Adaptive Approach for Fault classification of Parallel Transmission Line

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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, called 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 variety of fault is taken into account. When palmy simulation of LG fault remaining forms of fault like LL, LLG, and 3 phase short circuit fault 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 oversized range of patterns equivalent to numerous conditions, it will classify unknown patterns.*

In this technique, we have a tendency to think about the impact of fault resistance for line protection that influences the standard distance relay protection. So for removing this problem we have a tendency to introduced ANN primarily based line 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 wavelet multi resolution analysis and details signal constant analysis then send to ANN for zone identification for generation of trip signal for electrical fuse.

The project implementation are going to be done mistreatment MATLAB simulink package atmosphere MATLAB 2013b version during which ANN tool cabinet, installation tool cabinet and wavelet transform tool cabinet used for Simulink block modeling.

Key Words: *Parallel transmission line, protection of line*

1. INTRODUCTION

In the past many decades, there has been an ascension within the facility everywhere the globe that eventually diode to the installation of an enormous range of latest transmission and distribution lines. Moreover, the introduction of latest promoting ideas like release has redoubled the requirement for reliable and uninterrupted offer of electrical power to the tip users UN agency are terribly sensitive to power outages.

One of the foremost vital factors that hinder the continual offer of electricity and power could be a fault within the power grid. Any abnormal flow of current in an exceedingly power grid's elements is termed a fault within the power system. These faults can't be utterly avoided since some of those faults conjointly occur owing to natural reasons that are method on the far side the management of human beings. Hence, it's vital to possess a well-coordinated protection system that detects any quite abnormal flow of current within the power grid, identifies the sort of fault so accurately locates the position of the fault within the power grid. The faults are sometimes taken care of by devices that sight the incidence of a fault and eventually isolate the faulted section from the remainder of the facility system.

Hence, a number of the vital challenges for the incessant offer of power are detection, classification and placement of faults. Faults will be of varied sorts specifically transient, persistent, isobilateral or uneven faults and therefore the fault detection method for every of those faults is clearly distinctive within the sense, there's nobody universal fault location technique for of these sorts of faults. The High Voltage Transmission Lines (that transmit the ability generated at the generating plant to the high voltage stations) are a lot of vulnerable to the incidence of a fault than the native distribution lines (that transmit the ability from the substation to the industrial and residential customers) as a result of there's no insulation round the cable cables not like the distribution lines. The rationale for the incidence of a fault on a cable will be thanks to many reasons like a fugitive tree contact, a bird or associate animal contact or thanks to alternative natural reasons like thunderstorms or lightning. Most of the analysis worn out the sphere of protecting relaying of power systems concentrates on cable fault protection thanks to the that transmission lines are comparatively very long through varied geographical tract and thus it can take something from some minutes to many hours to physically check the road for faults.

2. PROPOSED APPROACH

2.1. Wavelet entropy based approach

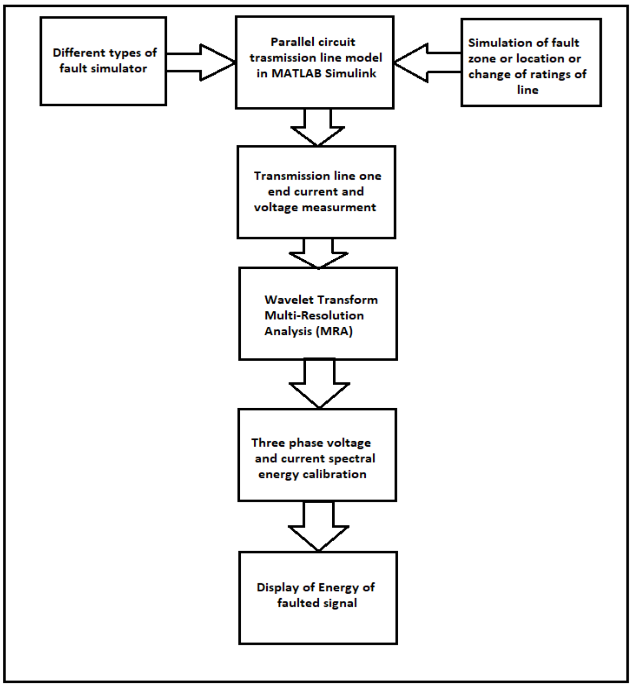

Fig-1: Generalized block diagram of wavelet spectral energy based approach for parallel transmission line fault identification

Figure 1 shows the block diagram of wavelet entropy based spectral energy approach for parallel circuit transmission line fault case analysis. In this approach parallel transmission line power system design in MATLAB 2013 simulink software. In this approach transmission line of 800km, 132kv, 50Hz line simulated and three phase RMS Voltage and current of circuit 1 and circuit 2 of transmission line measured using CT and PT at each phases of transmission line. That means six phase rms voltage and rms current was measured at one end of transmission line that is at zone 1 end of this approach.

- The measured six phases voltage and current of transmission line fed to the wavelet multiresolution analysis.
- Using HAAR mother wavelet and level 5 multi-resolution analysis we get five detail coefficient and one approximate A5 coordinate signal of six parameters of line.
- Then for each phases approximate signal i.e. A5 fed to the spectral energy calibration block of MATLAB simulation.
- Then analysis of spectral energy of each signal i.e. six phases of current and six phases of voltage done for normal condition.
- Simulation of different fault types done in MATLAB Simulink for different location offline. Then analysis of different fault condition and different location done for wavelet energy calibration.
- From analysis it is observed that, on faulted voltage signal energy of voltage decreases during fault condition of fault occur on that corresponding voltage signal phase. While energy of current signal for faulted phase increases. Hence from observing the energy signal it is clearly identify the faulted phase of transmission line or easily classify the type of fault occurs on transmission line.

2.2. Artificial Neural Network based approach

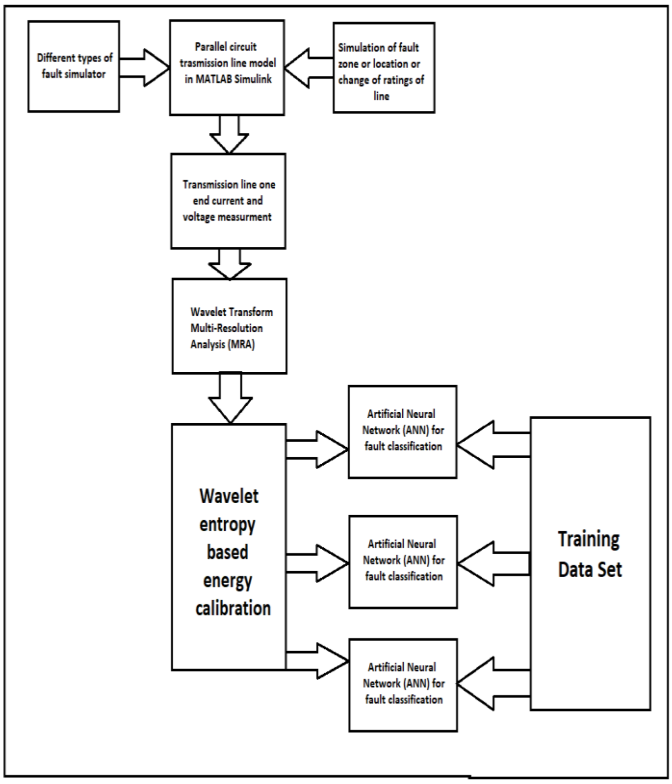

Fig-2: Generalized block diagram of ANN based parallel transmission line fault classification, identification and circuit classification

Figure 2 shows generalized block diagram of ANN based transmission line fault classification, fault zone classification and transmission line circuit classification approach. The step by step detail of approach is as follows:

- The wavelet spectral energy of six phases calibrated using wavelet multiresolution analysis. Six phase current and six phase voltage signal i.e. total 12 signals energy calibrated using MRA.
- Using MATLAB Simulink transmission line fault simulated at different location and different types of faults (LG, LL, LLG, LLL, LLG) on each phase of

circuit 1 and circuit 2 of transmission line at different location and different length of line.

- For each cases calibrated energy of 12 signals are note down. Same process repeated for different fault conditions.
- Then make data set for 12 signals for different fault types, fault location and distance of line.
- Then using Neural network toolbox in MATLAB, ANN training done for prepared data set for fault classification, fault zone classification and circuit type classification.

2.3. Project implementation

This project implementation will be done using MATLAB Simulink software. The major blocks will be design in MATLAB simulink as follows:

- ➢ Simulation of power system using sim-power system toolbox.
- ➢ Simulation of parallel circuit transmission line using sim-power system.
- ➢ Simulation of different types of faults in parallel transmission line.
- ➢ Simulation of different fault classifier approach.
- ➢ Simulate different fault classifier approaches like wavelet transform, s-transform, FFT, Artificial Neural Network approach etc.
- ➢ Comparative study of different fault classifier using MATLAB based system design.

3. MATLAB SIMULATION MODEL

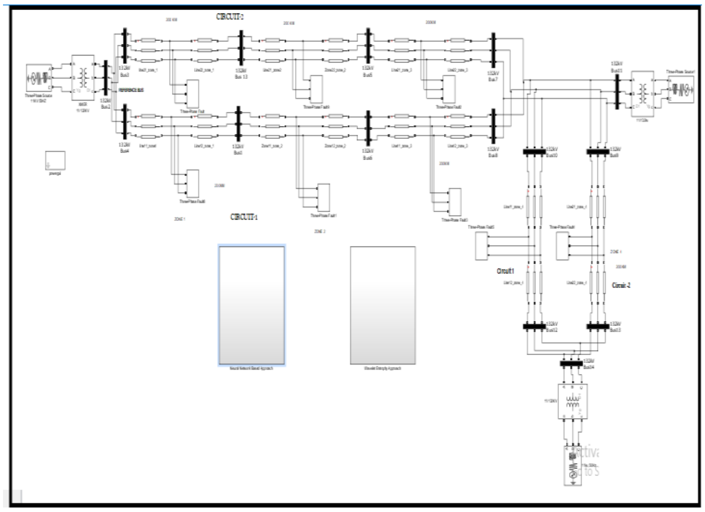

Fig-3: MATLAB simulation model of proposed parallel transmission line

Table-1: Matlab simulation model parameter specification

Sr No	Name of simulation block	Parameter specification
1	Three phase source	Phase to phase RMS voltage = 11KV, Phase difference =0 Degree, Frequency =50Hz, MVA Rating =100 MVA, Base voltage = 11KV, X/R Ratio =7
2	Three phase transformer	Primary winding connection = Star Secondary winding connection = Delta Nominal power =250 MVA; Frequency =50Hz; Primary winding parameter V1=11KV; R1=0.002pu; L1=0.058pu Secondary winding parameter V2=132KV; R2=0.002pu; L2=0.08pu; Magnetizing resistance Rm=500pu; Magnetizing inductance Lm=500pu
3	Distributed parameter line	Frequency = 50Hz; Positive sequence Resistance per unit length = 0.01273 Ohm/km; Negative sequence resistance = 0.3864 pu; positive sequence inductance = 0.9337 mH/km; Negative sequence inductance = 4.126mH/km; Positive sequence capacitance = 12.74nF/km; Negative sequence capacitance = 7.751nF/km
4	Transmission line zone	Four zone
5	Total length of line	800 Km
6	Length of each four zones	200 Km each

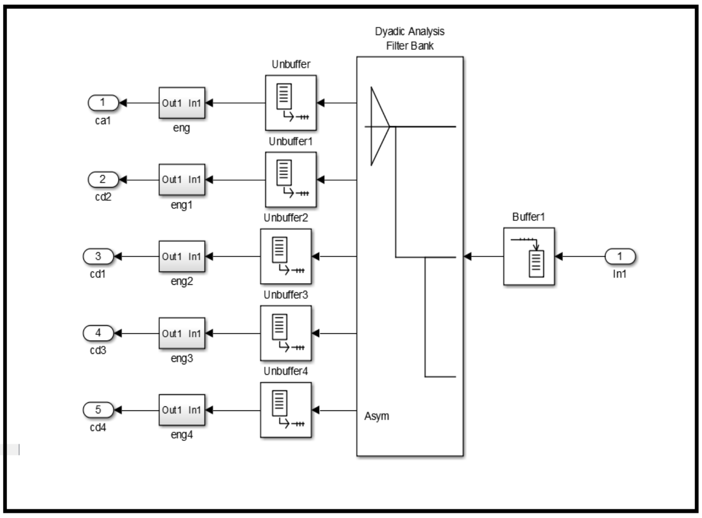

Fig-4: Wavelet multiresoltion analysis subsystem for wavelet entropy calibration of parallel transmission line rms voltage and current

3.1. Artificial Neural Network Approach

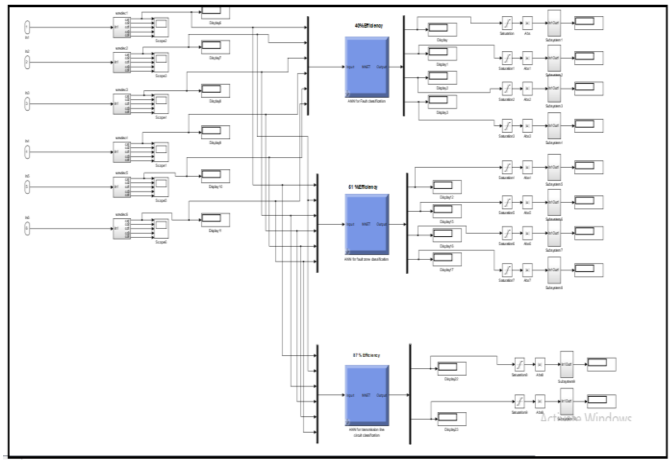

Fig-5: MATLAB subsystem for neural network for fault classification, fault zone classification and transmission line circuit analysis

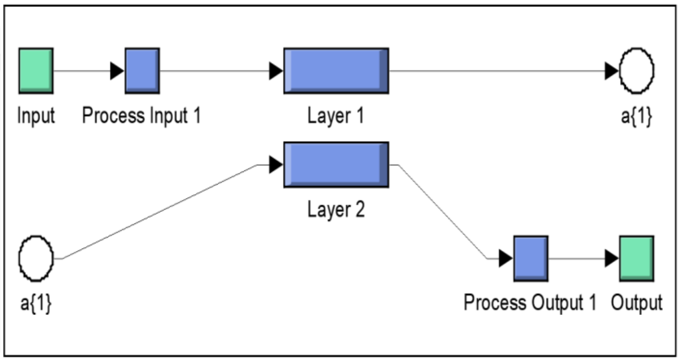

Fig-6: ANN structure for fault classification

Figure 6 shows the neural network structure, in which layer 1 is input layer while layer 2 is output layer of ANN2 for transmission line fault zone identification. Figure 7 shows the ANN architecture for fault type classification., in which layer 1 is input layer while layer 2 is output layer of ANN2 for transmission line which fault is occur in System it is LG,LLG,LLLG,LLL in fault zone identification for transmission line.

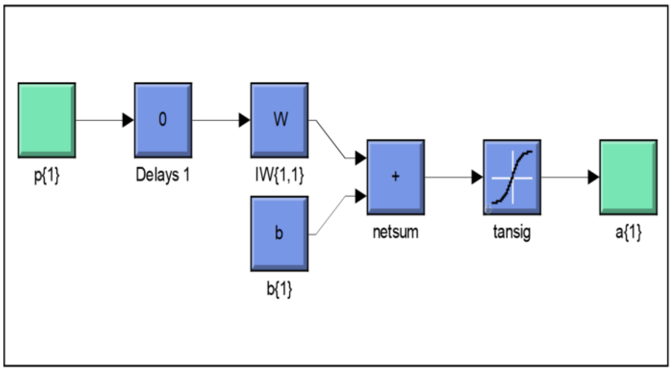

Fig-7: ANN-1 Weight and bias subsystem for neural network

Figure 7 shows the internal configuration of layer 1 of ANN2 in which total 10 number of neurons with weights and bias value shown. The weight value updated based on input training data set for generation of target value which also decided by designer. All 10 neurons consist of activation function or transfer function which coupled using multiplexer for generation of single decision based on training data set. Where layer 2 is output layer consist of 4 neurons layer which decide fault types, fault on transmission line shown in figure 7.

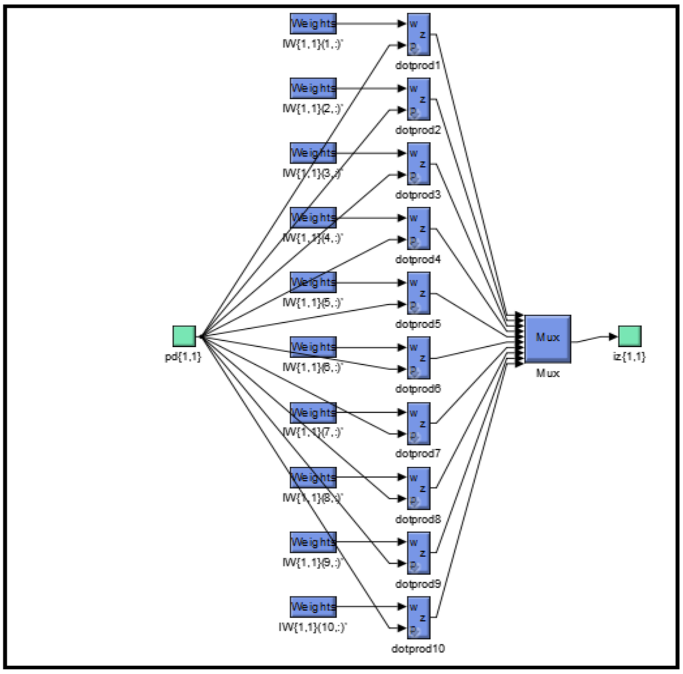

Fig-8: ANN layer 1 for fault classification

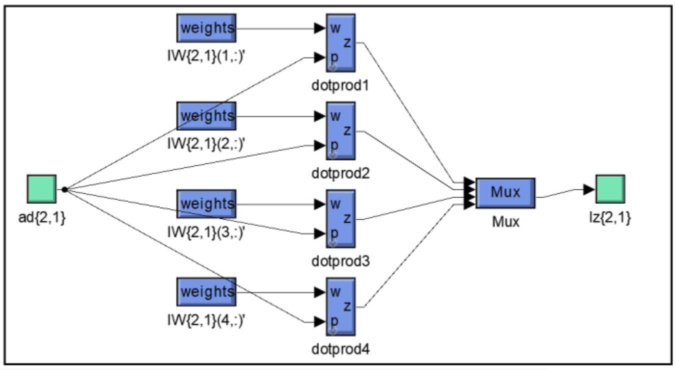

Fig-9: ANN layer 2 for fault classification

Total number of neurons in both ANN1 and ANN2 decided after training neural network. After training neural network required testing of data set in which checking of actual target with ANN output decides the ANN efficiency for classification. Based on best efficiency then ANN input and output layer neurons decided.

4. MATLAB SIMULATION RESULTS

4.1. Six phase transmission line three phase voltages and current analysis

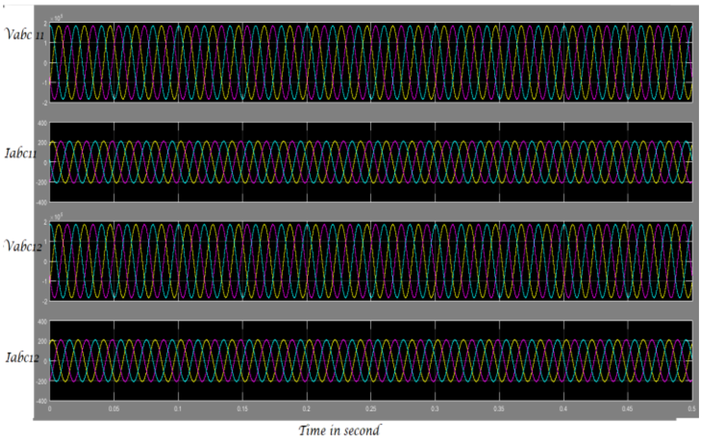

Fig-10: Three phase voltage and current of six phase parallel transmission line during normal condition

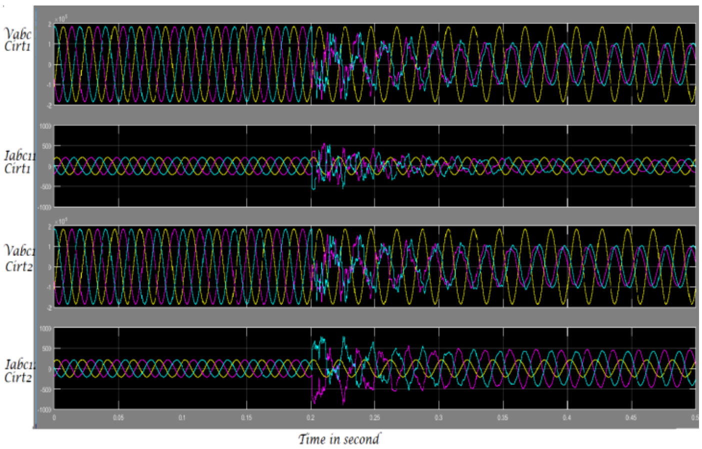

Fig-11: Three phase voltage and current of six phase parallel transmission line during LL fault at 280 km from generator bus bar in zone 2 & circuit1

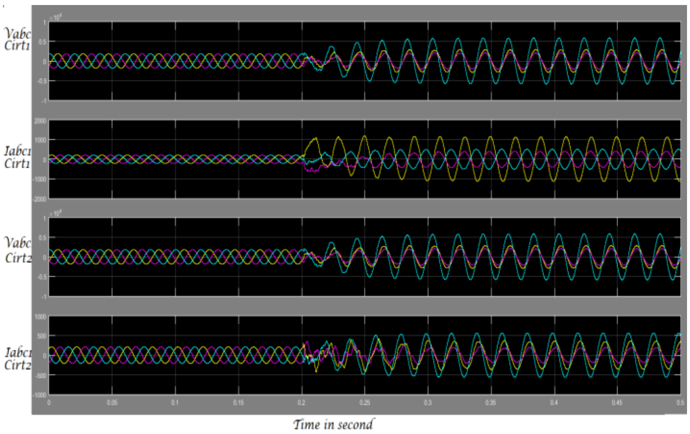

Fig-12: Three phase voltage and current of six phase parallel transmission line during LLG fault at 300 km from generator bus bar in zone 2 & circuit 2

4.2. Results from ANN approach

4.2.1. Results for ANN-1 of fault classification

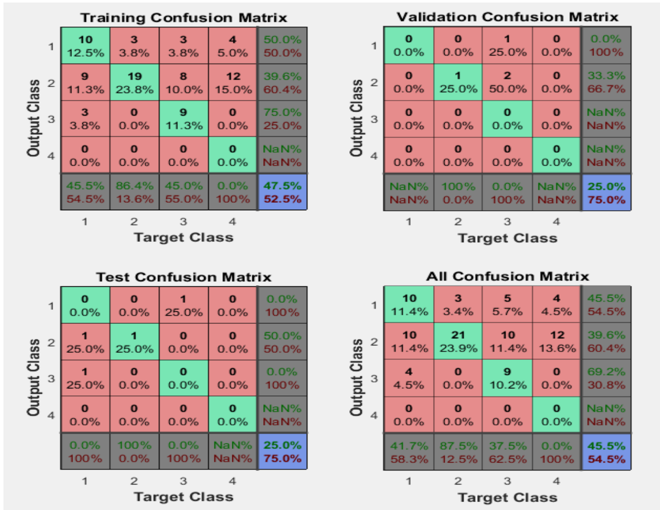

Fig-13: Confusion matrix for fault classification having efficiency 45 %

Figure 6.6 shows that 45% data are perfectly classify the fault type and remaining fault case data not classify using neural network 1. It means that for remaining 55% data set neural network was in confusion state for classify the fault.

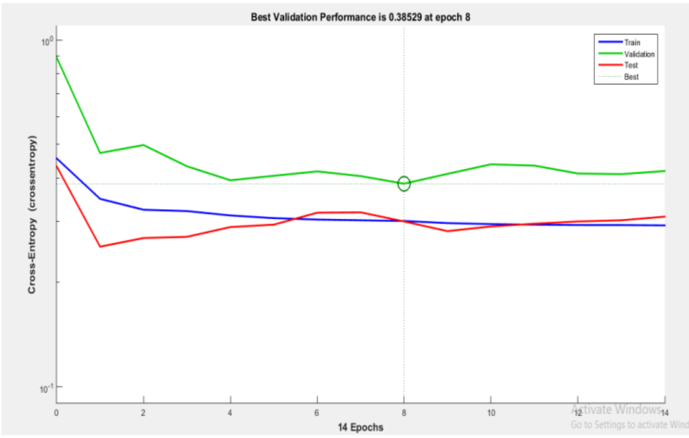

Fig-14: Training performance of ANN 1 for transmission line fault classification

During training of neural network for fault classification, neural network takes 8 epochs and mean square error becomes minimum of 0.38529 shows by green line in figure 14.

4.2.1. Result for ANN-2 of fault zone classification

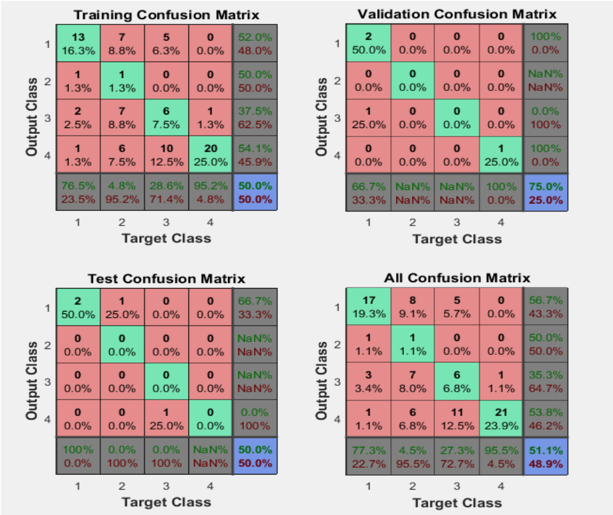

Fig-15: Confusion matrix for fault zone classification having efficiency 51.1%

Figure 15 shows that 51% data are perfectly classify the fault zone and remaining fault case data not classify using neural network 2. It means that for remaining 49% data set neural network was in confusion state for classify the fault.

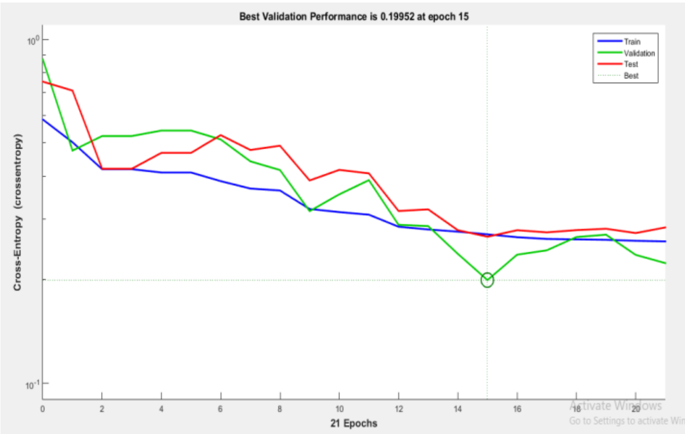

Fig-16: Training performance of ANN 2 for transmission line fault zone classification

During training of neural network for fault zone classification, neural network takes 15 epochs and mean square error becomes minimum of 0.19952 shows by green line in figure 16.

4.2.2. Result for ANN-3 of transmission line circuit classification

Figure 17 shows that 87% data are perfectly classify the parallel transmission line circuit and remaining fault case data not classify circuit using neural network 3. It means that for remaining 49% data set neural network was in confusion state for classify the fault.

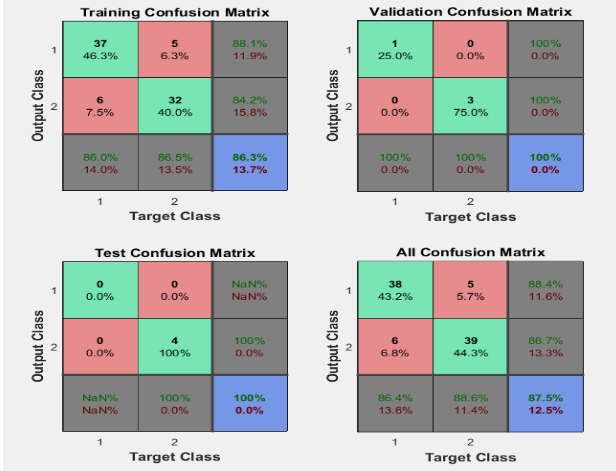

Fig-17: Confusion matrix for fault zone classification having efficiency 87.5%

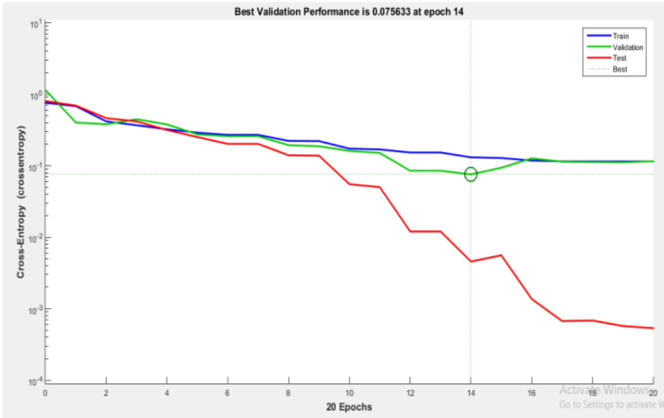

Fig-18: Training performance of ANN 3 for transmission line faulted transmission line circuit

During training of neural network for fault zone classification, neural network takes 14 epochs and mean square error becomes minimum of 0.075633 shows by green line in figure 18.

4.3. Wavelet entropy based energy calibration approach

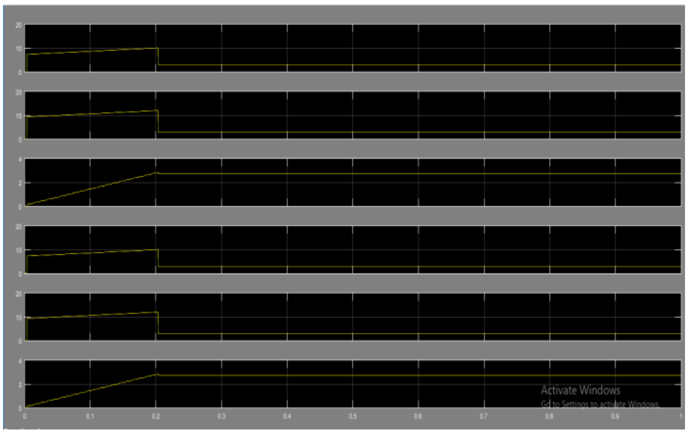

Fig-19: Wavelet energy of six phase currents for during normal condition

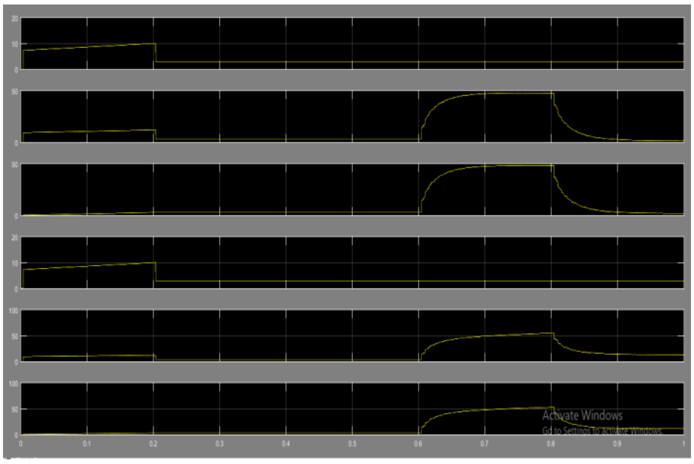

Fig-20: Wavelet energy for six phase current during Lin to line fault in BC phases at 280 km in zone 2 takes place in circuit 1

Table-2: Comparison of ANN approach and Wavelet energy based approach for transmission line fault analysis

Sr. No.	ANN Approach	Wavelet energy based approach
1	ANN Approach classify the fault type, fault zone and faulted circuit of line.	Wavelet energy based approach only identify the signals energy and easily identify fault occurred phases of line.
2	But efficiency of ANN approach is 45.5% for fault types classification, 51.1% efficiency for faulted zone classification and 87 % for faulted circuit of parallel transmission line.	Wavelet energy based system efficacy is 100% identify the faulted phase and fault conditions of parallel transmission line.
3	ANN approach fails to classify the type of fault and faulted zone of line.	Wavelet energy based calibration exactly identify the fault condition.

5. CONCLUSION

The proposed approach uses combination of wavelet transform and neural network, to solve the problem. While wavelet transform is a powerful mathematical tool which can be employed as a fast and very effective means of analyzing power system transient signals, artificial neural network has a ability to classify non-linear relationship between measured signals by identifying different patterns of the associated signals.

The proposed algorithm consists of time-frequency analysis of fault generated transients using wavelet transform, followed by pattern recognition using artificial neural network to identify the type of the fault. MATLAB/Simulink is used to generate fault signals and verify the correctness of the algorithm. But ANN have efficiency of 45 % for type of fault classification and 51 % efficiency for faulted zone classification. While 87% Efficiency for transmission line faulted circuit classification. Also wavelet spectral energy based approach easily identify the fault condition 100% by simply identify the energy of six phases current of parallel transmission lone.

Hence we apply this ANN approach for only transmission line circuit analysis and wavelet entropy approach apply for fault identification. Hence combination of ANN approach and wavelet energy based approach gives effective fault analysis system for parallel transmission line.

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