Distance Protection of Transmission Line using Multi-Resolution based Distance Relay

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Abstract—Electrical transmission lines area unit liable to faults and failures. Once a fault happens, it's not possible most of the days to repair it manually. Additional High Voltage (EHV) transmission lines area unit designed to transfer great amount of power from one location to a different. The length exposed to the surroundings may be a major reason for incidence of faults on the lines. A fault on a high voltage line stability of electrical power system that generally results in permanent harm of the instrumentation. Relays area unit developed and put in to guard and protect the lines. The cable protection relays, within the trade, area unit supported the elemental frequency elements of the voltages and currents. These relays would like a minimum of one first harmonic cycle for playacting the protection operation. Voltage and current traveling wave's area unit generated once a fault happens on the cable. The speed of propagation of traveling waves is finite and therefore the level of the waves decreases with increase within the distance travelled. Information regarding the fault will be obtained by analyzing the traveling waves. This proposed approach efforts, the power system transmission line protection system using discrete wavelet multi-resolution spectral energy calibration based distance relay. The faulted current and voltage signal get transfer into multi-resolution analysis the once analysis this transfer to threshold identification and detection system. That threshold system operates the circuit breakers connected at the every end of transmission line cable by causation trip signal throughout abnormal faulted condition happens. An improved simulation software package MATLAB 2015 was developed to check the planned fault designation techniques. Comprehensive performance studies were enforced and therefore the check results valid the improved performance of the planned approach over the standard fault designation performed by the cable distance relay.

Keywords: Multi-resolution analysis (MRA), wavelet transform, Distance relay, Transmission line protection Introduction

I. INTRODUCTION

An adaptation filter might be a process device that degree commit to model the link between 2 signals in real time in associate repetitive manner. Degree adaptation filter is made by four aspects as a result of the signals being processed by the filter, the structure that defines but the signal of the filter is computed from its sign, the parameters within this structure that will be iteratively changed to alter the filter's input output relationship. The variation algorithmic program that describes but the parameters are adjusted from just one occasion instant to consecutive. The matter of blending fast fault clearance with selective tripping of plant might be a key aim for the protection of power systems. To satisfy these requirements, high speed protection systems for transmission and 1st distribution circuits that are applicable to be used with the automatic re-closure of circuit breakers are below continuous development and are really wide applied. Distance protection, in its basic kind, might be a non-unit system of protection providing substantial economic and technical edges.

In power systems, many forms of faults and abnormal operational conditions may occur. The foremost common, and collectively the foremost harmful, are short circuits of assorted varieties of faults. Short circuit current can injury instrumentation of power systems, reduces the voltage of relevant pans of the system, and even threatens the stability of the system. Faults do not appear to be entirely caused by lightning, wind, ice, earthquake, fire, explosions, falling trees, flying objects, physical contact by animals and different natural events, but are caused by breakdown, incorrect operation etc. Notwithstanding the cause, faults ought to be isolated quickly and selectively. For this purpose, protective relays are place in at fully completely different parts of associate degree influence system. Due to changes in installation operation like reactive power compensation, flexible ac transmission techniques, increased power transfers over transmission lines, protective relays plays the way further important role therefore on continue an awfully high level of continuity of high quality power offer. Therefore, transmission of power wattage and necessary protective measures square measure the important issues need to be addressed properly. Distance protection is used to defend the cable against faults by measuring the road voltages and currents at remote end buses victimization digital fault recorders.

Transmission systems have nice importance in installation. Faults that occur typically with transmission lines system need to be clear as fast as potential. Distance relaying principle, because of their high-speed fault clearance compared with the over current relays could also be a large used protective theme for the protection of high and extra high voltage (EHV) transmission and sub-transmission lines. Faults on transmission lines ought to be detected, classified, settled accurately, and cleared as fast as potential. In line protection, faulty section identification and placement of fault square measure the two most important things that need being addressed during a very reliable and proper manner. Distance relaying techniques supported the live of the electrical resistance at the basic frequency between the fault locations and conjointly the relaying purpose have attracted wide unfold attention. The sampled voltage and current info at the relying purpose square measure accustomed realize and classify the fault involving the road with or whereas not fault resistance provides among the fault path. Signal analysis tools, presently used within the digital relays, have shown that, this which measure

really useful and economical in installation steady state analysis. Among this filtering based algorithm, analysis based algorithms, statistical procedure ways algorithms and FIR filtering based mostly protection. However in presence of non-stationary signals, the performance of these techniques is taboo. An additional trendy resolution to the matter is that the wavelet rework. Once a fault happens, this and voltage signals obtained from a line have long length low frequency parts and short length high frequency parts. Wavelet transforms appear to produce the right characteristics to analysis the data contained in these signals for the aim of line protection.

II. PROPOSED METHODOLOGY

A. MATLAB Simulation Model

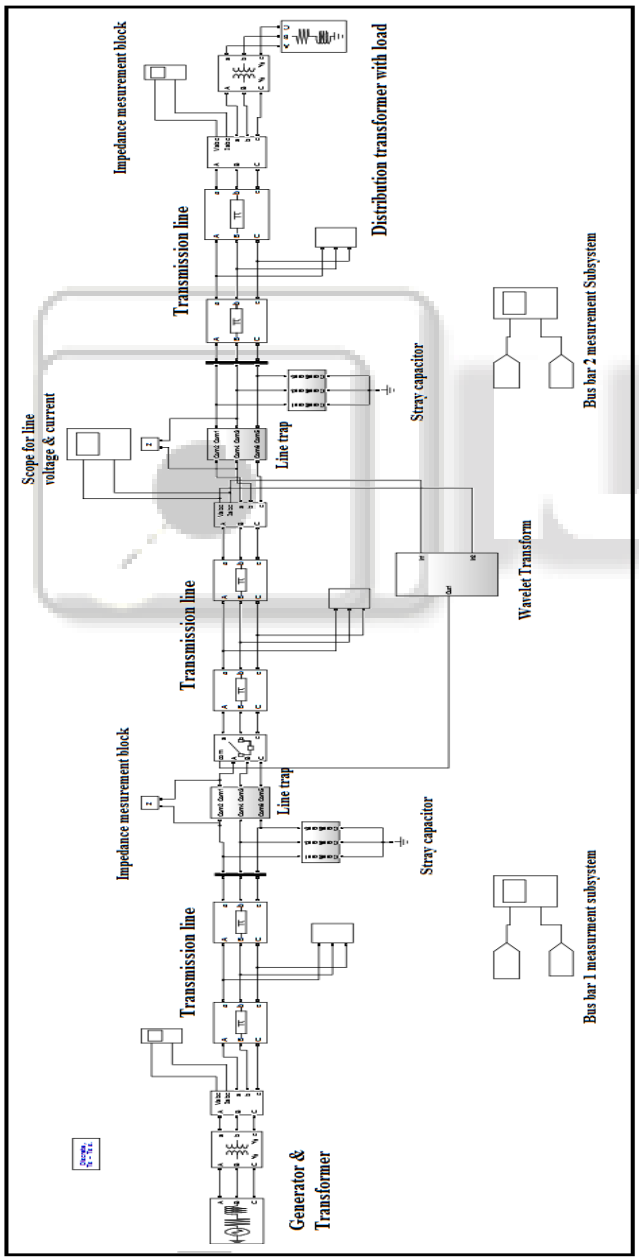

Fig. 1: MATLAB simulation model of proposed approach

The proposed matlab simulink model contain the wavelet transform block as subsystem as shown in the Fig. 3. In this subsystem buffer, dyadic analysis filter bank blocks are used and whose model parameter dataset is as given in the table 1.

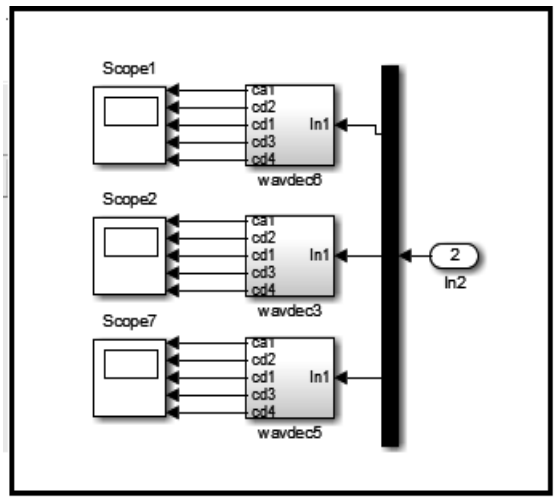

Fig. 2: MATLAB simulation model for multi resolution analysis

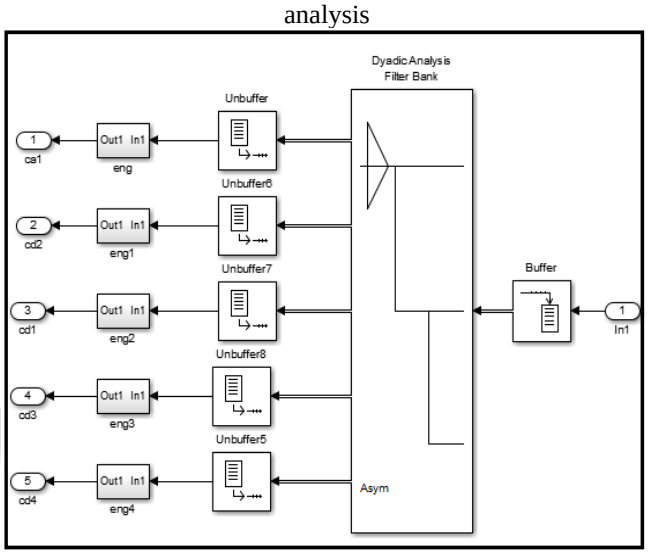

Fig. 3: Wavelet transform subsystem block in simulated model

Sr. no.	Name of Block	Parameters
1	Buffer	Output buffer size (per channel=64, Buffer overlap=0, Initial condition= 0
2	Dyadic analysis filter bank	Filter= HAAR, No of levels=4, Tree structure= Asymmetric, Output= multiple port
3	Unbuffer	Initial condition=0

Table. 1: Model Parameter Dataset in Wavelet Transform Subsystem

B. Threshold Subsystem

Fig. 4 shows the threshold subsystem used in the Matlab Simulink model. The generator generates the electricity, step up transformer step up the signal and share to the transmission line. Now second transformer steps down the signal and sends it to required load.

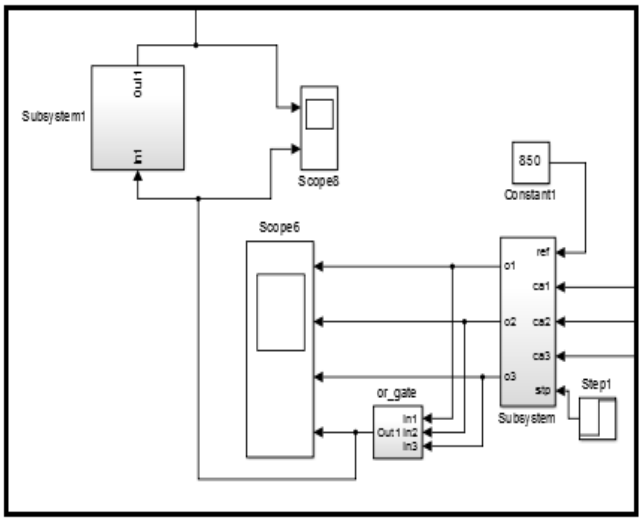

Fig. 4: Threshold subsystem

Now current transformer is used for takeout transients during the fault condition and this transients signal send to multi-resolution analysis and also transferred to the load side. C. T. sends it to phase current measurement and also MRA block. MRA block decomposed the signal into different frequency bands. At lower scale. And thus the data is going to decision tool. Now decision tool has its own standard threshold value pick up from its normal stage. Now this normal threshold is compared with appearing threshold value. As soon as, appear value goes above the standard threshold value, decision tool generates a trip signal and send it to the circuit breaker for isolating the transmission line from the transformer.

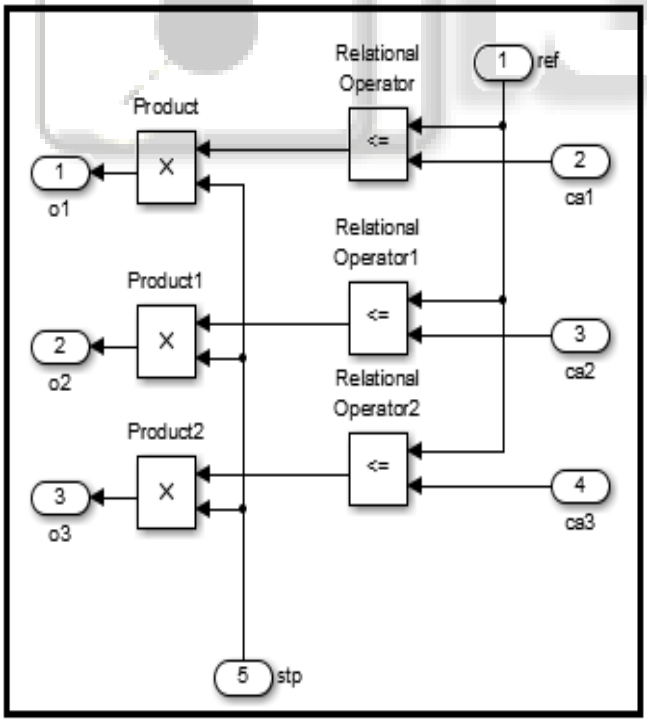

Fig. 5: Subsystem 1 for trip signal generation

C. Subsystem for Circuit Breaker Trip

The subsystem as shown in Fig. 5 in which the inputs are ca1, ca2, ca3 of three phases and the reference1. The values of 'Ca' inputs are compared with a reference value. If it exceeds reference value 1, output goes to high. Due to some uncertain condition, the output may be greater than the reference value and hence to protect from going high, the product block is used with step 5, which prevent output from not going high value. The subsystem 1 for trip signal generation uses the model parameter dataset as shown in the Table. 2.

Sr. no.	Name of Block	Parameters
1	Relational operator	Sample time (-1 for inherited) = -1, Output data type= Boolean
2	Product	No of input= 2, Sample time (-1 for inherited) = -1. Multiplication = elementwise (*)
3	Step	Port number = 5, Data type = inherit(auto), Port dimension (-1 for inherited) = -1, Sample time (-1 for inherited) = -1

Table 2: Specification of Blocks of Subsystem 1

D. OR Gate Subsystem 2

OR gate subsystem 2 as shown in Fig. 6 is used to generate a high signal if there is any fault on any phase, which gives high output if there is any input is high. As if the input value is above the normal threshold value, it will be considered as a fault if it appears after given time and so OR gate generates high signal.

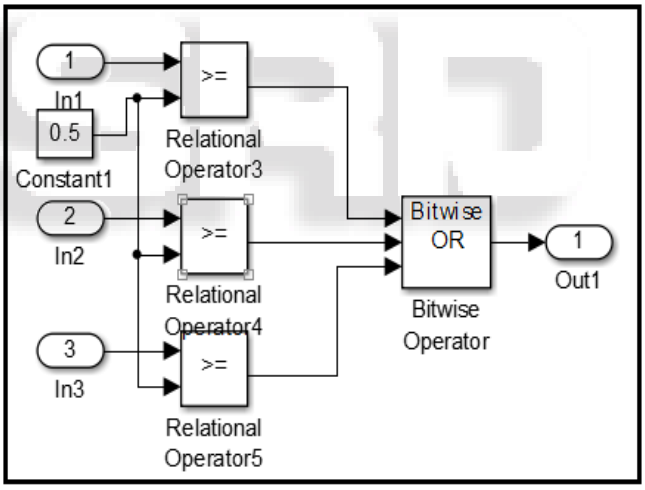

Fig. 6: OR gate subsystem

OR gate subsystem 2 in the MATLAB simulation model uses the block having the parameter dataset are as given in table 3.

Sr. no.	Name of Block	Parameters
1	Relational operator	Sample time (-1 for inherited) = -1, Output data type= Boolean
2	Bitwise OR operator	Number of ports = 3, Operator = OR
3	Constant	Constant value = 0.5, Sample time = inf

Table. 3: Specification of blocks of OR gate subsystem 2

III. MATLAB SIMULATION RESULTS

A. Normal Condition Voltage and Current

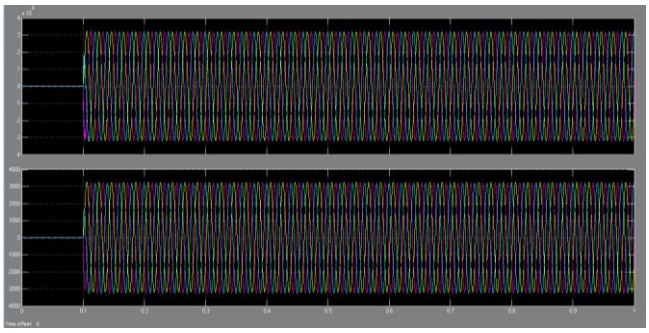

Fig. 7: Three-phase voltage and current signal at normal condition

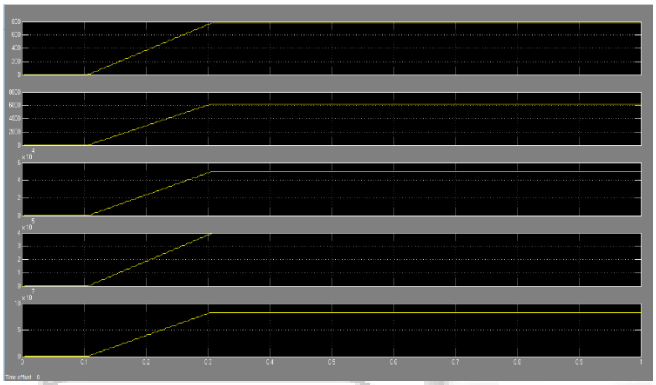

Fig. 8: Signal energy of phase current A using multi-resolution analysis at normal condition

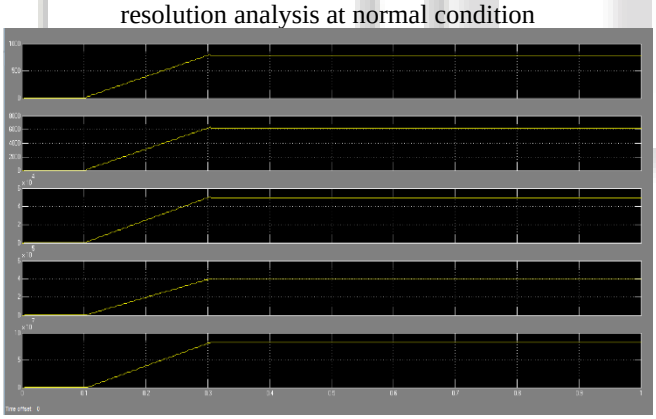

Fig. 9: Signal energy of phase current B using Multi-resolution analysis at normal condition

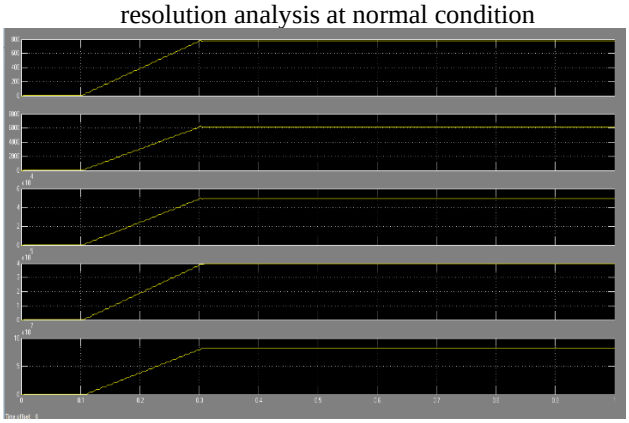

Fig.10: Signal energy of phase current C using Multi-resolution analysis at normal condition

At normal condition Fig. 8,9,10 shows four display in one window of each phase of current as phase current A, phase current B, phase current C. MRA block decomposes each phase of current into different frequency bands as shown in the figure with their different energy levels for phase current A, phase current B, phase current C. At normal condition the energies of all three phases are same.

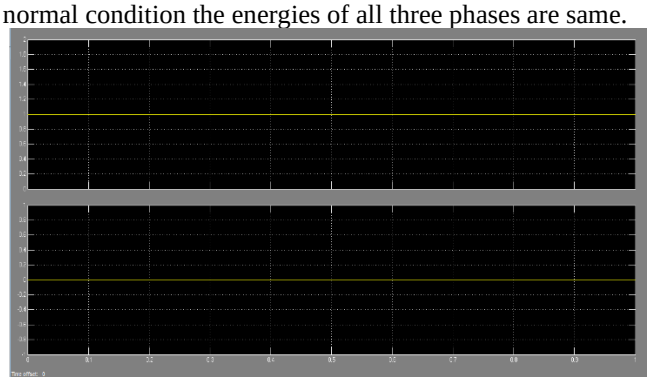

Fig. 11: Relay generating trip signal at normal condition

As there is no fault in the transmission line, relay not generates any trip signal as shown in Fig. 11.

B. Single Phase to Ground Fault

Fig. 12 shows that when there is the fault of single phase to ground in the transmission line, the first window shows that three phases of the voltage signal. The second window shows three phase current waveform. As the fault is a single phase to ground, there is a change in only one phase as it is at a high level and other two phases as it is.

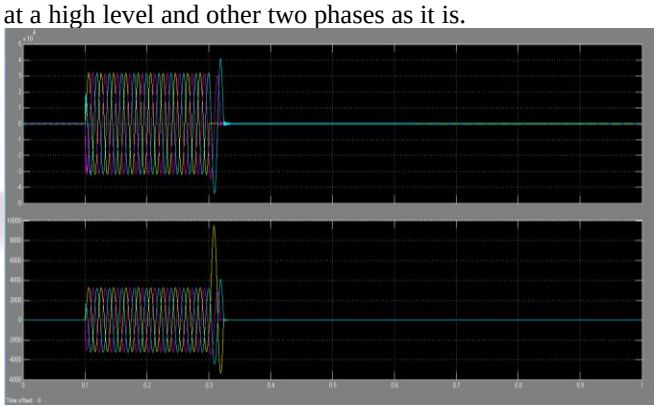

Fig. 12: Three phase of voltage and current signal at single phase to ground fault

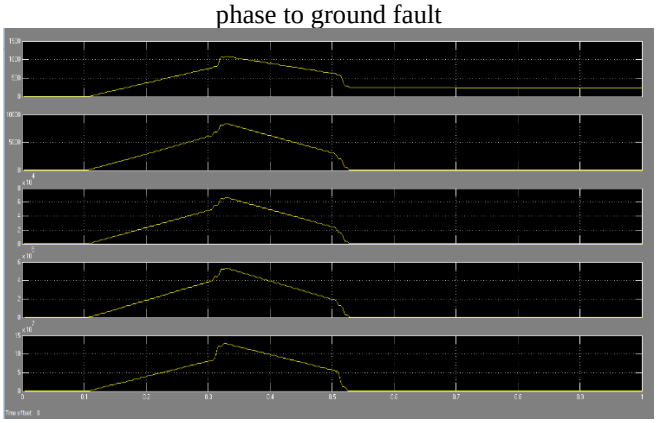

Fig. 13: Signal energy of phase current A using Multi-resolution analysis

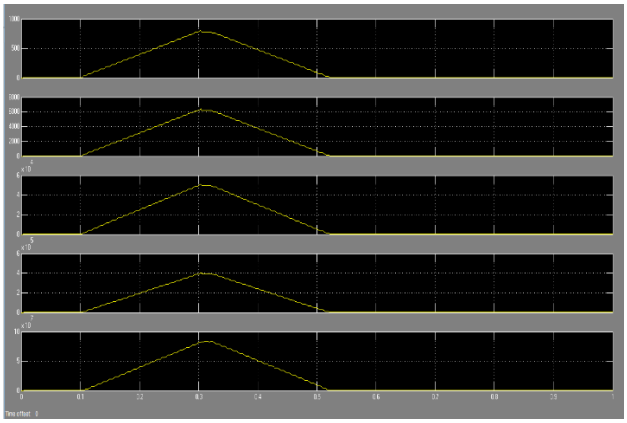

Fig. 14: Signal energy of phase current B using multi-resolution analysis

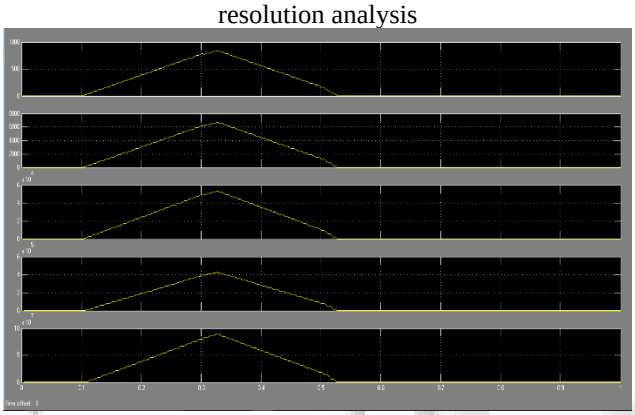

Fig. 15: Signal energy of phase current C using multi-resolution analysis

Fig. 13,14,15 shows four display in one window of each phase of current as phase current A, phase current B, phase current C. MRA block decomposes each phase of current into different frequency band as shown with their different energy levels of it for phase current A, phase current B, phase current C. The energy of faulty phase is greater than other two phases of current.

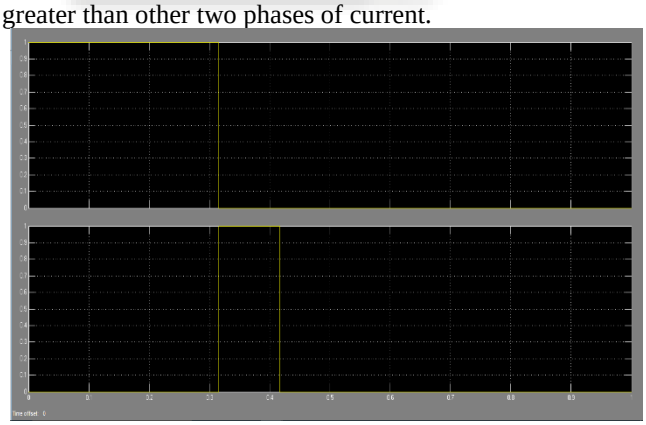

Fig. 16: Relay generating trip signal at single phase to ground fault condition

As the fault of single phase to ground in the transmission line, for the fault time of 0.3 seconds, relay generate a trip signal as the display shows variation with reference to normal or fault condition as shown in figure 7.0, the circuit will break of three phase of voltage and current signal. Then after sufficient time fault occurs at 0.3-second circuit will break.

C. Three Phase to Ground Fault

Fig. 17 shows that when there is the fault of three phase to ground to the transmission line, the first window shows that all three phases of voltage signal are at low level and all three phases of current are at a higher level as shown in the figure.

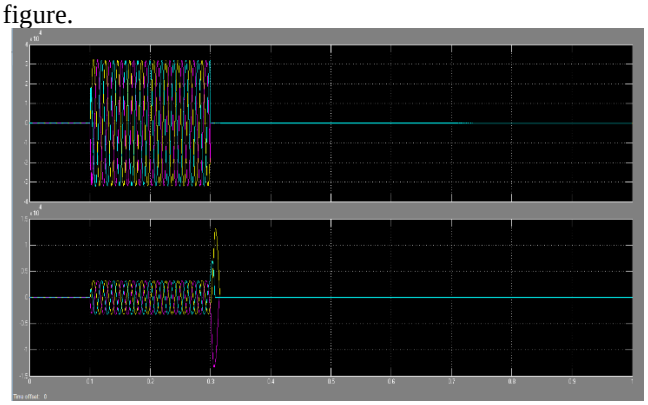

Fig. 17: Three phase of voltage and current signal at three phase to ground fault

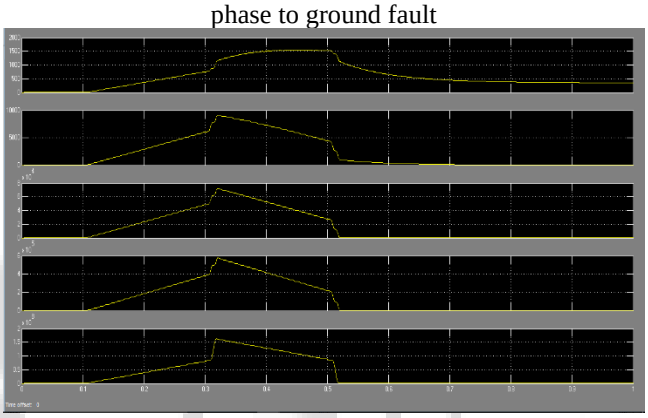

Fig. 18: Signal energy of phase current A using multi-resolution analysis

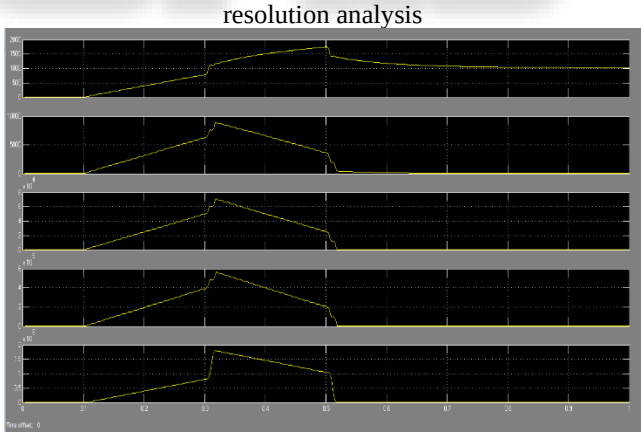

Fig. 19: Signal energy of phase current B using Multi-resolution analysis

As the fault added to the transmission line is three phase to ground, Fig. 18, 19, 20 shows four display in one window of each phase of current as phase current A, phase current B, has current C. MRA block decomposes each phase of current into different frequency band as shown with their different energy levels of it for phase current A, phase current B, phase current C.

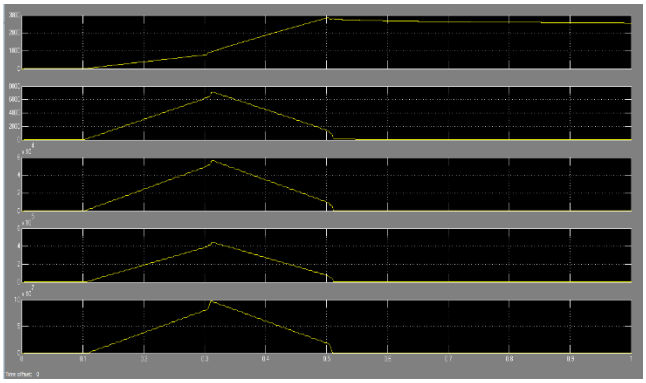

Fig. 20: Signal energy of phase current C using Multi-resolution analysis

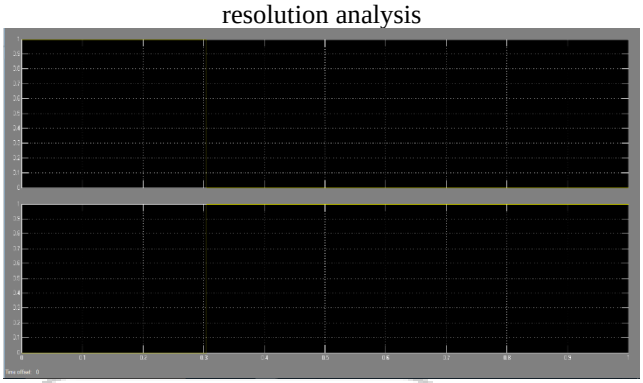

Fig. 21: Relay generating trip signal at three phase to ground fault condition

As the fault is three phase to ground fault in the transmission line, for the fault time of 0.3-second relay generating a trip signal as the display shows variation with reference to normal or fault condition as shown in figure 8.0 circuit will break of three phase of voltage and current signal. Then after sufficient time interval fault occurs at 0.3-second circuit will break.

IV. CONCLUSION

Transmission and distribution lines are very important links between generating units and customers. they're exposed to atmosphere, thence possibilities of prevalence of fault in line is extremely high, that must be instantly taken care of so as to reduce harm caused by it.

This work presents a brand-new high-speed protection theme, transient point protection (TPP), for power transmission lines. This theme is developed victimization advanced rippling analysis, supported the thought of transient-based protection (TBP), during which the fault-generated high-frequency transient signals contained within the primary voltages are used to sight fault position per their relative motion time and polarities. Combined info (CI) is obtained from advanced rippling coefficients to extract and localize a band of such high-frequency elements propagating on the line. A typical 400-kV very high voltage (EHV) transmission has been simulated by MATLAB SimPower system tool case to judge the theme. The simulation results show that this theme is capable of providing correct responses underneath numerous system configurations and fault conditions.

Different fault case situations are tested with the model system so as to verify the effectiveness of gift work. The steadiness improvement victimization this management strategy has been verified by the time domain simulation model developed in MATLAB/SIMULINK

The faults are detected and classified into differing types like single part to ground, double part to ground, three parts to ground etc. This detection and classification are done victimization HAAR mother rippling at level four. The energy of the actual current signal is obtained through rippling Multiresolution MRA block and it classifies fault. Victimization HAAR rippling at level four, all this and voltage signal waveforms are dole out at totally different fault cases of the line.

Also at the same time line entice and stray electrical device bank at every finish of line give the high transient primarily based protection to style line.

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