Transmission Line Fault Classification and Identification using Wavelet Transform

Neha S. Dudhe[1] Dhammaratna B. Waghmare[2] Soniya K. Malode[3]
[1]PG Scholar [2,3]Assistant Professor
[1,2,3]Shri Sai College of Engineering & Technology, Bhadrawati, India

Abstract— Along with alternative electrical elements, the conductor suffers from the sudden failures thanks to varied faults. Protective of transmission lines is one in every of the vital tasks to safeguard wattage systems. For safe operation of EHVAC conductor systems, the protection system ought to ready to detected, classified, set accurately and cleared is quick as doable to take care of stability within the network. The protecting systems square measure needed to stop the propagation of those faults. The incidence of any conductor faults offers rise to transient condition. Optimal operation of an influence system depends on however a fault location is accurately and quickly set, in order that restoration and maintenance of power is accomplished. Fault detection, fault classification, must be performed employing a quick responsive formula at completely different levels of an influence system. result of things like fault electric resistance, fault origination angle (FIA), and fault distance, that cause disturbances in cable are often countered by ripple multi resolution analysis (MRA). The tactic of fault discrimination projected during this work is on the idea of the three-phase current and voltage waveforms measured throughout the incidence of fault within the power transmission-line. Further, a superior technique, viz. ripple Singular Entropy (WSE) is applied each at conductor and electrical device level that minimizes the noise within the fault transients and is unaffected by the transient magnitude. The projected formula is verified victimization MATLAB/Simulink package and also the obtained results prove that each MRA and WSE based mostly fault detection and classification ways square measure much possible and reliable.

Key words: Transmission Line Fault, Wavelet Transform

I. INTRODUCTION

Electricity created by an influence plant is delivered to load centers and electricity shoppers through transmission lines command by immense transmission towers. Throughout traditional operation, an influence system is during a balanced condition. Abnormal eventualities occur thanks to faults.

Faults during a power grid will be created by natural events like falling of a tree, wind, Associate in Nursingd an silver storm damaging a conductor, and generally by mechanical failure of transformers and alternative instrumentality within the system. An influence system will be analyzed by conniving system voltages and currents underneath traditional and abnormal eventualities [1].

A fault is outline as flow of an oversized current that may cause instrumentality harm. If this is incredibly massive, it would result in interruption of power within the network. Moreover, voltage level cans modification, which might have an effect on instrumentality insulation. Voltage below its minimum level may generally cause failure to instrumentality.

Wavelet remodel (WT) may be a novel signal process technique developed from the Fourier remodel (FT) and has been wide accustomed signal process application [11-[3]. The wavelets possess 3d characters and area unit ready to regulate their scale to the character of the signal options. Singularities Associate in nursing irregular structures in signal wave typically carry vital data from an informatics-theoretic purpose of read. The WT analysis provides a form of mathematical “microscope” to center or zoom out on those fascinating structures [3]. Moreover, wavelets will be orthonormal and area unit ready to capture settled options. Therefore, WT will decompose a symbol into localized contributions labeled by supposed dilation and translation parameters. These parameters represent the data of various frequency part contained within the analyzed signals [3].

To monitor the standard of an electrical power grid, a curving wave at a rated voltage magnitude and frequency may be a correct index. Thus, any power disturbance (or fault) will be thought of as a deviation from that curving wave. The opposite drawback that ought to be detected once a fault happens on an influence system is that fault current is sort of bigger than the pre-fault load current in any system part. a really straightforward Associate in Nursing effective fault police investigation principle is that of victimization this magnitude as an indicator of a fault of the facility system.

Since the riffle remodel with its ability permitting the localization each in time and frequency domain, some publications [4]-[6] introduced the riffle remodel as a tool to investigate power grid disturbances. During this work, the authors apply the 2 riffle remodel with Haar wavelets to investigate 3 phase-currents of an influence system.

By the multi-resolution analysis characteristics of the II ripple remodel, the abrupt direct offset (DC) part of this during a grid may be found and wont to be a fault detection indicator. Meanwhile, the faulted-phase may also be known. The planned formula is enforced by mistreatment moving information window technique. The simulation studies show that this fault detection indicator is with quick time interval that provides an alternate approach for cable protection. It’s necessary to check an influence system below fault conditions so as to produce system protection

II. PROPOSED APPROACH AND MODEL

A. MATLAB simulation model

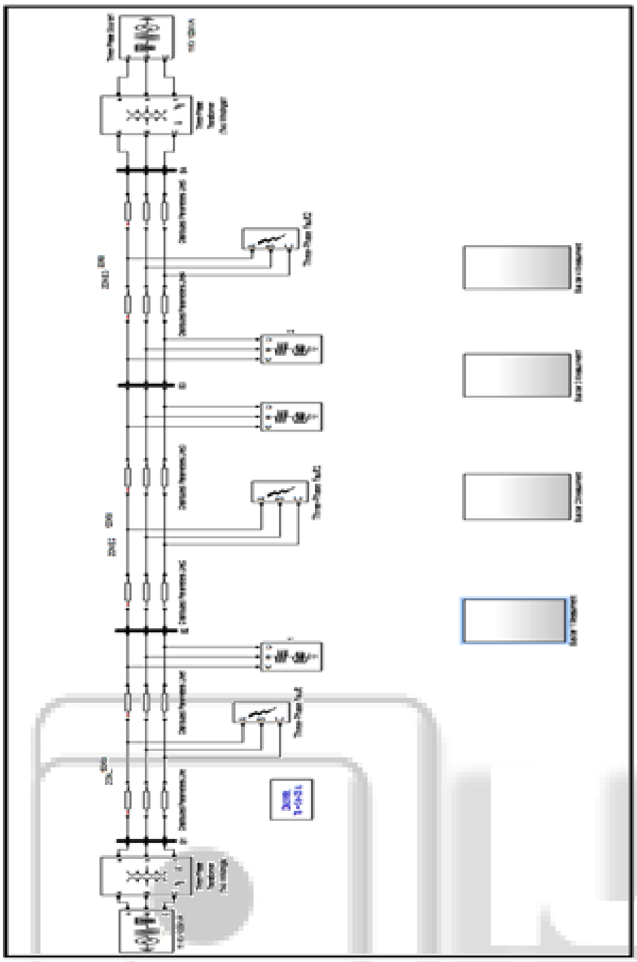

Fig. 1: Complete MATLAB simulation model of power system

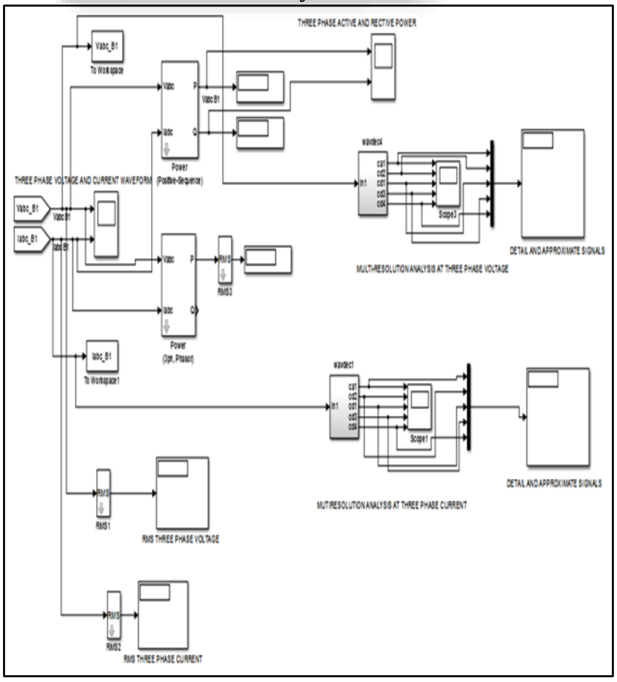

Fig. 2: MATLAB simulation model for bus bar 1 measurement subsystem with Multi-resolution analysis (MRA) simulation block

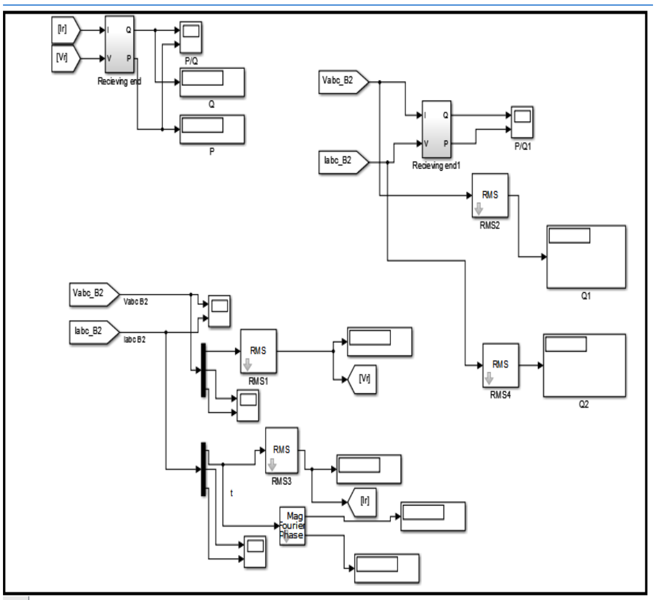

Fig. 3: MATLAB simulation model for Bus bar 2, 3 and 4 measurement subsystem

Sr No	Name of component	Parameter specification
1	Three phase generator 11kv, 50 Hz, 100MVA	Phase to phase RMS voltage = 11 KV; Frequency = 50 Hz; Internal winding connection star with ground connected; Short circuit MVA capacity; Base voltage = 25 KV; X/R ratio =7
2	Distributed parameter line	Number of phase =3; Frequency used for RLC specification =50 Hz; Positive sequence resistance = 0.01273 Ohm/Km; Zero sequence resistance = 0.3864 Ohm/Km; Positive sequence inductance = 0.9337mH/Km; Zero sequence inductance = 4.12 Mh/Km; Positive sequence capacitance = 12.74 nF/Km; Zero sequence Capacitance = 7.751 nF/Km; Line length zone 1= 100 Km; Line length zone 2= 120 Km; Line length zone 3= 80Km.
3	Three phase fault	Fault type simulated = AG, BG, CG, ABG, BCG, ACG, AB, BC, AC, ABCG, ABC; Fault resistance = 0.001 Ohm; Ground resistance = 0.001 Ohm; Fault transition time: Start time 0.2 Second and end time 2 Second.
4	Three phase series RLC load	Nominal phase to phase voltage = 11Kv;

		Nominal frequency = 50 Hz; Active power = 1 KW; Inductive reactive power = 4 KVAr.
5	Three phase generator 11kv, 50 Hz, 100MVA	Phase to phase RMS voltage = 11 KV; Frequency = 50 Hz; Internal winding connection star with ground connected; Short circuit MVA capacity; Base voltage = 25 KV; X/R ratio =7
6	Distributed parameter line	Number of phase =3; Frequency used for RLC specification =50 Hz; Positive sequence resistance = 0.01273 Ohm/Km; Zero sequence resistance = 0.3864 Ohm/Km; Positive sequence inductance = 0.9337mH/Km; Zero sequence inductance = 4.12 Mh/Km; Positive sequence capacitance = 12.74 nF/Km; Zero sequence Capacitance = 7.751 nF/Km; Line length zone 1= 100 Km; Line length zone 2= 120 Km; Line length zone 3= 80Km.

Table 1: MATLAB Simulation Model Parameter Specifications

III. SIMULATION RESULTS

A. *Wavelet Transform analysis results*

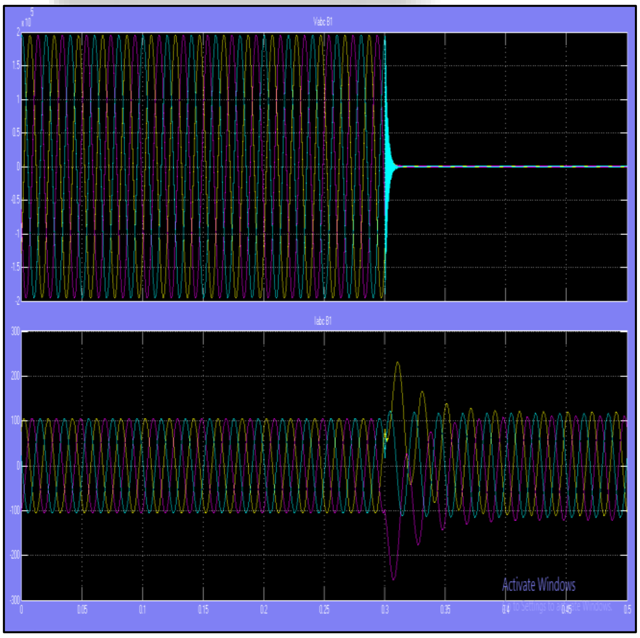

Fig. 4: Three phase voltage and current at bus bar 1 for LLLG (ABCG) fault in zone 1 at 65 km from reference bus bar 1

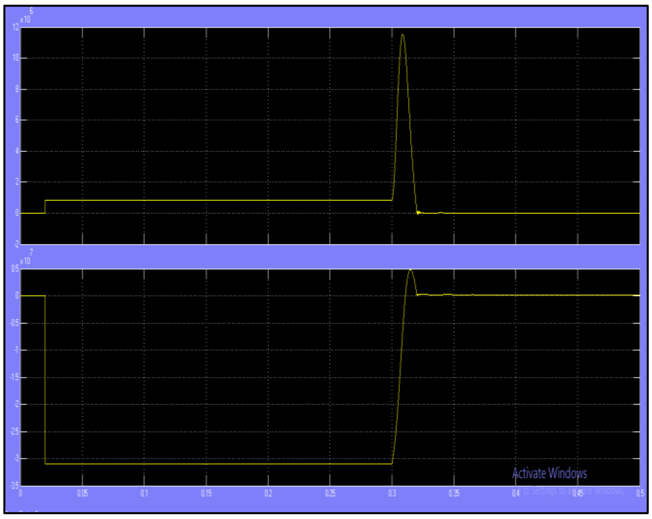

Fig. 5: Three phase active and reactive power at bus bar 1 for LLLG (ABCG) fault in zone 1 at 65 km from reference bus bar 1

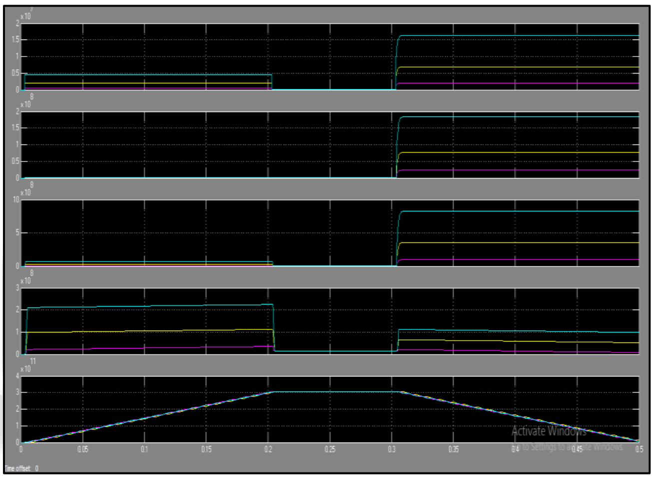

Fig. 6: Wavelet energy calibration for three phase current using symlet2 mother wavelet at bus bar 1 for LLLG (ABCG) fault in zone 1 at 65 km from reference bus bar 1

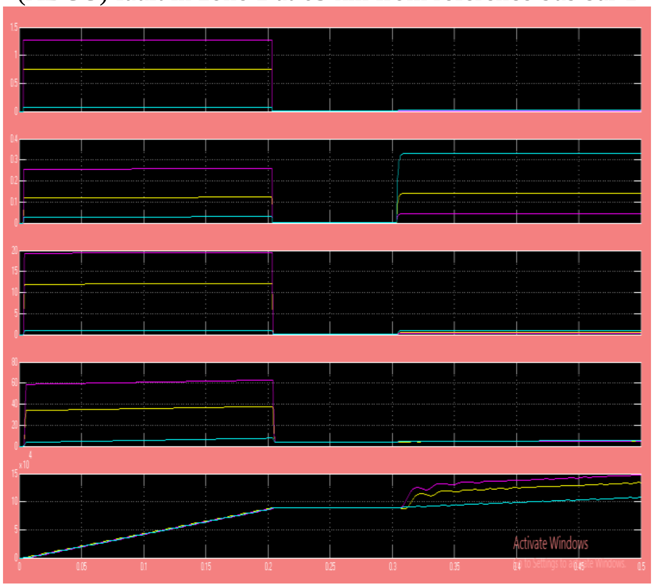

Fig. 7: Wavelet energy calibration for three phase voltage using symlet2 mother wavelet at bus bar 1 for LLLG (ABCG) fault in zone 1 at 65 km from reference bus bar 1

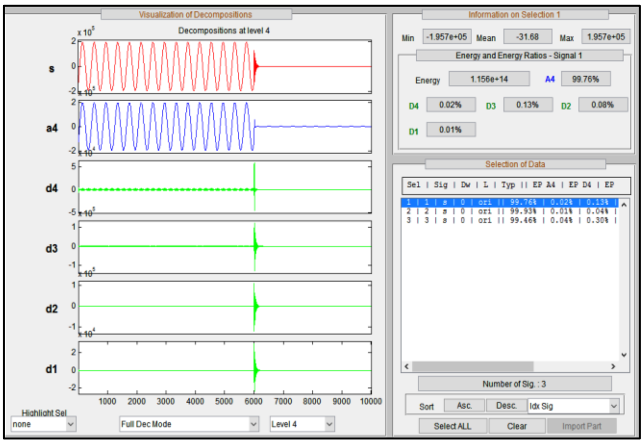

Fig. 8: Wavelet Multi resolution analysis detail and approximate signals for phase A voltage when LLLG (ABCG) fault occurs in zone 1 at 65km from reference bus bar 1 using symlet2 mother wavelet

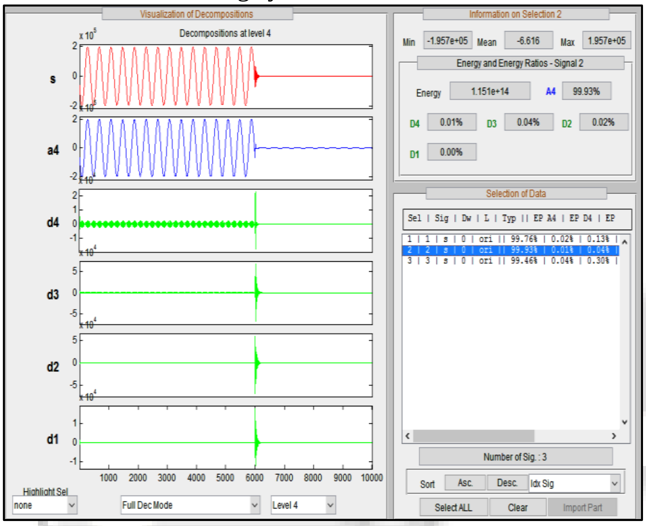

Fig. 9: Wavelet Multi resolution analysis detail and approximate signals for phase B voltage when LLLG (ABCG) fault occurs in zone 1 at 65km from reference bus bar 1 using symlet2 mother wavelet

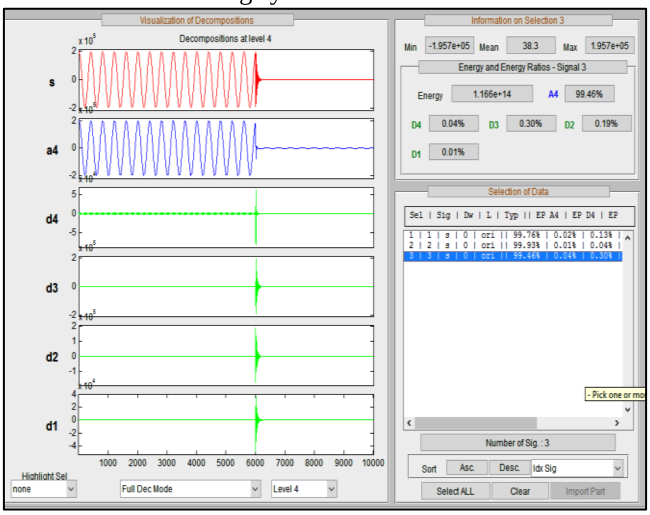

Fig. 10: Wavelet Multi resolution analysis detail and approximate signals for phase C voltage when LLLG (ABCG) fault occurs in zone 1 at 65km from reference bus bar 1 using symlet2 mother wavelet

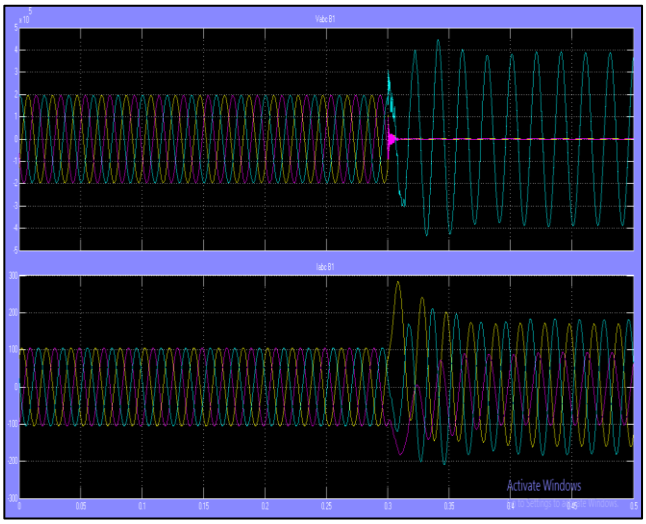

Fig. 11: Three phase voltage and current at bus bar 1 for LLG (ABG) fault in zone 1 at 80 km from reference bus bar 1

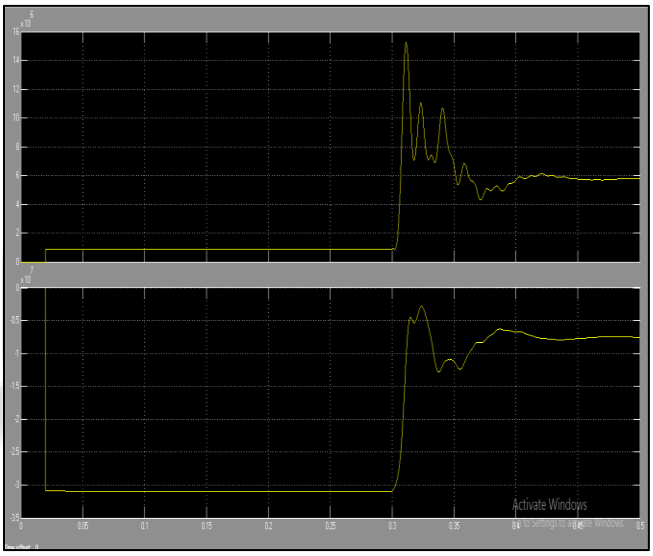

Fig. 12: Three phase active and reactive power at bus bar 1 for LLG (ABG) fault in zone 1 at 80 km from reference bus bar 1

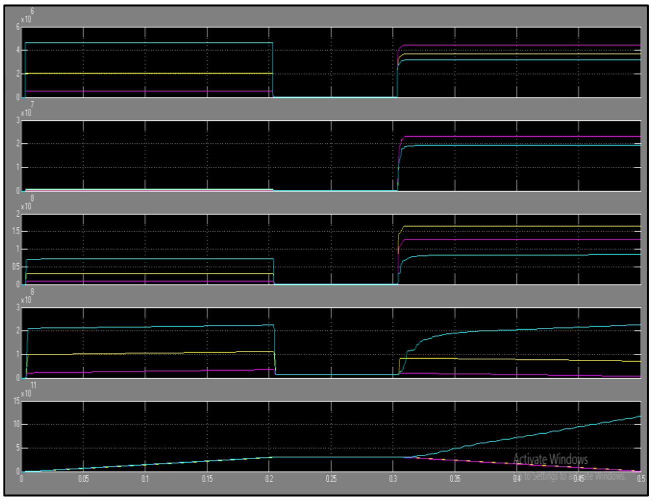

Fig. 13: Wavelet energy calibration for three phase voltage using Dabucheus2 mother wavelet at bus bar 1 for LLG (ABG) fault in zone 1 at 80 km from reference bus bar 1

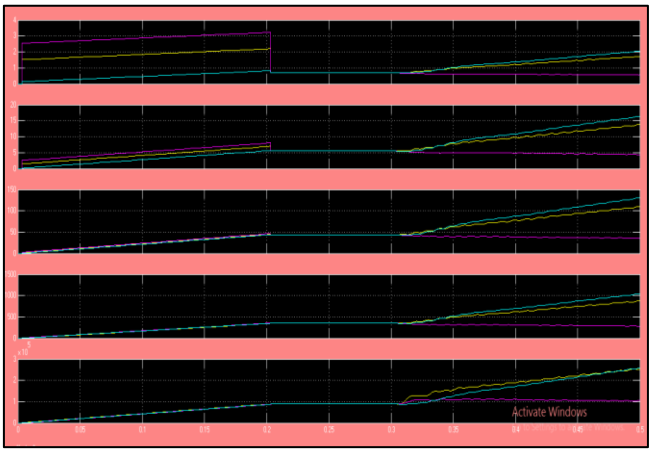

Fig. 14: Wavelet energy calibration for three phase current using Dabucheus2 mother wavelet at bus bar 1 for LLG (ABG) fault in zone 1 at 80 km from reference bus bar 1

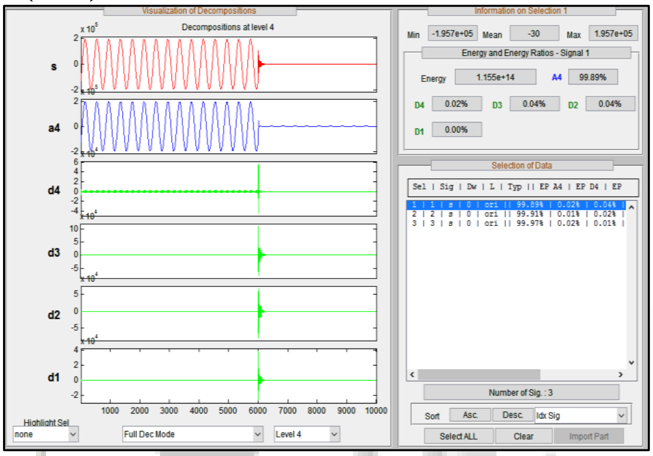

Fig. 15: Wavelet Multi resolution analysis detail and approximate signals for phase A current when LLG (ABG) fault occurs in zone 1 at 80km from reference bus bar 1 using Dabucheus2 mother wavelet

From above results from MATLAB simulation model and wavemenu (wavelet toolbox) in MATLAB was analyzed and following point was noted down: Points are as follows:

- In MRA and energy entropy window analysis window figure it is clear that when fault occurs in any phase of line then that phase wavelet energy of current of that phase more than other healthy phase current energy. Also energy of faulted phase was low as compared with other remaining healthy phases of line.
- Four mother wavelet was utilized for wavelet analysis on faulted signal like Debauches, Haar, Symlet, and Coieflet mother wavelets with 4 level of multilevel filer bank. In which Haar mother wavelet exactly classify the different types of fault location and fault types by simply observing the wavelet energy coefficients.
- Also signal frequency and time domain analysis done using this wavelet techniques using wavelet toolbox for different fault conditions.

IV. Conclusion

This thesis conferred a fault locater that's supported the characteristics of the traveling waves initiated from the fault. The signals area unit initial decoupled into their modal elements, then remodeled into the time frequency domain victimization the digital moving ridge remodel. This thesis has addressed the matter of fault distance estimation utilizing the measurements of current wave signals from one finish of a conductor and a case of multi-end at sparsely settled wave locators.

The wave theory was introduced within the second chapter conjointly the} properties of the traveling waves on transmission lines were also mentioned. the target of this thesis was to propose an automatic technique supported traveling waves for locating the fault location in transmission lines and to check the performance of the technique compared to the prevailing ones.

The moving ridge remodel is extensively studied during this thesis to extract the wave signals from the mensuration within the CT secondary windings and atomic number 78 signals from secondary of atomic number 78. AN improvement methodology was disbursed to pick the simplest candidate of various mother wavelets. The chosen mother moving ridge was accustomed analyze the fault signal to totally different details. The simplest details level, that carry the fault options, was elite supported its high energy content.

Four mother moving ridge was used for moving ridge analysis on faulted signal like Debauches, Haar, Symlet, and Coieflet mother wavelets with four level of structure filer bank. Also signal frequency and time domain analysis done victimization this moving ridge techniques victimization moving ridge tool chest for various fault conditions.

Further research is recommended to extend this methodology in the following concerns:

- Wireless traveling wave detection through directed antennas and/or other wireless sensors.
- Utilization of HV capacitive insulation tap currents of available CTs in fault location.
- Developing advanced signal processing techniques for analyzing traveling wave signals.
- More detailed analysis of the traveling wave speeds for ground and aerial modes based on frequency-dependent transmission line models.

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