International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 20 Issue 2 – FEBRUARY 2016.

CLASSIFICATION AND IDENTIFICATION OF FAULT LOCATION AND DIRECTION BY DIRECTIONAL RELAYING SCHEMES USING ANN

S.Shoba[#1], Dr.T.Guna Sekar[#2], A.Amuthaval[#3]

[#1]PG Scholar, Department of Electrical and Electronics Engineering, Kongu Engineering College, Erode, India
[#2]Ph.D, Assistant ProfessorDepartment of Electrical and Electronics Engineering, Kongu Engineering College, Erode-, India
[#3]B.E, Department of Electrical and Electronics Engineering, Kongu Engineering College, Erode, India

Abstract--- **This paper provides an approach for classifying, locating the various faults in transmission line and also to estimate its direction by using artificial neural network. The major drawback of conventional method is that it fails to adapt the dynamical conditions of power system. This method uses fundamental voltage and current signals measured at one end of the transmission line. The algorithm accurately classify and locate the various type of faults like single line to ground, double line to ground, three phases faults and also find its direction whether it is forward or reverse. By using ANN the performance has been improved with different system parameters and conditions. The simulation is carried out for the fault detection, classification, location using MATLAB/SIMULINK.**

Index terms--Artificial Neural Network, Fault classification, location, direction.

I.INTRODUCTION

Transmission lines are vital part of the electrical system, as they provide a path to transfer the power between generation and load. Electrical power system suffers unexpected failures in transmission lines for various causes such as natural events, physical accidents, failure of equipments and hence protection of transmission lines is an important element in power system. Any fault, if not detected and isolated quickly, it will cascade into a system wide disturbance causing interconnected system operating close to its limits. Initially decision tree based method is used for classifying the fault in single transmission line [1] and the voltage and current values are obtained from both end of the transmission line. Support Vector Machine is used for classifying and locating the fault but this leads to various problems like increased steady state current, voltage inversions which acts non-linearly during fault condition and it is not accurate[2][3]. Directional relays based on negative or zero sequence components or compensated post fault voltages [4]. These relays have drawback of their inability to respond to all types of faults and slow operating time. The proposed discriminator uses the principles of Artificial Neural Networks (ANNs) to reach a decision and it tends to emulate the conventional classification problem. The major drawback of conventional method is that it fails to adapt for the dynamical conditions of power system.This paper demonstrates the theory of Artificial Neural Networks (ANNs) that can be used as an alternative to the conventional approach for identifying, classifying and locating the various types of faults like single line to ground, double line to ground and three phase faults. The ANN provides a viable alternative because they can handle most situations based on dynamic conditions. Training patterns to be absorbed by the ANN were generated using voltage and current samples for different faults atvarious locations along the transmission line. An adaptive phasor which requires the communication link for other end data Phasor Measurement Unit (PMU)-based fault detection, direction discrimination, classification and location techniques are developed

The direction of the fault on a transmission line is determined by the phase angles of instantaneous voltages and current phasors but it does not determine the fault location. A directional relaying algorithm based on the phase angles between positive-sequence components of fault voltages and currents was developed for various types of faults [5] but it does not identify the faulted phase and the distance to fault point. There are several papers which uses superimposed components, high-frequency signals, wavelet transform for detection and classification of various types of faults [6-10].

II. POWER SYSTEM NETWORK

The system considered is composed of a section of 220KV and transmission line of 80-120 km length is connected to source at one end and load at another end. Various types of faults like AG, BG, CG, ABG, BCG, ACG, and ABC are considered and the location of faults are found. This method is used to analyze various faults, classify the fault and locate the fault by using Artificial Neural Network (ANN). Therefore, the faults are classified and located accurately. The block diagram of proposed method is shown in the figure given below.

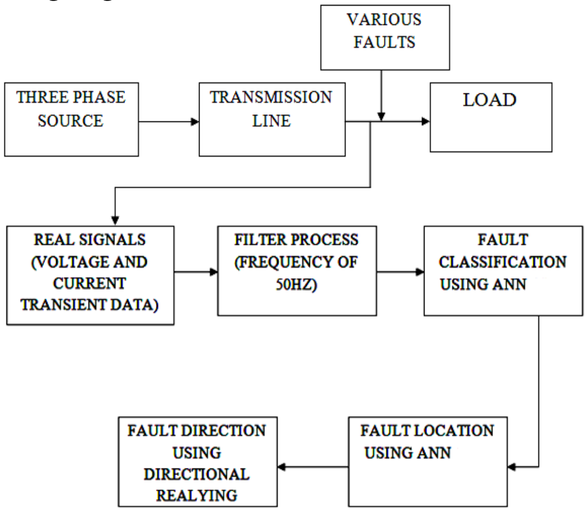

Figure 1 Block diagram

III. ANN BASED NETWORK

Artificial Neural Network (ANN) has emerged as a relaying tool for protection of power system. It has been widely used for providing the protective relaying schemes for transmission line protection and it can be an effective technique that helps to predict the fault, when it is provided with characteristics of fault currents and the corresponding past decisions as outputs. The ANN provides a viable alternative because they can handle most of the situation which are not defined sufficiently for a deterministic algorithm to execute such an approach have excellent noise immunity, robustness and the decisions made by an ANN are not seriously affected by the source impedance, fault resistance and the prevailing system conditions. The basic points used to implement neural network for the fault detection classification and direction estimation is described. The most significant aspects of ANN are

- Network Architecture
- Training method
- Checking of network behavior
- ANN fault locator.

A. Selection of Inputs and Outputs

One factor in determining the size and structure for the network is the number of inputs and outputs. If the numbers of inputs are low, the network will be small. But the input data to characterize the problem must be used. The magnitudes of the fundamental components (50 Hz) of three phase samples of post fault voltages and currents measured at the relay location three phase have been selected as input to neural network.Various faults are injected and corresponding voltage and current values are noted. These values are used for training ANN and it is used to detect the type of fault, identifies the faulted phase and estimates its direction whether it is forward or reverse fault. The proposed scheme allows the protection engineers to increase the protection of transmission line length as compared to earlier techniques [1]. Further the estimation of accurate fault location helps to reduce the fault clearing time. The total numbers of inputs to the neural network for classifying the fault are 6.

The basic task for the detection, classification and direction estimation network is to determine the fault type along with its phase and the direction. The outputs corresponding to three phases, ground and direction of fault (total 7) were considered as outputs provided by the network.

Table 1 Output Values

PHASES	TARGET VALUE			
	A	B	C	G
AG	1	0	0	1
BG	0	1	0	1
CG	0	0	1	1
ABG	1	1	0	1
BCG	0	1	1	1
ACG	1	0	1	1
ABC	1	1	1	0

B. Learning Rule

The back-propagation learning rule is used in many practical applications and hence this technique makesback-propagation more reliable and faster. This rule is used to adjust the weights and bias of the network to minimize the network error. This is done by continuously modifying the values of the network weights and biases with respect to error. The back-propagation method is slow because it requires small learning rates for stable learning. The various techniques were applied to the network architectures and it was concluded that the suitable training method is Levenberg–Marquardt optimization technique.

C. *Network Architecture*

After deciding the input and output for the network, the number of layers and the neurons per layer were considered. Various network with different number of neurons in the hidden layer of ANN based fault detector, classifier and direction estimator was considered. The neural network structure for the classification of fault is given in the figure below. The input has 6 layers, hidden has 2 layers and the output has 7 layers to classify the fault.

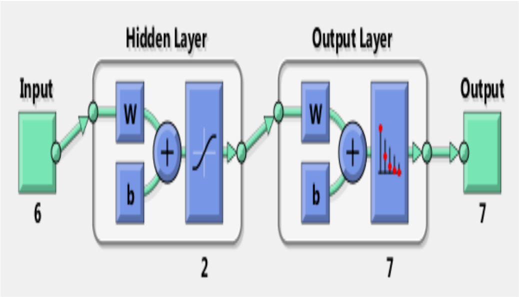

Figure 2 Architecture of neural network

D. Training the Network

Selection of suitable training pattems is an issue of prime importance for neural networks. Selection of suitable training algorithm is govemed by the factors such as type and size of the network, and convergence requirements. To train the network, a suitable number of relevant phenomenon must be selected so that the network can learn the fundamental characteristics once training is completed, provide correct outputs in new situations based on the training. Each type of faults like AG,BG,CG,ABG, BCG, ACG and ABC) at different fault locations between 80-120km of line length, fault resistance (0 & 100Ω)and fault inception angles (0 & 90°) have been simulated asshown below in Table 2.The data sets were used as spaced equal points throughout the original data. Both the networks were trained using Levenberg–Marquardt algorithm using neural network toolbox of MATLAB [12]. This learning strategy converges itself to the desired output.

Table 2 Pattern Generation

PARAMETER	SET VALUE
Fault type	AG,BG,CG,ABG,BCG, ACG,ABC
Fault location	80-120km
Fault inception angle	0 and 90

IV NETWORK SIMULATION

Fault is defined as the short circuit or open circuit or an external disturbance that occur in the power system. Hence the fault should be classified in order to obtain accurate result. The circuit for classification is shown in Figure 4. In the circuit, during compiling the fault is selected and the location is given. Neural network should classify and locate the accurate fault based on training.From the Figure 4, while compiling the fault is selected and location is entered in order to classify and locate it. The fault selected in Figure 4 is BCG and the location is given as 112km. The neural network should classify and locate based on the training. The output is shown in Figure 5 and it classifies the fault accurately based on training. From the training the fault classified is BCG and the fault is 112.4624.Therefore the error obtained is 0.4624.The performance plot is shown in Figure 3. In that the best validation performance is 0.072101 at epoch 5. In the plot the blue line is for training, the red line is for testing and green line indicates the validation.The table 3 provides the various types of fault location values. It provides the various types of faults and their distance. The neural network should locate the exact position based on the training.

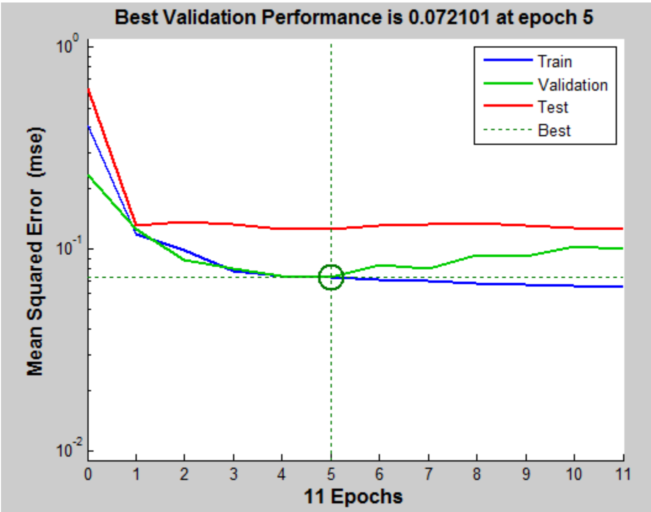

Figure 3 Performance Plot

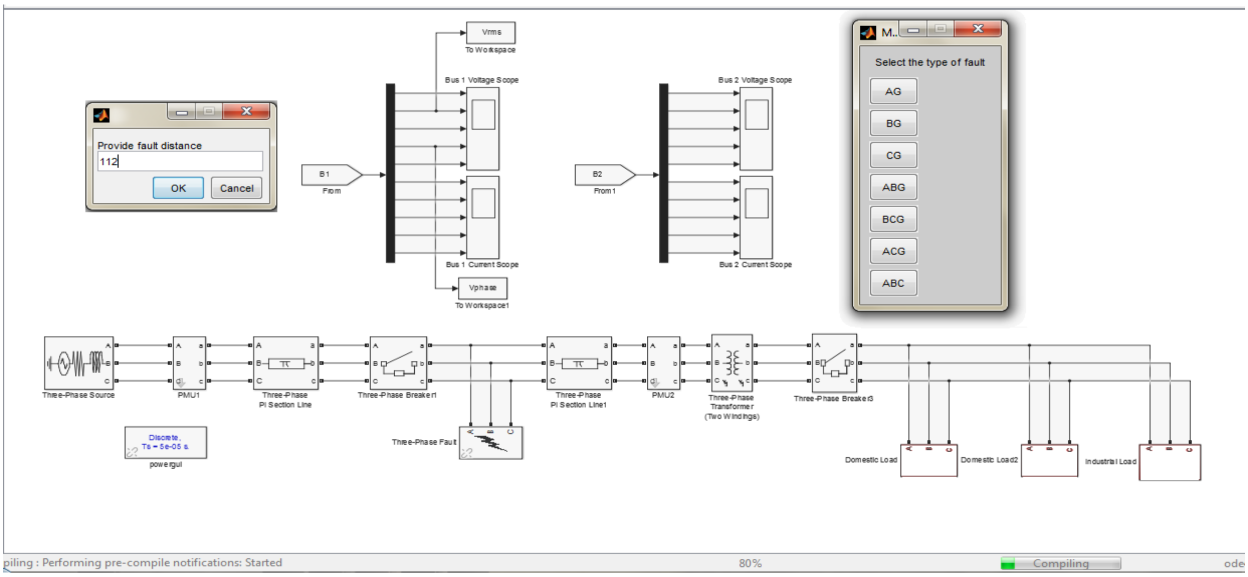

Figure 4 Circuit for classification and location

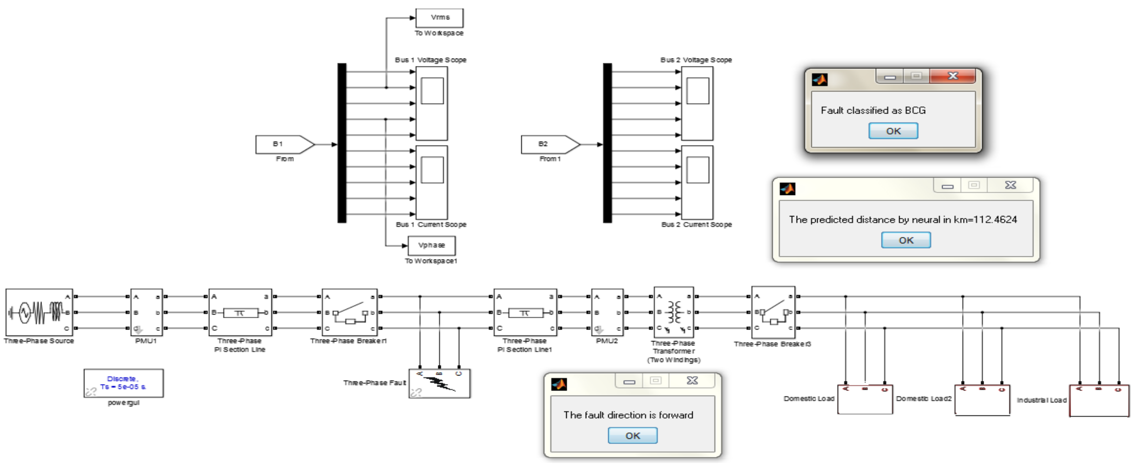

Figure 5 Classified and located circuit

Table 3 Fault Location Values

TYPE OF FAULT	DISTANCE FROM SENDING END IN km	DISTANCE ESTIMATED BY NEURAL NETWORK IN km	ERROR OCCURED
ABG	92	91.471	0.529
BCG	105	103.9497	1.0503
BG	100	100.6585	0.6585
AG	95	99.057	4.057
BG	85	93.474	8.474
CG	100	100.2971	0.2971
BCG	112	112.4624	0.4624
ABG	110	109.5291	0.4709
CG	94	96.2386	2.2386
BG	97	99.3872	2.3872
AG	90	96.9315	6.9315

The figure 6 provides the voltage waveform for BG fault. The magnitude of voltage at phase B is reduced. Next graph provides the RMS voltage value.

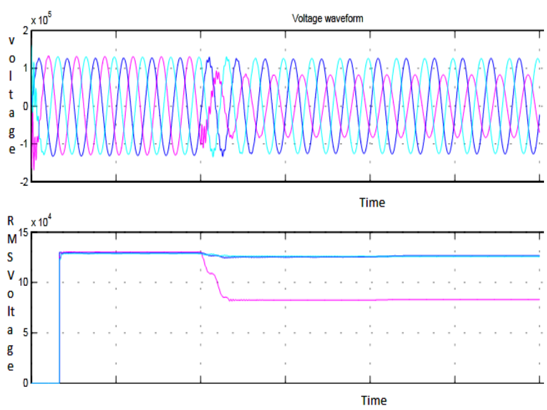

Figure 6 Voltage waveform

The figure 7 provides the current waveform at B phase. The magnitude of B phase is increased due to fault.

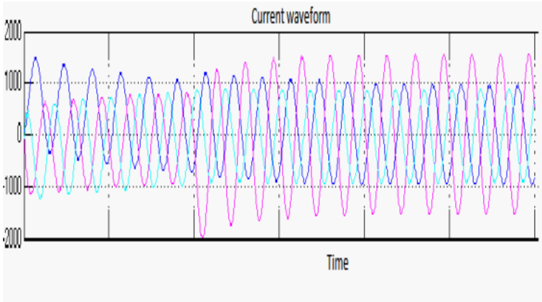

Figure 7 Current Waveform

CONCLUSION

By using ANN, the fault classification, location and direction has been estimated. The fault has been classified accurately for all types of faults. The fault location has error that could be rectified with more number of iteration of the fault location values. The computation complexity is more due to large training data, parameter selection, and large training time.The proposed method was analyzed for simple system.

REFERENCES

[1] Jamehbozorg, A., Shahrtash, S.M.: "A decision-tree-based method for fault classification in single-circuit transmission lines", IEEE Trans.PowerDeliv., 25, (4), pp. 2190–2196, 2010.

[2] Parikh, U.B., Das, B., Maheshwari, R.: "Fault classification technique for series compensated transmission line using support vector machine", Int. J. Electr. Power Energy Syst, 32, (6), pp. 629–636, 2010.

[3] Ekciki, S.: "Support vector machines for classification and locating of fault in transmission line", Appl. Soft Comput., 12, pp. 1650–1658, 2012.

[4] Duan, J.D., Zhang, B.H., Luo, S.B., Zhou, Y: "Transient-based ultra-high-speed directional protection using wavelet transforms for EHV transmission lines". IEEE/PES Transmission and Distribution Conf. and Exhibition: Asia and Pacific, pp. 1–6,2005.

[5] O. A. S. Youssef: "New algorithm to phase selection based on wavelet transforms," IEEE Trans. Power Del., vol. 17, pp. 908–914, 2002.

[6] Xinzhou Dong, Wei Kong, and Tao Cu: "Fault Classification and Faulted-Phase Selection Based on the Initial Current Traveling Wave", IEEE transactions on power delivery, Vol. 24, No. 2, 552-559,2009.

[7] Dong, X., Dong, X., Zhang, Y., Guo, X., Ge, Y.: "Directional protective relaying based on polarity comparison of traveling wave by using wavelet transform", Autom. Electr. Power Syst., 7, pp. 11–15,2000.

[8] A. Apostolov, D. Tholomier, S. Sambasivan, and R. Richards, "Protection of double circuit transmission lines," in Proc. 60th Annu. Conf. Protective Relay Engineers, pp. 85–101, 2007.

[9] D. Das, N. K. Singh, and A. K. Sinha, "A comparison of Fourier transform and wavelet transform methods for detection and classification of faults on transmission lines," presented at the IEEE Power India Conf., India, 2006.

[10] S. M. Brahma, "New fault-location method for a single multiterminal transmission line using synchronized phasor measurements", IEEE Transactions on Power Delivery, Vol. 21, No. 3, pp. 1148 – 1153, 2006.

[11] S. M. Brahma, "Fault location scheme for a multi-terminal transmission line using synchronized voltage measurements", IEEE Transactions on Power Delivery, Vol. 20, No. 2, pp. 1325 – 1331,2005.

[12] H. Demuth and M. Beale, "Neural Network –Toolbox"- For Use with MATLAB 2000.

[13] J. A. Jiang, C. S. Chen, and C. W. Liu, "A new protection scheme for faultdetection, direction, discrimination, classification, and location in transmission lines," IEEE Trans. Power Del., vol. 18, no. 1, pp. 34–42, 2003.

S.Shobareceived her B.E in Electrical and Electronics Engineering from Anna University, Chennai and doing her M.E in Applied Electronics at Kongu Engineering College, Anna University, Chennai, India. She had attended 1 National and 1 International conference. Her area of interest includes Power System and Digital Electronics.

T. Guna Sekar He received his B.E in Electrical and Electronics Engineering from Bharathair University, Coimbatore and M.E. in Power System Engineering from College of Engineering, Guindy, Anna University, Chennai, India. He has published 15 papers in International journals and 5 papers in conferences. His areas of interest include Power Systems, Power Quality Engineering, Active filters and Electrical Machines.

A.Amuthavaldoing her B.E in Electrical and Electronics Engineering at Kongu Engineering College, Anna University Chennai. Her area of Interest include Power System Protection and Electrical Machines