Simulation of Voltage Sag Event and Its Detection Method using Wavelet Transform

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Abstract: The power quality disturbances are still unsolved problems due to the increased power electronic load getting into the system. This paper explains the simulation of voltage sag event in power system network with the help of MATLAB software. This paper also presents the detection of voltage sag event using wavelet transform. The method is developed by using the discrete wavelet transform analysis. The graphical interface tool is used for analysis purpose. The generated signal is decomposed through the wavelet transform and any change on the smoothness of the signal is detected at the finer wavelet transform resolution level.

Index Terms: Discrete Wavelet Transform, MATLAB, Power Quality, Voltage Sag, Wavelet Transform

I. INTRODUCTION

The widespread of electronic equipment like computers, adjustable speed drive, PLC, CFL will create the power quality problems in the power system network. Voltage sag, swell, flicker, harmonics, impulse transient and interruptions are of most power quality problems. If we see the other side of this, the equipments which create the power quality problems are major victims of power quality problems [1], [2].

Fourier analysis is ideal for studying stationary data but is not well suited for studying data with transient events that cannot be statistically predicted from the historical data. Wavelets were designed with such non-stationary data in mind, and with their generality and strong results have quickly become useful to a number of disciplines [3], [4].

Voltage Sag:
It is defined as the reduction of 10-90 percent in AC RMS voltage at the power frequency, for duration from half a cycle to a few seconds. Figure 1 shows the simulated waveform of voltage sag event in pure sine wave.

Causes of Voltage sag:
Faults on the transmission or distribution network, Faults in consumer’s installation, Connection of heavy loads and start-up of large motors.

Consequences:
Malfunction of information technology equipment, namely microprocessor-based control systems (PCs, PLCs, ASDs, etc) that may lead to a process stoppage. Tripping of contactors and electromechanical relays. Disconnection and loss of efficiency in electric rotating machines [1].

II. SIMULATION OF VOLTAGE SAG EVENT

MATLAB is a user friendly software and used in many field for research. The single line diagram of test system is shown in figure 2. The system under study has been modeled using MATLAB is shown in figure 3. The system is simulated in normal mode of operation and result is generated. Figure 4 shows the wave form of normal mode of operation. Now if single line to ground fault is occur at bus G, the voltage at bus D will experience a voltage sag and is shown in figure 5. [7]

Figure 1: The Sag in a pure sine wave.

Figure 2: Test system one-line diagram.
III. WAVELET ANALYSIS

A variety of different wavelet families have been proposed in literature. The choice of mother wavelet plays a significant role in time frequency analysis. It also depends on a particular application. In this paper the “Db4” wavelet was adopted for study purpose. Figure 6. Shows the “Db4” wavelet [6].

The wavelet multi resolution analysis (MRA) is a new and powerful method of signal analysis. In multi resolution analysis technique that can be decompose the original signal into several other signals with different level of resolution. When original signal is decomposed approximation coefficients and detailed coefficients are obtained. Details and approximations of original signals are obtained by passing it through a filter bank, which consists of low and high—pass filter. A low pass filter removes the high frequency components while the high pass filter pick out the high frequency contents in the signal being analyzed. From these decomposed signals the original time-domain signal can be recovered without losing any information [5]-[10].

IV. RESULTS AND DISCUSSION

The decomposition of the signal of Figure 4 is shown in Figure 7. It is clear that no disturbances are observed in waveform. The decomposition of the signal of Figure 5 is shown in Figure 8. The coefficient line in detail d1 shows the exact location of the initiation of the disturbance. The magnitude of the coefficient line indicates the nature of the disturbance. For example coefficient line at scale 500 to 2050 voltage is of very small amplitude which is sag in nature. The signal contains voltage sag. The details from level 1 to 4 are shown and the instant of the occurrence of the disturbance can easily be detected from the Wavelet analysis.
V. CONCLUSION

Simulation study using computer models of the systems is a starting point to gain such expertise. The power blockset available in MATLAB is a very useful tool for such study and the results obtained through the study is presented in this paper. In this paper one type of voltage signal disturbance, called voltage sag has been detected using wavelet decomposition technique. The simulation results showed that the proposed method is able to detect and locate the power quality problems.

REFERENCES