Implementation of Wavelet Transform on Transient Fault

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ABSTRACT  
This paper presents the development of an algorithm for information about transient fault. The algorithm devised is based on Discrete Wavelet Transform (DWT) analysis of transient current signals recorded in the event of a short circuit on a transmission line. The DWT analysis of line currents are carried out for normal and various fault condition. Few parameters are defined using detailed coefficients of DWT analysis.

INTRODUCTION

The great majority of faults on overhead transmission lines are transitory in nature. Power system transients are fast, short duration events that produce distortions in AC waveform. They are caused by sudden changes in the power system. Some of the more common causes of transients are: lightning strikes, switching operations and electrical faults.

The effects of transients on equipment are cumulative, with every succeeding transient having a greater effect on the equipment. Transients are difficult to detect because of their short duration. About 80-90% of faults on overhead transmission network are transient in nature. The remaining 10%-20% of faults are either semi-permanent or permanent. For transient fault immediate tripping of one or more circuit breakers clears the fault. Subsequent re-energizing of the line is usually successful. For permanent fault reclosing is very risky to expensive equipment which may be damaged by high fault current during the reclosing procedure. Therefore it is very important to distinguish between transient and permanent faults.

Transients are momentary changes in voltage or current those occur over a short period of time. This interval is usually described as approximately 1/16th of a voltage cycle or about 1ms. Transients are classified into three categories: impulsive transient, oscillatory transient and transient due to fault. The transient is classified in the impulse category when 77% of the peak-to-peak voltage of the pure component is of one polarity. An oscillatory transient is a sudden, non-power frequency change in the steady state condition of voltage, current or both that includes positive and negative polarity values. The transient due to fault is caused by fault conditions, the energization of large loads which require high starting currents or intermittent loose connections in power wiring. Each category of the transient is sub divided into three types related to the frequencies contained. Each type of transient can be associated with a group of phenomena occurring on the power system.
amplified by a power systems resonance phenomenon. Measurement of these types of transients should be useful for all classes of application. The medium frequency impulsive transient lasting between 5 ns to 1ms and the oscillatory transient between 5 and 500 kHz are less frequent than the low frequency types but have much higher amplitude. These transients may not propagate as easily as the low frequency types but may cause arcing faults on the power distribution system which result in voltage sag on many user power systems. The high frequency transient types with high amplitude can be observed only near where the phenomenon occurs. The high frequency impulsive transient has duration below 50 ns and the frequency of the high frequency oscillatory type ranges between 0.5 to 5MHz.

Wavelet Transform provides the timescale analysis of the non stationary signal. It decomposes the signal to time scale representation rather than time- frequency representation. Wavelet transform expands a signal into several scales belonging to different frequency regions by using translation (shift in time) and dilation (compression in time) of a fixed wavelet function known as Mother Wavelet. Wavelet based signal processing technique is one of the new tools for power system transient analysis and power quality disturbance classification and also transmission line protection. In other words, the wavelet transform reacts the most to the gradient of a given signal. The more irregular the disturbance, the higher the gradient will be. In most power signals, the wave shape of a disturbance event is irregular compared to that of its background signal. As a consequence, the wavelet coefficients associated with the disturbance event will have very large magnitudes compared to those of a disturbance-free waveform. The multi resolution analysis (MRA) technique decomposes a given signal into its detailed and smoothed versions. By using the MRA technique, the power system transient signal is decomposed into two other signals; one is the blurred version of the PQ disturbance signal, and the other is the detailed version of the power system transient signal that contains the sharp edges, transitions, and jumps. Therefore, the MRA technique discriminates disturbances from the original signal which analyses them separately.

This circuit is a simplified model of a 230 kV three-phase power system. Only one phase of the transmission system is represented. The equivalent source is modeled by a voltage source (230 kV rms/sqrt(3) or 187.8 kV peak, 60 Hz) in series with its internal impedance $(RsLs)$ corresponding to a 3-phase 2000 MVA short circuit level and $X/R = 10$. $(X = 230e3^2/2000e6 = 26.45$ ohms or $L = 0.0702$ H, $R = X/10 = 2.645$ ohms). The source feeds a RL load ing to a 3-phase 2000 MVA short circuit level and $X/R = 10$. $(X = 230e3^2/2000e6 = 26.45$ ohms or $L = 0.0702$ H, $R = X/10 = 2.645$ ohms). The source feeds a RL load

$x = 230kV \sqrt{3}/(100MVA \sqrt{3}) = 2.645 \text{ohms}$

$R = X/10 = 0.2645 \text{ohms}$

$C_1$ and $C_2$ of $10\mu F/km$ are modeled by a single pi section $(R_{L1} = 5.2 \text{ohms} / \text{km})$. The load $(75 \text{MW} - 20 \text{Mvar per phase})$ is modeled by a parallel RLC load block.

**Conclusion:**

Analysis of various types of transients was carried out using Discrete Wavelet Transform. Comparison of detailed coefficient for various waveforms was done for identification of transient and steady state fault with respect to healthy condition.

Criteria for identification of transient fault were developed.

**Table 1** Values of parameters for various transients conduction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal</th>
<th>Steady State</th>
<th>Transient Load</th>
<th>Capacitor Switching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qd1</td>
<td>106.4263098</td>
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<td>11106.3609</td>
<td>11401.268</td>
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</tbody>
</table>

**Figure 4** Test system for generation of power system transients

**Value of these parameter for normal condition, permanent fault, transient fault, load switching and capacitor switching**
Figure 5 Line current and its DWT decomposition for normal condition Algorithm for steady state transient fault classification

Figure 6 Line current and its DWT decomposition for permanent fault
Figure 7 Line current and its DWT decomposition for transient fault

Figure 8 Line current and its DWT decomposition for transient due to switching of load

REFERENCE