Detection of Harmonics Disturbances Using Various Wavelet Transforms

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Abstract— Extensive use of modern power electronic devices and non-linear loads in electrical power system cause problem of harmonics. Renewable energy sources are also integrated to the grid through power electronics based equipment. Detection of harmonics disturbance helps to control such event. Wavelet transform allows the detection and localization of disturbances in the voltage waveform. Various wavelet transform methods are available in MATLAB. The most important is to select appropriate wavelet among the varieties of wavelet functions for particular application. This paper presents wavelet transform as tool for location of odd and even harmonics disturbances. In this paper odd harmonics and even harmonics are simulated using MATLAB code, various wavelet decomposition techniques are applied and compared.

Keywords- Wavelet Transform, Harmonics Disturbances

I. INTRODUCTION

Power quality issues have been a source of major concern in recent years due to extensive use of power electronic devises and non-linear loads in electrical power system. Electromagnetic disturbances cause big economic losses for industry and residential users. Therefore, monitoring harmonics disturbances of electric power is fundamental in order to offer solutions especially for utilities and industrial customers. Fourier transform is used for mapping signal from time domain to frequency domain by decomposing the signal into various frequency components, but in Fourier transform the time information of transients is completely lost. These drawbacks of Fourier transform is overcome by wavelet transform. Wavelet transform can be applied for stationary as well as non-stationary signals and provides time-frequency information of signal simultaneously. The Wavelet Transform (WT) processing technique is used because of time -frequency multi-resolution analysis property. [4]. By understanding wavelet family the properties of the analysis and synthesis wavelet, we can prefer a wavelet that is suitable for detection of harmonics.

The aim of this paper is to apply different wavelet transforms on the test signals (generated using MATLAB code with known harmonics disturbances) viz. odd, even harmonics with sag. We compared & analyzed for selection of particular wavelet for locating harmonics disturbances.

II. TEST SIGNAL GENERATION

The test signal was generated using MATLAB as per definition given in reference [1]. Three test signals with different harmonics disturbance viz., odd, even and odd & even combination with sag were considered.

Harmonics: Sinusoidal component of a periodic wave having a frequency that is an integral multiple of the fundamental frequency.

Sag: It is RMS reduction in the AC voltage at power frequency from half of a cycle to a few seconds' duration.

The different wavelet decomposition is applied to harmonics disturbances using various wavelet families available in MATLAB. Data generated using the MATLAB code at a sampling rate of 1 kHz. A pure sinusoidal voltage signal of 50Hz and 5 Volts amplitude is considered for all simulations.

III. METHODOLOGY FOR APPLYING WAVELET TRANSFORMS

Wavelet transform has capabilities to find out the instant at which the different harmonics present. We generated set of test signals, applied different wavelet transforms & detected location of harmonics disturbances using detail coefficient.

As shown in Fig.1, a voltage signal having 50 Hz, 5Volts amplitude, duration of 400 ms with odd harmonics for 80 ms duration starting at two hundredth milliseconds with sag[6] is generated. Details of first level decomposition with daubechies wavelet ('db4') is shown in Fig.2. First level wavelet decomposition of five different families is mention in result

Table I . As the odd harmonics with sag are from 200 ms to 280 ms, signal is sampled at 1 KHz and first level wavelet decomposition gives location of disturbance between 103 to 141 instance using 'db4' while other wavelets are not as accurate as db4. The same procedure is followed for even and combination of odd and even harmonics with sag.

IV. RESULTS

A: Odd Harmonics with sag

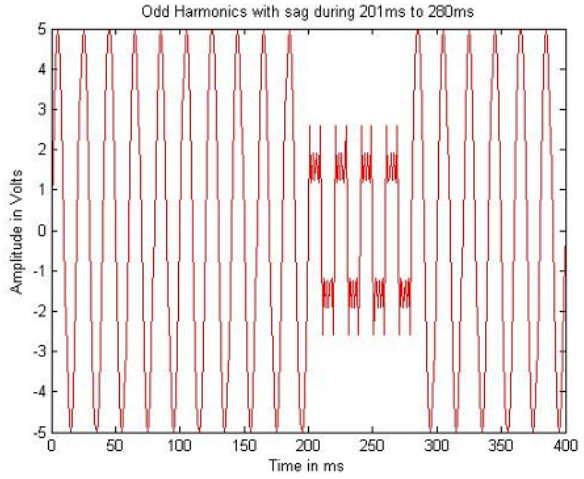

Fig.1 Odd Harmonics with sag

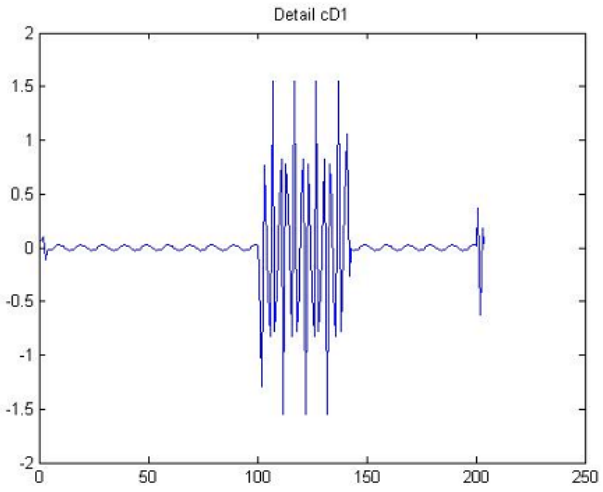

Fig.2 Details of first level decomposition of odd harmonics with sag with Daubechies wavelets ('db4')

TABLE I Result of Odd Harmonics with sag

Wavelet Used to detect Odd Harmonics with Sag	Position detected	Correct Fault Position	Remark
sym4	108,142	101,141	Not accurate
db3	107,141		Not accurate as db4
db4	103,141		Accurate
coif4	131,165		Not accurate
Dmey	110,144		Not accurate

B: Even Harmonics with sag

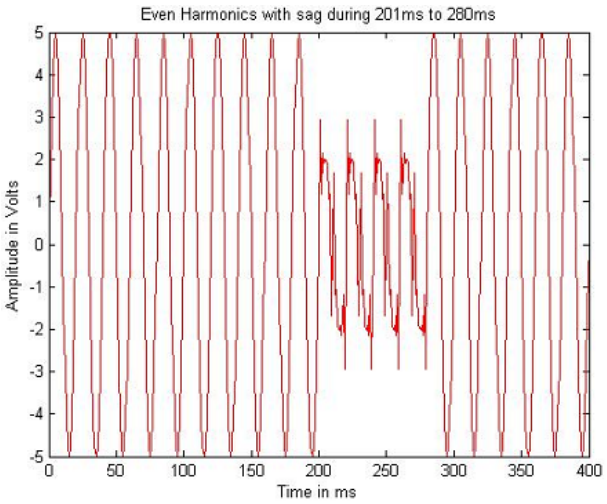

Fig. 3 Even Harmonics with sag

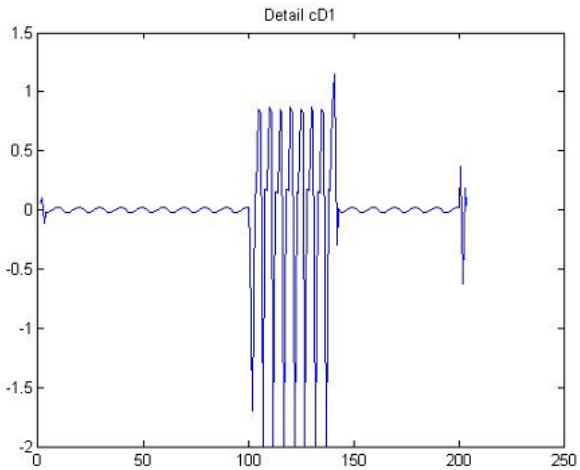

Fig.4 Detail of first level wavelet decomposition of even harmonics with sag with Daubechies wavelets ('db4')

TABLE II Result of Even harmonics with sag

Wavelet Used to detect Odd Harmonics with Sag	Position detected	Correct Fault Position	Remark
sym4	107,137	101,141	Not accurate
db3	102,140		Not accurate as db4
db4	102,141		Accurate
coif4	105,144		Not accurate
Dmey	126,165		Not accurate

C: Odd & Even Harmonics with sag

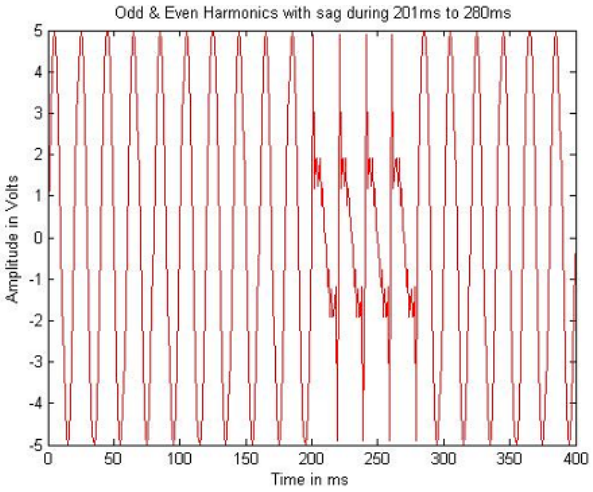

Fig.5 Odd & Even Harmonics with sag

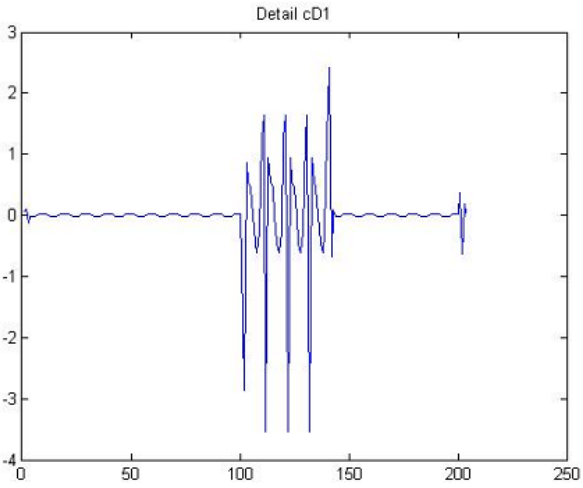

Fig.6 Detail of first level wavelet decomposition of odd & even harmonics with sag using Daubechies wavelets ('db4')

TABLE III Result of odd & even harmonics with sag

Wavelet Used to detect Odd Harmonics with Sag	Position detected	Correct Fault Position	Remark
sym4	112,142	101,141	Not accurate
db3	110,141		Not accurate as db4
db4	103,141		Accurate
coif4	135,165		Not accurate
Dmey	112,142		Not accurate

V CONCLUSION AND FUTURE WORK

In this paper different wavelet families available in MATLAB are applied for locating harmonics disturbances. By performing number of simulations it was concluded that daubechies wavelet is fairly accurate for detecting location of harmonics disturbances. In all case of odd, even and combination of odd and even harmonics with sag 'db4' gives fairly accurate result as compared to their other . Here we have injected harmonics disturbances with sag separately, but practical cases have multiple disturbances occurring simultaneously. Results can be further improved by applying multiple disturbances simultaneously in signal.

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