International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

Fault Location Using Discrete Wavelet Transform For Smart Grid Distribution Systems

Patcy Janice Gomes[1], Shrividya G.[2]

[1]*Student, Dept. of ECE, N.M.A.M Institute of Technology, Karnataka, India*
[2]*Associate Professor, Dept. of ECE, N.M.A.M Institute of Technology, Karnataka, India*

---***---

Abstract – *During power transmission from the point of generation to the distribution, power loss might occur due to fault. Fault location is necessary for the smooth flow of power to the distribution section. In this work, faulty signal is detected by Discrete Wavelet Transform (DWT) and Discrete Fourier Transform (DFT) techniques. Further, comparison of faulty signal obtained using DWT and DFT is presented, giving a clear idea of selecting DWT over DFT for fault location in Smart Grid distribution systems.*

***Key Words*: Fault, Power, Smart Grid, DWT, DFT**

1. INTRODUCTION

Smart Grid is an advanced technique of energy control and power management [1]. Due to the continuous research in the smart grid field, the system is getting more intelligent. Hence location of fault and its maintenance has to be done automatically, this helps in continuous monitoring of whole system automatically rather than doing it manually [2]. Fault location in the distribution section has been a great challenge nowadays. Issues pertaining to energy crisis are severe in modern world due to the fact that demand is more than supply [3]. Hence to deal with these issues an alternative solution has to be proposed.

Power networks of present era are large and tedious; therefore estimation of fault location manually is difficult [4]. In such a situation technique that can easily detect the fault and extract the faulty signal can be more useful as well as time saving.

This work focuses on Discrete Wavelet Transform (DWT) and Discrete Fourier Transform (DFT) based fault location techniques to extract the faulty signal easily. Additionally, faulty signals extracted using both the techniques are compared thereby enabling to select the best possible technique for the fault location.

1.1 Causes of Electrical Faults

a. Several electrical equipment are used in the power system such as generators, motors, transformers etc. cause faults due to ageing, improper functioning and insulation failure of wires [5].
b. Weather conditions such as heavy rains, winds, lightning, accumulation of snow, etc. can cause faults in the power systems [6].
c. Selection of inaccurate rating of electrical components can cause faults in the transmission of power [7].
d. Due to the presence of various pollutants in the atmosphere, electric sparks might arise between electric lines leading to damage of power lines [8].

3. METHODOLOGY

It is very essential to detect the faulty signal while transmission through power lines for the smooth functioning of the system. Faulty signal can be easily extracted by DWT technique in this work.

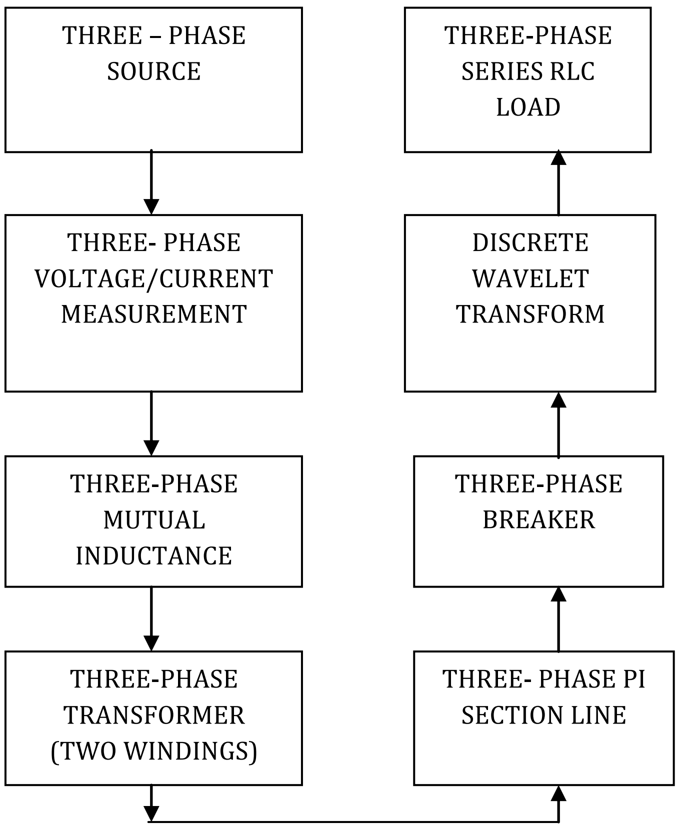

Fig -1: DWT based fault location

Fig-1 represents the block diagram of DWT based fault location. The three-phase voltage source in series with resistor and inductor having frequency 50Hz generates the voltage signal. The three-phase voltage/current measurement block is used for three-phase voltage/current measurements and it is implemented using a diode in parallel with a series RC (Resistor,Capacitor) snubber circuit. The three-phase voltage/current measurement output is fed to three-phase mutual inductance block. This block provides a three-phase impedance with mutual coupling between phases. Self-impedances and mutual impedances are set by entering positive and zero sequence parameters. The three-phase mutual inductance output is fed to a three-phase transformer (two windings). A three-phase transformer is implemented by using three single-phase transformers. Output of three-phase transformer is fed to three-phase PI section line. Three-phase PI section line is modeled as a three-phase transmission line with a single PI section. It consists of one set of RL (Resistor,Inductor) series elements connected between input and output terminals and two sets of shunt capacitances lumped at both ends of the line. Three-phase breaker implements a three-phase circuit breaker. It is meant to make and break the flow of electrical currents in transmission lines. DWT is used to determine the fault location.

In-order to select best possible technique among DWT and DFT, the faulty signal obtained using DWT and DFT is compared. Faulty signal using DFT can be obtained by just by replacing DWT block in Fig-1 by DFT block. The block diagram of DFT based fault location is shown in Fig-2.

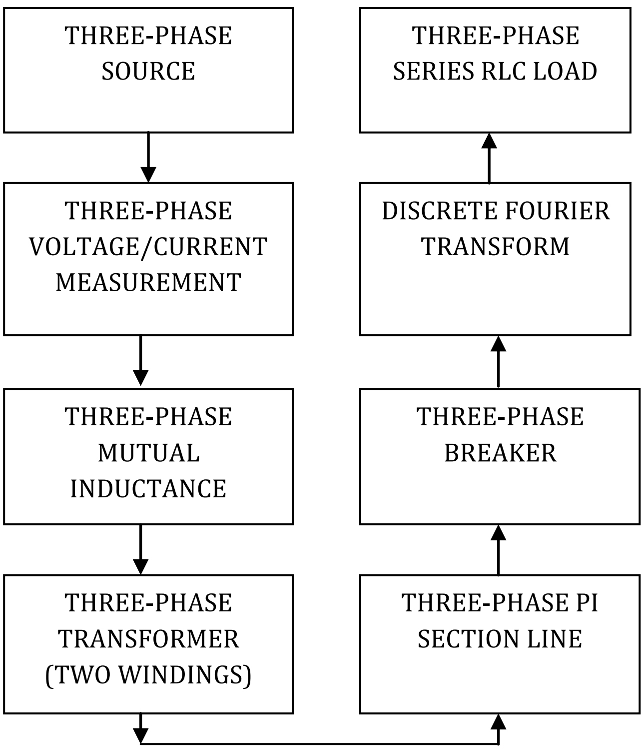

Fig -2: DFT based fault location

4. RESULTS AND DISCUSSIONS

Extraction of faulty signal using DWT consists of three-phase source, three-phase mutual inductance, three-phase transformer, three-phase pi section, three-phase breaker, three-phase series RLC load and discrete wavelet block. For extracting the faulty signal using DFT, the discrete Fourier block is used instead of discrete wavelet block. The parameters and values for each of the blocks are different.

Table- 1: Block parameters and values of three-phase voltage source

Block parameter	Value
Frequency	50 Hz
Phase to phase voltage	63 kV
Base voltage	63 kV
Source reactance to source resistance ratio	30
Three-phase short-circuit level at base voltage	1000 MVA

Table- 2: Block parameters and values of three-phase voltage/current measurement

Block parameter	Value
Frequency	50 Hz
Peak amplitude of ac voltage source	100 V
Amplitude of dc voltage source	10 V
Series RLC branch resistance	1 Ohm
Diode resistance	0.001 Ohm
Inductance	0 H
Forward voltage	0.8 V
Snubber resistance	500 Ohm
Snubber capacitance	250 nF

Table- 3: Block parameters and values of three-phase mutual inductance

Block parameter	Value
Positive sequence resistance	2 Ohm
Positive sequence inductance	50 mH
Zero sequence resistance	4 Ohm
Zero sequence inductance	100 mH

Table- 4: Block parameters and values of three-phase transformer with two windings

Block parameter	Value
Nominal frequency	50 Hz
Nominal power	1000 MW
Winding 1 and winding 2 phase to phase voltages	63 MV and 20 MV
Winding 1 and winding 2 resistances	0.002 Ohm and 0.002 Ohm
Winding 1 and winding 2 inductances	0.08 H and 0.08 H
Magnetization resistance	500 Ohm
Magnetization inductance	500 H

Table- 5: Block parameters and values of three-phase pi section line

Block parameter	Value
Frequency	50 Hz
Positive sequence resistance	0.01273 Ohms/km
Positive sequence inductance	0.9337 mH/km
Positive sequence capacitance	12.74 nF/km
Zero sequence resistance	0.3864 Ohms/km
Zero sequence inductance	4.1264 mH/km
Zero sequence capacitance	7.751 nF/km
Line length	100 km

Table- 6: Block parameters and values of three-phase breaker

Block parameter	Value
Breaker resistance	0.001 Ohm
Snubber resistance	1 MOhm
Snubber capacitance	inf

Table- 7: Block parameters and values of discrete Fourier/discrete wavelet

Block parameter	Value
Fundamental frequency	50 Hz
Harmonic	3

Table- 8: Block parameters and values of three-phase series RLC load

Block parameter	Value
Nominal frequency	50 Hz
Nominal phase to phase voltage	20 kV
Active power	15 MW

In order to determine the fault location, initially signal generated by the three-phase source is subjected to voltage/current measurement by a three-phase voltage/current measurement circuit.

Fig-3 shows the three-phase voltage/current measurement output. Further the three-phase voltage/current measurement output is fed to three-phase

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

mutual inductance block for implementing a three-phase impedance with mutual coupling between phases. Fig- 4 shows the three-phase mutual inductance output.

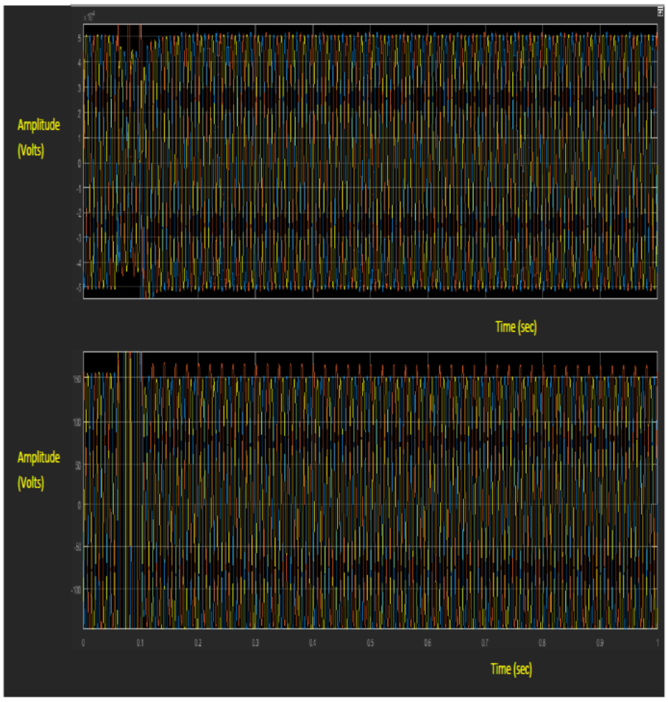

Fig -3: Three-phase voltage/current measurement output

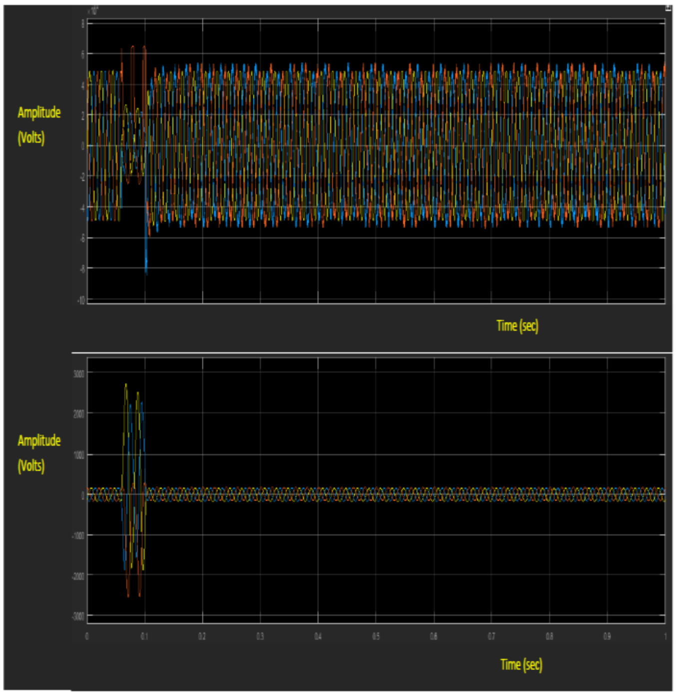

Fig -4: Three-phase mutual inductance output

The mutually coupled signal is then fed to three-phase transformer with two windings and then transmitted through three-phase pi section line. For interrupting the current flow, a three-phase breaker is introduced and fault location is determined by DWT.

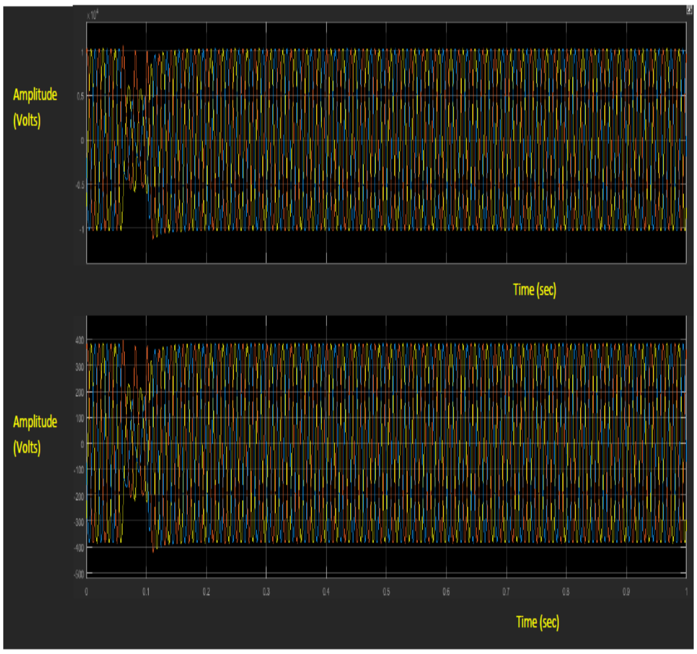

Fig -5: Propagation of signal through three-phase pi section line

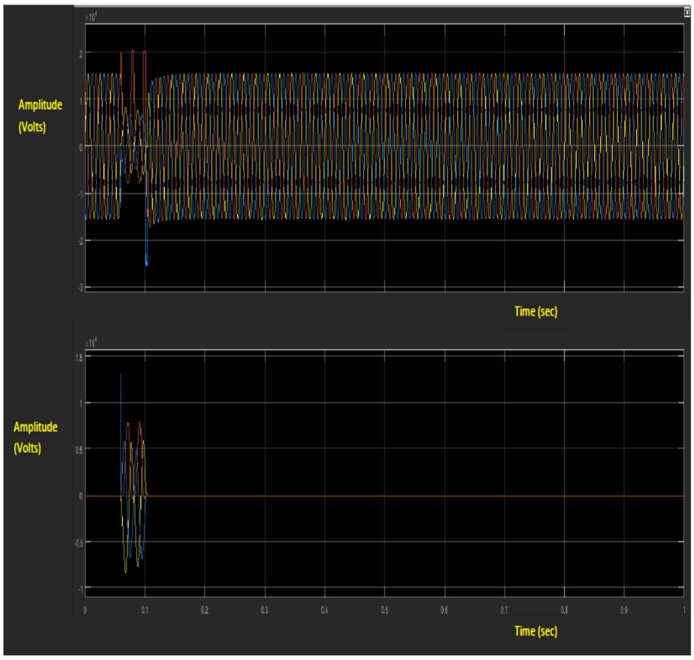

Fig -6: Three-phase breaker output

Signal propagation through three-phase pi section line is shown in Fig-5 and three-phase breaker output is shown in in Fig-6. DWT based fault location is shown in Fig-7.

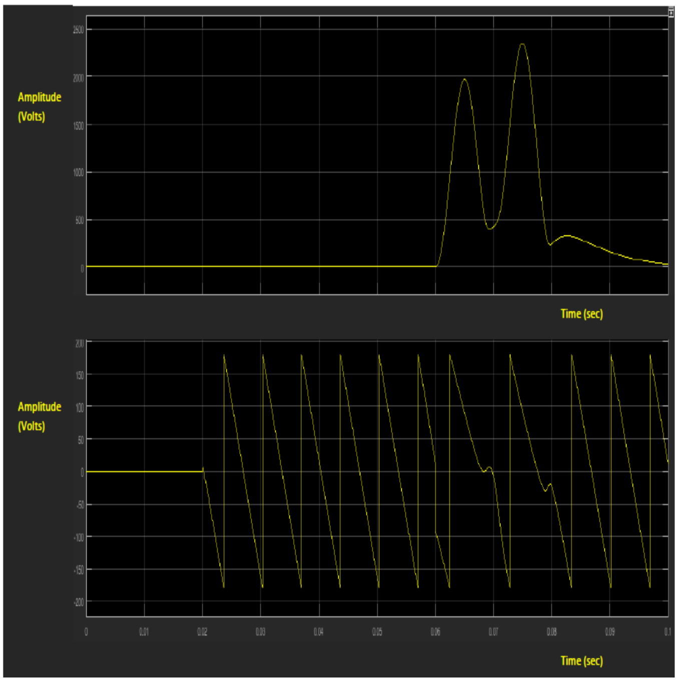

Fig -7: Faulty signal obtained using DWT

Further faulty signal using DFT technique has to be obtained in-order to select the best possible technique among DWT and DFT, by comparing the faulty signal obtained using both the techniques. DFT based fault location is shown in Fig-8.

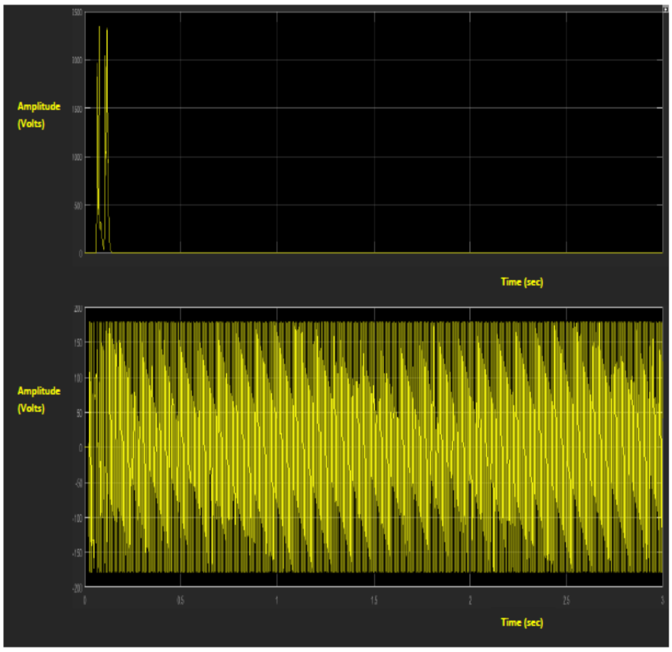

Fig -8: Faulty signal obtained using DFT

5. CONCLUSIONS

Faulty signal is detected using DWT and DFT techniques. Faulty signal is more clearly detected using DWT technique compared to the faulty signal obtained using DFT technique. Thus it can be concluded that DWT is the most reliable technique for fault location.

ACKNOWLEDGEMENT

The authors express sincere gratitude to NMAMIT, Nitte for the support and providing a pleasant environment to carry out the project work.

REFERENCES

[1] O. Gencer, S. Ozturk, T. Erfidan, "A new approach to voltage sag detection based on wavelet transform", Electrical Power and Energy Systems, pp.133–140, 2010.

[2] D. Bin, G. Li, C. Qiu, J. Pan, and Y. Tan, "Fault location and self-healing of distribution network based on function block and wireless sensor," in Proc. IEEE Innovative Smart Grid Technologies, pp. 1–9, 2012.

[3] A M Pasdar, I Husain, "Detecting and locating faulty nodes in smart grids based on high frequency signal injection", IEEE Transactions on Smart Grid, vol. 04, no. 2, pp. 1067–1075, 2013.

[4] Farshad, M., Sadeh, J., "A novel fault location method for HVDC transmission lines based on similarity measure of voltage signals", IEEE Transactions on Power Delivery, pp. 2483–2490, 2013.

[5] S. Das, S. Santoso, A. Gaikwad, and M. Patel, "Impedance-based fault location in transmission networks: theory and application," IEEE Access, vol. 2, pp. 537–557, 2014.

[6] Livani, H., Evrenosoglu, C.Y., "A single-ended fault location method for segmented HVDC transmission line", Electrical Power Systems Res., vol.107, pp.190–198, 2014.

[7] Yuangsheng, L., Gang, W., Haifeng, L., "Time-domain fault-location method on HVDC transmission lines under unsynchronized two-end measurement and uncertain line parameters", IEEE Transactions on Power Delivery, vol.30, pp.1031–1038,2015.

[8] A. Rajeev, T. Angel, and F. Z. Khan, "Fault location in distribution feeders with optimally placed pmu's," IEEE International Conference on Advancements in Power and Energy (TAP Energy), pp. 438–442, 2015.

[9] K. R. Krishnanand, P. K. Dash, and M. H. Naeem, "Electrical Power and Energy Systems Detection, classification, and location of faults in power transmission lines," International Journal of Electrical Power and Energy Systems, Vol. 67, pp. 76–86, 2015.