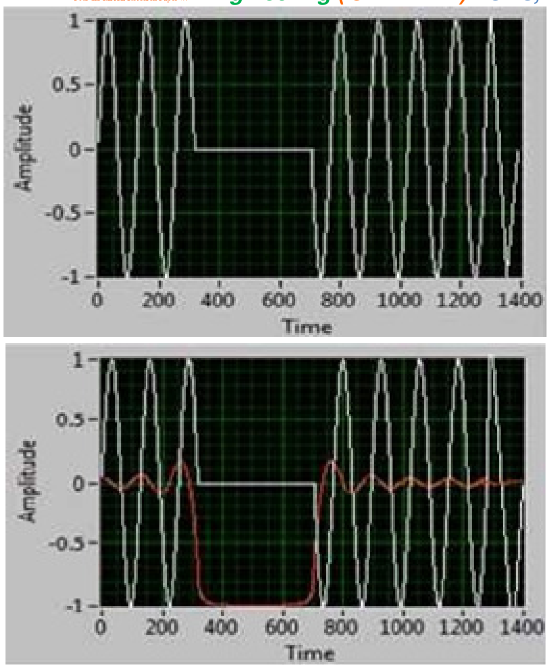

Fig. 6 Momentary Interruption and HT Output

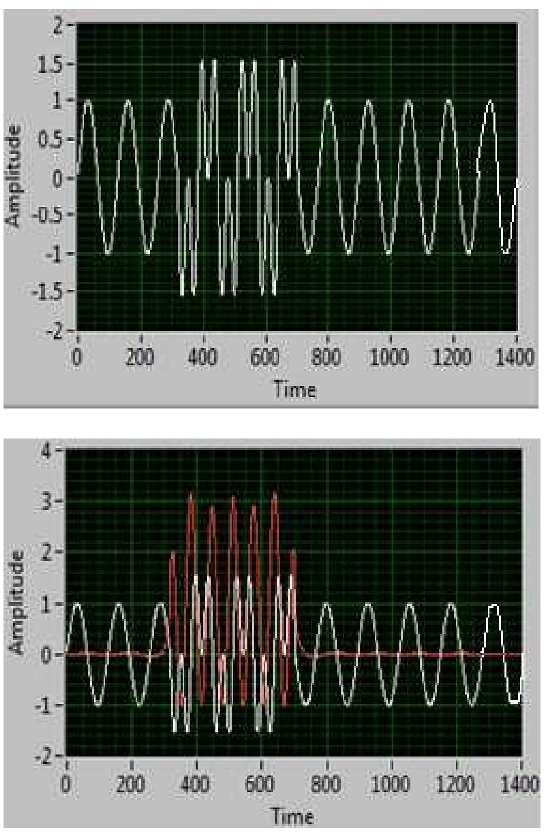

Fig. 7 Harmonics and HT output

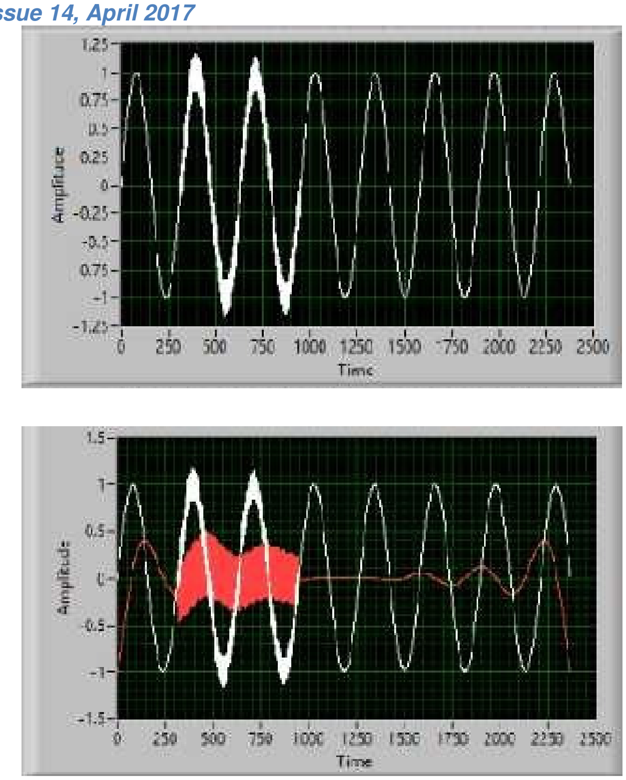

Fig. 8 Transient and HT Output

Fig. 7&8 shows the output of HT, which detects the duration of disturbance occurred in time accurately.

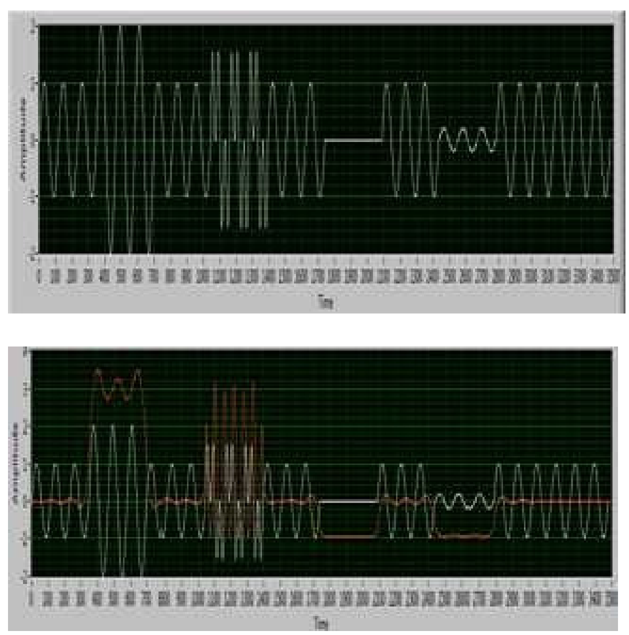

Fig. 9.Various Power quality disturbances and HT detection

Fig 9. Shows the various PQ disturbances in 30 cycles. Whose sampling frequency is 15800 Hz and amplitude is 1V with 50Hz frequency which localize the time duration of PQ distubances accurately and precisely.The same algorithm can be implemented for different sampling frequencies and different PQ disturbance.

III.CONCLUSION

The proposed work explains the duration of detection and classification of various Power Quality disturbances of short duration variations such as voltage sag,voltage swell momentary interuption,harmonics and transients.The classifier recognizes the non-stationary Power Quality events precisely for any number of cycles and can be adapted to any sampling rate.The results are proven with the great accuracy of recognisation for multiple pq events occur simultaneously in a continous signal. This method is appicable for nonlinear and nonstationary signals. The outputs of this method are in the time-frequency-energy space and instantaneous phase, frequency, and energy distribution can be extracted as features of nonstationary signals.

IV.REFERENCES

[1] Z. Kokolanski, M. Srbinovska, A. Simevski, C. Gavrovski and V. Dimcev, 2009, “Power Quality Monitoring and Power Measurements by Using Virtual Instrumentation”, ELECTRONICS, Vol. 13, No.1.

[2] M. Manjula, A.V.R.S. Sarma, 2010 “Classification of Voltage Sag Causes using Probabilistic Neural Network and Hilbert – Huang Transform”, International Journal of Computer Applications (0975 - 8887) Vol. 1 – No. 20.

[3] Subhra De, Sudipta Nath, Pampa Sinha, Sankhadip Saha, 2011, “A Virtual Instrument for Real Time Power Quality Measurement under Nonsinusoidal Conditions”, International Conference on Signal Processing, Communication, Computing and Networking Technologies.

[4] T. Jayasree, D. Sam Harrison, T. Sree Rangaraja, 2011 “Automated Classification of Power Quality Disturbances using Hilbert Huang Transform and RBF Networks”, ISSN: 2231-2307, Volume-1, Issue-5.

[5] Ravi Saxena, A.K.Swami, Sanjay Mathur,2012, “A Power Quality Signal Generator in LabVIEW Environment”, Proc. of the Intl. Conf. on Advances in Electronics, Electrical and Computer Science Engineering.

[6] Victor Garrido Arevalo, Jorge Luis Diaz R, Aldo Pardo Garcia 2012, “Analysis of the Power Quality using Intelligent Techniques”, ISBN: 978-960-474-365-0.

[7] Mario Ortiz, Sergio Valero and Antonio Gabaldon, 2012, “Transient Power and Quality Events Analysed Using Hilbert Transforms”, Journal of Energy and Power Engineering 6, 230-239.

[8] Alireza Forough, Ebrahim Mohammad, Saeid Esmaeil, 2014, “Application of Hilbert-Huang transform and support vector machine for detection and classification of voltage sag sources”.

[9] Swarupa, Vishnuvardhini, Poongkuzhali, M R Sindhu, 2014, “Power quality analysis using LabVIEW”, IJRET: International Journal of Research in Engineering and Technology, eISSN: 2319-1163, pISSN: 2321-7308.

[10]Tao Zhang,Rui Zhang, Tian-bo Wang2andRun-xiaZhu, 2014, “Voltage Sags Detection Based on Hilbert-Huang Transform”, International Journal of Signal Processing, Image Processing and Pattern Recognition Vol.7, No.3.

