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A SURVEY ON VARIOUS MACHINE LEARNING TECHNIQUES FOR DETECTION OF FAULTS IN TRANSMISSION LINES

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ABSTRACT

Fault classification is necessary for reliable and high speed protective relaying followed by digital distance protection. Hence, a suitable review of these methods is needed. The countless extent of power systems and applications requires the improvement in suitable techniques for the fault classification in power transmission systems, to increase the efficiency of the systems and to avoid major damages. The paper analyzes the technical literature, summarizing the most important methods that can be applied to fault classification methodologies in power transmission systems.

Keywords: *Fault Detection, Fault Classification, Transmission Lines, Machine Learning*

INTRODUCTION

Transmission lines safeguard against exposed fault is the most critical task in the protection of power system. The purpose of a protective relaying is to identify the abnormal signals representing faults on a power transmission system. For high speed protective relaying, fast and accurate fault classification and the key essential in a transmission line. Here transmission lines shield against uncovered deficiency is the most basic errand in the assurance of power system. Faults in overhead lines are an unusual condition, brought on by climate conditions, human mistakes, smoke of flames, hardware letdowns, for example, pivoting machines and transformers, and so on. These issues cause intrusion to electric streams, hardware harms and even cause passing of people, winged creatures, and creatures. These issues are hazard to the congruity of power supply. Fault is nothing but an abnormal condition [1].

Recent technological advancement in machine learning techniques creates an interest to engineers to do research in this area. Earlier various researchers have proposed different schemes for fault classification. The problem is raised, whenever a new user starts his research in this area, he/she may get confusion to select the method to classify the nature of the fault. Because, so many researchers have already developed different methods but each method have their own advantages and disadvantages [2].

It is a challenging task for power system operators to supply uninterrupted electric power to end-users. Although fault intrusion is beyond human control, it is essentially important to accurately detect, classify and locate the fault location. Fault detection, classification and location finding methods in power transmission systems have been extensively studied. Efforts are under way develop an intelligent protection system that is able to detect, classify and locate faults accurately. Advancements in signal processing techniques, artificial intelligence (AI) and machine learning (ML) have aided researchers in adopting a more comprehensive and dedicated approach in studies associated with conventional fault protection strategies [1] [2].

BACKGROUND: TYPES OF FAULT

Faults in overhead transmission system can be classified into two types, i.e. series (open conductor) faults, and shunt (short circuit) faults. Series faults can be identified easily by observing the each phase voltage. If the voltage values increases, it indicates that open conductor fault is occurred. These faults are classified into two types, i.e. one open conductor faults, and two open conductor faults. These faults are very rarely occurred faults. Short circuit faults can be identified easily by observing the each phase current. If the current values increases, it indicates short circuit fault is occurred. Short circuit faults are divided into two types, i.e. asymmetrical faults, and symmetrical faults. Asymmetrical faults line to ground (LG), line to line (LL), and double line to ground (LLG), and symmetrical faults are triple line (LLL) and triple line to ground (LLLG) faults. The Fig. 1 shows the classification of faults in overhead transmission system, in this figure A–C, and G indicate phase A, phase B, phase C, and ground respectively.

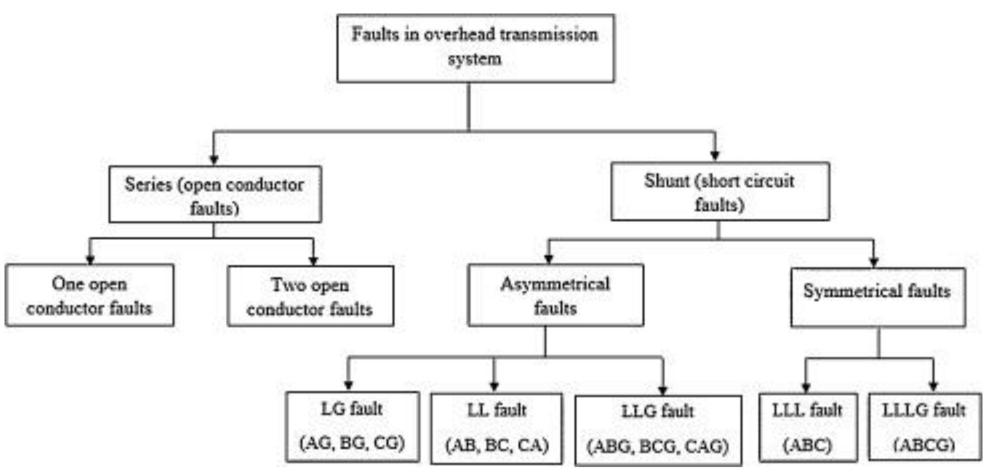

Fig 1: Types of faults occurs in transmission line [1]

RELATED WORK

In power system, overhead lines are most effortless to analyze since the issue is normally self-evident, e.g., a tree has fallen over the line, or a utility shaft is broken and the conductors are lying on the ground. The exactness about its fault recognition and classification are the most vital elements for protection of overhead line. The widely used fault classification techniques in recent study is discussed as follows:

S. Agarwal et.al. [3] identified the fault in less time so that trip command can be initiated to the dc breaker. The dc lines are economical for long length so at far end distance fault identification is essential. The converter control in dc transmission lines control the power and provides synchronous interconnection between two ac systems. The discrete Fourier transform is used to extract the dc current at rectifier end of the dc transmission line and the processed current is compared with the threshold value to identify the fault. The factors considering the effect of fault location and fault resistance are considered for the accuracy, reliability and selectivity.

S. Devi et.al. [4] addressed the variations in the system voltages and load currents during the faulty conditions with linear and non-linear loads. The investigated faults include line to ground fault, double line fault, double line to ground fault, and three phase faults. The detailed simulation study of transmission line faults with linear and non-linear loads has been carried out in MATLAB/Simulink environment. The simulation results show the impacts of faults on the system voltages and load currents.

F. Fayaz et.al. [5] presented a relaying algorithm based on Artificial Neural Network (ANN) technique for the protection of transmission line. A feed forward ANN with six inputs and eleven outputs has been developed for the detection and classification of faults. Data was generated by simulating a 400 kV, 50Hz, 100 km transmission line in PSCAD/EMTDC at a sampling frequency of 2 kHz. Three ANN configurations with different combinations of inputs have been attempted. Initially all the three ANN configurations were trained and tested using truncated data for their comparative performance. ANN-2 configuration has been found to be the best one and has an accuracy of 100% for fault detection and classification in both training and testing phases with the relay operating time of 12.5 ms. ANN-2 has been further trained and tested using full data. Two-fold cross verification was carried out. An accuracy of 100% was obtained on testing with 12.5 ms delay each time.

A. K. Gangwar et.al. [6] presented an algorithm for detection and classification of transmission line faults using time-frequency analysis (Stock-Well Transform) on current signal obtained from both the ends of transmission line. The current samples are synchronized with GPS clock and their absolute values are added at each end, to obtained resultant current signal. The cumulative differential sum of the resultant signal over a moving window of half-cycle is compared with the disturbance threshold, to detect a disturbance.

Subsequently energy of the signal over a half-cycle prior to the detection of disturbance is computed based on (Stock-Well Transform) and compared with fault threshold, to classify the disturbance into faulty and non-faulty transients. Finally, the faults are classified by computing energy of three-phase currents and zero sequence current in comparing with fault threshold. The proposed algorithm has been successfully tested for types of fault, fault impedance, fault incidence angle and fault location.

T. P. Hinge et.al. [7] proposed a novel scheme for fault detection, classification and location which compensate for phase angle error due to line charging current using synchronized phasor measurements in SMART GRID. The work includes fault detection in the phase domain with the extraction of synchronization operator from the measurements available from two ends of transmission line. Synchronization operator is estimated by equating the difference of conjugate of original fault distance and fault distance to zero, since distance is a purely real quantity. The synchronization operator used to locate accurate value of fault distance. Synchronised measurements received from two end terminals of transmission line are incorporated with equivalent-π model of transmission line. Extensive simulations studies show that the proposed scheme provides accurate fault location under various system and fault conditions. Also proposed algorithm is highly encouraging with symmetrical as well as unsymmetrical faults. Fault location estimation is independent of fault resistance.

Jain, Ankit et.al. [8] focused on detecting, classifying and locating faults on electric power transmission lines. Fault detection, fault classification and fault location have been achieved by using artificial neural networks. Feedforward networks have been employed along with backpropagation algorithm for each of the three phases in the Fault location process. Analysis on neural networks with varying number of hidden layers and neurons per hidden layer has been provided to validate the choice of the neural networks in each step. Simulation results have been provided to demonstrate that artificial neural network based methods are efficient in locating faults on transmission lines and achieve satisfactory performances.

J. B. Leite et.al. [9] proposed a strategy to detect nontechnical losses using a multivariate control chart that establishes a reliable region for monitoring the measured variance. After the detection of nontechnical losses, a pathfinding procedure based on the A-Star algorithm is able to locate the consumption point with the non-technical loss. Moreover, a geographical information system application displays the consumption point that is the target of the cyber-attack. The numerical results demonstrate the selectivity and efficiency of the proposed methodology applied for monitoring a real distribution network.

Y. Manjusree et.al. [10] adopted a new approach for detection, discrimination of faults for five terminal transmission line protection in presence of PV and Wind Energy system. It deals about transient current based protection scheme for multi terminal transmission system with discrete wavelet transform. Fault indices of all phase currents at all terminals are obtained by analyzing the detail coefficients of current signals using bior 1.5 mother wavelet. This scheme is tested for various types of faults in multi terminal transmission system in presence of hybrid generation and it is found effective for detection of faults with various fault inception angle, fault impedance at different distances.

R. Resmi et.al. [11] presented an efficient algorithm to detect unsymmetrical faults, classify the fault type and locate the fault zone in transmission lines using Artificial Neural Network (ANN), which could be implemented in numerical relays. The complete system is capable of identifying no-fault condition, the three different line-to-ground faults, line-to-line faults and double line-to-ground faults, and indicating the zone in which the fault has developed. To locate the fault, three zones have been recognized in each transmission line. The same algorithm is implemented in hardware and results are presented.

C. Rangari et.al. [12] implemented a Hybrid Wavelet Singular Entropy and Fuzzy System Based Fault Detection and Classification on Distribution Line with Distributed Generation. The scheme proposed here for fault discrimination ismainlydepends upon the measurement of three-phase current at 25kV bus of distribution line. By the use of DWT;thedetails coefficient are calculated and then the wavelet singular entropy (WSE)of each phase current signals is calculated. The WSE of each phase current are used as input to fuzzy system for classification of fault on distribution line. The simulation study of doubly feeded distribution line system consist of 120 kV, 60Hz source and 9MW wind farm connected to distribution line of 10 km. Simulation study shows that, the developed scheme works accurately for huge number of fault cases.

B. Rathore et.al. [13] deals with the application of wavelet based alienation technique for the detection and classification of faults on transmission lines. The three phase current signals of both the ends are synchronized with the help of Global Positioning System clock. These signals are decomposed with Haar wavelet to obtain approximate coefficients over a moving window of half cycle. Approximate Coefficients obtained over a half cycle are compared with the previous half cycle of same polarity to compute alienation coefficients at each end. A Fault Index, computed by adding alienation coefficients of local and remote end, is compared with the threshold to detect and classify the faults. The proposed algorithm has been tested successfully for various types of faults at different fault locations and different fault incidence angles.

P. Ray et.al. [14] has given an analyzing study on fault detection and classification in a long transmission line which is series compensated using artificial neural network and wavelet transform. The proposed scheme makes use of one cycle pre fault and one cycle post fault samples of the three phase current signals to find the ground current signal. Daubechies is used as the mother wavelet while using the discrete wavelet transform technique. The differential energy, based on discrete wavelet transform is applied to feed a system, designed for the classification of all eleven fault types. Finally, the optimal features which are the energies obtained from discrete wavelet transform of the current signals selected are fed to neural networks for the purpose of fault classification. The reliability of the suggested technique is experienced in a 735-kV, 50 Hz power systems under altered operating settings using MATLAB . The fault was detected and classified using discrete wavelet transform as well as artificial neural network. The results indicate that the proposed scheme can correctly classify every possible fault with large variations in system conditions.

T. Suman et.al. [15] presented the detection of power system faults in the presence of wind power generation. The power system faults such as line to ground (LG), double line (LL), double line to ground (LLG) and three phase fault involving ground (LLLG) has been investigated. An algorithm based on discrete wavelet transform has been utilized for detection of faults under investigation. The current supplied by the wind power system has been found to be key features for the detection of power system faults. The study has been performed using a test system and results have been validated in MATLAB/Simulink environment.

CONCLUSION

A comprehensive review of fault detection with classification in transmission lines has been presented in this paper. A range of techniques and methods are presented in addition to representative works. This work has included many recent fault classification techniques along with their key features. All these techniques have their own features and researches are still going on to obtain lesser operating time of relay at high speed. So there is a necessity for developing new algorithms using advanced optimization techniques and flexible alternating current transmission systems (FACTS) devices that have higher computational effectiveness and suitability for real time applications. Machine learning-based methods are widely employed by the researchers for fault-type classifications. Machine learning including deep learning methods is recommended for future fault detection finding methods due to increased involvement of communication and computation in transmission systems. This paper may provide basic development to the researchers and further study directions in this field.

REFERENCES

[1] Raza, Ali; Benrabah, Abdeldjabar; Alquthami, Thamer; Akmal, Muhammad, "A Review of Fault Diagnosing Methods in Power Transmission Systems", 2020, Appl. Sci. 10, no. 4: 1312. https://doi.org/10.3390/app10041312

[2] Anamika Yadav, Yajnaseni Dash, "An Overview of Transmission Line Protection by Artificial Neural Network: Fault Detection, Fault Classification, Fault Location, and Fault Direction Discrimination", Advances in Artificial Neural Systems, vol. 2014, Article ID 230382, 20 pages, 2014. https://doi.org/10.1155/2014/230382

[3] S. Agarwal, A. Swetapadma, C. Panigrahi and A. Dasgupta, "Fault detection in direct current transmission lines using discrete fourier transform from single terminal current signals," 2017 1st International Conference on Electronics, Materials Engineering and Nano-Technology (IEMENTech), 2017, pp. 1-5, doi: 10.1109/IEMENTECH.2017.8076975.

[4] S. Devi, N. K. Swarnkar, S. R. Ola and O. P. Mahela, "Analysis of transmission line faults with linear and dynamic loads," 2016 Conference on Advances in Signal Processing (CASP), 2016, pp. 99-103, doi: 10.1109/CASP.2016.7746145.

[5] F. Fayaz, A. Isa, H. K. Verma and S. Deb, "Improved ANN-based algorithm for detection and classification of faults on transmission lines," 2016 1st India International Conference on Information Processing (IICIP), 2016, pp. 1-6, doi: 10.1109/IICIP.2016.7975360.

[6] A. K. Gangwar and A. G. Shaik, "Detection and classification of faults on transmission line using time-frequency approach of current transients," 2018 IEEMA Engineer Infinite Conference (eTechNxT), 2018, pp. 1-5, doi: 10.1109/ETECHNXT.2018.8385354.

[7] T. P. Hinge and S. S. Dambhare, "Novel fault location algorithm for transmission line using synchronized measurements," 2016 IEEE/PES Transmission and Distribution Conference and Exposition (T&D), 2016, pp. 1-6, doi: 10.1109/TDC.2016.7519874.

[8] Jain, Ankit & Moses, Beaulah, "Soft computing based fault detection & classification for transmission lines" 2016. pp. 4061-4064. 10.1109/ICEEOT.2016.7755477.

[9] J. B. Leite and J. R. S. Mantovani, "Detecting and Locating Non-Technical Losses in Modern Distribution Networks," in IEEE Transactions on Smart Grid, vol. 9, no. 2, pp. 1023-1032, March 2018, doi: 10.1109/TSG.2016.2574714.

[10] Y. Manjusree and R. K. Goli, "Fault Detection of a Hybrid Energy Source Integration with Multiterminal Transmission Line Using Wavelet Analysis," 2017 International Conference on Recent Trends in Electrical, Electronics and Computing Technologies (ICRTEECT), 2017, pp. 120-126, doi: 10.1109/ICRTEECT.2017.15.

[11] R. Resmi, V. Vanitha, E. Aravind, B. R. Sundaram, C. R. Aswin and S. Harithaa, "Detection, Classification and Zone Location of Fault in Transmission Line using Artificial Neural Network," 2019 IEEE International Conference on Electrical, Computer and Communication Technologies (ICECCT), 2019, pp. 1-5, doi: 10.1109/ICECCT.2019.8868990.

[12] C. Rangari and A. Yadav, "A hybrid wavelet singular entropy and fuzzy system based fault detection and classification on distribution line with distributed generation," 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT), 2017, pp. 1473-1477, doi: 10.1109/RTEICT.2017.8256842.

[13] B. Rathore and A. G. Shaik, "Fault detection and classification on transmission line using wavelet based alienation algorithm," 2015 IEEE Innovative Smart Grid Technologies - Asia (ISGT ASIA), 2015, pp. 1-6, doi: 10.1109/ISGT-Asia.2015.7387062.

[14] P. Ray, D. P. Mishra, K. Dey and P. Mishra, "Fault Detection and Classification of a Transmission Line Using Discrete Wavelet Transform & Artificial Neural Network," 2017 International Conference on Information Technology (ICIT), 2017, pp. 178-183, doi: 10.1109/ICIT.2017.24.

[15] T. Suman, O. P. Mahela and S. R. Ola, "Detection of transmission line faults in the presence of wind power generation using discrete wavelet transform," 2016 IEEE 7th Power India International Conference (PIICON), 2016, pp. 1-6, doi: 10.1109/POWERI.2016.8077174.