Adaptive Backpropagation Neural Network In System Protection Scheme

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***Abstract*— This paper proposes technique of backpropagation neural network in power system protection scheme. The main objective this paper is perform protection system model to transmission line using technique Backpropagation Neural Networks. An improvement in performance to distance relay is expected after the backpropagation could acquire with different fault conditions. The implemented Backpropagation Neural Network should catch knowledge for the correct distance relay operation in appearance the different network conditions. In power system of three phase currents and voltages at fault location are used as inputs to Backpropagation Neural Network based on power system protection scheme. The Backpropagation Neural Networks are trained to address fault location. The reliability of proposed scheme investigated which using power system in transmission line by using Matlab.**

Keywords—backpropagation neural network; current; distance relay; fault location; voltage

I. Introduction

The disruption occurs in power system electrical, protection and control center will be given respond to stop the power system. It is meant, the power system go back to normal and reduce impact of the disruption. Performance from control center are not invented to be faster and may be run too slow.

Distance relaying scheme is adopted in transmission line as safety cover protection. Distance relays actions can work to catch the trip fault up until distance relays from a substation. Protection relay design on defining the power system beyond recognize design of voltage and current waveforms. The establishment an technique adaptive protective is applied carry out solution of pattern classification.

Backpropagation development is to determine the pattern of his behavior in the power system by using a number of neurons set in layers. These networks applied as a function to extra complex between power system variables. The function of network relationship are indefinable.

The technique of artificial intelligent for fault location have been proposed. In [3], the authors have developed an application of fuzzy relations for fault location. They analysed the construction of fuzzy relations for alarm processing and fault location in electrical power systems. The among Fuzzy associations system components that are: relays and circuit breakers have been indicated with the aid of human experts through their skill and knowledge on protection devices operation for faults involving different system component. In other researcher [1] and [5], distance relaying scheme is based on fuzzy neural network. The classifier uses normalize peaks of voltage and current waveforms as input whereas fault location. The among fuzzy relations alarm patterns and perhaps faulted system components are indicated and employed as training sets for artificial neural networks. That methodology has tested using the seven bus systems real Brazilian system. In [2], [4] and [6], the artificial neural network have been successfully apply to many power systems. With the information delivered by scada used to detection fault sections. The neural classifiers are trained off line using several different training alarm patterns. They are utilized for producing real time classifications; this is in order to acquire final diagnoses from the classification results.

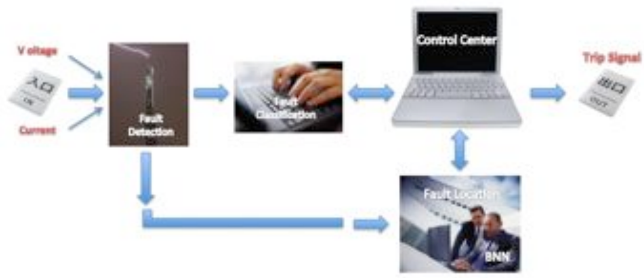

Fig. 1. The system protection scheme

Coordination of distance relays for transmission line parameters are based on the estimate amount of disturbance. The compensation is calculated off line quickly and tuning the relative easy. In the other hand, situation of the system are always changed that has resulted in the transmission line parameters. It is also changing, it cannot be predicted magnitude fault, the otherwise the existing relay settings cannot be effectived on usage it.

The main protection system may be fail, protections should act as backup either in the same station or in neighbor lines with time delay according to the selectivity requirements. All of determination time delay have backup relays. It is known as coordination of the protection system. For the provision was selective properties in relay protection of the properties to distinguish or determine. Parts of the system impaired can be done with two ways; (a) Pilot System Relaying, the word pilot mean is the end of the transmission put in the line information which it can deliver mutual information. The working principles pilot relay is provision of information via conductors from a telephone circuit as physical media. The high frequency signals are coupled to the power transmission line itself from one relay to the other relays, this device known as PLC. (b) Working time delay system relay, there is giving slowness workingtime for each relays, it can get coordination of work in order to obtain more both among the relay.

II. MODEL SYSTEM PROTECTION SCHEME

The present transmission system protection scheme utilizing backpropagation is shown in Fig. 2. The occurrence of fault detection unit activates the fault categorization unit. The categorization consists of Backpropagation Neural Network to select the phases brought with the fault accurately and the ground detection unit running in parallel with the Backpropagation Neural Network completes the categorization task of distance relay. One of categories is grouped, and then the control unit are burning the objective fault location.

The fault location unit consist of three of Backpropagation Neural Network. Moreover, the control block come from the decision of trip or it is not trip from the output signals of categorization and locator units. To generate of the presented distance relaying scheme used transmission line based as shown in Fig. 2.

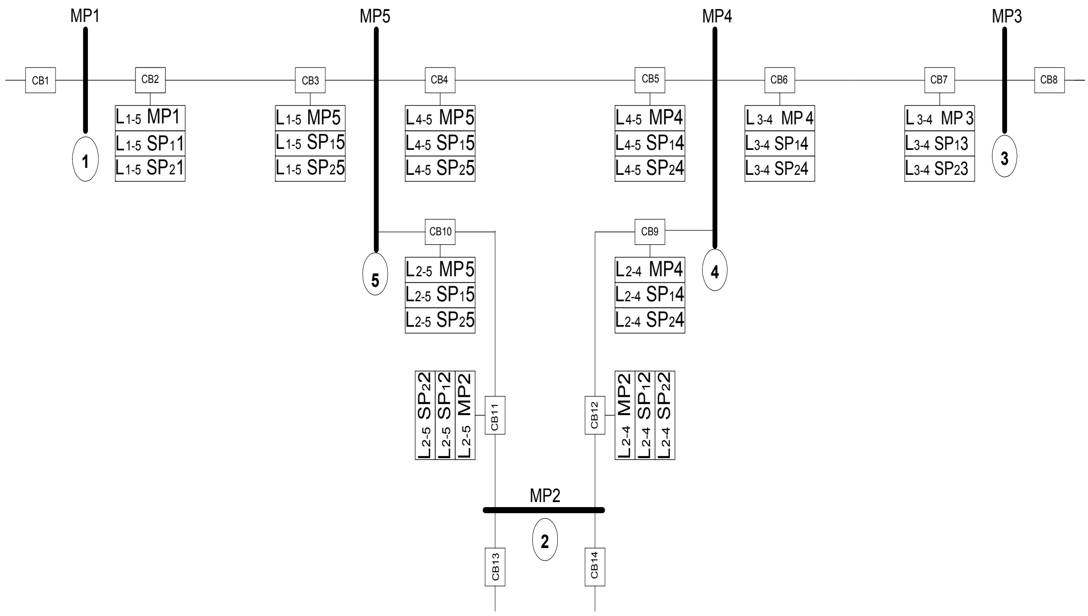

Fig. 2. Protection Scheme

III. BACKPROPAGATION NEURAL NETWORK

Backpropagation Neural Network (BNN) can be used to solve problems in this research to determine the zone of disturbance in an electric power system thus can make the right decision by given input pattern in testing. BNN is one model of feed forward neural network using supervised training which is based on the algorithm error back propagation training rule based on error correction. The process of error back propagation consists of two stages that are: feed forward and feed backward. Every neuron in each has the function of activation. Each neuron in the input using the identify activation function. Each neuron in the hidden layer using a non linear activation function, continuous activation functions used derivative and monotonous rise. Each neuron output use the same activation function is linear activation function. The activation functions must have a derivative usage in the algorithm method for BNN which using derivative of the activation in each to improve weights of neural network. Hidden layer is using the linear activation function; BNN can solve the problem because the composition of linear functions is linear.

Algorithm of BNN Model [6],[10]:
Stage 1: Initialized weights.
Stage 2: There are no specific criteria for determining the value that the algorithm stops.
Feed forward:
Stage 3: Each neuron input $(x_i, i = 1, \dots, n)$ receives signals x_i and sends value is the value of all these neuron in the next.
Stage 4: Each hidden neuron receives input $(z_j, j = 1, \dots p)(z_i, j = 1, \dots p)$ in the form of the result of

multiplying the value of each signal with the weight on the line connected to the hidden layer;

$$z_{in_j} = v_{0j} + \sum_{i=1}^{n} x_i v_{ij} \quad (1)$$

Use the activation function to c ompute its output signal;

$$z_j = f\left(z_{in_j}\right) = \frac{1}{1+ e^{-z\_in_j}} \quad (2)$$

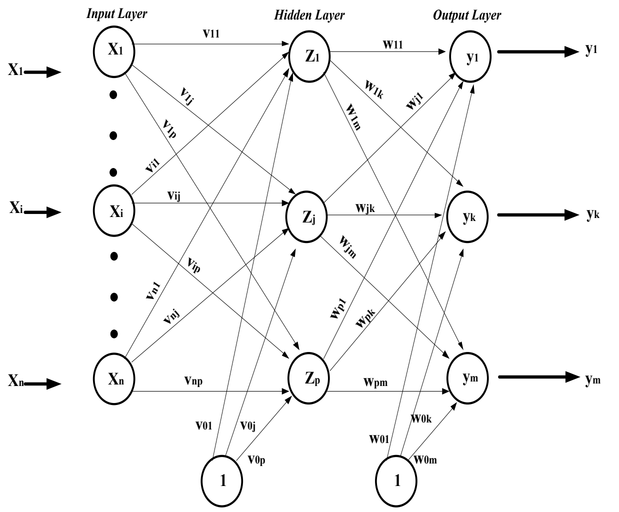

Fig. 3. The architecture back propagation neural network

Stage 5: Each neuron output; $y_k, k = 1, \dots, m)$ accept input in the form of the theoretical value of the output of each hidden layer with a weight on the line connected to the output layer;

$$y_{in_k} = w_{0k} + \sum_{j=1}^{p} z_j w_{jk} \quad (3)$$

Use the activation function is to calculate the output signal;

$$y_k = f\left(y_{in_k}\right) = \frac{1}{1+e^{-y\_in_k}} \quad (4)$$

Backpropagation of Error :

Stage 6: Calculate the output factor of error in each output layer by layer; $(y_k, k = 1, \dots, m)$

$$\partial_k = (t_k - y_k)\, f'\left(y_{in_k}\right) = (t_k - y_k) y_k (1 - y_k) \quad (5)$$

∂_k : error units that will be used in the changing weight layer.

Calculate of the spart weight change jk which will be used later to change the weight w_{jk} rate perception α $(z_j = j = 1, \dots, p)$

To update the hidden layer bias to the output layer;

$$\Delta w_{0k} = \alpha \partial_k \quad (6)$$

Stage 7: Calculate the hidden layer based on the error factor in each hidden layer; $(z_j = j = 1, \dots, p)$

assumed ö input;

$$z_j = j = 1, \dots, p) \quad (7)$$

The factor ∂ hidden layer;

$$\partial_j = \partial_{in_j} f'\left(z_{in_j}\right) = \partial\_in_j z_j \quad (8)$$

Calculate of the spart weight change; v_{ij}

$$\Delta V_{ij} = \alpha \partial_j X_i \;, j = 1,2, \dots, n \quad (9)$$

Which will be used later to change the weight;

$j = 1,2, \dots, p$ and $i = 1,2, \dots, n$

To update the weights with the input layer hidden layer;

$$\Delta V_{0j} = \alpha \partial_j \quad (10)$$

Renewed Weight and Bias:

Stage 8: Each neuron output $(y_k, k = 1, \dots, m)$ update the weights and bias $(j = 1, \dots, p)$;

$$w_{jk}(new) = w_{jk}(old) + \Delta w_{jk} \quad (11)$$

Every neuron hidden; $(z_j, j = 1, \dots, p)$ to update the hidden layer bias $(i = 1, \dots, n)$;

$$v_{ij}(new) = V_{ij}(old) + \Delta v_{ij} \quad (12)$$

Stage 9: Test the value that has been determined to quit.

After learned the process, the network above can be used for the testing process. In this case only the feed forward measures are used to determine the output results of the network.

TABLE 1. DATA TRAINING FOR 5 BUS SYSTEM

BNN	Input layer	Hidden layer	Output layer
BNN_1	5	6	3
BNN_2	2	2	1
BNN_3	3	3	2

IV. TRAINING AND TESTING OF BNN

The training and testing of method proceses in modeling the Back propagation Neural Network by using the value of learning rate and hidden layer. The resulted of obtain the back propagation method can detect the output from work process in the form of output protection method that CB was connected electric power systems, where it done modeling interference testing in one of the long line between lines of bus 4 and bus 5, backpropagation neural network modeling output CB will detect the location or zone disrupted at zone 1 and zone 2. The simulation of modeling methods BNN and Table 2 and 3, it can be seen in the current system interference with reading protection equipment installed CB respective bus systems in substations, the BNN will be able to detect the location or zone of disturbance. In Table 2 showed that testing the five bus system training and testing BNN can find out the number of input layer 20 neurons, the number of hidden layer 37 neurons and the values of neuron output layer 24 neurons. BNN on the distance relay will read the location of the disruption that occurred in zone 1, because of the zone 1 is the primary protection zone along 80% of the line. Then if the interference cannot be secured along the zone 1, the BNN in the distance relay will give respond which is the fault location occurred in zone 2. The results of the modeling using BNN can be seen modeling method and detect the location or zone of disturbance more accurate. As long as line system is the main zone of protection, in other words BNN can handle and overcome the problem of detect interference in electrical power system transmission line.

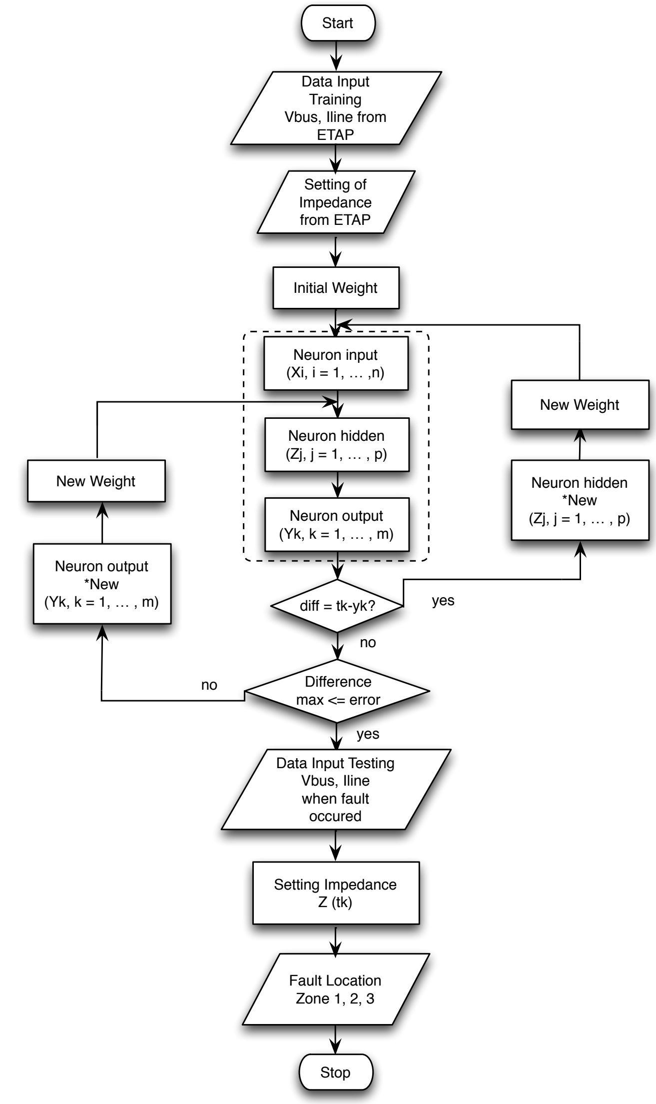

Fig. 4. Flowchart BNN generated using Matlab

TABLE 2. TESTING 5 BUS SYSTEM

Fault	**Relay**	**Circuit Breaker**	**Alarm**
Multi fault in three area	$L_{1\text{-}5}MP_1$, $L_{1\text{-}5}MP_5$, $L_{4\text{-}5}MP_4$, MP_5 & $L_{4\text{-}5}MP_5$	CB2, CB3, CB5, CB4,	Normal operation
Single fault at Bus 4	MP_4, $L_{2\text{-}4}$ $SP2_4$	CB5 and CB9	Failed trip in CB6
Double fault	$L_{2\text{-}4}MP_2$, $L_{3\text{-}4}$ MP_3, $L_{3\text{-}4}$ MP_4	CB12, CB7 and CB6	Relay $L_{2\text{-}4}MP_4$ not operated
Error communication in Bus 2	-	-	Error at CB1 & CB2

The results of the modeling using BNN can be seen modeling method and detect the location or zone of disturbance more accurate. Almost as long as line system is the main zone of protection, in other words BNN can handle and overcome the problem of detect interference in electrical power system transmission line.

TABLE 3. SIMULATION OF RESULTS OUTPUT BNN

The zone of protection	**Fault Location**	**Protective Devices Work**
Zone 1	Bus 1, bus 2, bus 3, bus 4, bus 5	CB1, CB2, CB3, CB4, CB5, CB6, CB7, CB8, CB9, CB10, CB11, CB12
Zone 2	Bus 1, bus 3	CB2, CB7

V. CONCLUSIONS

The using of Backpropagation Neural Network as an alternative protection model to transmission lines was investigated in this paper. The distance relay zone was determined in zone 1 and zone 2 in transmission line. The implementation in this paper present voltage and current element as input. It can be seen in the performance of BNN which is acceptable to classify fault location. However, to classify while the fault condition inside or outside the relay primary protection zone. It is performance are not so good. Many errors occurred near the regions where trip or un-trip condition changes. In order to expand the proposed scheme, this expansion is under development.

REFERENCES

[1] P.K Dash, A.K Pradhan, and G. Panda, "A Novel Fuzzy Neural Network Based Distance Relaying Scheme", IEEE Transaction on power Delivery, Vol. 15, No. 3, July 2000.

[2] Z.E Aygen, S. Seker, M. Bagriyanik, F.G Bagriyanik and E. Ayaz, "Fault Location in Electrical Power Systems Using Intelligent Systems Techniques", IEEE Transactions on Power Delivery, Vol. 16, No. 1, January 2001.

[3] H.C Chin, "Fault Section Diagnosis of Power System Using Fuzzy Logic", IEEE Transactions on Power Systems, Vol. 18, No. 1, February 2003.

[4] W.M Lin, C.H Lin, and Z.C Sun, "Adaptive Multiple Fault Detection and Alarm Processing for Loop System with Probabilistic Network", IEEE Transactions on Power Delivery, Vol. 19, No. 1, January 2004.

[5] J.C.S de Souza, E.M Meza, M.Th Schilling, and M.B.C Filho, " Alarm Processing in Electrical Power Systems Through a Neuro Fuzzy Approach", IEEE Transactions on Power Delivery, Vol. 19, No. 2, April 2004.

[6] G.Cardoso, Jr. J.G Rolim, and H.H Zurn, "Application of Neural Network Modules to Electric Power System Fault Section Estimation", IEEE Transactions on Power Delivery, Vol. 19, No. 3, July 2004.

[7] A.N Sarwade, P.K. Katti, J.G Ghodekar, "Adaptive Solutions for Distance Relay Settings", 978-1-4244-7398-4, IEEE, 2010.

[8] L. Wang, Q. Chen, Z. Gao, "A New Framework for Power System Fault Diagnosis", IEEE PES ISGT ASIA, 2012.

[9] Azriyenni, M.W. Mustafa, "Performance Neuro-Fuzzy for Power System Fault Location", International Journal of Engineering and Technology Vol 3 No 4, April, Page: 497-501, ISSN 2049-3444, 2013.

[10] Azriyenni, M.W Mustafa, D.Y Sukma, M.E Dame, "Application of backpropagation neural network for fault location in transmission line 150 kV", IJEEE, ISSN 2278-9944, Vol. 2, Issue 4, sep 2013, 21-30.