TELKOMNIKA Indonesian Journal of Electrical Engineering
Vol. 12, No. 8, August 2014, pp. 5969 ~ 5975
DOI: 10.11591/telkomnika.v12i8.6085

Fuzzy Neural Network for Classification Fault in Protection System

Azriyenni*[1], Mohd Wazir Mustafa[2], Naila Zareen[3]
[1]Faculty of Electrical Engineering, Universiti Teknologi Malaysia,
Skudai, 81310, Johor Bahru, Malaysia
*Corresponding author, e-mail: azriyenni@gmail.com

Abstract

Novel intelligent technique is a combination of fuzzy and neural network techniques that can be used to classify faults in electric power system protection. There have two problems in the protection system, which are: undesired tripping and fail to operate. Loss of power supply to relays and circuit breakers or failure in protective devices may cause failures in protection system. Construction of neural networks to explore fact to identify fault component is from control center. The objective of this paper is to develop novel concept for classification failures protection system are using Fuzzy Neural Network technique. Methodology consists of Neural Network and Fuzzy. The Neural network is also conscientious for estimating degree of membership in system components from corresponding area in classification of disorders. The input variables of neural network formed of binary numbers. Value of 1 indicates if fault occurs and value of 0 indicates no-fault occurs. Fuzzy relations will represent by fuzzy. These Fuzzy relations can be represented by fuzzy diagram consisting of three sets of node that would be considered to represent components, relays and circuit breakers. Fuzzy diagram is built as causal operation of relays and circuit breakers on event of the fault in protection system. The causality is represented in arrows. Finally, the concept of Fuzzy Neural Network can be proposed as alternative to solve issue of failures that occur in the protection system.

Keywords*: classification fault, failures, fuzzy, membership degree, neural networks*

1. Introduction

Hybrid intelligent technique is composed of fuzzy and neural network technique, in which fuzzy techniques are used as fault identification and neural network techniques are used as a classification fault. There have two problems in the protection system, which are: undesired tripping and fail to operate. Missing power supply to relay or failures in protective devices can cause the failures. When system disruption occurs, the system of protection failures can generate damage to equipment resulting in several important elements out of the system. Disoperation of protection system can reduce level of system reliability. In some cases, undesired tripping can occur for fault outside protection zone. If protective device does not operate properly when fault occurs, then back-up protection devices will isolate faults in area of transmission system. After fault occurs to power stream in the system will change due to topology change. It will lead to overloading and tripping due to overload. Protection system components such as Current Transformer (CT), Voltage Transformer (VT), Relay, and Circuit Breaker will fail unknown. For this model, the circuit breaker can not obvious fault current is tripped due to a failure in the mechanism. In the case of circuit breaker failure, undesired tripping can occur, and relays on adjacent bus fault may occur outside of primary protection zone.

In this research, explained that messages from control center associated with fault protection device disoperation. In many cases, it is difficult to make conclusions about what had happened. Especially, when protection scheme does not work well and communication failures may occur. To identify fault protection device, it is very important to be handled in real time. When a fault occurs on power system components, then status of adjacent components will be affected when the protection system operated.

Many intelligent techniques application for fault has been proposed in literature [1-3], [5-6], [9-10]. Souza *et.al* (2004) presented a combination method uses Neural Networks and Fuzzy

Received April 9, 2014; Revised May 24, 2014; Accepted June 10, 2014

Logic through alarm processing and identification of fault [1]. In the same time, Yu *et.al* (2004) proposed fuzzy identification using fuzzy neural network [2]. And also, Flauzino *et.al* (2012) recommended Hybrid Intelligent architecture for the fault identification in power distribution system [3]. It detects fault in the transmission line and classification scheme based on single measurement using sinusoidal waveform [4]. Kemal *et.al* (2009) also expressed implementation of the Neuro-Fuzzy inference system in electrical transmission line protection to address different issues in power system [5]. Then, Aziz *et.al* (2011) proposed application the high impedance detection of fault and classification in distribution systems [6]. In the problem of classification fault in power systems using intelligent technique has been reported by several researchers [1, 2, 5, 9, 10]. There are also, fault identification in power system distribution system using hybrid intelligent have been declared by researchers [3, 6]. However, to the best our knowledge, they have not been discussing about fault classification in failure protection system. The aim of this study was to propose the novel concept for fault classification as well as hybrid intelligent technique and to develop new structure in Fuzzy Neural Network.

2. Research Method

For a clearer illustration of failures protection system in Figure 1 is simple electrical power system. Two systems G1 and G2 source energized connected in series and each one is limited by the circuit breaker. G1 is a protection system component for backup protection system component G2. The system of protection G2 acts as a backup system for the protection of G1.

There are two kinds of failures in the protection system, namely:

a) Failed to operate
b) Un-tripping

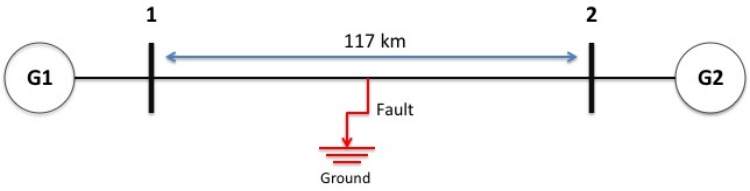

Figure 1. Model of Power System

Protection system is designed to isolate system components in power systems for every time a fault occurs. It should be done very quickly to lower risk of damage to the system protection devices. Speed, selectivity and coordination are some of the most hoped for characteristic in protection system. Then, protection device must operate and coordinated in protection scheme to ensure that only component of fault will be disconnected. The protection device should also have backup protection. If protective device is responsible for isolating fault component that is not working properly, then other protection devices should work. Classification fault defined independently of fault detection [4]. This training procedure is separated according to distance protection schemes in a variety of system conditions.

Classification error is as follows:

a) Class 1 for Single Line to Ground (SLG)
b) Class 2 for Triple Line to Ground (TLG)

In this methodology, Fuzzy Sets are capable of handling problems and certainly qualitative information provided by human experts based on their knowledge and experience that given solution in some problem. Beside that, Neural Networks are difficult to represent some of qualitative data, generalization ability and fault tolerance. Fuzzy Sets represent some structural relationship between several different patterns of fault in system components. Here is a Fuzzy describe structure to establish patterns of system component fault. While the temporary output of Fuzzy Relations to be achieved are:

a) 0 for not fault conditions.
b) 1 for fault conditions

For each fuzzy diagram consists of input variables relays and circuit breakers can operate in fault condition involving components in the area monitored. The input variable in binary numbers; be equal to 1 if a signal has been received or equal to 0 if signal has not been received.

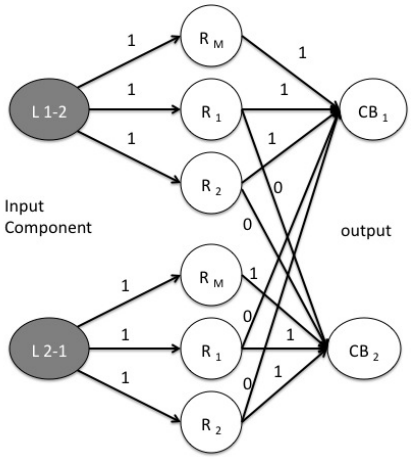

Figure 2. Fuzzy Diagram for Transmission Line

Fault classification is taken from various fault circumstances, carried out for various types of fault, such as single line to ground and triple line to ground. As value of structure Neural Network input voltage and current is to get fault classification. Figure 3 is structure of neural network as classifiers fault. The structure diagram of Neural Networks classifies fault based on information from incoming messages originating from restricted area system. Using several Neural Networks does this; each classification fault is responsible for determining the area of fault in component system.

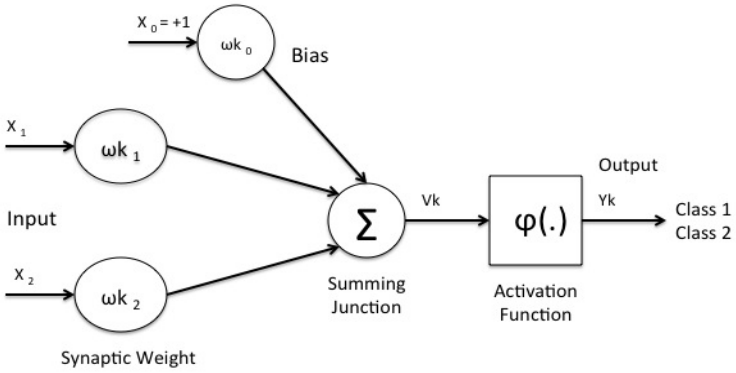

Figure 3. Model of Neural Networks

$$V_k = \sum_{j=0}^{m} \omega kj \, X_j \quad (1)$$

The Sigmoid;

$$\text{Sgn (x)} = \begin{cases} +1 \; if \; x \geq 0 \; then \; class \; 1 \\ -1 \; if \; x < 0 \; then \; class \; 2 \end{cases} \quad (2)$$

The output;

$$Y_k = \varphi(V_k) \tag{3}$$

For linear function;

$$\varphi(V) = \begin{cases} 1, V \geq +\frac{1}{2} \\ V, +\frac{1}{2} > V > -\frac{1}{2} \\ 0, \ V \leq -\frac{1}{2} \end{cases} \tag{4}$$

3. Results

In this section is shown algorithm of fault identification that there five modules compose system: data acquisition, transient identification, occurrence or condition normal condition, signal processing, decision fault, and fault classification as shown in Figure 4. The proposed system operates using only data obtained from substation acquisition, which is derived from three phase voltages and currents. Voltage and current are the input of neural network algorithm, and it will be done after class fault. Prior to classification of faults that will be performed by neural network, also known to determine necessary degree of membership of fuzzy sets. Fuzzy systems are accuracy values in Fuzzy Logic and membership value indicated by value in range of 0 and 1. A value of 0 absolute falsity and declared are declared value of 1 for the absolute accuracy. Fuzzy Sets often mistakenly affected to indicate some format of probability.

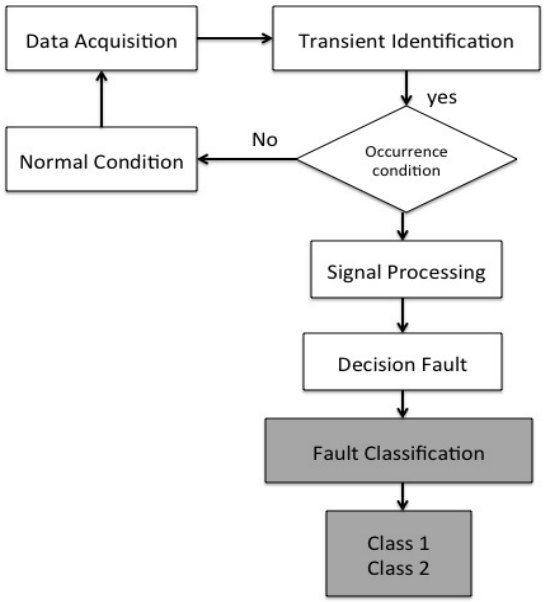

Figure 4. Schematic Diagram of Fault Identification and Classification

3.1. Membership Functions

There are many possible formats of membership function, fuzzy operation largely drawn which set of curves, in this paper using a triangular function. The methodologies to establish membership functions are broadly classified in the following categories: Subjective Evaluation, elicitation, probability, physical measurement, learning and adaptation.

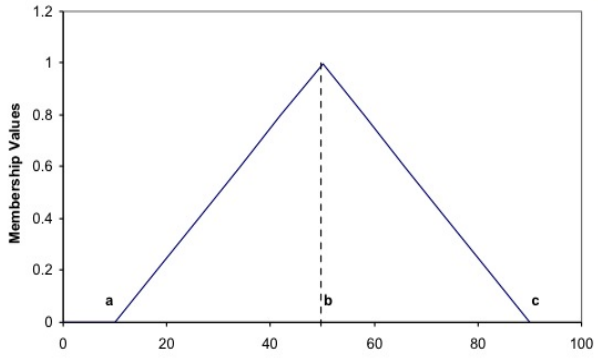

Figure 5. Membership Triangular Function

Min and max operators have been commonly adopted in determining the membership functions that to reflect Fuzzy intersection and union sets. Adaptation can be accomplished through which utilize of parameter family of operators Fuzzy Sets, which might be very useful to obtain the membership functions in several of issues. *Hamacher's* model in [1] and [9], found to be most appropriate in the problem to determine fault in electric power system. In this model, the intersection and union of two fuzzy sets A and B are defined as follows:

$$\mu\, A \cap B\, (\chi) = \frac{ab}{\gamma+(1-\gamma)(a+b-ab)} \tag{5}$$

$$\mu\, A \cup B\, (\chi) = \frac{a+b+(\gamma^{'}-1)ab}{1+\gamma^{'}ab} \tag{6}$$

The distance error is calculated from the number of errors that are similar to the circle of search errors. Simulated power system using ETAP software to provide data errors, the fuzzy rules will be designed and implemented using MATLAB software.

3.2. Neural Network Classifier

Training neural network is built to determine different fault grading involving various components of system. For each neural network consists of input variables consisting of voltage and current are obtained from data records errors that have occurred at the substation. Each training produces fault grading (class 1 or class 2). In Figure 6 shows the structure of hybrid intelligent techniques are used to determine classification fault in power system protection.

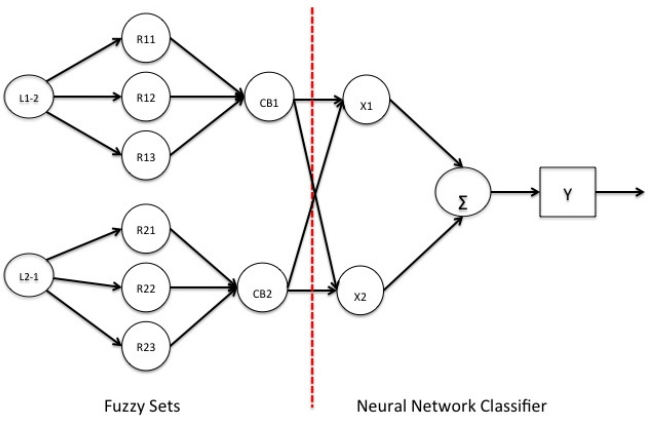

Figure 6. Structure of Fuzzy Neural Network Classifier

Adaptation of weight vector of perceptron;

$$\omega(n+1) = \omega(n) + \eta[d(n) - \gamma(n)]\, x(n) \quad (7)$$

Where;

$$d(n) = \begin{cases} +1\ if\ x(n) belongs\ to\ class\ C1 \\ -1\ if\ x(n) belongs\ to\ class\ C2 \end{cases} \quad (8)$$

Training data used to train neural network classifier for classification Fault taken on different fault conditions. The first, single fault conditions fault to ground. While the second, triple fault conditions fault to ground. Figure 7 shows grading fault with input element, which is voltage and current in fault conditions in system.

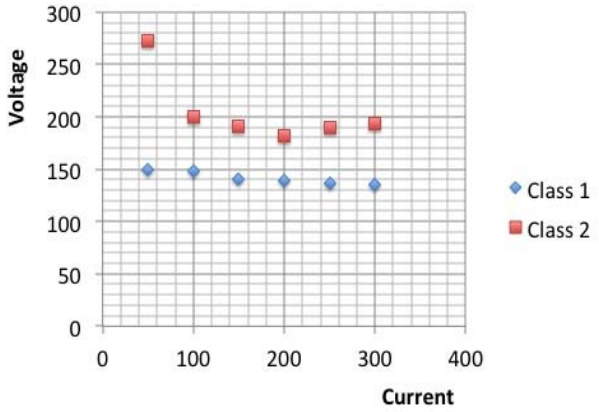

Figure 7. Classification Fault

4. Discussion

In this paper a combined structure was generalized Fuzzy Sets and Neural Network techniques to classification of faults in system of protection. The classification has been done in this paper is classification fault linear Neural Network by using a formula. The Fuzzy Neural Network is able to generalize communication failures that occur on the condition or operation failure relays and circuit breakers on transmission line. Fuzzy Sets are used to identify the fault, while the Neural Network is used to classify fault. This condition can make a different circuit topology in Neural Network training. However, topology changes necessary to train the Neural Network and monitor components of system that one area reconfiguration occurs. Proposed hybrid intelligent technique is also very possible incorporation of some qualitative aspects of problem being solved. This is one of the major advantages of Fuzzy Neural Network. It should be mentioned that maintenance for the proposed model is used as an independent classifiers for each of the different components of monitoring system. The proposed model can easily be used to resolve the power system protection section.

5. Conclusion

This paper presented hybrid intelligent technique for classification of faulty components in power system. System components in power system protection are as a set of training used by Neural Network. The Neural Network was trained to produce an estimate of degree of membership of system components. The structure of proposed hybrid intelligent technique is described between Fuzzy Sets and Neural Network. Fuzzy Sets are used as identification systems failure transient protection as neural network fault grading algorithm. Power protection systems simulated using ETAP software to provide data fault, the Fuzzy rules designed and implemented using MATLAB. Value of 1 indicates if fault occurs and value of 0 indicates no-

fault occurs. This technique has been tested using a real system Riau. The test results showed that diagnosis has been achieved using Fuzzy Neural Network with output of Neural Network. Finally, the concept Fuzzy Neural Network can be proposed as alternative to solve issue of failures that occur in protection system.

References

[1] Souza, JCS et al. Alarm processing in electrical power systems through a neuro fuzzy approach. *IEEE Transaction in Power Delivery*. 2004; 19(2): 537-543.
[2] Yu, W & Li, X. Fuzzy identification using fuzzy neural networks with stable learning algorithms. *IEEE Transaction on Fuzzy System*. 2004; 12(3): 411-419.
[3] Flauzino R An, et al. Hybrid intelligent architecture for fault identification in power distribution system. *IEEE*. 2012; 1-6.
[4] Yusuf AA, et al. A novel fault feature extraction scheme for power transmission line fault diagnosis. *IEEE Africon.* 2011; 13-15.
[5] Kamel TS et al. Advanced distance protection scheme for long transmission lines in electric power systems using multiple classified ANFIS Networks. *IEEE*. 2009. 1-5.
[6] Aziz AMS et al. Application of ANFIS in high impedance faults detection and classification in distribution networks. *IEEE*. 2011.
[7] Li FK et al. *Real-time classification of sports movement using adaptive clustering.* International conference on complex. Intelligent and software intensive system. 2012.
[8] Ismail MM, Hasan MAM. *Distance relay protection for short and long transmission line*. Proceedings of international conference on modelling identification & control (ICMIC). 2013.
[9] Azriyenni, Mustafa WM. Performance Neuro-Fuzzy for Power System Fault Location. *International Journal of Engineering and Technology*. 2013; 3(4): 497-501.
[10] Azriyenni, Mustafa WM, Sukma YD, Dame EM. Application of Backpropagation Neural Network for Fault Location in Transmission Line 150 kV. *International Journal of Electrical and Electronic Engineering (IJEEE).* 2013; 2(4): 21-30.
[11] Pang C, et.al. Fast Distance Relay Scheme for Detecting Symmetrical Fault During Power Swing. IEEE Transaction on Power Delivery. 2010; 25(4). 2205-2212.
[12] Upendar J, et al. Comprehensive Adaptive Distance Relaying Scheme for Parallel Transmission Lines. *IEEE Transaction on Power Delivery.* 2011; 26(2): 1039-1051.
[13] Lee H, et al. Novel Protection Scheme with the Superconducting Power Cables and Fault Current Limiters Through RTDS Test in Icheon Substation. *IEEE Transaction on Applied Superconductivity*. 2012; 22(3).
[14] Jiang K, Singh C. New models and concepts for power system reliability evaluation including protection system failures. *IEEE Transactions on power system.* 2011; 26(4): 1845-1855.
[15] Zhang JF, Smith JS, Wu QH. Morphological undecimated wavelet decomposition for fault location on power transmission lines. *IEEE Transactions on circuits and systems*. 2006; 53(6): 1395-1402.
[16] Lee H, Jung C, Chong SS, et al. Novel protection scheme with the superconducting power cables and fault current limiters through RTDS test in Icheon substation. *IEEE Transactions on applied superconductivity.* 2012; 22(3): 1-5.
[17] Fonseca WADS, et al. Simultaneous fault section estimation and protective device failure detection using percentage values of the protective devices alarms. *IEEE Transaction on power systems*. 2013; 28(1): 170-180.