FAILURE RECOGNITION IN TRANSFORMER USING TIME-REQUENCY ANALYSIS

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ABSTRACT:

The method of analyzing and detecting transformer faults earlier were based mainly on observing the analog waveforms recorded. A new approach using wavelet as a approach has been proposed to analyze the failure of transformer winding during impulse tests. The wavelet transforms offer great insight in finding not only the frequency components but also the time instants at which they occur with great accuracy . A waveform is simulate and performing wavelet transform on it gives the information of desired frequency components. The scales are selected according to the frequency of interest. The faulted frequency components in the waveform could be detected in addition to the time instances of their occurrences.

INTRODUCTION

Transformers are very important and costly apparatus in power system. Great care has to be exercised to see that the transformers are not damaged due to transient overvoltages of either lightning or power frequency. Wavelet transform is proposed as a tool, which helps in detecting the faults in transformers. The wavelet transforms not only help in determining the faulted frequency components but also the exact time instants of fault occurrences. So, the system could be effectively designed. The transient overvoltages in a transformer winding cause a lot of damage to the system though it occurs for a short amount of time. So, failure detection in transformers is an important task to be carried out.

The different types of fault in transformers are
1.short circuit fault
2.Mechanical fault
3.Partial discharge due to insulation failure

IMPULSE TESTING

The purpose of impulse tests is to determine the ability of the insulation of the transformers to withstand the transient voltages due to lightning etc. Since the transients are impulses of short rise time, the voltage distribution along the transformer winding will not be uniform. If an impulse wave is applied to such a network the voltage distribution along the element will be uneven, and oscillations will be sent in producing voltages much higher than applied voltage. Impulse testing of transformer is done using both the full wave and the chopped wave of the standard impulse, produced by a rod gap with a chopping time of 3-6μsec. To prevent large overvoltages being induced in the windings not under test, they are short-circuited and connected to ground. But the short-circuiting reduces the impedance of the transformer and hence waveshape of the impulse generators. It also reduces the sensitivity of detection.

HISTORY OF FAULT ANALYSIS:

The method of performance of the test is specified in the standards such as IEC-76.Conventionally the voltage & current waveforms during testing have been recorded on analog impulse oscilloscopes. The advent of fast flash ADC's has resulted in the use of digital recording of test data. A recent IEEE standard caters to the use of digital recorders. Typically the recording involves the use of 10 bit ADC's at 60MegaSamples/Sec sampling. However, even the use of digital recording does not solve the problem of comparison of differing input waveforms such as the lightning impulse and the chopped lightning impulse. The transfer function method shows some promise in such applications. The transfer function suffers the drawback of an inability to compare a chopped lightning impulse at 2 microseconds with that at 6 microseconds.

WAVELET TRANSFORMS

Wavelet transforms are used as a tool a to measure the Faults that occur in a transformer. The wavelet series is simply a sampled version of the CWT, and the information it provides is highly redundant as far as the reconstruction of the signal is concerned. This redundancy, on the other hand, requires a significant amount of computation time and resources. The discrete wavelet transform (DWT) provides sufficient information both for analysis and synthesis of the original signal, with a poses problems in adjusting the standard significant reduction in the computation time.

THE DISCRETE WAVELET TRANSFORM (DWT) HISTORY:

The foundations of the DWT go back to 1976 when Crosier, Esteban, and Galand devised a technique to decompose discrete time signals. Crochiere, Weber, and Flanagan did a similar work on coding of speech signals in the same year. The analysis was named as **subband coding**. In 1983, Burt defined a technique very similar to subband coding and named it **pyramidal coding** which is also known as multiresolution analysis. Later in 1989, Vetterli and Le Gall made some improvements to the subband coding scheme, removing the existing redundancy in the pyramidal coding scheme.

THE SUBBAND CODING AND THE MULTIRESOLUTION ANALYSIS

A time-scale representation of a digital signal is obtained using digital filtering techniques. The continuous wavelet transform is computed by changing the scale of the analysis window, shifting the window in time, multiplying by the signal, and integrating over all times. In the discrete case, filters of different cutoff frequencies are used to analyze the signal at different scales. The signal is passed through a series of high pass filters to analyze the high frequencies, and it is passed through a series of low pass filters to analyze the low frequencies. **T**he resolution of the signal, which is a measure of the amount of detail information in the signal, is changed by the filtering operations, and the scale is changed by upsampling and downsampling (subsampling) operations. Subsampling a signal corresponds to reducing the sampling rate, or removing some of the samples of the signal. Upsampling a signal corresponds to increasing the sampling rate of a signal by adding new samples to the signal.

DISCRETE WAVELET TRANSFORM COEFFICIENTS

The procedure starts with passing the signal through a half band digital lowpass filter. A half band lowpass filter removes all frequencies that are above half of the highest frequency in the signal. For example, if a signal has a maximum of 1000 Hz component, then half band lowpass filtering removes all the frequencies above 500 Hz. The sampling frequency of the signal is equal to 2π radians in terms of radial frequency. Therefore, the highest frequency component that exists in a signal will be π radians, if the signal is sampled at Nyquist's rate (which is twice the maximum frequency that exists in the signal); that is, the Nyquist's rate corresponds to π rad/s in the discrete frequency domain. After passing the signal through a half band lowpass filter, half of the samples can be eliminated according to the Nyquist's rule, since the signal now has a highest frequency of $\pi/2$ radians instead of π radians. Simply discarding every other sample will **subsample** the signal by two, and the signal will then have half the number of points. The scale of the signal is now doubled. The lowpass filtering removes the high frequency information, but leaves the scale unchanged. Only the subsampling process changes the scale. Resolution is related to the amount of information in the signal, and therefore, it is affected by the filtering operations. Half band lowpass filtering removes half of the frequencies, which can be interpreted as losing half of the information. Therefore, the resolution is halved after the filtering operation. The subsampling operation after filtering does not affect the resolution, since removing half of the spectral components from the signal makes half the number of samples redundant anyway. Half the samples can be discarded without any loss of information. The lowpass filtering halves the resolution, but leaves the scale unchanged. The signal is then subsampled by 2 since half of the number of samples are redundant. This doubles the scale.

METHOD PROPOSED TO DETECT FAULTS IN TRANSFORMERS

The experimental value of lightning impulse voltage waveform is plotted and high frequency sinewaves are introduced. Wavelet transforms are used to determine the exact time instants at which each fault or the instances at which each frequency components occur. The earlier Fourier transform procedures were not usable to determine the exact time instants at which each faulted components. The difference in the Fourier transforms of the faulted and faultless waveforms could not give out accurate results and more over the time instants of fault occurrences were not obtained.

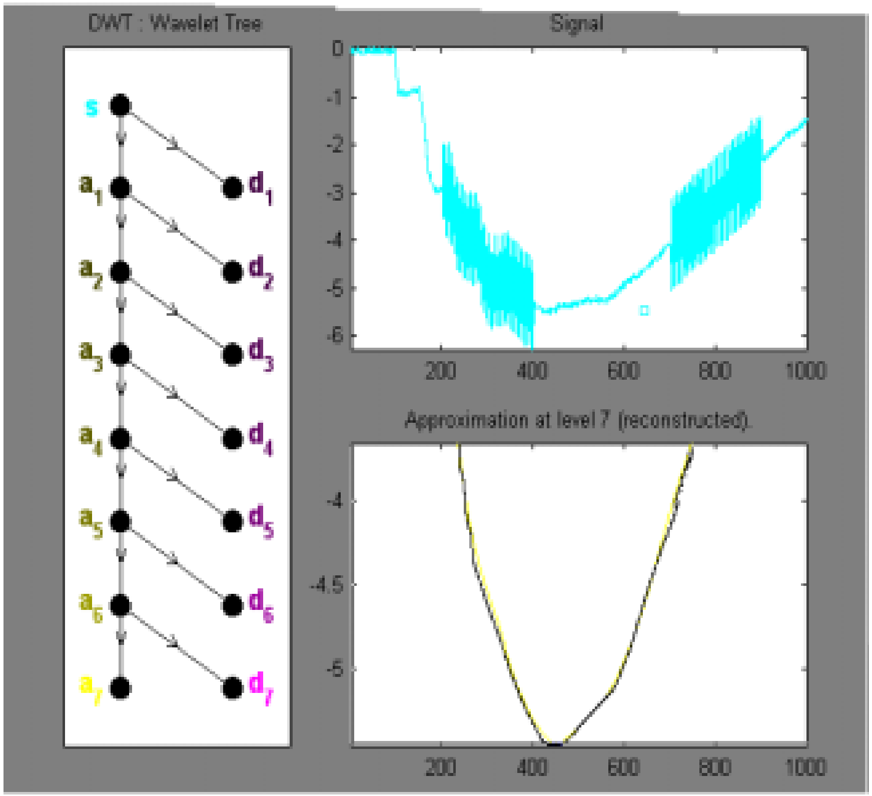

Fig 1
Wavelet coefficients as a tree representation.

The experimental lightning impulse voltage waveform with introduced sinusoids are taken and their wavelet coefficients are plotted as shown in Fig1. The Fig1 shows how the frequencies are spliced using the wavelet transforms and the manner in which the signal is filtered into high and low frequency components d1 and a1. The low frequency components are then subdivided into still more low frequency component till the level until the desired frequency information is got. This depend on the order upto which the wavelet is used as a filter. In this example the initial signal is reconstructed in the seventh stage. The different frequency components are observed as shown in Fig 2. The plot is then analyzed for fault detection. The scales and the order of wavelet transforms are selected depending on the frequency of interest. Hence by observing the plot, the faulted frequency components are detected along with the instances at which each fault occur. Thus this method is proposed as an improvement over the existing methods. The scales and the order of wavelet transforms are selected depending on the frequency of interest. Hence by observing the plot, the faulted frequency components are detected along with the

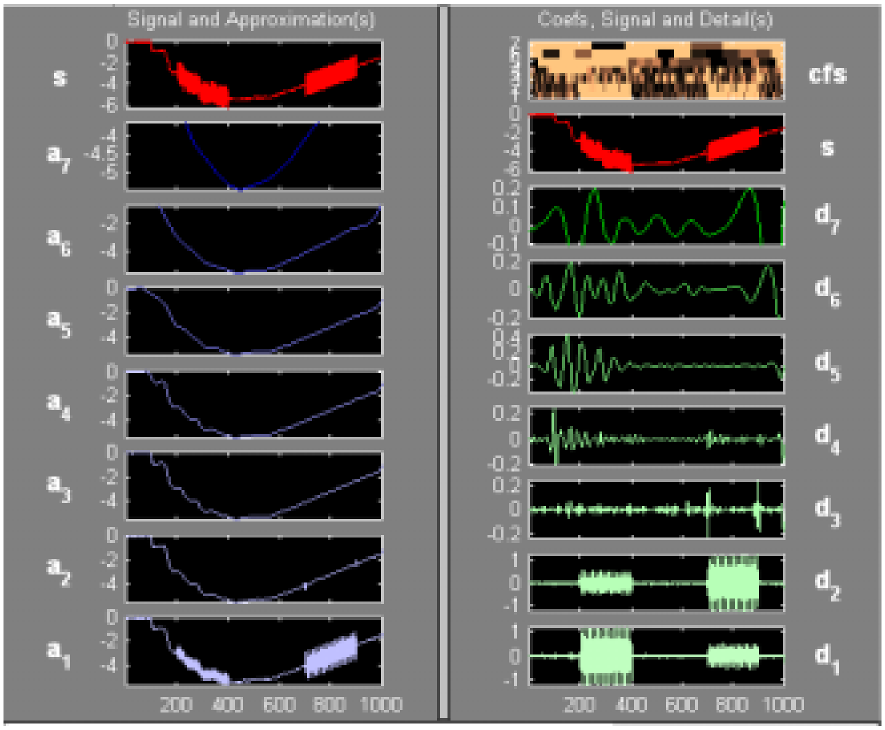

Fig 2
Decomposition of Frequencies

instances at which each fault occur. Thus this method is proposed as an improvement over the existing methods.

CONCLUSION:

The wavelet approach to characterize the failure of winding during Lightning Impulse tests on the transformer offers great insight as computed with time-domain approach. Analysis on experimental observed waveforms and simulated waveforms show that it is capable of analysis defects, which are not possible with evaluation method.

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BIOGRAPHIES

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