International Journal of Applied Power Engineering (IJAPE)
Vol. 12, No. 4, December 2023, pp. 359~366
ISSN: 2252-8792, DOI: 10.11591/ijape.v12.i4.pp359-366

Improving fault identification in smart transmission line using machine learning technique

Radhika Venkutuswamy[1], Baskaran Kaliyaperumal[2]
[1]Department of Electronics and Instrumentation Engineering, Sri Ramakrishna Engineering College, Coimbatore, India
[2]Department of Electrical and Electronics Engineering, Alagappa Chettair Government College of Engineering and Technology, Karaikudi, India

Article Info

Article history:

Received Feb 15, 2023
Revised May 20, 2023
Accepted May 20, 2023

Keywords:

Arduino
GPS location
Internet of things
Machine learning methods
SMS
Transmission line

ABSTRACT

In this work inevitable for power transmission boards such as Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) to look for a low-cost communication system with low power usage and to improve supply reliability, to transmit reliable fault information back to the control centre in real time. This work aims to design an automated and effective fault identification and position system for all overhead power transmission network networks using all current fault indicator technologies, machine learning methods, and commercially tested communication technology to easily and reliably pin a transmission system's flawed point parts. This will help to people avoid touching the electrical wire and prevent electrical shocks and current wastage as well. Smart transmission lines have played a decisive role in developing human protection and preventing current wastage. The transmission line is opened and the state of the line is evaluated, and the information goes to electrical board (EB) office. The system monitors the data by sending the alert message to the person responsible for the GPS location, either via SMS or BUZZER, or by displaying the alert message lives. Transmission line distribution is broad and most of them are spread around the geographical environment.

Corresponding Author:

Radhika Venkutuswamy
Department of Electronics and Instrumentation Engineering, Sri Ramakrishna Engineering College
Coimbatore, Tamil Nadu 641022, India
Email: radhika.senthil@srec.ac.in

1. INTRODUCTION

A flaw in electrical hardware is represented by a flaw in its electrical circuit, which causes the flow to diverge from its intended path. Mechanical dissatisfaction, wounds, unnecessary internal and external anxieties, and so forth are common causes of faults. The defect impedance is modest, but the deficiency fluxes are rather significant. During the defects, the force stream is diverted to the issue, and the gracefully to the adjoining zone is hampered. The voltages are unbalanced [1]. The deficiency must be identified as soon as possible, which is why an internet of things (IoT) based device was created to speed up the process. It will identify the following four major faults and issue a trip signal for hand-off. Over current shortcoming, propensity issue, and sparking line broken, phase failure defects are the four flaws identified by the model. The electric power system is divided into several sections. One of these is the transmission framework, in which power is transmitted from producing stations and substations to customers via transmission lines. The two methodologies may encounter various types of faults, which is sometimes referred to as a "shortcoming". Flaw is essentially defined as a variety of irritating but unavoidable occurrences that can inadvertently upset the steady state of the force framework, which occurs when the framework's protection fizzles at any point. If not properly monitored, there are a variety of power transmission flaws that might result in power blackouts. Among the most significant are i) faults at the force age station, ii) damage to control transmission lines (tree falling on lines), iii) faults at the substations or parts of dissemination subsystem, and iv) lightening.

i) Types of transmission line faults

Defects in the force framework might be classified as shunt difficulties or arrangement flaws. Single line-to-ground (SLG) defects are the most well-known type of shunt flaw. When one conduit falls to the ground or comes into contact with the unbiased wire, this type of defect occurs. It could also be the result of trees collapsing in a strong wind. As shown in Figure 1, this type could be approached.

The line-to-line (LL) deficiency is the second most common type of shunt flaw. When two transmission lines are short-circuited, this is said to happen. If a large flying creature remains on one transmission line and contacts the other, or if a tree branch falls on the heads of two force transmission lines, As seen in Figure 2, this type could be conversed with.

The double line-to-ground (DLG) deficit in Figure 3 is the third type of shunt inadequacy. This could be the result of a tree falling on two electrical cables, or it could be the result of other factors. The fourth and most serious type of insufficiency is the reasonable three-stage as in Figure 4, which can occur when three electrical lines in diverse buildings come into contact.

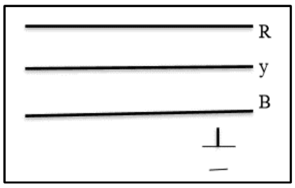

Figure 1. Single line-to-ground (SLG) deficiencies

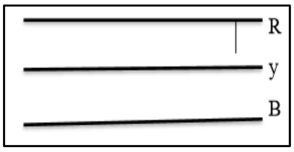

Figure 2. Line-to-line (LL) deficiency

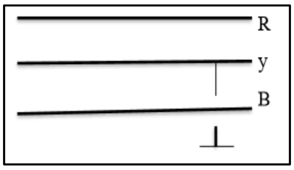

Figure 3. Double line-to-ground (DLG) deficiency

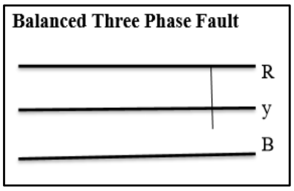

Figure 4. Balanced three phase faults

2. PROPOSED SYSTEM

The electric force foundation is deeply weak in the current framework against a wide range of typical and noxious physical events that can have a negative impact on the matrix's overall display and security. Despite the fact that flaw marker innovation has provided a reliable approach to locate perpetual issues, the specialized group and watch groups still need to observe and examine the devices for extended periods of time to identify broken transmission lines. When a deficit in a transmission line occurs, it is usually hidden, unless it is a major problem.

However, over time, these slight flaws might cause harm to the transformer and even endanger human life. It could also cause a fire. In today's India, we don't have a system in place that will alert us when a flaw occurs on a regular basis. The issue is that because we don't have a genuine memory framework, we end up harming the concealed gear and wind up being a hazard to the people around us. Support or checking of the transmission lines is frequently done on a subsequent premise in order to maintain a strategic distance from such incidents to the maximum extent possible. As a result, there is a greater demand for workers. The reality is that the genuine expectation of this isn't met the same number of times numerous times line disappointment could be due to downpour or tree overturning that can't be predicted. For example, in the Western Ghats, transmission lines are generally routed through the backwoods, and in places like Chirapunjee, massive precipitation virtually brings everything to a halt. It's critical to appreciate the gravity and potential consequences of a line failure.

A global system for mobile (GSM) based transmission line defect detecting system to combat them was proposed [2]. When the preset edge is crossed, the microcontroller promptly sends a message to the region lineman and the control station, indicating the precise shaft to post area. This helps us to comprehend a framework that is in use. The true goal of identifying deficit gradually and safeguarding the transformer as soon as possible has been found out. It's worth noting that transformers aren't cheap. On a regular basis, an 11 KV transformer costs $3000 USD. As a result, we're developing a realistic and quick-response framework to aid in the improvement of wellness. A transformer is an important piece of equipment for power transmission. Constant observation is an important step in extending the life of a transformer. Similarly, a transformer is a pricey asset, and its failure cannot be repaired as rapidly as other sections of the transmission medium.

An approach utilizing the global system for mobile (GSM) communication and a microcontroller is presented to monitor the transformer's failure and communicate it to the intended work force as shown in Figure 5. The information and yield voltages (periods) of the transformer are examined using a comparator. In the case that a critical decrease is identified, the authorities are notified via IoT. An approach for detecting spillage and intensity robbery in transmission is proposed. The proposed method is implemented using an ESP8266 and a microcontroller. It is implemented as two subsystems, one for detecting power outages and the other for detecting burglaries. Estimating the voltage difference between power transmission and gathering detects force spilling or line disappointment. In the suggested framework, the burglary is discovered by calculating the total force consumed and comparing it to the total force sent. The electrical officials are advised to distinguish between the limits using IoT [3].

The failure in the electrical cable is identified and located using a remote sensor network. The force transmission line is partitioned in this paper by remote sensor organizations. It occasionally measures the energy distinction and any deviations, which are then communicated to the appropriate authorities. This proposed paradigm is especially useful for identifying imbalanced problems. For power disappointment detection, a counterfeit neural network is used [4]. In any event, neuronal organization necessitates preparation, which may or may not be complete. The support vector machine (SVM) is used to prepare data. All studies concerned with force transmission disappointment have been exaggerated. Furthermore, the sensor does not handle the interference caused by nature in detecting the required data. Furthermore, the computerized reasoning technique used necessitates preparing data, which is difficult to obtain in real time, and the framework's yield is solely dependent on the preparation set. We propose a productive arrangement based on the internet of things (IoT) in this research, as well as several techniques of correspondence.

Currently, the electric force framework is extremely vulnerable to a wide range of natural and malicious physical events, which can have a negative impact on the network's overall appearance and dependability. Furthermore, there is an impending need to prepare the deep-seated transmission line foundation with a superior information correspondence organization, which underpins future operational requirements such as continuous checking and control, which are critical for brilliant lattice coordination. Many electric power transmission companies have traditionally relied on circuit markers to identify faulty transmission line portions. Regardless, pinpointing the precise location of these defects continues to be a challenge. Despite the fact that shortfall pointer innovation has provided a reliable approach to detect long-term flaws, specialized groups and watch groups need actually watch and study the gadgets for extended periods of time to identify defective portions of their transmission lines.

Remote sensor-based transmission line inspection addresses some of these concerns, such as continuous auxiliary awareness, faster deficiency confinement, precise flaw conclusion by recognizable proof and separation of electrical issues from mechanical flaws, cost reduction due to condition-based maintenance rather than intermittent support, and so on [5]. These applications establish stringent requirements, such as the delivery of a massive amount of extremely reliable data in a short period of time. The success of these applications is dependent on the creation of a practical and dependable organization with a quick response time. The organization must be able to send sensitive data to and from the transmission matrix, such as the current state of the transmission line and control data. This investigation provides a cost-effective approach for planning a continuous data transmission organization. Sensors are positioned in various places of the force organization to monitor the status of the force framework. These sensors can produce a large amount of data by making fine-grained estimates of a variety of physical or electrical boundaries. A basic test to be attended to in order to construct an intelligent dazzling framework is delivering this info to the control community in a cost efficient and convenient manner [6]. Because of the vast scope, vast landscape, unprecedented geography, and basic planning requirements, organization layout is an essential aspect of sensor-based transmission line inspection. Mechanical difficulties, cost savings due to condition-based assistance rather than routine maintenance, and so on. Sensor networks have been proposed for a number of applications, including mechanical state handling and dynamic transmission line rating. Sensors are deployed in various parts of the force network to continuously monitor the status of the force framework.

A switched-mode power supply (SMPS) gracefully produces a similar final output at a reduced cost and with more efficiency [7]. The yield power is lighter and smaller for a given yield. This is due to the fact that if the frequency of activity is increased, transformer works can be relocated. The setup or field device consists of four major components: a transformer (CT and VT), a GPS modem, and an Arduino, ESP8266 is shown in Figure 5. The CT and VT primaries, which are associated with the line, sense the framework's current and voltage estimations and send the yield to the Arduino's ADC, which converts the sign to a computerized structure that can be produced by the Arduino's CPU [8].

The circuit serves as the setup's most important concern. It has a large number of programming codes stored in the electrically erasable and programmable read-only memory (EEPROM) that enable it to classify issue types based on voltage and current characteristics. The microcontroller considers these attributes in light of the program to see if they fall within the necessary range. When the voltage and current quality are out of range when compared to the reference, it indicates that there is a problem. The GPS also determines the issue separation in comparison to the device using an impedance-based computation, and then sends this information to the modem for transmission.

In short, the Arduino characterizes, computes the shortcoming separation, and transmits the data to the IoT via the sequential correspondence interface (SCI), which serves as an interface between the Arduino and the ESP8266 Wi-Fi. The ESP8266 serves as a bridge between the Arduino sequential correspondence port and the internet of things [9]. In the transmission framework, the gadget is placed at the edge of the sectionalized districts, and the area of the shortfall is established in relation to the gadget's location. The IoT's one-of-a-kind nature is used as a location for the device, which might be saved as a Cloud website page in the control room.

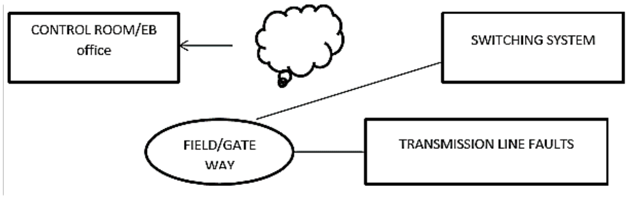

Figure 5. Working of proposed system

3. HARDWARE IMPLEMENTATION OF PROPOSED SYSTEM

To realize the concept, an Arduino Mega, a transfer potentiometer, an ESP 8266 transformer, a signal, a temperature sensor, and an LCD is needed as shown in Figure 6. The venture is equipped with a fault detecting equipment that uses a large number of switches at each known location to double-check the precision of the equivalent. The voltage drop throughout the transfer is fed into an ADC, which generates precise advanced data that the modified microcontroller displays on a website page. A 16X2 LCD interfaced with the Arduino Mega microcontroller displays the shortfall at what stage and sends an SMS to the EB office.

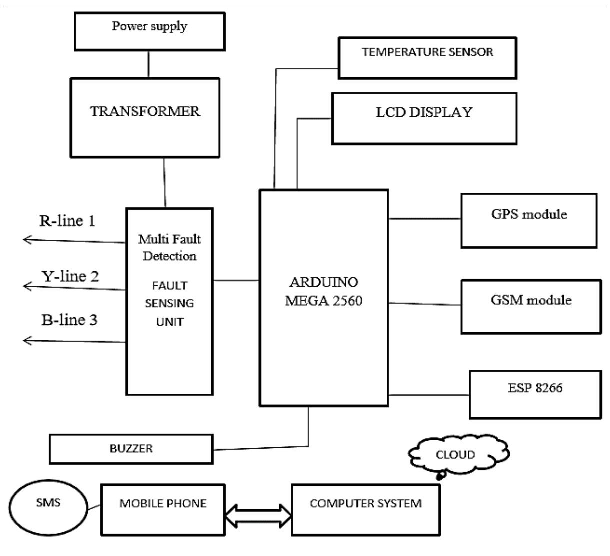

Figure 6. Hardware interfacing of proposed system

This work is limited to the development of a competent framework for detecting and locating line-to-line and line-to-ground faults in overhead transmission lines, which will naturally show the control room the particular location of the transmission line where a shortfall occurred via IoT. In order to plan an effective impedance-based and vigorously programmed issue recognition and area framework for overhead force transmission lines. To reduce the amount of time it takes to rectify a problem and protect expensive transformers from harm or robbery, which is common during extended power outages. To improve the efficiency of specialist teams because the time available to uncover flaws would be restricted.

3.1. Machine learning algorithm

Support vector machines (SVMs) are a class of supervised learning methods for classification, regression, and detection of outliers is explained below:

i) Step 1: Sensors will initially detect variations in transmission line boundaries such as voltage, scope, longitude, and so on.
ii) Step 2: The data is sent from the Arduino microcontroller.
iii) Step 3: The microcontroller will send individual indications to the Wi-Fi module for transmission based on the detected data.
iv) Step 4: Using the Wi-Fi module, the detected boundaries are sent to the administrator.

3.2. Hardware implementation

The hardware implementation of the proposed system is shown in Figure 7. Various approaches for dealing with transmission line disappointments and defects may be received. In this section, a few of them are depicted in depth. The control room will be able to see the precise location of the transmission line as a result of this. The proposed framework, the Arduino Mega is introduced with an inbuilt worker that is connected to the transformers whenever there is a problem, such as a short out, which has a yield in the high voltage and low current range, and an open circuit, which has a yield in the low voltage and high current range. The online page can surely be used to examine and control this. The issue of recognizing the deficit in the dispersion lines and the intended implication to the electricity board (EB) is dealt with by identifying transmission line flaws and reporting them to the EB. The task is in charge of the design and production of the power gracefully, Arduino Mega, circuit board, and ESP 8266, GPS modem. The Arduino's electric appropriation network connects to the electrical wires and delivers a message to the IoT about the type of defect in the line. This reduces the amount of time spent locating the problem. The ultimate goal is to continuously monitor the circulation line state and hence the flaws of the dispersion line due to limits such as overvoltage, undervoltage, SLG, and DLG deficits [10]. In the case that one of these events occurs, a message will be sent from the planned controlling unit or substation. The goal is to locate the transmission line fault and to inform the worker about the problem [11]. Sensors, such as a fire identifier, a spark indicator, and a multi-issue locator circuit, are used to detect the specific problem in the transmission lines. Sensors detect the transmission line's force properties [12]. Sending data to the cloud is a good option.

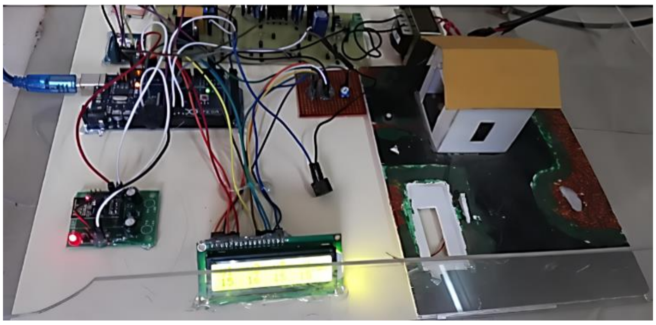

Figure 7. Hardware implementation of the proposed system

This work is limited to the development of a framework that will identify and locate line-to-line and line-to-ground defects in overhead transmission lines where a problem has occurred [13], [14]. The internet of things (IoT) is a networked collection of physical objects that may alter the climate or their own borders, collect data, and transfer it to various devices [15]. It is the third wave in the evolution of the internet. This innovation will provide instant access to information about the physical environment and the items that make it up, allowing for creative administrations as well as an increase in proficiency and profitability. Recent occurrences, brilliant sensors, communication advancements, and internet conventions have all aided the IoT [16]. A web of things (IoT) organization is envisioned in this venture. The future fate of IoT and its outcomes are given a lot of thought. The identified location at Unnamed Road, Eachanari, Coimbatore, Tamil Nadu, India, is shown in Figure 8.

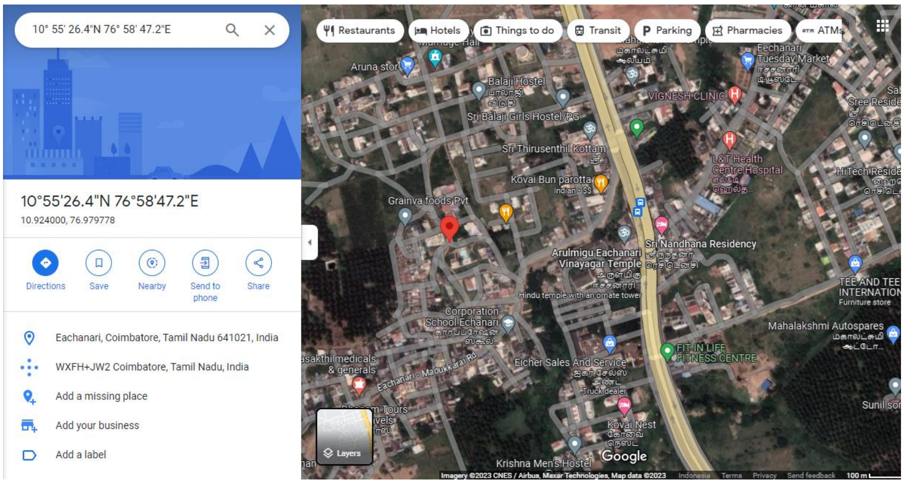

Figure 8. Location identification

4. RESULTS AND DISCUSSION

To evaluate the performance of the suggested system using the accuracy, delay, location identification, and fault probability graphs [17]. Performance analysis was done based on the occurrence of fault by applying machine learning and without machine learning is shown [18], [19] in Figure 9. Occurrence of faults was reduced on applying machine learning algorithms [20]–[22]. Figure 10 potraits the identification of location of fault that helps the electric workers was improved by applying machine learning algorithms. The proposed system incorporates a machine learning technique that improves accuracy by over 90% while lowering delay time is shown in Figure 11 [23]–[25].

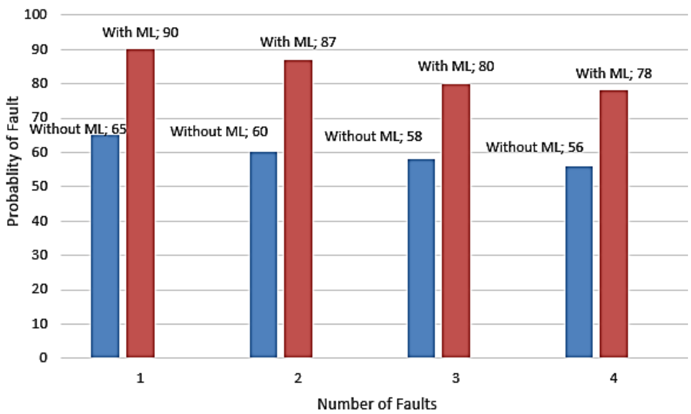

Figure 9. Performance analysis based on probability fault

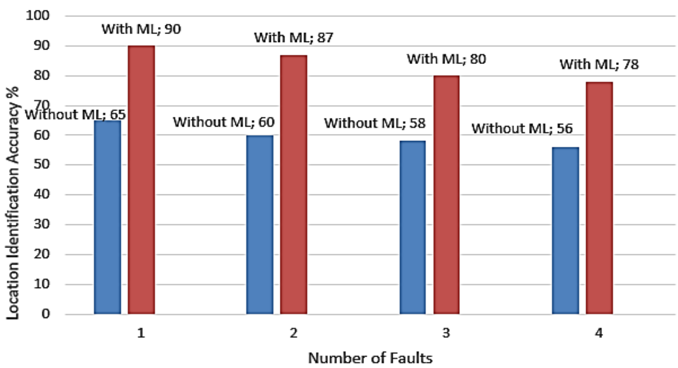

Figure 10. Performance analysis based on location identification accuracy

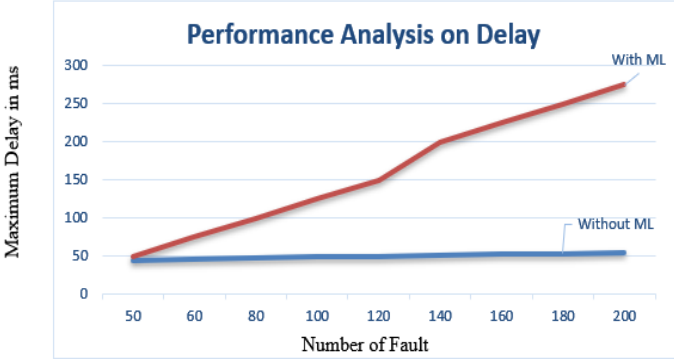

Figure 11. Performance analysis based on minimum delay

5. CONCLUSION

Using all existing fault indicator technologies and machine learning techniques, create an automatic and effective fault identification and position system for all overhead power transmission network networks. The transmission line between the EB office and the information, as well as the location latitude and longitude, has been opened. The machine learning method aids in improving accuracy and speed. The new method employs a machine learning approach to boost accuracy by more than 90% while reducing delay time.

ACKNOWLEDGEMENT

Authors thank the Management, Principal of Sri Ramakrishna Engineering College, Coimbatore for providing the support to carry out this research work.

REFERENCES

[1] H. Li, G. W. Rosenwald, J. Jung, and C. C. Liu, "Strategic power infrastructure defense," *Proceedings of the IEEE*, vol. 93, no. 5, pp. 918–933, May 2005, doi: 10.1109/JPROC.2005.847260.
[2] G. V. Krishnan, R. Nagarajan, T. Durka, M. Kalaiselvi, M. Pushpa, and S. S. Priya, "Vehicle Communication System Using Li-Fi Technology," *International Journal of Engineering and Computer Science*, vol. 6, no. 3, pp. 20651–20657, Mar. 2017, doi: 10.18535/ijecs/v6i3.47.
[3] V. C. Gungor and F. C. Lambert, "A survey on communication networks for electric system automation," *Computer Networks*, vol. 50, no. 7, pp. 877–897, May 2006, doi: 10.1016/j.comnet.2006.01.005.
[4] R. Nagarajan, S. Sathishkumar, K. Balasubramani, C. Boobalan, S. Naveen, and N. Sridhar, "Chopper Fed Speed Control of DC Motor Using PI Controller," *IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)*, vol. 11, no. 3, pp. 65–69, 2016.
[5] V. C. Gungor, B. Lu, and G. P. Hancke, "Opportunities and challenges of wireless sensor networks in smart grid," *IEEE Transactions on Industrial Electronics*, vol. 57, no. 10, pp. 3557–3564, Oct. 2010, doi: 10.1109/TIE.2009.2039455.
[6] J. Ausen, B. F. Fitzgerald, E. A. Gust, D. C. Lawry, J. P. Lazar, and R. L. Oye, "Dynamic thermal rating system relieves transmission constraint," *Proceedings of the IEEE International Conference on Transmission and Distribution Construction and Live Line Maintenance, ESMO*, 2006, doi: 10.1109/TDCLLM.2006.340738.
[7] R. Nagarajan and M. Saravanan, "Staircase multicarrier SPWM technique for nine level cascaded inverter," in *Proceedings of 2013 International Conference on Power, Energy and Control, ICPEC 2013*, Feb. 2013, pp. 668–675, doi: 10.1109/ICPEC.2013.6527741.
[8] J. Chandramohan, R. Nagarajan, K. Satheeshkumar, N. Ajithkumar, P. A. Gopinath, and S. Ranjithkumar, "Intelligent Smart Home Automation and Security System Using Arduino and Wi-fi," *International Journal of Engineering and Computer Science*, vol. 6, no. 3, pp. 20694–20698, Mar. 2017, doi: 10.18535/ijecs/v6i3.53.
[9] P. Zhang, F. Li, and N. Bhatt, "Next-generation monitoring, analysis, and control for the future smart control center," *IEEE Transactions on Smart Grid*, vol. 1, no. 2, pp. 186–192, Sep. 2010, doi: 10.1109/TSG.2010.2053855.
[10] R. Nagarajan and M. Saravanan, "Performance analysis of a novel reduced switch cascaded multilevel inverter," *Journal of Power Electronics*, vol. 14, no. 1, pp. 48–60, Jan. 2014, doi: 10.6113/JPE.2014.14.1.48.
[11] P. Ramachandran, V. Vittal, and G. T. Heydt, "Mechanical state estimation for overhead transmission lines with level spans," *IEEE Transactions on Power Systems*, vol. 23, no. 3, pp. 908–915, Aug. 2008, doi: 10.1109/TPWRS.2008.926093.
[12] S. Ullo, A. Vaccaro, and G. Velotto, "The role of pervasive and cooperative sensor networks in smart grids communication," in *Proceedings of the Mediterranean Electrotechnical Conference - MELECON*, 2010, pp. 443–447, doi: 10.1109/MELCON.2010.5476236.
[13] K. S. Hung *et al.*, "On Wireless Sensors Communication for Overhead Transmission Line Monitoring in Power Delivery Systems," in *2010 First IEEE International Conference on Smart Grid Communications*, Oct. 2010, pp. 309–314, doi: 10.1109/smartgrid.2010.5622059.
[14] S. Malhara and V. Vittal, "Mechanical state estimation of overhead transmission lines using tilt sensors," *IEEE Transactions on Power Systems*, vol. 25, no. 3, pp. 1282–1290, Aug. 2010, doi: 10.1109/TPWRS.2009.2038703.
[15] S. Chandrasekar and G. C. Montanari, "Analysis of partial discharge characteristics of natural esters as dielectric fluid for electric power apparatus applications," *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 21, no. 3, pp. 1251–1259, Jun. 2014, doi: 10.1109/TDEI.2014.6832272.

[16] F. M. Shakiba, S. M. Azizi, M. Zhou, and A. Abusorrah, "Application of machine learning methods in fault detection and classification of power transmission lines: a survey," *Artificial Intelligence Review*, vol. 56, no. 7, pp. 5799–5836, Jul. 2023, doi: 10.1007/s10462-022-10296-0.
[17] M. O. F. Goni *et al.*, "Fast and Accurate Fault Detection and Classification in Transmission Lines using Extreme Learning Machine," *e-Prime - Advances in Electrical Engineering, Electronics and Energy*, vol. 3, p. 100107, Mar. 2023, doi: 10.1016/j.prime.2023.100107.
[18] D. Gutierrez-Rojas, I. T. Christou, D. Dantas, A. Narayanan, P. H. J. Nardelli, and Y. Yang, "Performance evaluation of machine learning for fault selection in power transmission lines," *Knowledge and Information Systems*, vol. 64, no. 3, pp. 859–883, Mar. 2022, doi: 10.1007/s10115-022-01657-w.
[19] J. Hosseinzadeh, F. Masoodzadeh, and E. Roshandel, "Fault detection and classification in smart grids using augmented K-NN algorithm," *SN Applied Sciences*, vol. 1, no. 12, p. 1627, Dec. 2019, doi: 10.1007/s42452-019-1672-0.
[20] E. H. Abualsauod, "Machine learning based fault detection approach to enhance quality control in smart manufacturing," *Production Planning and Control*, pp. 1–9, Feb. 2023, doi: 10.1080/09537287.2023.2175736.
[21] S. R. Fahim, S. K. Sarker, S. M. Muyeen, S. K. Das, and I. Kamwa, "A deep learning based intelligent approach in detection and classification of transmission line faults," *International Journal of Electrical Power and Energy Systems*, vol. 133, p. 107102, Dec. 2021, doi: 10.1016/j.ijepes.2021.107102.
[22] S. R. Fahim, S. K. Sarker, S. M. Muyeen, M. R. I. Sheikh, S. K. Das, and M. Simoes, "A Robust Self-Attentive Capsule Network for Fault Diagnosis of Series-Compensated Transmission Line," *IEEE Transactions on Power Delivery*, vol. 36, no. 6, pp. 3846–3857, Dec. 2021, doi: 10.1109/TPWRD.2021.3049861.
[23] M. F. Guo, N. C. Yang, and W. F. Chen, "Deep-Learning-Based Fault Classification Using Hilbert-Huang Transform and Convolutional Neural Network in Power Distribution Systems," *IEEE Sensors Journal*, vol. 19, no. 16, pp. 6905–6913, Aug. 2019, doi: 10.1109/JSEN.2019.2913006.
[24] C. Velasco-Gallego and I. Lazakis, "Development of a time series imaging approach for fault classification of marine systems," *Ocean Engineering*, vol. 263, p. 112297, Nov. 2022, doi: 10.1016/j.oceaneng.2022.112297.
[25] S. Senemmar and J. Zhang, "Deep Learning-based Fault Detection, Classification, and Locating in Shipboard Power Systems," in *2021 IEEE Electric Ship Technologies Symposium (ESTS)*, Aug. 2021, pp. 1–6, doi: 10.1109/ESTS49166.2021.9512342.

BIOGRAPHIES OF AUTHORS

Radhika Venkutuswamy completed her Doctoral degree in the Faculty of Information and Communication Engineering in Anna University Chennai during June 2017. Presently, she is working as Associate Professor in the Department of Electronics and Instrumentation Engineering at Sri Ramakrishna Engineering College, Coimbatore. Her area of interests includes VLSI design and embedded systems. She has published more than 18 research papers in international journals, 2 national conferences, and 10 international conferences and published three book chapters. She was a life member of ISTE, member of ISOI and IEEE. She can be contacted at email: radhika.senthil@srec.ac.in.

Dr. Baskaran Kaliyaperumal is a Professor and Head Department of Electrical and Electronics Engineering, Alagappa Chettiar Government College of Engineering and Technology, Karaikudi. He is a member of IEEE, ISTE and his research areas include mobile computing and wireless communication and VLSI. He can be contacted at email: drbaskaran@gct.ac.in.