Investigation of Wavelet Transform for Travelling Waves Timestamps

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***Abstract*— Precise and fast fault location in branched distribution network with high presence of electronic based renewable generation is of vital importance to system reliability and continuous supply. Travelling wave based fault location is one the common technique and widely used in highvoltage trasmssion line. However, the application of travelling wave in distribution networks with shorter distances and branches faces few challenges, such as the accuracy of the timestamp and the detection of the refected wave timestamp [1]. Wavelet Transform (WT) is one of the most widely used method to process recorded fault transient and extract timestamps [2, 3]. An investigation of three different wavelet decomposition techniques was explored and compared in order to quantity the more accurate timestamping approach . The investigation is performed using a 11kV network with mixed overhead line and under ground cable with two branches which are simulated using ATP-EMTP, and the recorded data are analysed using MATLAB programming. The obtained outcomes clearly show that the three investigated approaches show similar accuracy.**

Background & Main Results

The extraction of the travelling wave timestamp using signal processing can be performed in the following order: pre-processing the recorded fault transient data (voltage signal) which include window arrangements and blackman windowing in order to minimize frequency leakage during time-frequency transformation, second stage is the application of wavelet decomposition which decompose the pre-processed time window into five time-frequency bands that show the transients waves as a clear discrete peaks, and final stage is the detection of the first arrived wave which can be perform using peak detection algorithm. In this study, a comparison between, Daubechies2, biorthogonal2.2 and Coifficent3 motherwaves have been explored and an example of the analysed voltage and the five decomposed levels with original signal are presented in Figure 1. The algorithm shows clearly the first and second waves with three different motherwaves, Daubechies in Green, Biorthogonal in Black and Coifficient in Cyan, while the top Red line is the analysed voltage. The zoomed view in figure 1(b) shows that decomposion level 1 (d1) which shows the higher frequency band while level 5(d5) shows the lower frequency band. Timestamp of the peaks in each band is detected and an average is calculated which represents the arrival timestamp.

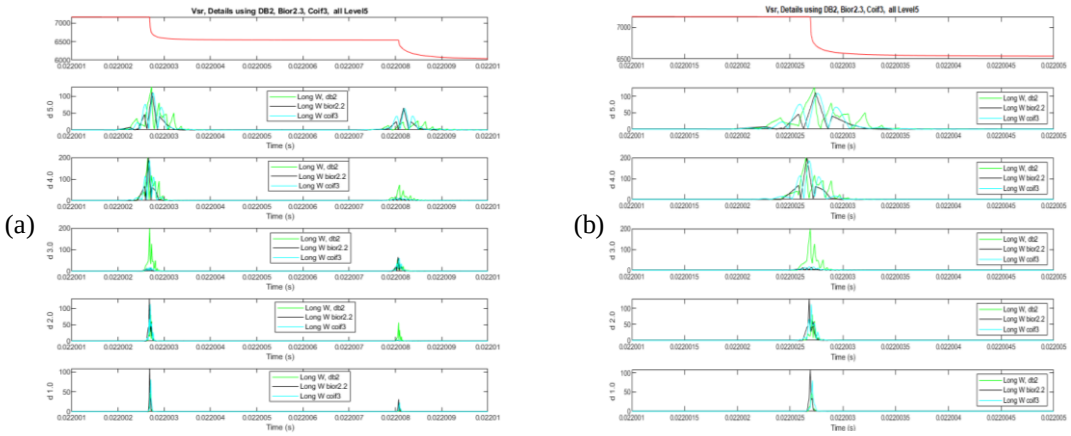

Figure 1: Figure 1. (a) A comparison of decomposed source voltage into 5 levels with three different mother waves, (b) A zoomed view of the first arrived wave.

Conclusions

This work investigated wavelet decompoision with three different motherwaves. The analysis showed that the three mother waves clearly have similar decomposition accuracy in representing the travelled wave to the recorder with clear peak of the first and second waves. The timesampe difference between the three method is within 10ns which generate a very minimum distance error equivalent to 3m. Therefore, any of the three technique can be utilized for travelling wave based fault location in distribution networks.

References

[1] R. Kumar, D. Saxena , “A Traveling Wave Based Method For Fault Location In Multi-Lateral Distribution Network,” 2018 IEEE Innovative Smart Grid Technologies - Asia (ISGT Asia), 2018.

[2] N. Bhatnagar, Introduction to Wavelet Transform, Taylor & Francis Group, 1st edition, 2020.

[3] A. Raqib, et al. "Comparison of Frequency Transform Methods for Condition Monitoring of a DC-Link Capacitor." The 10th International Conference on Power Electronics, Machines and Drives (PEMD 2020), December 2020.