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A Review on Artificial Neural Network for power system fault detection

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ABSTRACT

This paper presents a review of many papers and various techniques of Transmission line Protection over a past decade. Electrical power transmission lines carry electrical power and hence, have been the important element of power system as the power continuity is concerned. Power continuity is a major concerned for any power system, hence discontinuity at any point of power system results into major economical loss. Artificial Neural Network is a soft computing method, which, once trained, can substitute conventional distance relays or numerical relays with an advantage that it adjusts itself with the changing network configurations. Due to characteristics of Artificial Neural Networks such as pattern recognition, generalization, fault tolerance, high speed parallel processing, it can detect, classify and locate the faults. The main objective of this project is to develop an integrated Artificial Neural Network based protection scheme, that can resolve the problems associated with conventional distance protection techniques. In this thesis, back propagation algorithm based Artificial Neural Network will be developed. For error minimization, Gradient Descent method will be used. The performance of ANN, then can be compared with the literatures available. The main aim of this paper is to put all studies together under single heading for comparison & better understanding of ANN.

KEYWORDS transmission line Fault detection, Artificial Neural Network.

Introduction:

For Protection Engineer, the most important tasks to protect a transmission line are to detect a fault, classify it, and then actuating particular circuit breaking devices at particular locations. Detection of fault means to identify whether it is continuous fault or momentary transient, whether it is in the protection zone or outside the zone. Once the fault is detected in the protection zone, then the next task to carry out is classifying the fault. Classification means to determine the fault belongs to which of eleven possibilities (3-LG, 3-LL, 3-LLG, LLL, LLLG, Refer fig. 1.1). After classification of fault, the tripping commands are sent to particular line breakers.

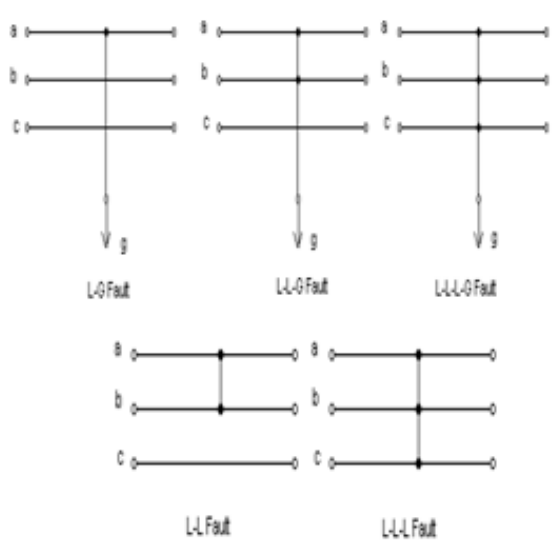

Figure- 1.1 Different Faults in Transmission Line

The conventional or numerical distance relays have fixed settings for a particular transmission line that is to be protected. But, the Electrical Power System or to be precise, Transmission line is the varying element of Power System. The network conditions are changed many times for example; a new line is added to the existing electrical network or a line taken out of service for maintenance or repair. These changing network conditions affect the reach of distance relays and sometimes they malfunction. Also, the effect of arc resistance and power swings affect the relay operation and hence special care has be taken while implementing them in distance protection.

D. V. Coury and D.C. Jorge, "Artificial Neural Network Approach to Distance Protection of Transmission Lines"is state that D. V. Coury and D.C. Jorge have shown how the conventional relay for the transmission line has limitation due to fixed settings and changing network configurations. The paper presented by them has shown the how Artificial Neural Network has been capable of generalizing the non-linear input data and has shown encouraging results in Distance Protection Scheme employed with ANN. In their research paper, the Artificial Neural Network has been used as a pattern classifier to simulate a distance relay. The protection zone of relay has been careful 80 percentage of one section of transmission line. Research paper has shown that the ANN relay can provide a fast and precise operation, keeping its reach accuracy when faced with different fault conditions considering the DC offset in the current waveforms as well as network changes. D. V. Coury and D.C. Jorge have mentioned that the process involved training and testing different ANN configurations until satisfactory performance was achieved. They have pointed out that the ANN tool has opened new dimension in relay idea, which should be widely investigated, allowing researchers to deal with various harms related to transmission line protection. [1]

Mario Oleskovicz1, Denis V. Coury1, Andre C.P.L.F. de

Carvalho2, Artificial Neural Network Applied to Power System Protection is state that This research paper has implemented an alternative protection model to transmission lines applying Artificial Neural Networks. Improved performance to the conventional distance relay was expected, once the ANN could learn the different fault conditions as well as network changes in order to operate in less time correctly. In their work, relay protection zone considered was 96 % of a transmission line length. ANN was supposed to take trip or restrain decision when input pattern of LG (forward and reverse direction) presented to the ANN. The ANN module was probable to learn the correct relay operation during changing network conditions. They have concluded that the use of ANN as an alternative protection model for transmission lines was investigated and relay protection zone was determined by forward and reverse single line to ground fault condition only. It was seen that the performance of ANN to classify forward and reverse fault condition was good quality but ANN reflected poor performance in classification of fault whether it was inside or outside the protection zone. [2]

M Oleskovicz1, D V Coury1, R K Aggarwal2, "A complete scheme for fault detection, classification and location in transmission line using Neural Networks" is state that This paper signifies the voltage and current sets as input data and their generalization by the Neural Network. A complete scheme, by which the distance protection of transmission line can be achieved and has been shown in this paper. This paper has shown important work in complete scheme such as some ANN modules detect fault, some ANN modules classify the fault and some ANN modules place the fault in a given transmission line. Also, this paper has suggested different architectures in the literature to solve problems related to power systems. The paper has mentioned that Neural Networks are useful for power system applications because they can be trained with off-line data. The work, in this paper has presented an ANN move toward to simulate a complete scheme for distance protection of a transmission line. In order to perform this simulation, the distance protection task was subdivided into different neural network modules for fault detection, fault classification as well as fault location in different protection zones. They have used three-phase voltages and currents sampled at 1 KHz, in pre and post fault conditions, were utilized as inputs for the proposed scheme. The results obtained in this paper showed that the performance of ANN was highly satisfactory concerning accuracy and velocity of response for all modules described. The ANN output converged to the correct levels very quickly after up to 5 ms of the fault occurrence. The ANN module has also worked as direction discriminator.ANN relay estimated the expected response in around 98% of the 4,050 patterns tested considering changes in the operational conditions of the system. [3]

Eisa Bashier M. Tayeb Orner Al Aziz AlRhirn, "Transmission Line Faults Detection, Classification and Location using Artificial Neural Network" is stat that This paper describes how back propagation neural network architecture has been used as an alternative approach for transmission line protection. The RMS values of voltages and currents have been considered as inputs and the derived impedances have been used to train the neural network. The results were satisfactory and could have been impressive if more input patterns were used for training the neural network. Due to the litheness of the nural networks which accept any real values as an input, resistant to errors in the training data and fast evaluation. [4]

Hasan Rastegar, Amir P. Khansaryan, "A New Method for Adaptive Distance Relay Setting in the Presence of SSSC Using Neural Networks" is state that This paper has revealed that the series compensation can influence the relay performance. The distance relay operation is precious in series compensated line due over-reach or under-reach. Artificial Neural Network has been used to overcome such problems typically faced by the relay. The Neural Network undergoes training with the changing line parameters. The trained ANN then, can be used as relay providing output such as fault detection, classification etc. when the transmission line is compensated with Static Synchronous Series Compensation (SSSC). [5]

S. Websper, R. W. Dunn, R. K. Aggarwal, A. T. Johns and A. Bennett, "Feature extraction methods for neural network-based transmission line fault discrimination" is state that In this research paper artificial neural network-based transmission line protection scheme has been presented. Fundamental to ensuring the correct and accurate process of this scheme has been detailed research into extracting the best features from the available phase voltage and current waveforms. It is apparent from the results presented that, by including information from the unfaulted phase(s), the protection technique lends itself very well to such factors as variable source impedances and variable fault resistance, including high resistance earth faults. It is also shown that, by including phase angle relationships between voltage and current signals as part of the input features to the ANNs, the attributes of the technique are further enhanced, in particular in the presence of prefault load. The performance demonstrates that the designed protection relay gives very low under overreach errors under a whole variety of practically encountered system and fault conditions; this is in marked contrast to the performance attained from traditional distance protection techniques which, even with adaptive features, give large errors (in excess of 10%) under many practically encountered different conditions. [6]

A.P.Vaidya, Prasad A. Venikar, "ANN Based Distance Protection of Long Transmission Lines by Considering the Effect of Fault Resistance" is state that The above research paper signifies the effects of fault resistance on the performance of electromechanical distance relays. It has mentioned that every fault condition has particular pattern. ANN, as a pattern recognizer, can improve the relay performance. The paper tells that the traditional electromechanical relay process is affected because of effects of fault resistance. An LG fault has been considered and it was seen that ANN was capable of identifying the model. Resistance and Reactance were the inputs provided to Artificial Neural Networks. Levenberg-Marquardt (LM) algorithm in association with back propagation method has been used in this research paper. Results have depicted that the LM method requires less epochs but training period is longer than other algorithm. The suggested neural network is able to detect fault condition and it determines whether the fault is in the protected zone or outside the zone. [7]

F. Zahra, B. Jeyasurya, J. E. Quaicoe "High-speed Transmission Line relaying using artificial neural networks" is state that This paper has presented a scheme for transmission line relaying using ANN. The design of the ANN for transmission line protection can be essentially treated as a pattern acknowledgment problem. The ANN identifies the patterns of associated Voltage and Current frequency components and gives a relaying decision. Using this neural network the relaying decision could be obtained within a cycle after the fault inception. [8]

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