ANN Based Distance Protection of Long Transmission Lines with Effect of Ground Resistance of Fault

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Abstract— Distance relays are wide used for defense of transmission lines. Historically used mechanical device distance relays for defense of transmission lines are liable to effects of fault resistance. Every fault condition corresponds to a selected pattern. Therefore use of a pattern recognizer will improve the relay performance. This system presents a brand new approach, referred to as artificial neural network (ANN) to beat the impact of fault resistance on relay mal-operation. During this technique, impact of fault resistance for single line to ground kind of fault is taken into account. When roaring simulation of LG fault remaining styles of fault like LL, LLG, and 3 part faults are going to be simulate and analyze for various fault resistance. The theme utilizes the magnitudes of resistance and electrical phenomenon as inputs. Once trained with an outsized variety of patterns comparable to numerous conditions, it will classify unknown patterns. In this technique, we have a tendency to take into account the impact of fault resistance for cable protection that influences the standard distance relay protection. In order that for removing this issue we have a tendency to introduced ANN based mostly cable protection by considering the impact of ground resistance. During this approach ANN classify the precise fault location and send the trip signal to it zone relay same as distance relay zone protection. For this, we are going to initial analyzed the voltage and current signals measured at reference bus bar and send this signals to riffle rework energy standardization and details signal constant analysis then send to ANN for zone identification for generation of trip signal for the electrical fuse. The project implementation is going to be done victimization MATLAB Simulink computer code surroundings victimization MATLAB 2013b version in which ANN tool cabinet, installation tool cabinet and riffle tool cabinet used for Simulink block modeling.

Key words: Artificial Neural Network (ANN), Ground Resistance of Fault

I. INTRODUCTION

Distance relays are with success used for several years because the commonest sort of protection of transmission lines. Zone one of distance relays is employed to produce primary high speed protection, to a big portion of the conductor. Zone two is employed to hide the remainder of the protected line and supply some backup for the remote finish bus. Zone three is that the backup protection for all the lines connected to the remote finish bus. [l]

Distance relays effectively measures the ohmic resistance between the relay location and also the fault. If the resistance of the fault is low, the ohmic resistance is proportional to the gap from the relay to the fault. A distance relay is meant to solely operate for faults occurring between the relay location and also the elite reach purpose and remains stable (or inoperative) for all faults outside this region or zone [2].

However it's seen that the relay performance gets affected once the fault involves resistance. To beat this downside, this paper presents a brand new approach supported Artificial Neural Networks (ANN). This is often as a result of the bulk of installation protection techniques area unit concerned in process the system state through distinguishing the pattern of the associated voltage and current waveforms measured at the relay location [3]. This suggests that the event of adaptive protection will be basically treated as a tangle of pattern recognition and classification. ANN is powerful in pattern recognition and classification. They possess glorious options like generalization capability, noise immunity, and strength and fault tolerance. Consequently, the choice created by associate degree ANN-based relay won't be seriously plagued by variations in system parameters. Such schemes also are mentioned in [4], [5], [6], [7], [8] wherever application of artificial neural network for distance protection is enforced with success. It will be seen that typically voltage and current signals area unit used as inputs to the network.

In [9], ANN is applied to spot whether or not the facility swing is stable or unstable, and results show that the theme is ready to classify the facility swing consequently. In [l0], completely different structures area unit developed for arc resistance and power swing classification. In [11], the substitute neural technique is employed for motorcar Reclosing theme on Single Machine-Infinite Bus Model with IEEE 14-Bus System Model knowledge.

Power transmission lines area unit important to power systems as they represent the facility systems' backbone. Thanks to their spreading over long distances and their exposure to out of doors surroundings, the fault rate of the power transmission lines is far above that of the opposite elements of the facility system. The faults within the power transmission lines result from insulation, electrical, mechanical and thermal faults. These faults area unit classified as shunt faults and open-circuit faults. The frequency of prevalence of the open-circuit faults is a smaller amount than that of the shunt faults. Most of the open-circuit faults area unit typically remodeled into shunt faults by later events. Relays for shielding the facility transmission lines should react for the many forms of shunt faults, as well as three-phase-to-ground, two-phase-to-ground, single-phase-to-ground and phase-to-phase faults. The foremost common protecting relays, accustomed shield the facility transmission lines, area unit the space relays. The principle of operation of the space relay is predicated on activity the ohmic resistance, at the elemental frequency, between the relay location and therefore the fault purpose. This provides the power to see if the fault is within or outside the protected zone. Voltage and current values,

measured by the space relay, area unit accustomed calculate the worth of the ohmic resistance seen by the relay. These voltage and current values contain the elemental frequency signals and therefore the higher-order harmonics that degrade the standard of the present and voltage waveforms detected by the ohmic resistance relay. The feeder length protected by the space relay is often divided into 3 zones, covering eighty five, a hundred and fifty and 225% of the feeder protected length, severally. For faults among the primary zone of the feeder (within eighty fifth of the feeder protected length), the protection circuit breakers area unit ordered to open instantly and with none delay. For faults outside this zone (faults at distances larger than eighty fifth of the feeder protected length) and for faults among the connected circuits, the protection circuit breakers area unit ordered to open when some delays. The essential characteristics of the space relay: the space relay is characterized by having 2 activity circuits that live the feeder current and therefore the feeder voltage at the relaying purpose. The ohmic resistance seen by the relay is calculated because the quantitative relation between the voltage and therefore the current values measured by the relay activity circuits. The ohmic resistance relay can operate once the magnitude of the ohmic resistance seen by the relay is a smaller amount than the relay setting price.

II. PROPOSED APPROACH

A. MATLAB Simulation model

Figure 2 shows the subsystem model for ANN and wavelet transform Multi-resolution analysis filter bank for three phase voltage and current signal measured at bus bar B during normal and abnormal different fault conditions. In this subsystem wavelet filter system calibrate the detail and approximate signal coefficient of three phase voltage and current measured at bus bar B. That signals are utilizing for training the Neural Network for fault zone trip signal generation for operating exact zone circuit breaker.

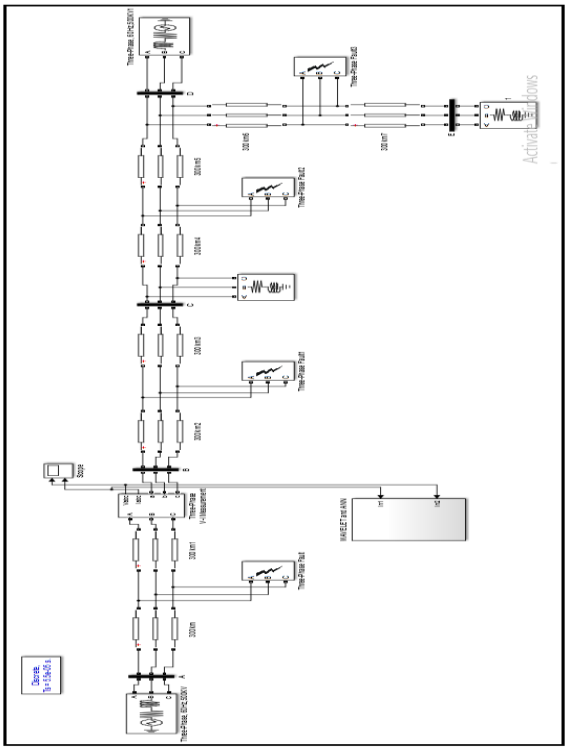

Fig. 1: MATLAB simulation of proposed power system

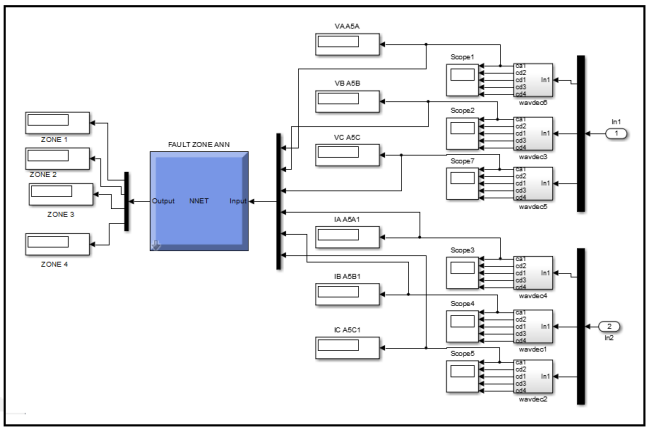

Fig. 2: MATLAB subsystem for wavelet transform and ANN model

Sr No	Name of simulation block	Parameter specification
1	Three phase source	Phase to phase rms voltage = 11Kv; phase angle of phase A=0 Degree; Frequency = 50 Hz; Source resistance = 0.0001 Ohm; Source inductance = 0.000001 H; Base voltage= 25 KV.
2	Distributed parameter line	Number of phases = 3; Frequency used for RLC specification = 50 Hz; Inductance per unit length R1=0.97 Mh/km; R0=0.99 mH/km;Capacitance per unit length L1= 11.5 nF/km; L0=11.5 nF/km; Line length = 80km
3	Three phase series RLC load	Nominal phase to phase volage = 11KV; Nominal frequency = 50 Hz; Active power P = 800 MW; Inductive reactive power Ql = 600 MVar

Table 1: Matlab Simulation Model Block Parameters

III. SIMULATION RESULTS

A. *Power system parameter*

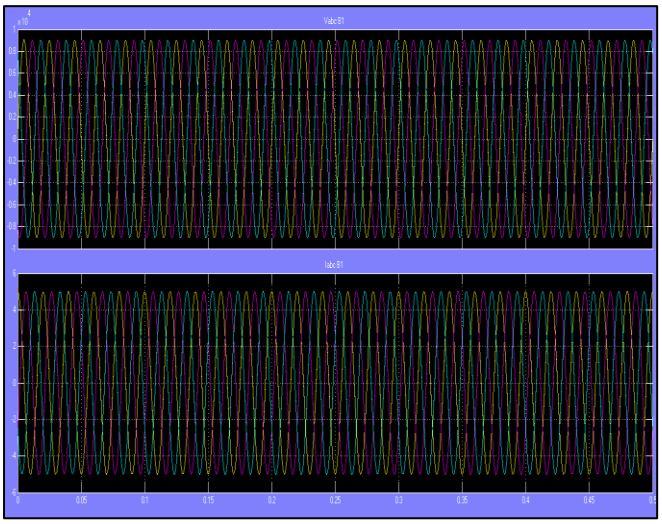

Fig. 3: Three voltage and current waveform for normal condition measured at bus bar B

Figure 3 shows that three phase voltage and current waveform of power system model at bus bar B during normal operating condition. That signal get transfer to the wavelet multi resolution analysis filer bank for signal processing. For signal processing Haar mother wavelet with 5 level multi resolution filter bank utilized.

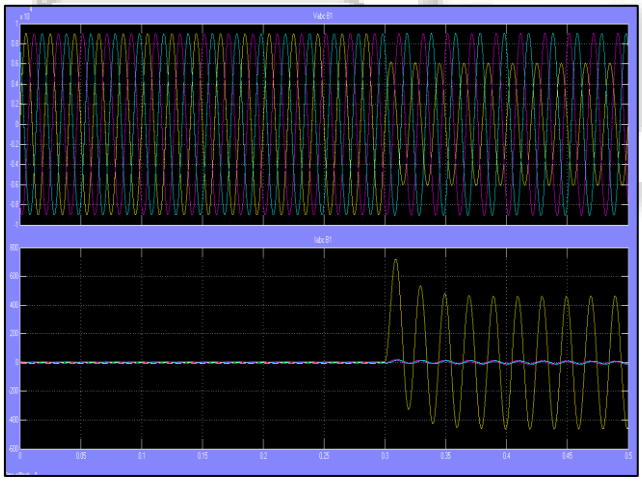

Fig. 4: Three voltage and current waveform when LG (AG) fault occurs in zone 1 on 20km from reference bus bar B

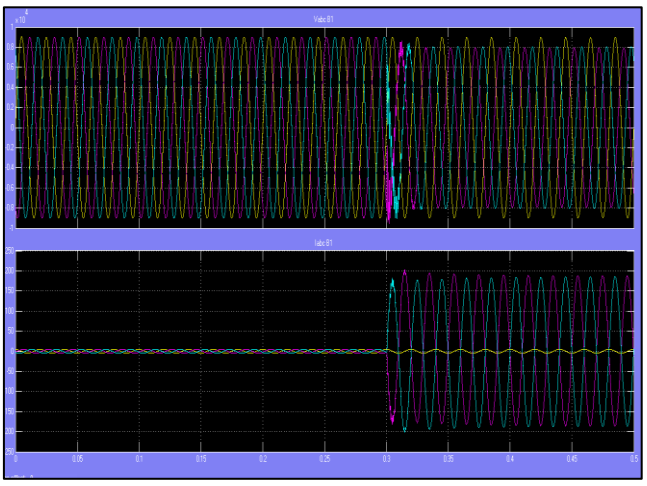

Fig. 5: Three voltage and current waveform when LLG (BCG) fault occurs in zone 2 on 120km from reference bus bar B

Figure 4, 5 and 6 are three phase voltage and current signals measured at bus bar B for generation of training data set for ANN training by using the wavelet transform multi resolution analysis Haar mother wavelet.

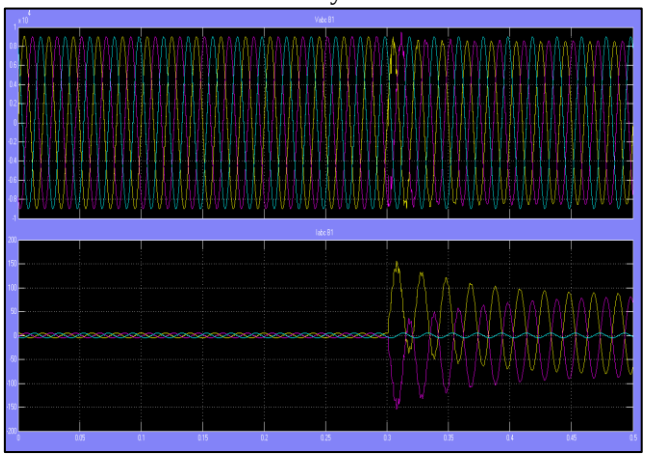

Fig. 6: Three voltage and current waveform when LL (AB) fault occurs in zone 3 on 285km from reference bus bar B

B. *Result from Neural Network*

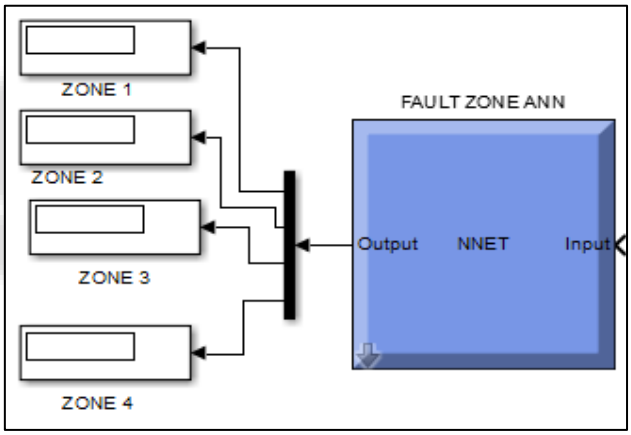

Fig. 7: MATLAB simulation model for ANN for fault zone identification

Figure 7 shows that ANN matlab simulation models that model connect with output of wavelet coefficient for training the neural network. Input to neural network is approximate signal of three phase current IA, IB, IC and approximate signals of three phase voltage VA, VB, VC Phase. That utilized decomposed signals utilized for training neural network for different fault condition and at different fault zone of line. Table II and III shows the training data set and corresponding ANN outputs.

C. ANN training performance

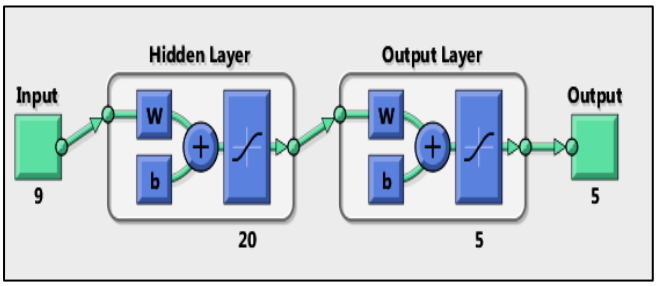

Fig. 7: Neural network configuration

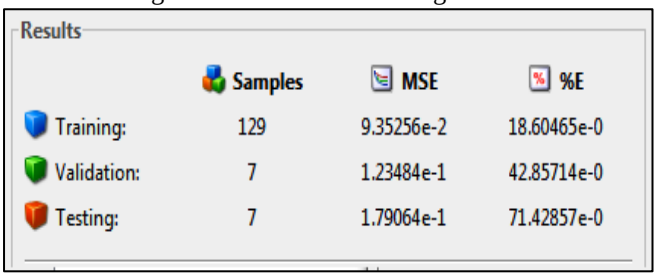

Fig. 8: Training performance parameter for neural network

For training 129 data sample was utilized out of 143 fault sample cases data set i.e. 90% data utilized for training. For validation and testing 5% dataset was utilize.

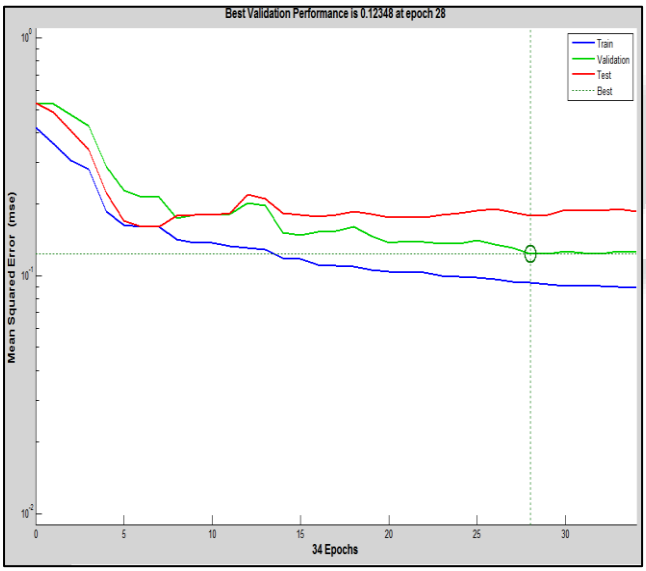

Fig. 9: Training performance of neural network

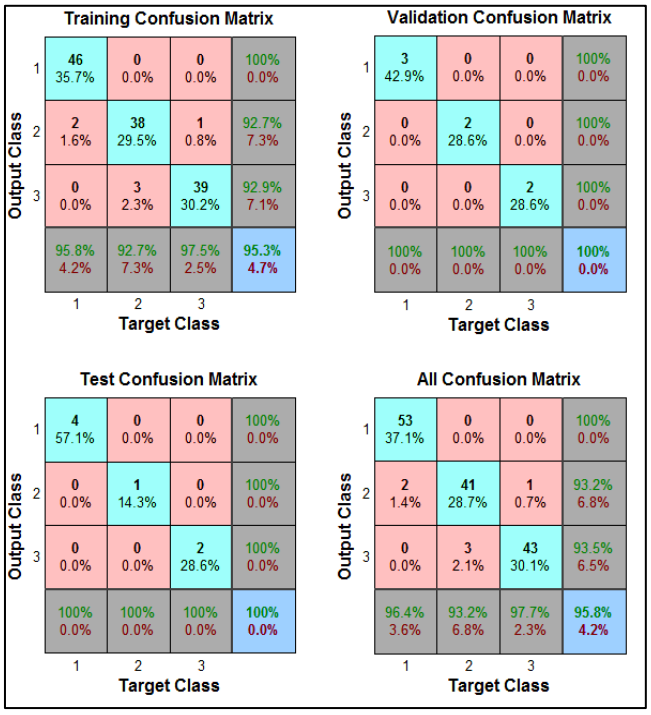

Fig. 10: Confusion matrix for training of neural network

In figure 10, the receiver operating characteristic is a metric used to check the quality of classifiers. For each class of a classifier, roc applies threshold values across the interval [0, 1] to outputs. For each threshold, two values are calculated, the True Positive Ratio (the number of outputs greater or equal to the threshold, divided by the number of one targets), and the False Positive Ratio (the number of outputs less than the threshold, divided by the number of zero targets).

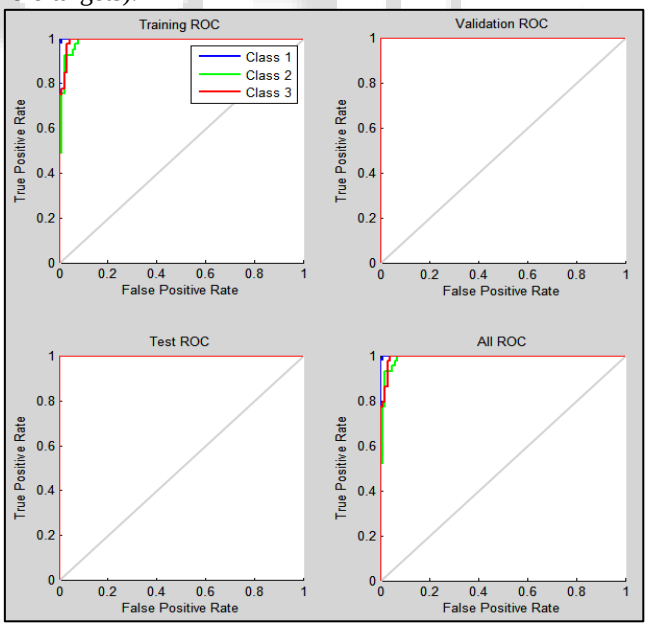

Fig. 11: Receiver operating characteristic (ROC) for neural network

Figure 11 shows that 95 % data are perfectly classify the fault zone and remaining fault zone not classify using neural network. It means that for remaining 5 % data set neural network was in confusion state for classify the fault zone.

IV. CONCLUSION

In this technique, we have a tendency to think about the result of fault resistance for cable protection that influences the standard distance relay protection. So for removing this problem we have a tendency to introduced ANN based mostly cable protection by considering the result of ground resistance. During this approach ANN classify the precise fault location and send the trip signal to it zone relay same as distance relay zone protection. For this we are going to initial analyzed the voltage and current signals measured at reference bus bar and send this signals to rippling remodel energy standardization and details signal constant analysis then send to ANN for zone identification for generation of trip signal for circuit breaker.

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