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A SURVEY ON THE APPLICATION OF ARTIFICIAL NEURAL NETWORK-BASED APPROACH FOR FAULT LOCATION IN EXTRA HIGH VOLTAGE (EHV) NETWORK

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Abstract- Recently, neural networks have acquired substantial relevance in defect location. The widespread use of neural networks began in the late 1980s and early 1990s. Normally, neural networks are used to improve defect detection, classification, and localization. There has been a lot of study and material written on fault location using neural networks. This research covers use of artificial neural networks (ANN) in identification of faults in EHV networks. We choose recent publications to uncover research gaps or expansions in the chosen study field.
Keywords- Artificial Neural Network, Fault Identification, Extra High Voltage Networks, Defect Location.

I. INTRODUCTION

It has proven possible to perform fault detection, fault classification, and fault localization via the use of ANN. During each of the three steps of the fault-finding process, feedforward networks and a backpropagation algorithm have been used. This section contains analysis of neural networks having different numbers of hidden layers. There are different numbers of neurons in each hidden layer. This justify the choice of sensory networks in each phase. Several simulations have been implemented to validate the usefulness of ANN based technologies in detecting problems in transmission lines. Also this approach provides acceptable performance. Under the fault circumstances, the relay acts as switchgear device in power system. Generalized relays may be divided into the following types of configurations:

Differential Relays: The size of the algebraic difference of two or more of their inputs is what these relays react to when they are used as differential relays.

Magnitude Relays: These relays react to the magnitude of the input amount they are assigned to control.

Input signals from a distant place are received and processed by pilot relays, which react to the signals received and processed by the relay.

Distance Relays: It is dependent upon the current and voltage values at the time of fault. These relays are the most important of the numerous types of relays. In the protection of power lines

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these relays acts as the fault locators. It is common practice to utilize a pair of these distance relays to safeguard a two-terminal transmission line while protecting a network.

II. LITERATURE SURVEY

Recently many researchers use neural networks to find defect, yet they have already garnered substantial traction. The widespread use of neural networks began in the late 1980s and continued into the early 1990s. When it comes to defect detection, classification, and localization, neural networks are often utilized to improve their efficiency. Lots of research and a large amount of literature have been produced on the topic of fault location using neural networks, which is a growing field of study. To identify research gaps or research extensions relating to the specified topic of study, we have picked some recent publications for inclusion in the present paper, which includes some recent studies. The following publications were chosen for inclusion in the study:

Adhikari, S., et al. (2016) [1] presented a fuzzy logic-based online detection of fault and fault classification of transmission lines with help of Compact Reconfigurable I/O (CRIO) devices. For this they used programmable automation and control technology is used. When the LabVIEW software and the CRIO are used together, the real-time data capture of transmission lines may be accomplished. When a problem develops in the system, current waveforms are distorted as a result of transients, and the pattern of the distorted waveforms varies depending on the kind of fault that has occurred. Through the CRIO-9067, LabVIEW generates three phase ac current data with positive and zero sequences. Then this data was processed and sent to the appropriate device. The results validate the suggested approach by performing proper tripping action as well as classification of the kind of fault at high speeds, and as a consequence, it may be used in a real setting.

Anh, T. T. (2018) [2] presented a new method using the classical artificial neural networks MLP (Multi-Layer Perceptron) in parallel with distance relays to correct the fault location estimation of the relay. The Alternative-Transients Program / Electro-Magnetic Transients Program (ATP/EMTP) is used to create the training sample signals of the transient states. The numerical results will demonstrate that the method has assisted in lowering the fault location error from 0.92 percent to 0.42 percent.

AUNG, K., et al. (2017) [3] presented ANN based fault classifier and employed a methodology to find location of fault in double-circuited transmission lines in Myanmar. The suggested approach detects and classifies defects using voltage and current information from each sector. An ANN can characterize nonlinear relationships between observed data by detecting their patterns. The adaptive protection method using ANN is evaluated for fault resistance and fault initiation angle. Once trained, the neural network provides reliable answers for a variety of system characteristics and scenarios. The obtained test results proposed a new protection approach for teed transmission circuit fault finding and sorting. It can increase the performance of standard fault section methods.

Bhupatiraju, R. K. V., et al. (2018) [4] presented a fast and accurate fault classifier for three-terminal transmission circuits. Traditional phasor-based approaches cannot fulfill the high-speed needs of current power networks. Transient-based systems employ powerful signal processing techniques to quickly identify faults. The suggested approach uses transients generated in fault for promptly and accurately identification of the fault. Many transient founded methods fail due to the fault-induced transient patterns with relay-measured signals. An efficient classification system is built founded on the usual designs exposed by the examination of transients generated by fault. At the relay side post-fault voltage signals are recorded. The wavelet transform will be used to extract features from this recorded quarter cycle signals. The approach contains a probabilistic neural network hybrid procedure to deal with transient fluctuations in inception angle and resistance of fault. It is meant to solve the double-line-to-ground fault categorization issue. The suggested method's effectiveness is shown by thorough simulation experiments and comparisons.

Chang, H. H., et al. (2020) [5] proposed a novel fault-localization method that is based on the nonintrusive fault-monitoring (NIFM) methods in EHV transmission. They use the Hyperbolic S-transform (HST) to extract fault signals before identifying them. This research uses power-spectrum-based HST to quantitatively modify HST coefficients reflecting fault transient signals and minimize input size for recognition algorithms (HSTCs). After feature selection, SVMs detect the fault-location indication (SVMs). The electromagnetic transient software is used to simulate different failures in power system. The results show that the suggested approaches successfully locate faults in transmission networks.

Dwivedi, A., et al. (2019) [6] implemented algorithm based on a real-time supervisory protection. This is used to prevent the incorrect operation in the distance relay's third-zone element throughout the load encroachment. The planned supervisory method manages the zone-3 of distant relays by evaluating synchro-phasor data from PMUs spread throughout the power system network. Since PMUs convey information to the central control center more slowly than Zone-3 elements, the algorithm is suited for transmission line protection. In the System Protection and Control Centre, the suggested solution is validated by extensive real-time tests on laboratory model of EHV transmission line. For this they implement the LabVIEW based protection algorithm. To implement PMUs, LabVIEW field-programmable gate array software and NI Compact Reconfigurable Input-Output embedded controllers are used. The experimental findings support the suggested algorithm's practicality for real-time implementation.

Ferreira, V. H., et. al. (2020) [7] proposed the application of autonomous neural networks for charting the correlation among fault statistics on transmission lines and one terminal electrical signals. The suggested neural models change automatically to give information about detection, types and placement. This can give inference hesitation. If a problem is probable, the detection model yields a false positive probability. It offers probabilities for each class and an error margin around the projected short-circuit spot. Essai proposes a fast voltage and current. The experiments simulate real-world transmission line failures in Brazil's electrical grid. The approach works well with multi-terminal and series-compensated lines.

Gayathri, K., & Kumarappan, N. (2015) [8] developed a new algorithm as a highly flexible solution for problems by integration between two circuits under error conditions related with double-circuit transmission lines. The method was founded on six-line circuit currents and three-line voltages. It uses SVM with the recorded frequency characteristics of a +ve sequence voltage and current data. Pre-error conditions and error resistance are tested. The exactness of the method is checked using an error correction tool. In the first step, the accuracy of the method was assessed using SVM reconstruction. In the next step, single line common end current and voltage data is used. Their research introduces a new hybrid EHV error detection method that combines a SCALCG-based neural network algorithm and RBF-based SVM with recreated inputs. The proposed method minimizes error in the short term using both SVM-based RBF inputs and SCALCG-based sensor networks.

George, N., et al. (2019) [9] proposed a novel machine learning-based reach element for zone-1 transmission line distance protection. The challenge is tackled using artificial neural networks as binary classification. The superimposed three-phase currents and voltages are derived using a power cycle window moving average. The first peak rise time and its slope following fault are utilized for model training to predict the fault reach. In addition to fault kinds, pre-fault load flows, and source impedance-to-line impedance ratios, the suggested solution is evaluated for different fault scenarios. Zone-1 detection is accurate to 98.4% within 10 ms of a fault.

Ghorbani, A., et al. (2020) [10] introduced a communication-assisted system to improve calculations of detection and location of fault for a transmission line compensated with TCSC. Only the remote end's current data synchronously transmitted to the local end. The suggested technique requires less data transmission bandwidth than existing pilot impedance-based protection methods. In the proposed approach, the pre-fault situation and fault resistance are irrelevant. This technique does not use TCSC parameters in the resulting formula of location of fault. Hence TCSC parameter fluctuations have no influence on outcomes of the proposed method. Power swing circumstances and measurement errors are used to evaluation of the accuracy of suggested method. The simulation show the suggested scheme's great accuracy and speed in all fault conditions.

Hessine, M. B., et al. (2015) [11] provides an accurate high speed protection algorithm based on ANN for estimating location of fault on EHV transmission lines. This technique was developed using disrupted transmission line models. The suggested protection employs just 3-ϕ current signals at one end of the wire. The suggested approach includes fault detection, classification and fault localization. The samples of 3-ϕ, zero-sequence current components of pre and post fault condition are used for the process of detection and classification of fault. Four ANN networks are used to locate faults. 3-ϕ current pre and post-fault magnitudes are employed. They are tested for several malfunctions such as various fault sites, resistors and installation angles using MATLAB software to validate their performance. The ANN-based classification and location of fault are very accurate for all tests. The simulation outcomes suggest that the given ANN-based technique may be employed for transmission line fault prevention.

Hessine, M. B., et al. (2015) [12] presented a novel algorithm for fault location in EHV transmission lines. Voltage and current at both ends of the post-fault is necessary to calculate the synchronization angle. In the first part, the synchronization angle is valued mathematically.

Then the balanced and unbalanced fault locations are established. The suggested approach is unaffected by pre-fault measurements or fault states. The suggested algorithm's performance is evaluated using digital simulation in MATLAB. The suggested algorithm's simulation results show remarkable accuracy.

Jana, S., & De, A. (2017) [13] presented waveform provides an analysis-based approach for detecting and classifying short-circuit faults. The new zone identification system will be used to divide the large power network into an ideal zones with various buses and lines. This reduced the computational stress of dealing with large amounts of waveform data. The first module of ANN-based taxonomy was designed to achieve an "exploratory world search" for a faulty area, which was further enhanced by the second module of taxonomy to determine the exact "local search" in the zone. Wrong conditions and the like. Disturbance recorders installed at selected bus stops called "monitoring points" collect basic wave data. The extended Kalman filter feature implements abstraction, which is often the basic idea of any waveform analysis based error finding system. The indicated technology has been effectively verified with positive results on the IEEE 57 bus network.

Jiang, J. A. et al. (2018) [14] used long-term wind speed history data to determine types of areas may be at risk for incorrectly measuring temperature of line in the DTR model. The researchers then developed a model which allowed them to predict line temperature with high accuracy. In the case study, it is shown that the projected model can efficiently measure the wind speed in a particular region of the EHV network. The line temperature predicted by this technique may be used as a dependable orientation for the energy transfer approach, which is consistent with the findings.

Kalam, M. A., & Jamil, M. (2018) [15] proposed a new way to protect the EHV-AC transmission system by innovative use of DWT and abstract thinking via the discrete Fourier transform (DFT) in the frequency-phasor. As a result of the maintenance of this method in both the basic components and the current defective signals high frequency, it is possible to obtain greater reliability and selective protection. Using an EHV-AC transmission system mathematical model, the findings were tested against the original data. It has been found that the planned procedure is more precise, humbler computerized, quicker, and legal in more general cases of error than in the literature.

Kapoor, G. (2018) [16] used fault current data from both transmission line terminals, a discrete wavelet transform founded fault finder for a 3-ϕ two-terminal transmission line was given. A discrete wavelet transform toolbox in MATLAB is used to measure 3-phase current and the magnitudes of the approximation and detail coefficients of the 3-phase current are used to determine where the fault is. The suggested approach has been verified for different sorts of faults with a variety of modifications in where the fault is located. It has been shown via testing that the suggested approach is not influenced by variations in fault type and position. This is a significant accomplishment.

Mahari, A., & Seyedi, H. (2015) [17] proposed a new algorithm for detection and discrimination of high impedance fault (HIF) with the help of Wavelet Packet Transform (WPT) for protection in HV transmission lines. The proposed approach takes advantage of the

HIF induced alteration of current and voltage waveforms to identify HIF and discriminate between fault locations. An iterative recursive approach is used to build the algorithm, which sums up the absolute values of high-frequency signal coefficients that have been produced throughout a single cycle of computation. Discussions are also held on the potential use of the suggested algorithm to pilot protection programs. Simulation simulations using the Electro-Magnetic Transients Program (EMTP) are used to test the suggested approach. Several simulations, each of which is carried out using an appropriate HIF model, provide data that are used to evaluate the accuracy with which the proposed approach detects real-time overhead transmission lines fault. The outcomes validate the helpfulness of the suggested protection technique from the views of reliability and safety, among other things.

Maheshwari, A., et al. (2019) [18] developed algorithm based on backpropagation neural network to detect and locate fault in fast protection systems and overhead transmission lines. For this they used terminal data. In order to train the neural FL, multiple data sets from a specified power system model are used. Simulations of different fault situations and diverse power system data from different sources are used. For correlative research of fault locators (FLs), two ANN-based FL1 and FL2 are suggested. The investigation is carried out in the context of traveling wave based FL in order to establish which FL provides the best performance and which FL does not. Related to traveling wave-based FL, the suggested ANN-based FL achieves superior fault-location outcomes, as shown by the results of the experiment. The results also show that the various single line to ground faults are more accurately found with proposed ANN-based FL than the previous FL.

Mallikarjuna, B., et al. (2019) [19] proposed a real-time synchronized harmonic phaser measurement based fault location finding technique. At the protection center, phaser measurements are found from phaser measurement units (PMUs). The PMU calculates the time-tagged 100Hz and 150Hz phasers of different current signals on each bus. The recommended method finds the error using 100Hz and 150Hz 3-ϕ current and EHP. Time-tagged 50Hz, 100Hz and 150Hz 3-ϕ current phasers are used to determine EHP. The RT-SHPM-FL approach uses SVR to estimate the fault distance as of its imitating, generality, and sturdiness. The suggested fault-finding approach was tested in real-time on a 400km long laboratory model of a 400kV EHV transmission line. The outcomes and discussions show that the suggested approach will definitely solve the transmission line problems. The comparison of the SVR misdiagnosis approach to the Adaptive Neuro-Fuzzy Estimation System, with an error of 1%, was found to be more reliable at the fault location than the previous one.

Mbamaluikem, P. O., et al. (2018) [20] *developed a single ANN to find and categorize faults in Nigeria's 33-kV power transmission lines. For the defect detector-classifier, they used feedforward artificial neural networks using a backpropagation method. The simulation model of transmission lines was done in MATLAB. The simulation outcomes shows the advanced smart systems for finding and cataloguing fault. The MSE and the confusion matrix are used to assess the detector performance-classifier. The systems attained satisfactory MSE of 0.00004279 and an accurateness of 95.7 percent. The designed system outperforms previous systems in the literature on Nigerian transmission lines.*

Mbamaluikem, P. O., et al. (2019) [21] applied ANN to improve electric power line protection by identifying asymmetrical faults in the line. In order to train the suggested artificial neural network-based shunt fault identification systems, a collection of voltage and current readings from states of distinct asymmetrical fault of the examined power system was used. The ideal ANN-based model/configuration was determined by comparing the three asymmetrical fault recognition models. With the highest performance, the ANN-based technique which takes current and voltage readings as input may be used to develop asymmetrical fault detection devices for electric power lines.

Mbamaluikem, P. O., et al. (2018) [22] presented a new approach to recognize shunt faults on the 33-kV Nigeria power line network using an artificial neural network. Network get modeled and simulated with the help of MATLAB/Simulink 2015. Here the researcher used a feed-forward neural network and back-propagation method. The suggested method leverages instantaneous voltage and current readings from power lines to identify shunt faults. The designed smart fault identification system for shunt faults was 100% accurate in all tests. The findings demonstrate that this technique can accurately detect all shunt faults on 33-kV Nigerian power lines.

Mishra, D. P., & Ray, P. (2018) [23] explained various signal processing methods, impedance-based measurement methods, AN-based technique, traveling wave phenomenon-technique, and some specific techniques for locating, positioning and classifying various defects in transmission networks are discussed. In this study, the paper outlines all the policies and procedures used as of August 2017. This concise and efficient survey aids the researcher in better understanding the many approaches and procedures available.

Mosavi, M. R., & Tabatabaei, A. (2016) [24] described and compared four-fault location algorithms based on DWT using a global positioning system. To enhance the replies, two ways use the arrival instances of traveling waves to discover where the fault is located. The position of the fault is also identified in two additional approaches using the artificial neural network to mimic the non-linear relations and therefore improve the responses. The ATP–EMTP is used to produce all of the conceivable fault types, and the findings obtained utilizing the four approaches are described. Extensive simulation experiments have shown that by using a small-size database for training, the suggested networks may reduce the error percentages of two wavelet-based techniques from 0.350 to 0.220 and 0.210 to less than 0.150 percent, respectively, compared to the original approaches.

Mukherjee, A., et al. (2021) [25] proposed a probabilistic neural network (PNN)-based fault classification methodology. A three-phase fault intensity index is extracted from differencing-based modulated fault signals and then examined for direct fault classification using a decision tree like analysis. The analyzer's resilience has been improved by simulating faults in a realistic setting with a range of fault sites, resistance of fault, and intrinsic power line noise. This study achieves 99.33 percent classifier accuracy while employing just 1/6th of post-fault data, is low related to comparable recent research. The suggested classifier may also recognize ground faults deprived of analyzing the neutral current. To train the model, they only utilize 35.7% of the total fault sites, which is above average. The analyzer uses a single PNN model as a classifier, reducing computational complexity.

Onaolapo, A. K., & Akindeji, K. T. (2019) [26] presented a model for predicting electricity outages caused by weather events. They employed the back-propagation method, which is linked to ANNs (ANNs). The performance of the ANN model is compared to various traditional models using real-world data from Pietermaritzburg, South Africa. These are the ES and MLR models. Compared to MLR and ES, the ANN model's outcomes are good. The findings show that artificial neural networks are resilient and can forecast power interruptions due to weather-related issues.

Peter, O., et al. (2018) [27] explained that the University of Lagos is exploring the use of ANN technology to detect and categorize several faults in an 11 kV distribution network. ANN is used because it is fast, efficient and requires very little human interaction. Case study data are divided into three categories: training, testing and certification. Programming language Python is used in this method for mathematical formulations. The study's findings for voltage and current under various fault situations are graphed and analyzed. Due to the restricted datasets employed, the model produced good results in fault detection and cataloguing in a distribution network. This study's findings may assist system operators to identify and classify issues, allowing them to make more informed choices on power system design and dependability.

Prasad, A., & Edward, J. B. (2017) [28] presented a survey on the location of faults in overhead transmission lines using ANN. The daily energy demand increasing in proportionate to population growth, and they need to create more power to keep up. It is a difficult responsibility for power engineers to offer customers high-quality electricity that meets their needs. The majority of failures in an electrical power system occur on overhead transmission lines. Locating a defect is a critical step in fault analysis. As a result of the unanticipated changes in electrical power systems, it is required to upgrade older protective relaying systems. Their review demonstrates the relevance of ANN for fault identification, owing to their many benefits over existing soft computing approaches, including support vector machine, wavelet, fuzzy logic and other traditional methods.

Radhi, A. T., et al. (2021) [29] introduced a fast and accurate misalignment, classification and directional algorithm using one-dimensional convolutional neural networks (1DCNN) of transmission lines, which can be used as a learning algorithm to sidestep feature removal difficulties and misclassification. As a result, a discrete feature extraction approach is no longer required, bring about more operative defensive system. The suggested algorithm uses the 3-phase currents and voltages of one end at the relay point in the network. The proposed 1DCNN technique uses MATLAB Simulink to simulate a 132kV power transmission line. The suggested algorithm's testing accuracy is compared with other methods. The test outcomes show that the newly suggested identification system is faster and more efficient to detect and specify discriminatory errors in transmission lines with greater accurateness compared to other existing methods.

Raval, P. D., & Pandya, A. S. (2016) [30] introduced the proposed novel approach to protect the EHV multi-bus transmission system used by the capacitor series bank. The wide variety of operating conditions and error conditions in the transmission chain compliant transmission line makes it difficult to identify and classify problems using the standard transmission method. To differentiate the defect, a multi-resolution wavelet variation is used to classify CT signals into lower and upper extremities. The PNN-based technique with a unique feature extraction methodology has been proved to classify transmission line problems. Extensive simulation experiments show that the classification of fault pattern technique given here is effective and resilient under a broad range of transmission line operating situations.

Raval, P. D., & Pandya, A. S. (2017) [31] presents a novel idea of protection of the multi-terminal Extra High Voltage network with multiple series compensation. They suggested employing statistical learning to enhance classification of fault using ANNs. Single-end current measurements from three phases of the line are used to identify and categorize problems. They used an MRA wavelet transform to fragment the data and extract statistical characteristics. Varying neural network parameters of ANN structures series are used to select the optimum ANN topology for classifier. This adjusts system parameters in the test system and produces fault patterns based on fault situations. To increase classification accuracy, ANOVA F-test statistics are used to pick relevant characteristics. The fault pattern characteristics are supplied to the Hybrid Wavelet-ANN structure. After training it is tested on the remainder of the patterns and verified. To categorize the fault patterns, a "Support Vector Machine Classifier" is utilized. The data set is cross-validated 5 times to ensure SVM correctness. SVM is proven to be less accurate and reliable in finding and classifying fault patterns than the suggested hybrid pattern recognition algorithm.

Raval, P. D., & Pandya, A. S. (2020) [32] introduced a new way of distinguishing faults in EHV power lines with compensation for the series. The strategy uses single-ended currents from three sections of the transmission line to identify and classify errors. The complete model is designed to test error patterns in a dual EHV feed system with multi-chain compensation. The algorithm employs a whole post-fault cycle. In this case, a multiresolution wavelet-based decomposition is applied. Various defect classifiers employing SVM with various feature vector groups are designed. The performance of SVMs in a specific defect feature space is compared. The Ensemble technique is suggested using ANN, K-Nearest Neighbor (KNN) and SVM. Ensemble Classifiers are taught and evaluated on a variety of fault patterns. The subspace partition approach improves the performance of the Ensemble Classifier with varied feature combinations. The suggested Ensemble Classifier is 99.5% accurate.

Saini, M., et al. (2016) [33] proposed a new technique to detect and classify faults using DWT and BPNN. This technique was based on Clarke's transformation. PSCAD / EMTDC and MATLAB are used to simulate and train the network. The high-frequency signals are decomposed using the DB4 mother wavelet. Back-propagation neural networks employ wavelet energy coefficients (WEC) and wavelet transform coefficients (WTC) to classify faults and find patterns. After that, a neural network classifies the failure situation. We show a preprocessing DWT with near-optimal performance. It compares outcomes of training DWT and BPPN with and without Clarke's transformation and finds that employing Clarke's transformation reduces "mean absolute error (MAE) and mean square error (MSE)". The results indicates that new method is more accurate and trustworthy.

Salam, M. A., et al. (2016) [34] studied an efficient neural network-based estimation technique to appraisal the magnetic field strength near any power substation and to assess the possible exposure to electromagnetic radiation received by the residents living near that substation. The measurements and estimations were made near high-powered equipment at four substations in Brunei Darussalam. Initially, the TM-191 gaussmeter was used for all four 66/11kV substations. The Telisai substation measured 12.5mG near the lightning arrestor, whereas the Lamunin substation measured 0.1mG near the same equipment. A neural network with one or two layers was used to estimate magnetic field strengths (ANN). The greatest coefficient of determination was obtained using a single-layer ANN estimate at 98 percent, and about 99 percent using two-layer ANN estimation. These coefficients of determination show that the artificial neural network can accurately predict magnetic field intensity.

Serry, S., & Halim, H. (2015) [35] demonstrated the usage of artificial neural networks (ANN) for extra-high voltage (EHV) series compensated network location of fault. The suggested ANN is quite precise and promising for fault location estimation. Also shown is the ANN for a compensated line with one three-phase bank. A 400-kV, 300-km transmission line was also thoroughly evaluated using MATLAB software. The findings showed the ANN-based algorithm's great accuracy and resilience. The angles of fault initiation and detection are explored. The sources' currents, voltages, capacitances, angles, and time constants are discussed. The experimental findings backed up the theoretical results precisely. Other studies complemented and clarified the current work's findings.

Singh, S., & Vishwakarma, D. N. (2016) [36] presented a unique method for finding fault location by combination of AI technique and wavelet transform. The suggested method analyzes faults by sampling defective current signals from the Simulink model. The Db5 mother wavelet decomposes the fault current signals. The norm entropy of the coefficients and standard deviation are retrieved from defective signals and input into ANN models for fault distance estimation. A comparison of Cascade-forward, Feed-forward and generalized regression neural networks' mistakes in calculating fault distance was also given (GRNN). The suggested algorithm's precision and workability were tested on a 400KV, 300km series compensated transmission line using MATLAB simulation. The findings show that the suggested method can accurately identify faults in a series compensated transmission line.

Singh, S., & Vishwakarma, D. N. (2016) [37] proposed an accurate approach for classifying and locating faults in a series compensated (SC) network employing DWT and ANN. Using a Db5 mother wavelet, the suggested technique decomposed fault current samples from simulation. The wavelet coefficients' norm entropy, minimum and maximum values, and standard deviation of detail coefficients of 1st and 5th levels are used to identify fault signatures. The acquired characteristics are then used to train and evaluate classifier and distance estimator models. An SC network with a 400 KV, 300 km capacity was used to evaluate the suggested two-stage approach's effectiveness and accuracy. The test results show that the suggested method consistently classifies and locates defects.

Swetapadma, A., & Yadav, A. (2016) [38] demonstrated a time-domain relaying scheme for complete protection of parallel transmission lines using Violet transformation and ANN. Four different ANN networks are being developed for temporary identification, incorrect section identification, incorrect classification and incorrect localization on a temporary domain, all of which are separated from each other. Estimated Disc Violet Transformation (DVT) modules of signals from one end are used as inputs in the third level abstraction to the ANN network. This approach is evaluated with various fault characteristics such as defect location, installation angle, type and resistance of fault. The outcomes showed that the problem was correctly identified and detected within 5 milliseconds. For the lines, this design provides main protection as well as backup protection.

Swetapadma, A., & Yadav, A. (2017) [39] proposed finite-state automata or finite-state machine-based directional protection schemes for transmission lines. The phase angle of +ve sequence current is utilized to estimate fault direction using finite state automata. Finite-state automata are used to detect fault patterns and predict fault direction. The proposed FSM-based approach would output ‘1' for main section faults and ‘1' for reverse section faults. In this study, the suggested technique's performance is assessed using data simulated for fault resistance and failure kind. The method's accuracy is 100% across all 11,500 fault situations. Unlike standard directional relaying techniques, the suggested methodology does not employ voltage, allowing for close-in defect detection. A reach setting of up to 99.9% of the line length is suggested, vs 80–85% for standard relaying methods. Unlike an artificial neural network, the suggested approach requires an additional training module to appropriately identify the direction. As opposed to training-based algorithms, the suggested approach is successful since it does not need any training. The suggested approach is also tested in an existent network in India, predicting fault direction accurately.

Terojeni, G., & Koochaki, A. (2017) [40] suggested an efficient and practical algorithm based on using wavelet transformers for precise detection, classification and location of fault. The wavelet coefficients' spike directions and magnitudes are utilized to identify and classify faults. The total of the five-level MRA coefficients of the currents is supplied into an adaptive neuro-fuzzy inference system (ANFIS) to locate the fault. The suggested technique can identify internal faults at various places on HVDC transmission lines, at various inception angles, and at various fault resistances. It may also distinguish between internal and exterior defects. The results suggest that the proposed technique is straightforward and obvious in recognition. The simulations are done using EMTP-RV.

Tong, Z., et al. (2018) [41] proposed ANN based method of a fault diagnosis and location on regularized radial basis function (RRBF). In detail investigation of the phase angle of the fault voltage and the current signal are done. In the suggested technique, synchronized amplitude and phase angle features are used for defect identification, and the RRBF neural network is used to accomplish this. In the IEEE 13-bus active distribution network (ADN) system, researchers are looking at fault diagnostics and the location of the distribution branch's defect. The influence of diverse input signals, fault position, and fault resistance on diagnostic accuracy and location precision is investigated in this research. The result illustrates that the localization approach based on the phase angle feature has greater accuracy than the other two methods tested. The RRBF fault diagnostic and localization approach seeks to locate and fix the issue in ADN while also laying the groundwork for the long-term stability of the ADN system.

Uzubi, U., et al. (2017) [42] presented a unique and efficient ANN based detection, classification and location of fault on the part of the Nigerian 132kV transmission line. An ANN-based relay linked at both ends of a line using a feed-forward non-linear supervised backpropagation method with Levenberg-Marguardt network topology is evaluated. They are supplied into the same line using two distinct 132kV voltage sources with multiple changes of fault initiation angle, position, and resistance. MATLAB program extracts, processes, and divides the fault currents into training and testing data. The simulation findings are confirmed using actual data from an Aba-Umuahia 132kV transmission line microprocessor-based relay. The findings show that ANN can accurately detect, categorize, and locate a defect on a transmission line.

Verma, A., & Yadav, A. (2015) [43] proposed a directional relaying scheme for fixed series capacitor compensated transmission lines using ANN. This ANN is trained on the basic voltage and current data and then trained on the results to identify a defect on the transmission line and to identify the section of the fault. To examination of the behavior of the planned technique, several factors such as type, location, inception angle and resistance of fault are modified. The suggested algorithm's accuracy and efficacy are shown by the results of the tests. For the suggested technique, the time required for relay operation is less than half a cycle. The defect detection technique has a 99 percent accuracy rating, whereas the section identification scheme has a 100 percent accuracy rating.

Vogelsang, J. et al. (2015) [44] proposed an approach for a real-time adaption of the dead time for auto reclosing on high-voltage lines. The goal was to optimize a single-phase auto-closing cycle's dead time by computing secondary arc current from data. The optimization techniques were for real-time applications. The load currents of the parallel non-faulty cables were also measured. The dead time was measured and calculated during the fault condition. This optimized the dead-time setting for the actual fault site and loading circumstances. This method determines the minimal dead time required for effective reclosing based on the fault site and load circumstances. Tests on high-voltage field lines and analytical computations confirmed the findings.

Vyas, B. Y., et al. (2021) [45] presented a new and fast approach for the detection and classification of the fault on a transmission line. An uncompensated transmission line may be detected and classified using the suggested approach. The same algorithm can identify and categorize faults in fixed series compensation lines with same correctness without any practical adjustment. This solution eliminates the new setting required for series compensation. Vice versa may safeguard a series compensated line during maintenance or a compensator bypass. This makes the algorithm flexible. To classify faults, the suggested technique needs no data after producing the fault detection signal, allowing the use of quicker circuit-breaking devices. Only measured 3-phase current signals are used in the two-stage Wavelet Transform using

Chebyshev Neural Network. The scheme's accuracy, speed, and efficacy were tested using a PSCAD/EMTP fault data production system with varying system parameters including resistance, inception angle, class of fault and load angle. The findings demonstrate that the suggested approach is both accurate and quick.

Wadi, M., & Elmasry, W. (2021) [46] proposed an anomaly-based technique for fault detection in electrical power systems. It is also necessary to use a one class SVM model as well as a Principal Component Analysis (PCA)-based model in order to complete the assignment. The models utilized are trained and evaluated using the VSB power line fault detection dataset, which consists of a vast quantity of real-time waveform data made available on Kaggle. Finally, our findings are subjected to performance and Receiver Operating Characteristic (ROC) curve studies, which are used to demonstrate the usefulness of the suggested approach in solving the defect detection issue.

Yadav, A., et al. (2012) [47] presented an accurate algorithm to classify and locate fault for Teed transmission circuit based on ANN. The suggested method detects, classifies, and locates defects by measuring voltage and current signals at one end of the teed circuit. An ANN can characterize nonlinear relationships between observed data by detecting their patterns. The adaptive protection method using ANN is evaluated for resistance and inception angle of shunt faults. Once the neural network is properly trained, it offers correct results for various system characteristics and settings. The suggested adaptive protection approach is ideally suited for teed transmission circuit fault classification, distance localization, and defective section identification. The suggested neural network-based module outperforms standard fault selection techniques in performance tests.

Yang, Q., et al. (2020) [48] proposed an in-depth learning approach to directly detect faulty situations based on the detection and extraction of supervised feature for positional judgment by taking advantage of the hidden layer activations of repetitive neural networks. To analyze both frequency domain and time domain signals, enhancing deep repetitive neural networks with a gated recurrence unit is used in conjunction with a long-term short-term memory unit. The suggested technique is tested on a four-terminal high-voltage direct current system that is built on a modular multilevel converter architecture. Different defects under different conditions were simulated. The simulation outcomes confirmed a high level of accuracy, rigidity and speed as a result of the use of characteristic abstraction in the simulation process.

Yashvantrai Vyas, B., et al. (2016) [49] presented an approach to identify fault type based on pattern recognition with SVM. In order to complete the job, the technique solely makes use of half-cycle post fault data from 3ϕ currents. Discriminatory measures have been proposed to account for changes in current signal characteristics during a malfunction. Throughout this work, the created technique is put through its paces on a huge collection of defect data that includes changes in both system and fault factors. These fault instances were created using PSCAD/EMTDC on a 400kV, 300km transmission model, and they are shown here. Because of its enhanced accuracy and speed, the new algorithm has shown to be more suitable for application on TCSC compensated lines.

Zhuang, T., et al. (2019) [50] demonstrated a wireless sensing network based on IoT technology for insulation condition perception. First, the wireless sensing network's fundamental foundation is created with extensibility and accessibility in mind. It then goes into depth on the technical needs of the sensor node, power management, and data transfer. Two examples of IoT-based partial discharge sensing networks implemented on switchgear cabinets and power cables are described, with information on sensor node design, energy consumption, Lora/NB-IoT network architecture, and data utilization techniques. With the distribution grid, this IoT-based insulation condition monitoring is likely to be referenced for future prospective IoT applications.

III. PROPOSED METHODOLOGY

Despite the fact that the fundamental notion of relays has remained the same, digital technology has had a considerable impact on the way relays function and has provided various advantages over old electromechanical relays in terms of performance.

In this study, the primary objective is to design, develop, test, and finally implement a comprehensive method for fault identification, as shown in Fig.1. Initial data collection and sub-division will be carried out on the full dataset, which will be separated as the training and testing data sets. The initial phase in the procedure will be the identification of faults. Once we have determined that a fault has occurred on the transmission line, the following step will be to categorize the problem into various categories depending on the phases that have been affected by the issue.

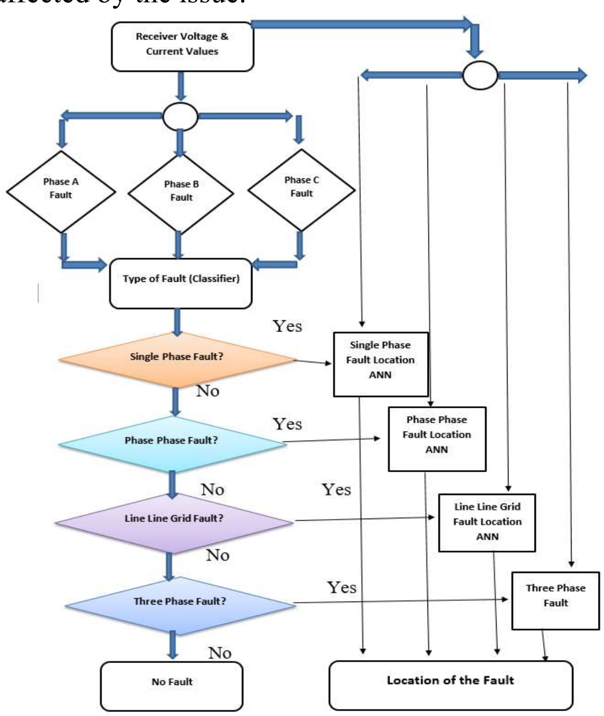

Fig. 1. Complete Strategy for the Fault Diagnosis

Neuronal networks will be used in this research to investigate if they can be used as a substitute for traditional methods for detecting, classifying, and locating transmission line problems. Neuronal networks will be fed information from the techniques used to make use of phase voltages and phase currents (scaled in relation to their pre-fault values) that will be used to detect faults.
There are many different types of faults that may occur, including single line to ground faults, line to lines, double line to ground faults, and three-phase faults that should be considered in this study, and various for each of these issues, it has been recommended that ANNs be used. All of the neural networks explored in this study are based on the back-propagation neural network design, which is described in detail below. With the help of ANN, it will be possible to design a fault location scheme for the transmission line system that will operate successfully from the point of detection of problems on the line to the point of fault placement. The simulation results produced will demonstrate that all of the suggested neural networks, taken as a whole, have attained sufficient performance.

IV. CONCLUSION

It can be concluded by referring to various research articles that we can use artificial neural networks for fault identification in extra high voltage networks. Recently, neural networks have acquired substantial relevance in defect location. Normally, neural networks are used to improve defect detection, classification, and localization. There has been a lot of study and material written on fault location using neural networks. We have fixed our own strategy to solve the fault location problem in the EHV network.

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