Analysis of Various Power Quality Disturbances based on Maximum Deviation using Fractional Fourier Transform

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ABSTRACT

In this paper we have detected and analyzed transient, sagged flicker and sagged harmonic types of disturbance in power signal using fractional fourier transform method. Each signal is analyzed for different values of transform order in the range of 0 to 1. We have analyzed this algorithm in MATLAB simulation tool. This analysis is performed to find out the performance of this method on different types of disturbances. We have analyzed this to find out maximum deviation in each disturbance and compare it for each signal.

Keyword: - *Fractional Fourier Transform, Harmonic, Transient, Flicker, Power Quality*

1. INTRODUCTION

The time span and the frequency of the interruption affect the loss due to the intervention. The losses due to interventions can be categorized as direct losses – loss in production atmosphere, damages to devices etc, indirect losses – delay in the delivery of the product etc and non-economic troubles. In our previous published paper we have already described about the economic features of power quality disturbances. The first step towards categorization of power quality disturbances is to know about the features of several disturbances. In a general scenario power quality disturbances can be widely classified as transients, long duration voltage fluctuations, short-duration, voltage fluctuations, voltage unbalances, voltage variations, power frequency fluctuations. However, it is boring to consider all kinds of these disturbances and therefore the disturbances which happened the most are considered in this research work [3].

There are many literatures [1] – [4] which dealt with the several regulation regarding observing power quality disturbances. Literature [3] provides the initial introduction to all the power quality disturbances may occur in power distribution scenario. Literature [1] gives a survey of several distribution sites and as a result provides various interesting observations about the various types of disturbance occurrence statistics which involves computations that the majority of the voltage sags in power signal have a magnitude of around 80% and a time span of around 4 to 10 cycles and that the total harmonic distortion on harmonic disturbances has value around 1.5 times the normal value. These surveys give basic fundamental information about the event and reason of the disturbances.

Fractional Fourier transform (FRFT) is a simple form of Fourier transform (FT). It has been demonstrated to be one of the most important equipment in non-stationary signal processing methods. There has been a vast research on the significant topics connected with Fractional Fourier Transform. One of the benefits for the FRFT differentiated with the FT is that the signal which is non-band limited in the fourier transform domain may be band limited in the fractional Fourier domain (FRFD). Sampling theorem is an important problem in signal processing. In the sampling mechanism, the sampling rate must fulfill the Nyquist sampling rate, otherwise the spectrum aliasing will happen and influence the performance of the signal recovery and estimation. However, non-uniform sampling usually occurs in practical applications. The signal recovery and spectral analysis from non-uniform sampling sequence in the fractional fourier transform have been researched in recent years.

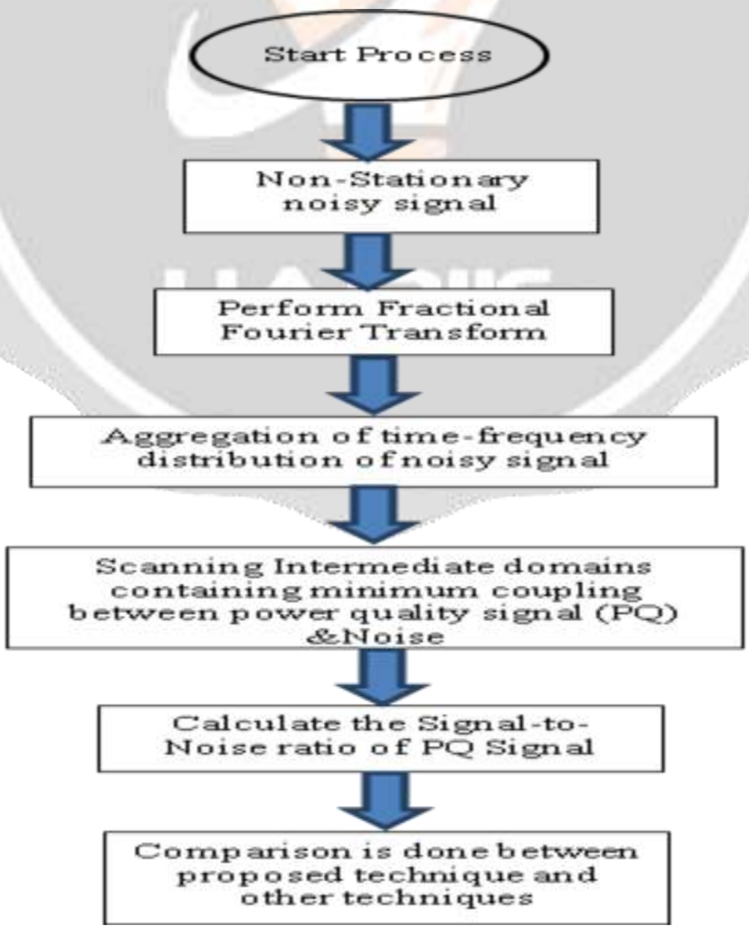
2. LITERATURE REVIEW

Wavelet transform is a current signal processing device which is broadly being used for disturbance determination in power quality. Wavelets can give precise frequency resolution and bad time localization at low frequencies and its opposite at high frequencies. The feature that the wavelets add to zero represents the capability of the standard deviation of different resolution stages to show the distribution of the distorted signals. This capability is used to categorize and quantify the short term fluctuations within the power signals.

Poisson, P. Rioual and M.Meunier [5] proposed the possibility of utilizing continuous wavelet transform, Quadratic Transform and Multi-resolution analysis for identification of the disturbances. They concluded from their investigations that quadratic transforms and multi-resolution analysis are suitable and reliable devices for the recognition of sharp alterations in the power signals and frequency transients. The continuous wavelet alongside all the above characteristics can directly calculate the magnitude of the 50 Hz signal. We can notice that none of these techniques uniquely or jointly are able to recognize all types of disturbances. However their research could successfully examine the strengths of each of these above methods.

Olivier Poisson, Pascal Rioual, and M.Meunier [6] presented a technique of using continuous wavelet transforms to recognize and examine voltage sags and transients. The features of the examined signals are computed on a time-frequency domain and are compared with the standard benchmark values. Any alteration will indicate that there is a disturbance in the signal. This method allowed exact time localization, magnitude calculation of voltage sags and transient recognition. Many more artificial intelligence based automated recognition methods followed this paper.
One more interesting transform known as S-transform which is an advancement of wavelet transform is presented by P. K. Dash, B. K. Panigrahi, and G. Panda [7]. The S-transform process had many promisingly impressive time-frequency resolution features.

3. PROPOSED ALGORITHM



4. PROPOSED WORK

In our work we have taken the signal with given specifications: T_s (time period) = 0.5 sec, f_s (sampling frequency) = 6.4 KHz, f = 50Hz, No of cycles = 25, No of samples/cycle = 128, Total Sampling points = 3200.Duration of disturbance = 0.2 second. All the simulations have been performed in MATLAB tool. Each disturbed signal is analyzed for different values of transform order in the range of 0 to 1.

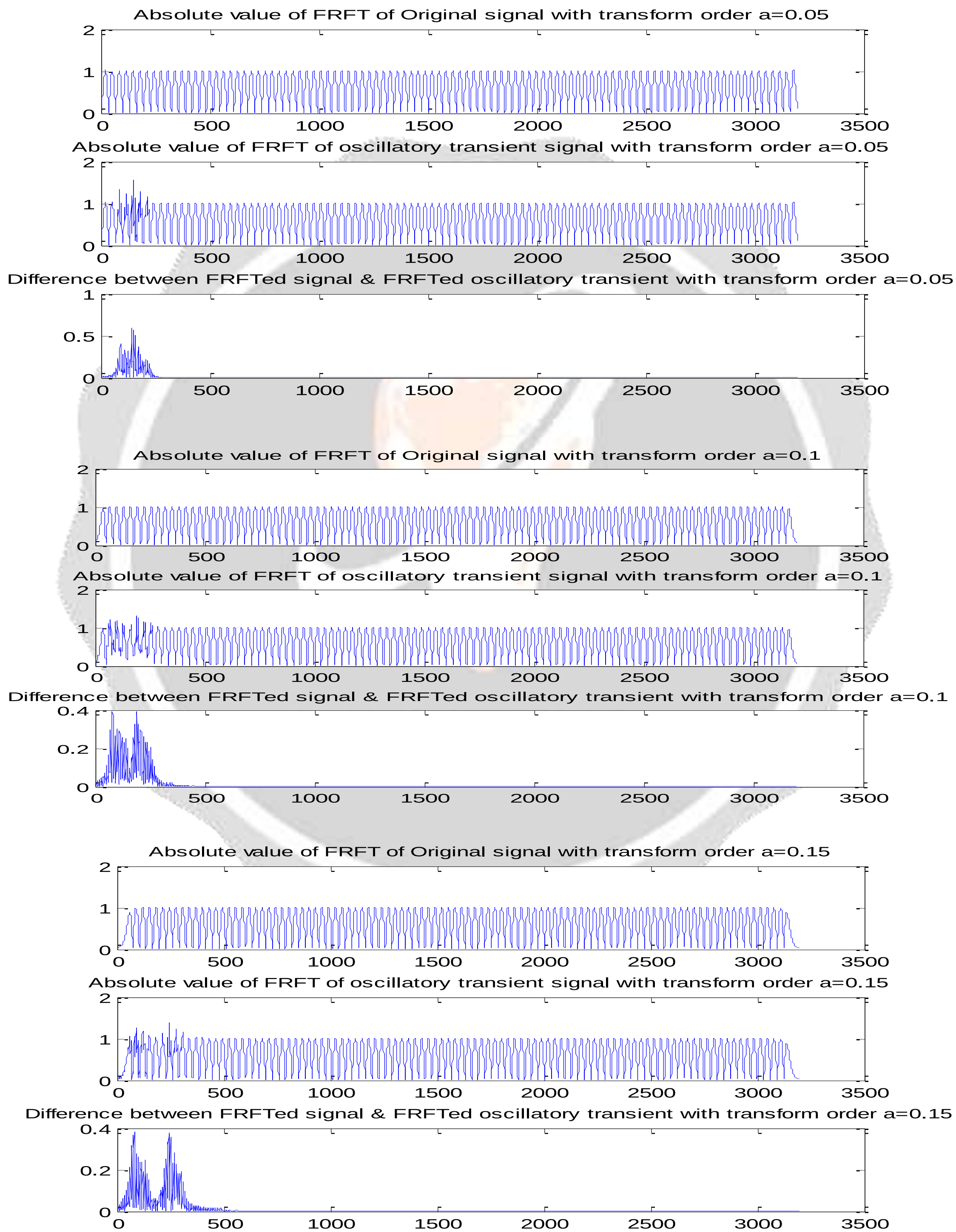


Fig 1 FRFT analysis of transient signal

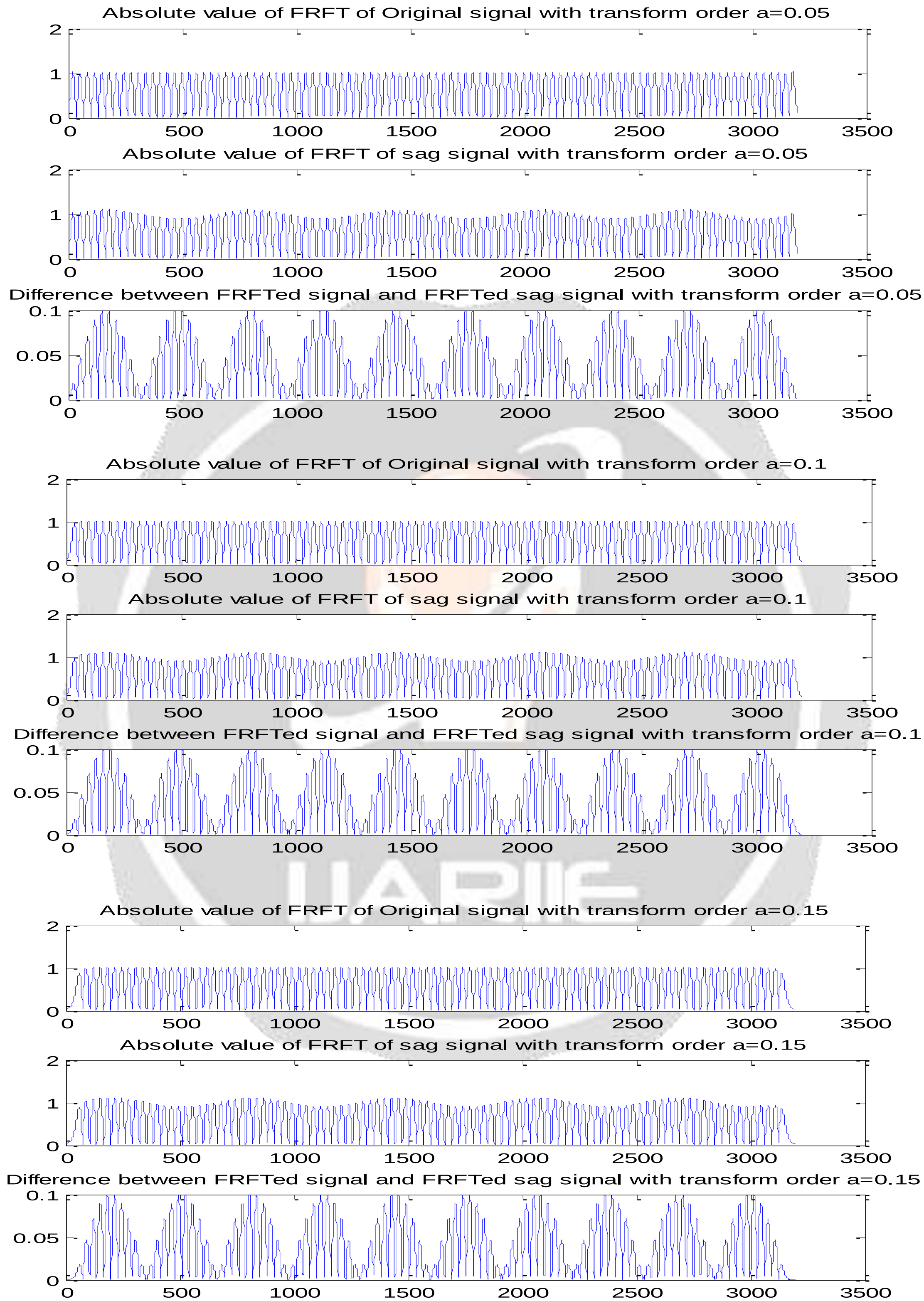


Fig 2 FRFT analysis of sagged flicker signal

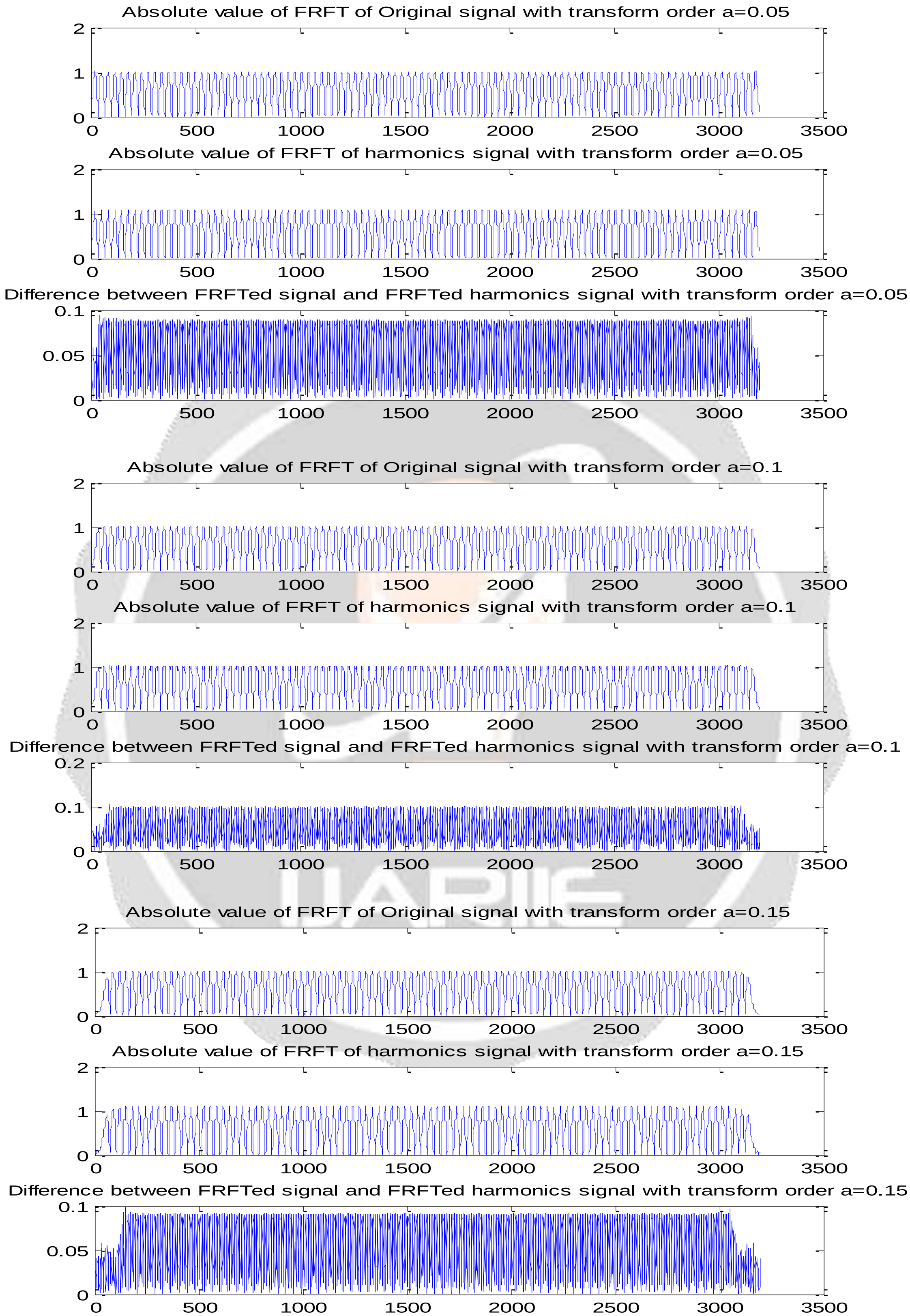


Fig 3 FRFT analysis of sagged harmonic signal

5. EXPERIMENTAL RESULTS

We have calculated maximum deviation for each signal and compared at different values of transform order. Comparison table is shown below.

Table 1: Maximum deviation comparison table

Transform order	Transient	Sagged Flicker	Sagged Harmonic
0.05	0.0989	0.0942	0.9810
0.1	0.0991	0.1056	0.9867
0.15	0.0995	0.0984	0.9889
0.2	0.1000	0.1007	1.0166
0.25	0.1006	0.0619	1.0248
0.3	0.1014	0.1080	1.0305
0.35	0.1022	0.1170	1.0800
0.4	0.1029	0.0829	1.1240
0.45	0.1034	0.1187	1.1412
0.5	0.1036	0.0739	1.1894
0.55	0.1029	0.1291	1.2458
0.6	0.1009	0.0782	1.2702
0.65	0.0950	0.1174	1.4101
0.7	0.1129	0.0887	1.5017
0.75	0.1424	0.1065	1.6131
0.8	0.1701	0.1158	1.8057
0.85	0.1719	0.1651	2.1222
0.9	0.2469	0.1306	2.5934
0.95	0.3379	0.1841	3.6625
1.0	1.3303	2.4897	2.8814

6. CONCLUSIONS

In this paper we have proposed a new method based on Fractional Fourier transform (FRFT) to detect and analyze the power quality disturbances from the power quality signal. We have considered transient, sagged flicker and sagged harmonic disturbed signals in this paper. We have already detected and analyzed sag and swell disturbances using fractional fourier transform in our previous work.

7. REFERENCES

[1] E. W. Gunther and H. Mehta, “A survey of distribution system power quality—preliminary results,” IEEE Transactions on Power Delivery, vol. 10, no. 1, Jan. 1995, pp. 322-329.

[2] M. B. Hughes, J. S. Chan, and D. O. Koval, “Distribution customer power quality experience,” IEEE Transactions on Industrial. Applications, vol. 29, no. 1, Nov./Dec. 1993, pp. 1204-1211.

[3] IEEE Recommended Practice for Monitoring Electric Power Quality, IEEE Inc., New York, USA, 1995.

[4] J. J. Burke, D. C. Grifith, and J. Ward, “Power quality—Two different perspectives,” IEEE Transactions on Power Delivery, vol. 5, no.3, June 1990, pp. 1501-1513.

[5] Oliver Poisson, Pascal Rioual and Michel Meunier, “New Signal processing tools applied to power quality analysis”, IEEE transactions on Power Delivery, vol. 14, no. 2, July 1999, pp. 324-327.

[6] Oliver Poisson, Pascal Rioual and Michel Meunier, “Detection and Measurement of Power quality disturbances using Wavelet transform”, IEEE transactions on Power Delivery, vol. 15, no. 3, July 2000, pp. 214-219.

[7] P K Dash, B K Panigrahi and G Panda, “Power quality analysis using S transform”, IEEE transactions on power delivery, vol. 18, no. 2, April 2003, pp. 23-29.