TRANSMISSION LINE FAULT CLASSIFICATION AND IDENTIFICATION USING ARTIFICIAL INTELLIGENCE

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ABSTRACT

Transmission lines, among the opposite power system elements, suffer from sudden failures owing to varied random causes. These failures interrupt the dependability of the operation of the facility system. Once unheralded faults occur protecting systems square measure needed to stop the propagation of those faults and safeguard the system against the abnormal operation ensuing from them. The functions of those protecting systems square measure to observe and classify faults further on confirm the placement of the faulty line as within the voltage and/or current line magnitudes. Then once the protecting relay sends a trip signal to a circuit breaker(s) so as to disconnect (isolate) the faulty line.

The options of neural networks, like their ability to be learn, generalize and multiprocessing, among others, have created their applications for several systems ideal. The utilization of neural networks as pattern classifiers is among their commonest and powerful applications.

This methodology presents the utilization of back-propagation (BP) neural network specification as another method for fault classification and fault zone identification during a transmission line system. The most goal is that the implementation of complete theme for distance protection of a line system. So as to perform this, the line protection task is divided into totally different neural networks for fault classification additionally as fault location in numerous zones.

Four unsymmetrical faults were discussed; single line to ground faults (LG), double line faults (LL) and double line to ground faults (LLG) and additionally two symmetrical fault cases additionally mentioned.

Keyword: - *Fault, Artificial Neural Network.*

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1. INTRODUCTION

The greatest threat to the continuity of electricity provide is system defects. Faults on power systems area unit associate ineluctable drawback. Hence, a well-coordinated protection system should be provided to notice and isolate faults speedily so the harm and disruption caused to the facility system is decreased. The clearing of faults is typically accomplished by devices that may sense the fault and quickly react to disconnect the faulty section. It's thus associate everyday truth of life that differing types of faults occur on electrical systems, however sometimes, and arbitrarily locations. Faults will be broadly classified into two main areas that are selected as "Active" and "Passive" [1].

In the management centers of the electric power systems sizable amount of alarms area unit received as a results of differing types of faults. To shield these systems, the faults should be detected and isolated accurately. On primarily overhead line systems, the bulk of short-circuit faults, generally 80-90%, tend to occur on overhead lines and therefore the rest on station equipment and busbars combined [2]. The operators within the management centers ought to manage with huge amount of data to urge the specified information concerning the faults.

The information process via biological neural networks is completed by the massive quantity of advanced interconnections of the neural cells (neurons) that move among one another by exchanging temporary electrical pulses or nerve impulse. Galvanized by the biological nervous system, ANN operates on the principle of for the most part interconnected straightforward parts operational as a network perform. In doing thus, no previous data is assumed, but data, records, measurements, observations square measure thought-about. ANN analysis stands on the actual fact of learning from knowledge to mimic the biological capability of linear and nonlinear drawback finding [3].

Basically, area unit able to style and train the neural networks for finding specific issues that are tough to resolve by the mortals or the standard machine algorithms. The machine that means of the coaching comes right down to the changes of weights that are the key components of the ANN. This is often one amongst the key variations of the neural network approach to downside finding than standard machine algorithms that work bit-by-bit. This adjustment of the weights takes place once the neural network is bestowed with the input file records and also the corresponding target values.

Due to the likelihood of training neural networks with offline knowledge based data, they're found helpful for power system and grid applications. The neural network applications in line protection area unit chiefly involved with enhancements in achieving more practical and economical fault diagnosing and distance relaying [4].

The goal of this methodology is to observe and determine the types of fault within the line and to see that zone (segment) of the line has become faulty. Back-propagation neural network approach is studied, enforced and changed to perform these three tasks. To identify the existence of faults within the system voltage and current signals of a line square measure ascertained. These signals are accustomed specify the fault type and zone.

2. PROPOSED METHODOLOGY

This work aims at to achieve Artificial Intelligence based transmission line fault detection, classification and location. The main objectives of this project are:

To study the existing fault classification, detection and location scheme for transmission line.

To appropriately design transmission line model with power system components with specification.

Design Artificial intelligence system using Neural network or fuzzy logic controller based on training data set or fuzzy rule base respectively.

Design Multiresolution analysis (MNA) for discrete wavelet transform techniques for faults signal decomposition.

Use neural network or fuzzy logic controller as decision tool for discriminate between faults of transmission line.

Training and testing of Neural network for fault classification, detection and location.

Design MATLAB simulation model for propose methodology using MATLAB 2013 b software environment.

In this methodology voltage and current signal from one end bus utilized for measurement of positive sequence active power, three phase active power, three phase reactive power as well as each phase rms phase current and each phase rms phase voltage. This nine input fed to back propagation algorithm based neural network for classification and zone identification of fault event. Based on training data set neural network able to classify fault and fault zone.

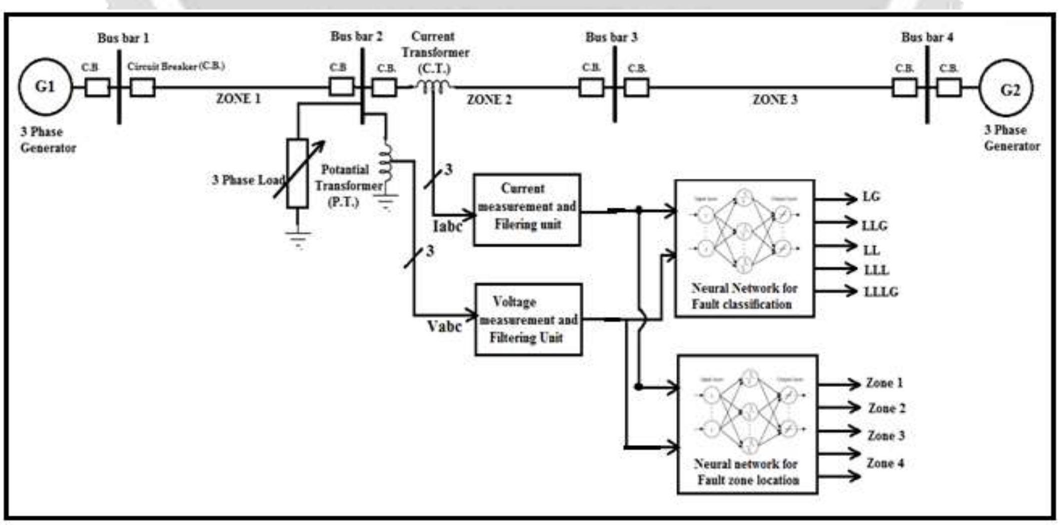

Fig.1:- Block diagram of proposed methodology

3. SIMULATION MODEL

The project model implemented using MATLAB simulink atmosphere. Figure 2 shows the complete matlab simulation model of proposed approach.

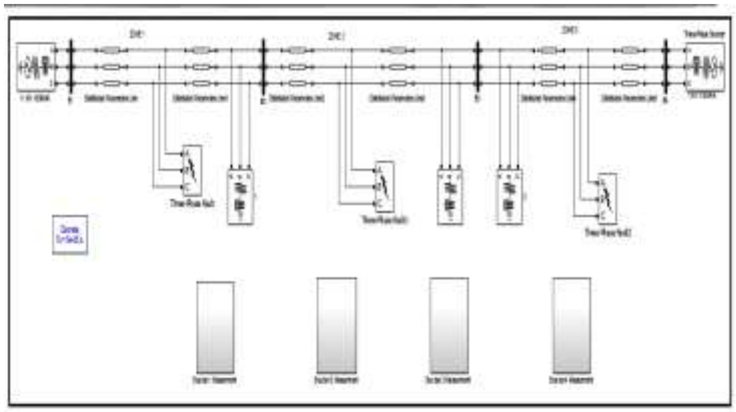

Fig.2:- MATLAB simulation model of main transmission system

The transmission system consist of distributed parameter transmission model, three phase alternator, bus bar, three phase voltage and current measurement (C.T. & P.T.), three phase fault, bus bar parameter measurement subsystem. The transmission system is operating on 11kv, 100MVA, 50Hz supply.

3.1 Bus bar1 measurement subsystemwith ANN

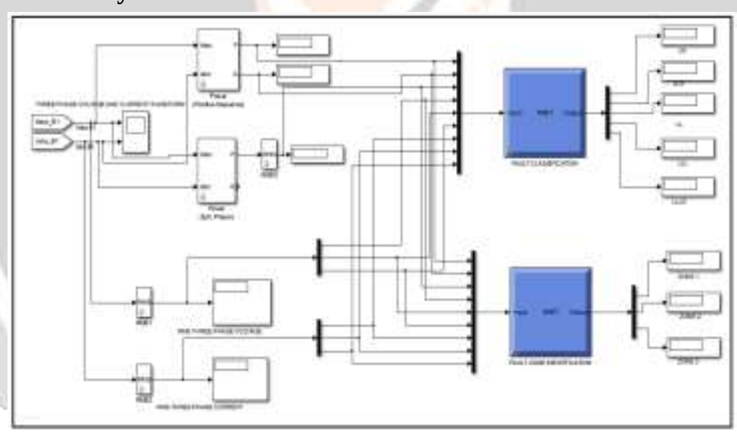

Fig.3:- Bas bar parameter measurement subsystem with ANN

Bus bar measurement subsystem use for measurement of bus bar parameter during fault and normal condition. This parameter are three phase positive sequence active power, positive sequence reactive power, three phase active power, each phase voltage and each phase current. That parameter data utilize for classification of fault and fault zone identification using artificial neural networks. That data also utilize for training that two neural network for fault classification and fault zone identification.

3.2 Bus bar 2 to 4 measurement subsystem

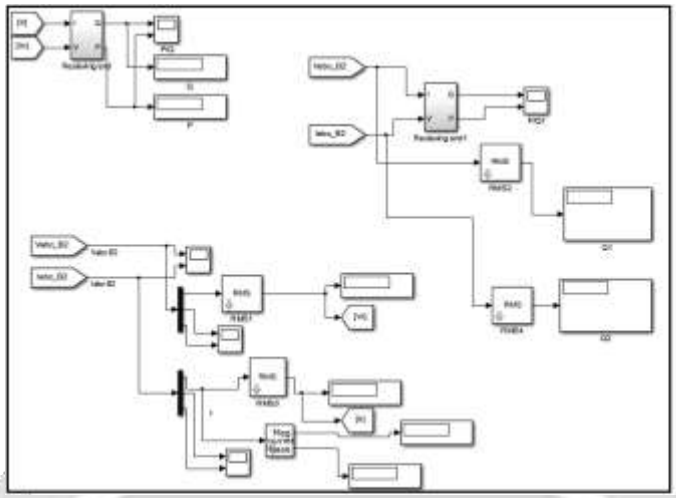

Fig.4:- Bus bar measurement subsystem for bus 2 to 4

This subsystem utilize for measurement of bus bar parameter for normal and fault condition of transmission line.

3.3 Neural network subsystem for fault classification

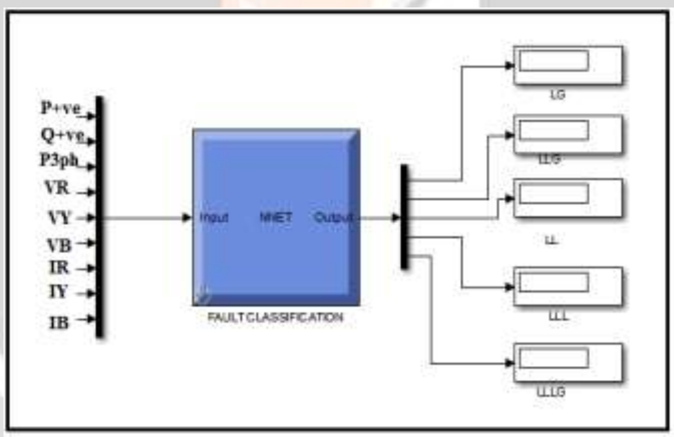

Fig.5:- ANN MATLAB simulink model for fault classification

Figure 5 shows the matlab simulink model for artificial neural network for fault classification. Input for neural network is measured bas bar 1 parameter. This neural network has 9 input and 5 fault classification output. If fault occurs is LG fault on phase R to ground then output becomes of that fault shows on i.e. LG block display shows 1 and remaining blocks output becomes zero. The network have input neurons of 9 and hidden layer neurons of 20. Back propagation algorithm use for training neural network.

3.4 Neural network for fault zone identification

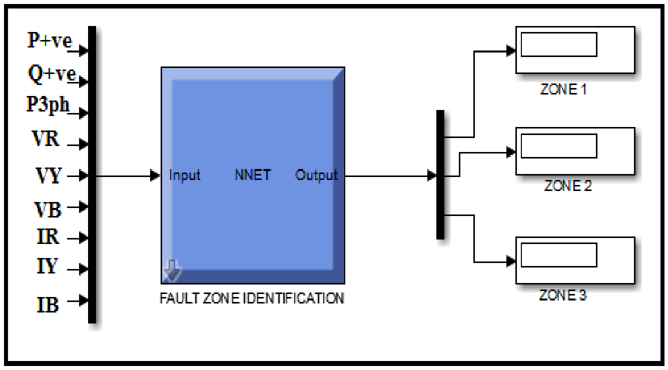

Fig.6:- ANN MATLAB simulink model for fault zone identification.

Similarly this neural network has same input and utilize for fault zone identification. Input neurons and hidden neurons are nine and ten respectively. Suppose fault event occurs in zone 2 then zone 2 display reading is 1 and remaining display reading becomes zero.

4. TRAINING OF NEURAL NETWORK

Neural network training for fault classification and fault zone identification. For that two separate neural network structure are utilized but input for both network becomes same i.e. bus bar 1 measurement parameters. That parameters are positive sequence three phase active and reactive power, actual active power, each phase current and each phase voltage.

Neural network train for 143 fault cases. This fault cases simulate in three zone of transmission line. Total three unsymmetrical and two symmetrical fault case simulate on each phase of transmission line at different 10 fault location of transmission line. Always transmission line simulate for 1 seconds of simulation time and each fault event takes place at 0.3 second. During that fault resistance becomes 0.001 ohm and ground resistance 0.001 ohm for all types of fault simulation.

4.1 Fault classification ANN training

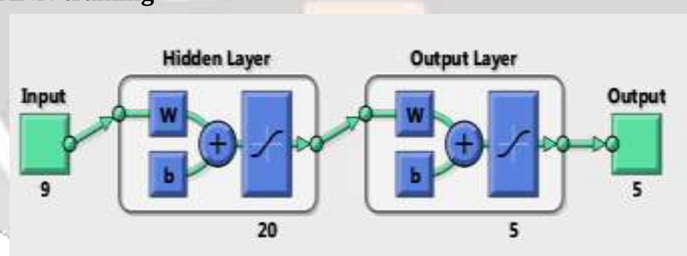

Fig.7:- Neural network configuration for fault classification training

Results

	Samples	MSE	%E
Training:	129	9.35256e-2	18.60465e-0
Validation:	7	1.23484e-1	42.85714e-0
Testing:	7	1.79064e-1	71.42857e-0

Fig.8:- Training performance parameter for neural network 1 fault classification

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.

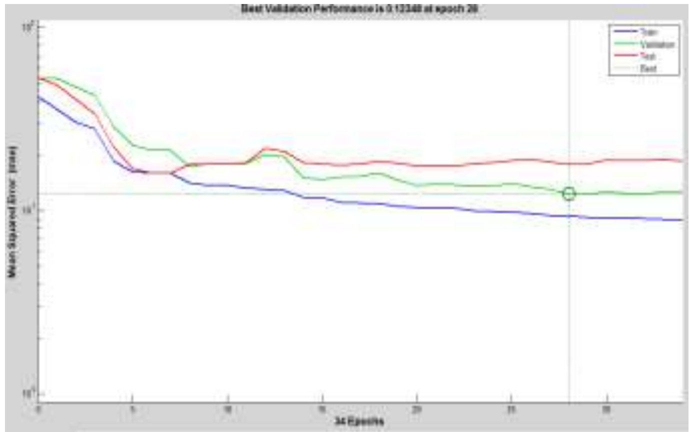

Fig.9:- Training performance of neural network for fault classification

During training of neural network for fault classification, neural network takes 28 epochs and mean square error becomes minimum of 0.12348 shows by green line in figure 9.

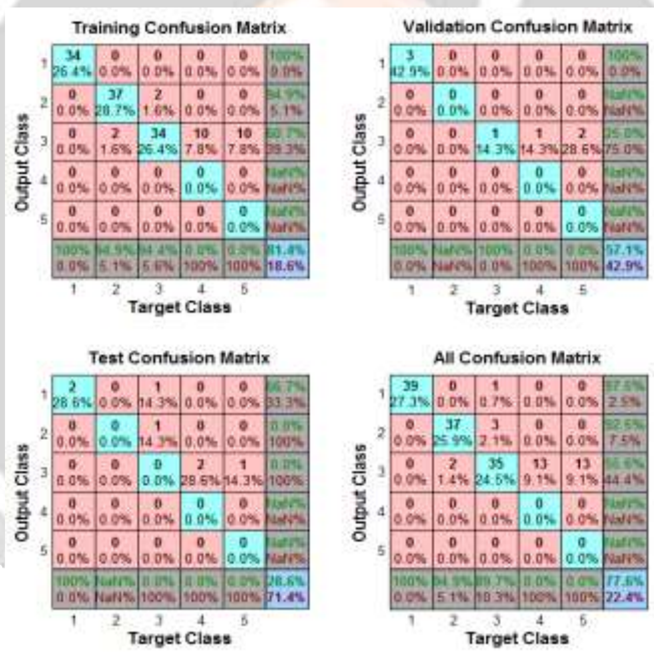

Fig.10:- Confusion matrix for training of neural network 1 for fault classification.

Figure 10 shows that 77.6% data are perfectly classify the fault and remaining fault case data not classify using neural network 1. It means that for remaining 23% data set neural network was in confusion state for classify the fault.

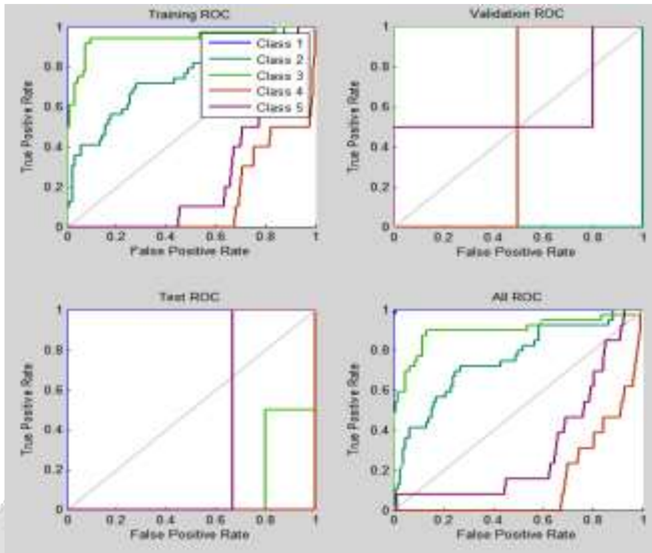

Fig.11:- Receiver operating characteristic (ROC) for neural network 1 training for fault classification

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).

4.2. Fault zone Identification Neural network training

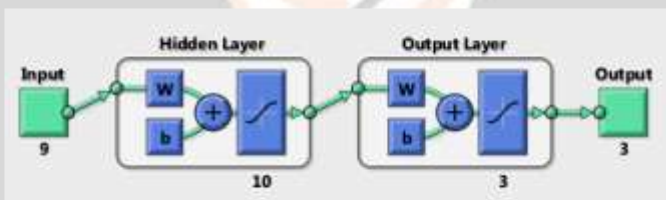

Fig.12:- Neural network configuration for fault zone identification.

Results

	Samples	MSE	%E
Training:	129	2.92287e-2	4.65116e-0
Validation:	7	4.14676e-3	0
Testing:	7	1.28641e-3	0

Fig.13:- Training performance parameter for neural network 2 fault zone identification.

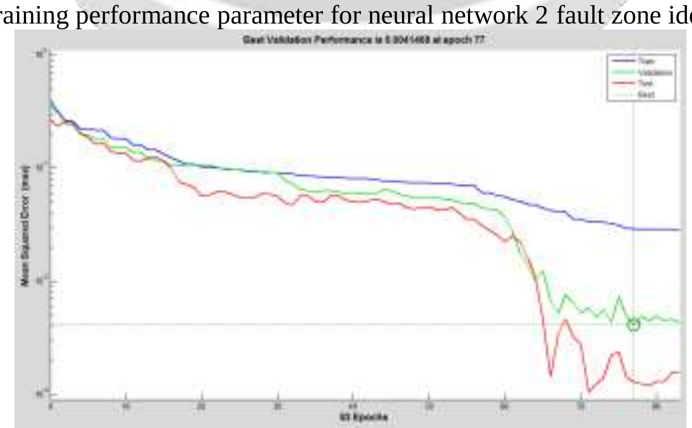

Fig.14:- Training performance of neural network 2 for fault zone identification.

During training of neural network for fault zone identification, neural network takes 77 epochs and mean square error becomes minimum of 0.004156 shows by green line in figure 14.

Fig.15:- Confusion matrix for training of neural network 2 for fault zone identification.

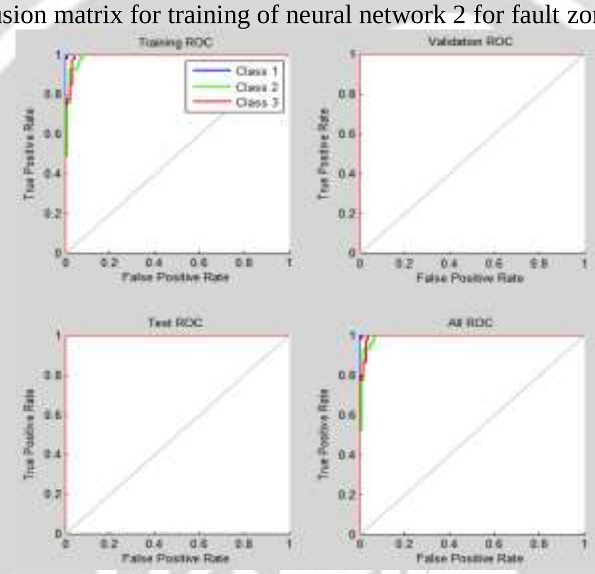

Fig.16:- Receiver operating characteristic (ROC) for neural network 2 training for fault zone identification.

Figure 15 shows that 95 % data are perfectly classify the fault zone and remaining fault case data not classify using neural network 1. It means that for remaining 5 % data set neural network was in confusion state for classify the fault zone.

5. MATLAB SIMULATION RESULTS

5.1 Fault cases

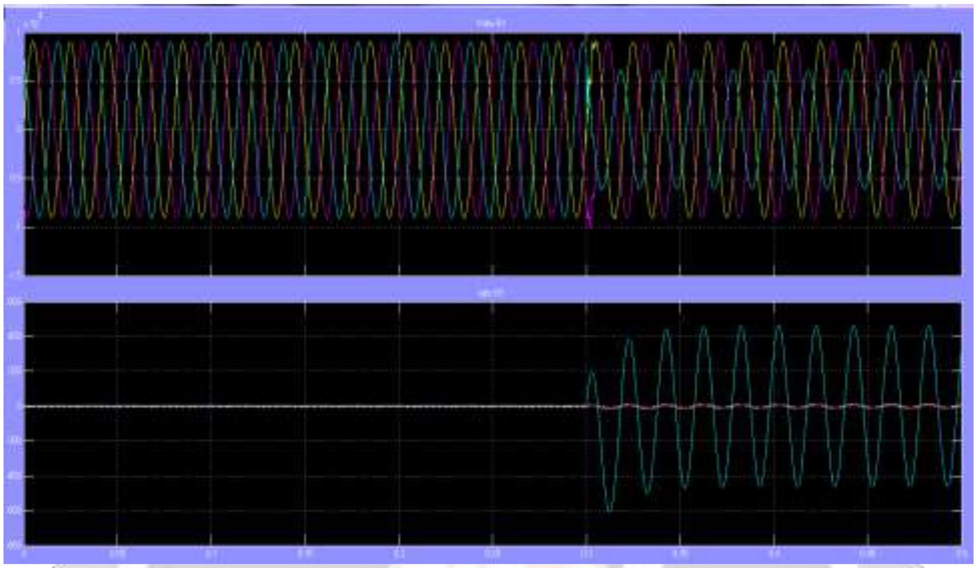

Fig.17:- Three phase Voltage and current waveform of transmission line at bus bar1 for BG (LG) phase fault at 20km in zone 1 from reference bus bar1.

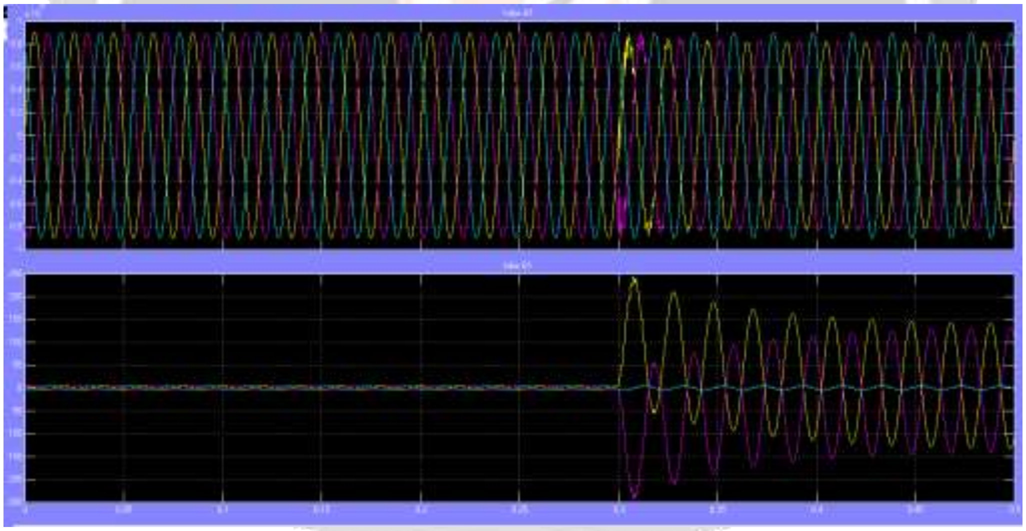

Fig.18:- Three phase Voltage and current waveform of transmission line at bus bar1 for RY (LL) phase fault at 170km in zone 2 from reference bus bar1.

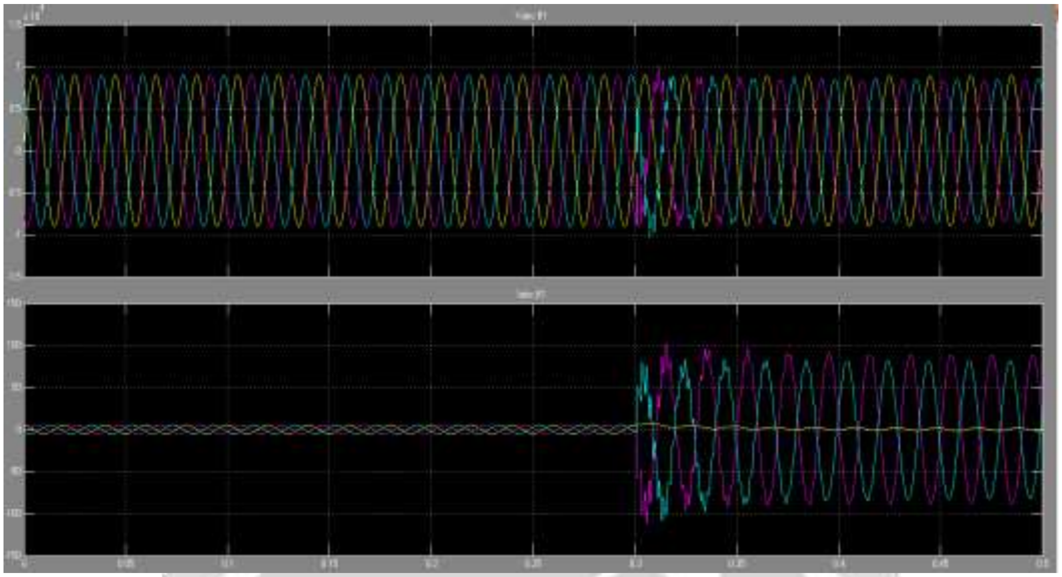

Fig.19:- Three phase Voltage and current waveform of transmission line at bus bar1 for RYG (LLG) phase fault at 285km in zone 3 from reference bus bar1.

5.2 Neural network result for fault classification and zone identification.

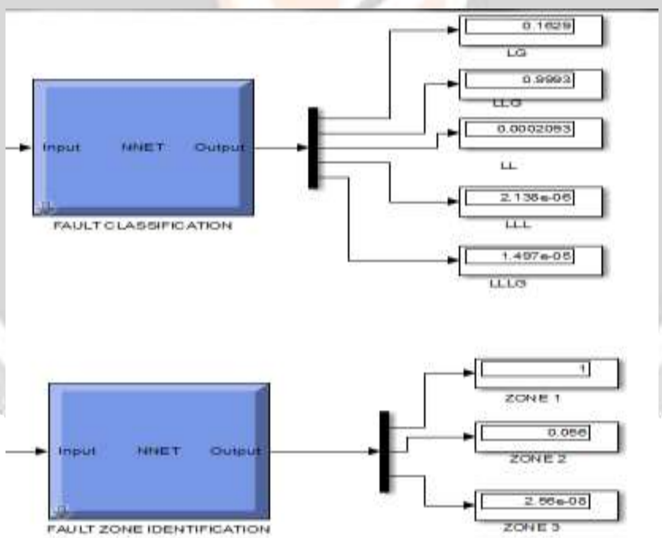

Fig.20:- Fault classification and fault zone identification for BG (LG) phase fault at 20km in zone 1 from reference bus bar1.

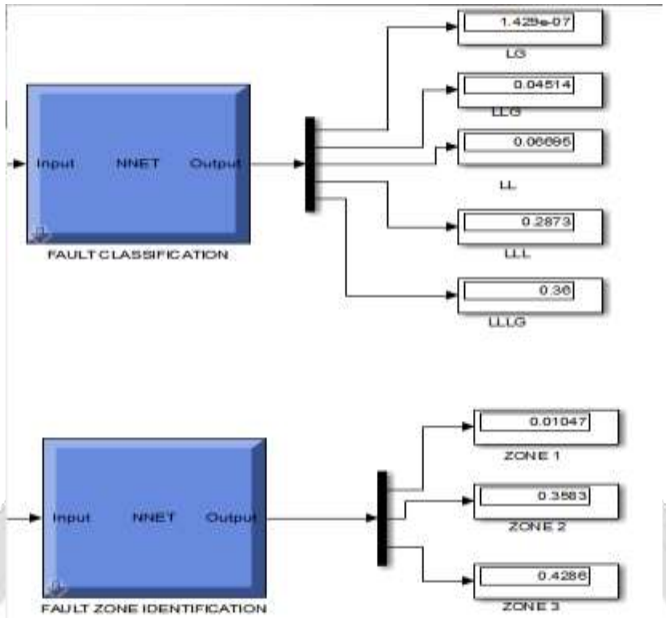

Fig.21:- Fault classification and fault zone identification for RY (LL) phase fault at 170km in zone 2 from reference bus bar1.

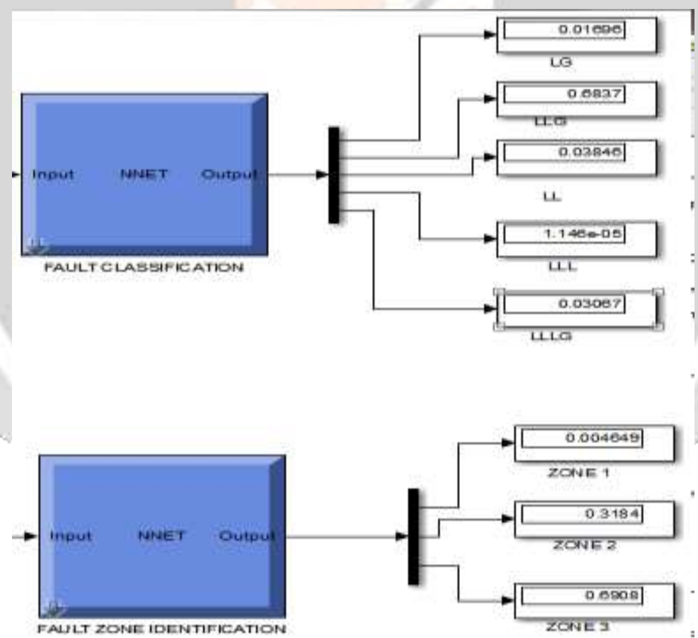

Fig.22:- Fault classification and fault zone identification for RYG (LLG) phase fault at 285km in zone 3 from reference bus bar1.

6. CONCLUSION

This methodology presents the utilization of back-propagation (BP) neural network specification as another method for fault classification and fault zone identification during a transmission line system. The most goal is that the implementation of complete theme for distance protection of a line system. So as to perform this, the line protection task is divided into totally different neural networks for fault classification additionally as fault location in numerous zones. Four unsymmetrical faults were discussed; single line to ground faults (LG), double line faults (LL) and double line to ground faults (LLG) and additionally two symmetrical fault cases additionally mentioned. MATLAB simulation result shows that ANN1 for fault classification classify the 77% of fault cases out of 143 cases and ANN2 classify fault zone of 95% of fault cases out of 143 fault cases.

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