Machine Learning Model to Forecast Power System Breakdowns

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Abstract: For the modern power system to be protected from transmission line failures, real-time monitoring and quick controlare necessary. For power systems to operate with reliability, it is essential to identify and classify fault conditions. The conventional methods for fault diagnosis rely on several scholars have suggested the manually extracted feature of experienced engineers for defect identification and classification. Any analogue circuit's reliability depends heavily on the capacity to detectproblems. Early detection of circuit failures can considerablyaid in system maintenance by preventing potentially damaging from the issue. In particular for fault orientations and severity levels, intelligent fault detection still has a significant challenge inaccurately finding the emerging micro-fault in the power system. Intelligent fault detection methods based on machine learningare the topic of a research boom in fault diagnosis

1 INTRODUCTION

The power transmission network, which carries substantial volumes of high-voltage power from generators to substations, is the most crucial component in the nation's energy system. Being a complex network, the modern electricity system demands a quick, accurate, and reliable protection mechanism.It is unavoidable for the power system to develop faults, and these faults frequently include important components connected to higher overhead transmission lines. Being ableto predict faults (type and location) with a high degree of accuracy, therefore, increases the operational reliability and stability of the power system and aids in preventing catas- trophic power outages(K. Eldeeb 2021).Power system faults can happenfor a number of reasons, despite the fact that numerous essential protection devices are used in their detection These errors must be detected and identified as soon as in possible, and they occasionally cause full system failures with an effect on clients Yet, in order to avoid the aforementioned issues,it is vital to anticipate the defects in advance. These defects must be predicted and identified as soon as possible, though,as they occasionally cause total system outages that have an impact on the client Even though, it is fundamental to identifythe defects in advance in order to avoid the problems [Y.Zhang 2021].

As a consequence of the arrival of digital technology and the development of a smart grid, it is now feasible to install sensors along power lines that can record data on large defects.These sensors give crucial data that will be used to identify problems in transmission lines.

2 THE GENERATION, TRANSMISSION AND DISTRIBUTION OF ELECTRICITY

The generation, transmission and distribution is shown in figure.1

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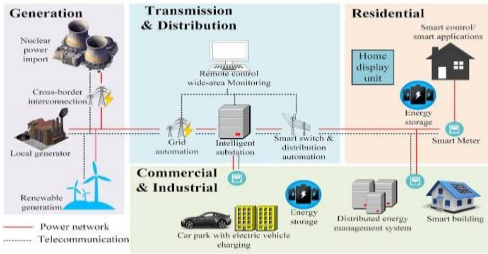

Fig. 1. Generation, Transmission and Distribution

2.1 *Knowledge of transmission*

Electricity is moved through the energy transmission process from power plants and other electricity-generating facilities to substations that are closer to customers. Transmission lines transmit a lot of high voltage energy over vast distance Transmission lines carry energy at a voltage that is too hi to be directly transmitted to customers. As a result, before supplying electricity to households and businesses, energydistributors typically reduce the voltage levels of transmitted electricity [B. Guo 2020].A transmission line can be recognized by in structure and height. These long, lofty lines, which are nor mally 30 feet above the ground, contain numerous wires, as they cross great distances

2.2 *Knowledge of distribution*

The final step in the delivery process from energy generation to user is the distribution system. The distribution systemtransports electricity at a voltage suitable for use in homesand businesses(Y.Zhang 2020). Consumers can quickly spot distribution lines since they follow residential streets. Appliances and other essentials are powered by the electricity delivered throughdistribution ..

3 FAULTS

Generally speaking, the appliances or equipment in the power system are made to execute a continuously needed function, with the exception of times when preventive maintenanceis required or there are no external sources available. As this defect can develop under any conditions at any given time in the power system, it is an unpredictable element that might enter the system to stop it from performing its essential function. Transformer failure is an example of an electrical fault, which is an unusual condition caused by moving equipment, operator error, and climate changes(Y.Zhang 2020). Electric flow interruptions,equipment damage, and even human, bird, and animal deaths are all results of these faults.

4 TYPES OF FAULTS

Electrical faults are specified as voltage and current di-vergence from reference value or states. Usually working under typical circumstances, power system components or lines operate with typical voltages and currents, making the system safer to use. The equipment was harmed as a resultof the very huge currents that flow when a fault occurs. The electrical infrastructure is prone to two different forms ofproblems. There are faults which can be both symmetricaland asymmetrical.

4.1 *Knowledge of distribution*

The proportion of symmetric system errors is only 2–5 percent. If these problems occur, the system remains balanced,but the machinery of the transmission system for power is seriously affected. Three-phase symmetrical faults come in two varieties: (L-L-L-G) and (L-L-L).These faults are easy to analyze, and the process is frequently carried through phaseby phase basis.

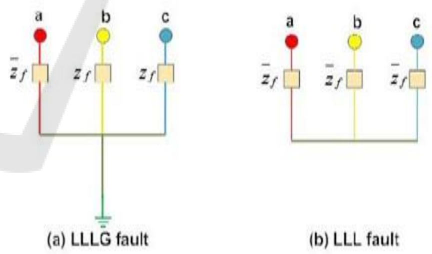

Fig. 2. Example of Symmetrical faults.

Line to Ground (L-G), Line to Line (L-L), and Doubleline to ground (LL-G) faults are three basic types of Un-symmetrical faults. Line to Ground faults (L-G), which make

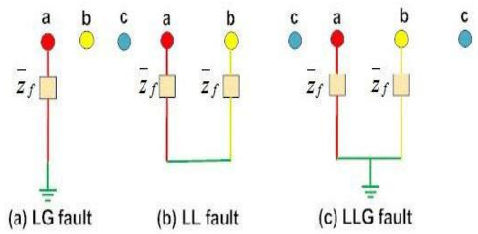

Fig. 3. Example of Unsymmetrical faults

up from 65 to 70 percent among all problems, are the most common form of fault. Double line to Ground faults happen for 15 to 20 percent of all faults and put both conductors into the path of the ground (O. A. S. Youssef ,2004).Line to Line faults are however known as unbalanced faults because they cause the system to become unbalanced when they occur. An unbalanced system flows unbalanced current because each phase has a different impedance level (F. B. Costa et al.,2012, A.M Gauoda et al.,2002)

5 MACHINE LEARNING

Machine learning makes predictions using statistical models. Simplest and basic technical terms, machine learning refers to the employment of algorithms that take empirical or previous data as input, analyze it and then output results based on the that analysis. In certain techniques, the algorithms first run on so-called" training data" drawing conclusions, and working out strategies to enhance their accuracy over time[9].

Table1.Fault parameters

Type of Fault	Percentage %
Single line to ground fault (L-G).	65-70
Line to Line fault (L-L).	10-15
Double Line to ground fault (L-L-G).	8-10
Phase to Phase and third Phase to ground fault.	2-3
All the three phases to ground (L-L-L-G).	2-3
All the three phases short circuited (L-L-L).	2-3

5.1 Types of Machine learning

The three basic techniques employed in machine learning are supervised, unsupervised and reinforcement learning. One of the proposed methods that may be adapted to the problema scientist seeks to answer is semi-supervised learning. Each tactic has certain advantages as well as disadvantages, and some are greater than others at solving particular sorts ofproblems.

1) Supervised Learning: In supervised learning, inputs and outputs from a variety of data sets are utilized to train a computer in order to teach it a universal principle that maps inputs to outputs. The two fundamental subcategories areclassification, which entails estimating a target class, and regression, which entails predicting a numerical value.

2) Unsupervised Learning: With unsupervised learning, thelearning algorithm is not given this form of guidance; instead, itmakes an independent attempt to recognise the pattern in the data. Clustering, which involves finding groups in the dataset that share characteristics which examine the statistical distribution of the data set.

3) Reinforcement Learning: In reinforcement learning, a challenge is presented to the machine and algorithms in adynamic environment, and as they try to achieve a goal, they are provided feedback , which encourages their learning and goal-seeking efforts [10]

6 TECHNIQUES FOR FAULT CLASSIFICATION BY MACHINE LEARNING

- Support Vector Machine.
- Bayesian Learner (Na¨ıve Bayes).
- Sequential Minimal Optimization.
- Logistic Regression.
- Decision Tree.
- K Nearest Neighbour.

1.Support Vector Machine: Regression as well as classifica- tion problems can be solved using Support Vector Machine,or SVM, one of the most used supervised learning techniques. However, it's mainly used in classification by machine learning problems. [11]. Support Vector Machine can be of two types:

Linear SVM: Linearly separable data are those that canbe divided into two subgroups using just a single straight line. Linear SVM is used to classify such data

- Non-linear SVM: When a dataset cannot be identified us- ing a straight line, the classification method is consideredto as a non-linear SVM classifier.

2. Bayesian Learner (Na¨ıve Bayes): Bayesian learning is a probabilistic technique to machine learning which involves finding a probability over the model parameters. It is based onthe Bayes theorem, which states that the likelihood of the data given the hypothesis and the prior value of the hypothesis are combined in order to determine the possibility of a hypothesis given the data.

3. Sequential Minimal Optimization (SMO): SMO breaks down this substantial quadratic programming problem into a number of more accessible ones. Solving such simple quadratic programming issues theoretically eliminates the requirement for a time-consuming inner loop quadratic programming optimization. When matrix calculation for a variety of test problems focused on linear and quadratic equations is omitted, SMO scales the size of training set. learning.

4. Logistic Regression: The likelihood of a binary answer variable is modelled using the statistical technique of logistic regression. Making predictions and categorizing observations based on a collection of independent factors is a typical taskin data analysis.In logistic regression, the dependent variable Y has interesting outcome values between 1 and 0.

$$Logit(Y = 1) = ln[P(Y = 1)/P(Y = 0)] = a + Bx \quad (1)$$

Input values (x) combined continuously with weights or coef- ficient values to anticipate an outcome value (y). In contrast, a binary value (0 or 1) compared to a numeric number is the output value being represented. In which b0 is the bias or intercept term, b1 is the coefficient for the single input value, and y is the predicted output (x). The data from your training data set are all included in each part of your training set.The following expression may be employed to represent the probability that an input (X) corresponds to the default class (Y=1):

$$P(X) = P(Y = 1|X) \quad (2)$$

5.Decision Tree (DT): A really well machine learning ap- proach called decision trees is utilised both for classification and regression problems. This simple yet efficient model gen- erates a tree-like pattern of decisions that leads in a projected output by recursively dividing the information depending on the input's value variables. The representation of decision treesis one of its key benefits since the resultant tree is simple to see and understand for people. Along with processing categoryand numerical data, decision trees are also capable of capturingcomplex linkages in between variables being input and output [12].

K nearest neighbour (KNN): The K-NN method places each new instance in the group that most closely resembles theexisting categories, assuming that the new case and the existing instances are equivalent. After storing all previous data, anew data point is classified using the K-NN algorithm based on similarity. This shows that applying the K-NN technique, new data may be quickly sorted into a group that best fits it

Although classification problems typically are handled using the K-NN approach, predictions may also be made to use this method.

7 CLASSIFICATION OF APP

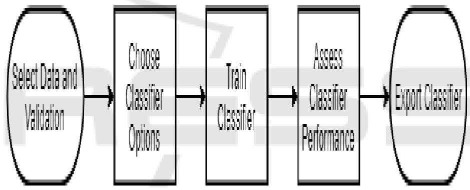

Fig. 4. Classification Learner Workflow

In Classification Learner, training a model entails two steps:

- Train a model using a validation strategy, or validated model. By default, the programme uses cross-validation to guard against overfitting. You can also select holdout validation as an alternative.
- Complete Model: Without validation, train a model usingall the data. The software also trains this model in addition to the approved model. The whole data model, however, is not accessible in the app. The whole model is exported when you select a classifier to send towards the workspace in Learner.

The confusion matrix's error rate (ERR) and accuracy (ACC) measurements are the most widely used.

1) Error rate: The error rate is determined by dividing the total number of wrong predictions by its total number ofobservations included in the data set. The ideal error rate is0.0, the worst rate of error is 1.0.

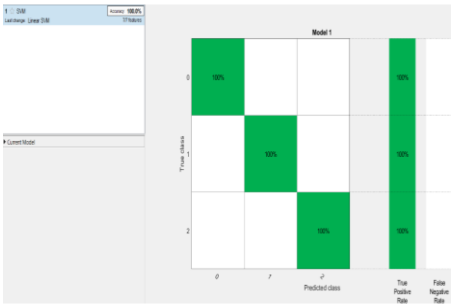

Fig 5. Confusion Matrix

$$ERR = \frac{FP + FN}{TP + TN + FP + FN} = \frac{FP + FN}{P + N}$$

2) Accuracy: Accuracy is calculated as the total number of correct predictions divided by the entire sizeof the dataset (ACC). From 0.0 to 1.0, having 1.0 being the best. This may also be determined by dividing by the ERR.

$$ACC = \frac{TP + TN}{TP + TN + FP + FN} = \frac{TP + TN}{P + N}$$

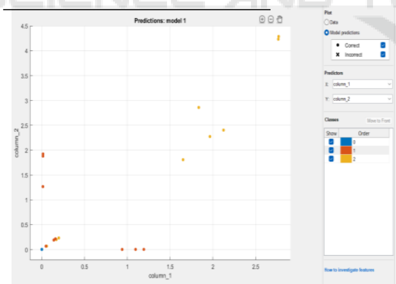

Fig 6. Scatter Pot

The function scatter (x, y) emits a plot with spherical mark- ers in which the vectors x and y specify the locations. Set bothdirections as similar vectors to plot a single set of coordinates.You must provide at least one x or y as a matrix of valuesto plot several sets of values on one set of axes. The graphsthat indicate the relationship between the variables in a dataset are termed as scatter plots.

8 CONCLUSION

Transmission lines need to be safeguarded if reliable and efficient power flow is to be achieved. The crucial safety tasks of transmission lines include fault detection and classification. In light of machine learning technologies, it is now easier to manage the power system's complicated challenges. Existing techniques are not computationally practical solutions due to their inability to handle huge quantities of information (includ- ing bits from diverse data sets) from units of measurement likemeasures of phasor analysis. In order to protect the electricity system, defects must be found and fixed before they cause harm to utility infrastructure or consumer property. Given the growing number of measurements in distribution systems, there is a chance to improve defect detection methods. The power transmission system protection procedures may be im- proved by using potent machine learning algorithms to predictfaults. Also, it will save the amount of time needed to repair defects, particularly on long transmission lines, improving the overall dependability and effectiveness. The use of algorithmshas been found to not only simplify the problem but also to ensure more precise and predictable execution. Current experiments may recommend validating the current process via data. from an ongoing simulation or a real network. The efficiency, simplicity, and preparation time of various machine learning

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