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Underground Cable Fault Detection Using IOT

Mrs. Pallavi S. Bangare, Umesh Patil, Momin Huzaifa, Saurabh Shinde

Department of IT, Sinhgad Academy of Engineering, Savitribai Phule Pune University, Pune, India

Abstract: *Underground lines rather than cables are used in this downtown. A fault detection system for underground cable lines built on the Internet of Things makes it relatively simple to identify defects and their locations. With the growth of the electrical system grid, underground cables have been utilized extensively. Due to the underground environment, wear and tear, and rats, underground cables are vulnerable to a wide range of problems. Because the entire line must be dug to check for fault at the cable line, locating the fault site is challenging. Only that area needs to be probed to find the fault's source because the repairmen know exactly which portion is defective. As a result, it helps to service subterranean cable lines more quickly and saves a lot of time and money. We use IOT technology, which enables the government to track and examine issues online. With the use of a potential divider network installed across the cable, the system may identify a fault. According to the resistor network configuration, a specified voltage is produced when a defect occurs in a cable line. The microprocessor detects this voltage, and the user updates it. The user is informed of the distance that that voltage relates to. The microcontroller locates the data from the damaged cable line, displays it on an LCD, and sends it to an online display through the internet.*

Keywords: Arduino, LCD, MCU Wi-Fi Module, IoT (Internet of Things).

I. INTRODUCTION

In the most recent decades, cables that are more effective than previous methods were developed to deploy underground cable overhead. Therefore, no harmful weather phenomena, such as storms, snow, or heavy precipitation, as well as pollutants, affect the underground cable. But once a cable problem arises, it becomes difficult to isolate the issue. As a result, we'll go to look for a fault's precise site. The research aims to identify any problems with digital approaches as the world becomes increasingly digital. Many urban regions use the subterranean television system as a frequent application. When a fault arises for a variety of causes, the individual's method of repair is used Being unable to pinpoint the exact position of the cable failure makes cables problematic.

This IoT-based initiative, called "Underground Cable Fault Detection," seeks to precisely and effectively identify any fault spots in transmission lines, particularly in the case of underground cable lines. With this approach, we are attempting to address this issue by outlining a technique that is suitable for the digital age. It is IoT-based. In this case, the Node MCU was utilized to link Arduino sensors to the Internet.

Through the router, we had set up a Hot spot for communication. We used the Google database to check the state of transformers after connecting each MCU Module to a transformer. When compared to previous procedures, our suggested method has greater accuracy and efficiency. Locating can be difficult, but as more underground equipment is put in, it's expected to get even harder. Understanding how the equipment operates is just as crucial as being well-versed in the specific technology being utilized.

Faults in the cable may be classified into the following groups:

- **Fault in an Electrical Circuit:** Open circuit faults are more serious than tangency faults because, once they occur, electricity flowing through the cable stops. This type of fault is brought on by a conducting path break. Such errors happen in several or a single portion of conductor breaks.
- **Short Circuit Fault:** More tangency faults that are short circuit faults can be divided into two categories:
- **Symmetrical Fault:** Three-phase fault is referred to as a symmetrical fault. All three phases are short-circuited during these.
- **Unsymmetrical Fault:** in this fault, the magnitude of the stream is deviated by 120 degrees from being equal.

II. LITERATURE SURVEY

A literature review is crucial to understand faults in underground cable lines before starting a research project. This will give the researcher much-needed extra knowledge on the methodology and technology available and used by other research complements throughout the world.

Dharani Dhivya One aSowmya.T [1] Development of a Prototype Underground Cable Fault Detector is the title of the study. Damage to cables that affect the resistance in the cable is known as a cable fault. This may result in a voltage breakdown if allowed to continue. It is necessary to test the cable for problems before attempting to discover one. This prototype relies on the straightforward idea of OHMs legislation. Depending on how long the cable is, the current will change.This prototype's construction includes a series of resistors that indicate the cable length in kilometers, and a set of switches to cross-check the accuracy of each known Kilometer (km). A 16X2 LCD connected to the microcontroller displays the fault's location, phase, and timing. The microcontroller's ROM has the program burned into it. A 230/12V step-down transformer makes up the power supply, stepping down the voltage to 12V AC. A bridge rectifier is used to convert this to DC. A capacitive filter is used to remove ripples, and a voltage regulator 7805 is used to regulate the voltage to +5V, which is necessary for the operation of the microcontroller and other components.

Rajesh Kajla and Nikhil Kumar Sain's [2] Underground Cable Fault Distance Conveyed Over GSM is the title of the paper. This paper proposes a microcontroller-based fault location model for an underground power wire. The goal of this research is to calculate the underground cable fault's distance in kilometers from the base station. Ohm's law principle is used in this project. Since the current varies when a problem like a short circuit happens, the voltage drop will vary based on the length of the fault in the cable. Therefore, the cable is represented by a set of resistors, and one end is provided with dc voltage. An analog-to-voltage converter is utilized to detect the voltage change that indicates a problem, and a microcontroller is then used to perform the necessary calculations to display the fault distance on the LCD.

R.K. RaghulMansingh, R. Rajesh, S. Ramasubramani, G. Ramkumar [3] titled as Underground Cable Fault Detection using Raspberry Pi and Arduino ‖ -The aim of this project is to determine the underground cable fault. The straightforward CT Theory idea is applied in this project. Since the current varies when a problem like a short circuit happens, CT is used to determine how much voltage will drop depending on how far up the cable the fault is. IoT devices employ a microcontroller to perform the necessary computations while the signal conditioner manipulates the voltage change to display the fault distance. The main part of the underground cable is the core conductor, which transmits the electrical energy from the source point to the load.

Underground cables are still being developed and are currently available for a variety of uses and voltage levels. The choice of a conductor is subjective and subject to the manufacturer judgement. Either solid or copper could be used. Additionally, the conductor chosen for a given application may vary depending on the flexibility, economics, physical characteristics, form, voltage, ampacity, and other parameters [4]. When laying cables, conductors are designed to endure pulling forces and carry current under a variety of circumstances [5]. A semiconductor interface is placed between the conductor and the insulation to prevent electrical field concentration. Typically, this is black. There is a conductor screen here (or shield). Together with the insulation shield, it creates a uniform cylindrical surface that distributes electrical stress evenly [6]. As cable ages, deterioration is inevitable. Most utility components, especially underground cables, have higher failure rates as time passes [7]. This deterioration is caused by thermal, mechanical, electrical, and environmental factors or a combination of any of these factors [8].

The underground cable eventually fails due to the persistence of the acting factor. We also studied the work proposed by S. Nagaprasad et al. [21], Ajay S. Ladkar et al. [22], S. L. Banagre et al. [23-25] K. Gulati et al. [26], P. S. Banagre et al. [27], Xu Wu et al. [28] and V. Durga Prasad Jasti et al. [29].

Underground Cable Faults:

If left unfixed, faults often have negative or significant effects on how power systems function in several ways. They produce an anomalous rise in voltage or current levels at particular system locations, and this rise reduces the equipment's lifespan. Instability in the power system brought on by faults leads to irregular operation of three-phase equipment. In addition to putting workers in danger, flaws can also ignite a fire [9] [10]. To to keep the remainder of the system functioning normally, it is best to disconnect or fix a fault as soon as it arises.

In general, there are two types of defects in power systems: symmetrical faults and unsymmetrical faults. In a power system, symmetrical errors can happen without producing a system imbalance (i.e., the phases continue to maintain 120° phase angles between them). Rarely occurring and showing heavy current flow, this kind of fault. When the three phases are short-circuited to earth, that is an illustration of a symmetrical fault [11].

In one phase or two phases, unsymmetrical defects might exist. The power system becomes unbalanced as a result of an unsymmetrical fault because the phases are no longer separated by a 120° phase angle. Between phases, or between phases (or phases) and ground, they can occur [11].

Open Circuit Faults:

Ferro- resonance is another name for these fault types [12]. Extremely high voltage levels are produced by this Ferro-resonance across transformer windings and from line to ground. The transformer's insulators and windings risk damage due to the high voltage level. However, the open circuit poses less of a risk to workers because no current passes through it. This typically occurs when the cable has been stretched past its breaking point, and an example of this is a loose joint connection or a damaged conductor [13]. It may also result from a protective device going bad (e.g., circuit breaker, fuses, etc.). Open circuit faults separate the supply or generating side from the load side and may result in a system imbalance [14].

Short Circuit Faults:

Impedances fall with short circuit faults, with le phase angle rises. However, this is based on how far the fault is from the source. Because short circuit defects increase fault current and drastically reduce impedance closer to the source, they are dangerous [14] [15]. They might be the result of conductor overheating brought on by damage to the insulation of the cable. Arcing typically takes either at the fault's location or a spot nearby [16]. On the other hand, the most frequent problems in electrical systems are earth faults. When a current-carrying conductor contacts the lead (or metallic) sheath, the current is transferred to the earth and causes this kind of fault [13].

III. METHODOLOGY

Making a block diagram connecting all the input and output devices to the Arduino board is the first step. Each connected hardware piece is examined to ensure that it functions as intended. if a piece of hardware is unable to produce the desired effects. Other gadgets are substitutes that are employed to obtain the desired outcomes. The programming code for each piece of hardware and its features must then be written. The logic development process entails the creation of a common logic that incorporates all of the hardware components of our project and effectively uses this logic to produce the desired output. Once the last bit of code is finished, it's time to combine all the objects and do the project's final testing based on the circumstances provided. By stringing resistors together in series to create two underground cables, resistors are used to demonstrate cable defect detection (Underground cable1, Underground cable2).

The GPRS module is used to communicate the fault to relevant parties and authorities. and offer a database with information on the location and detection of the defect. To display overload circumstances, a transformer and voltage divider circuit are employed.

Hardware Requirements

- Arduino Micro Controller
- LCD
- Watt Resistor

- GPRS
- Voltage Divider Circuit
- Transformer
- Relay
- Bulb

Arduino Micro-Controller- The 32-pin Arduino microcontroller is a popular choice. It is a programmable board with several uses. An ATMEGA328PU microcontroller chip is used by Arduino. Use either 5 volts or 12 volts to power this device. It delivers 5v and 3.3v of output voltage from each of its corresponding pins.

Fig. 1: Arduino Board

Arduino has two types of pins:

1.Analog Pins
2.Digital Pins

A0 to A5, or a total of 6 analog pins, are designated as analog pins. Devices that use analog input or if they provide analog output analog pins. Digital pins are numbered 2 through 13. 11 pins in all. These pins are used in conjunction with digital devices that output 0 or 1. PWM (Pulse Width Modulation) pins, which also function as analog pins, are utilized with some digital pins. PWM pins are identified on the Arduino board by the symbol (~).

LCD Display

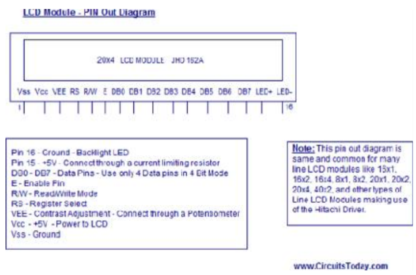

Fig.2: structure of LCD

A 20*4 LCD will be used in our project. An LCD module as shown above can be connected to Arduino using the i2c protocol. I2c protocol enables serial communication between Arduino and LCD modules.Watt Resistors-To stop the passage of current, we utilize resistors. There are numerous sites on underground wires where Watt resistors are linked. to limit current flow and provide a precise sensor reading for the Arduino end.

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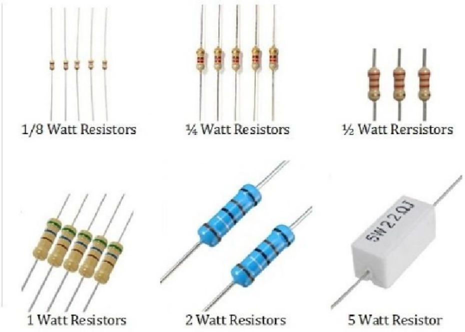

Fig.3: Watt Resistors

GPRS:

GPRS/GSM technology was utilized used to provide Arduino access to the internet. This module can be programmed to connect the Arduino board to the internet, send SMS or calls to a certain number, or both. In our project, we use a GSM module to alert concerned parties through SMS of cable failures.

Fig.4: GPRS/GSM module

Relay

Digital switches are relay boards. Relay modules' on/off mechanisms can be managed by Arduino programming. The relay turns on if the data pin of the relay is set to high in programming. The relay switches off when the data pin is set to zero.

Fig.5: Relay Driver

Software Specification

- **Embedded C:** Embedded systems switched to C as their preferred embedded programming language as the use of microprocessor-specific assembly-only decreased. The most popular programming language for embedded controllers and processors is C. Assembly is also utilized, however, it is mostly employed to implement those parts of the code that require extremely high timing accuracy, code size efficiency, etc.
- **C Language:** A program or application that software developers use to create, debug, maintain, or otherwise support other programs and applications is known as a programming tool or software development tool. Typically,

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the phrase refers to a rather straight forward program that may be present alongside application and system software. As one might use several hand tools to fix a physical object, C is a general-purpose imperative programming language that supports structured programming, lexical variable scoping, and combination.

- **ThingSpeak:** As stated by its creators, "Using the HTTP protocol over the Internet or through a Local Area Network, ThingSpeak is an open-source Internet of Things (IoT) application and API that stores and retrieves data from objects. Applications for sensor logging and location tracking can be created using ThingSpeak. applications and a status-updating social network of things ".
- **Design:** Design Goals - Our design should achieve the following fault detections and performance guarantees to enable secure outsourcing of files under the model.
- **Detecting Fault Accurately:** The hardware system must be built so that it can withstand the demands of underground lines while still providing accurate fault details.
- **Efficiency**: In this system refers to how much less power the microcontroller uses to provide more accurate fault detection. Since Arduino-based systems operate in the 5V to 12V range and accurately produce the required output, their efficiency is sufficient.

IV. SYSTEM ARCHITECTURE

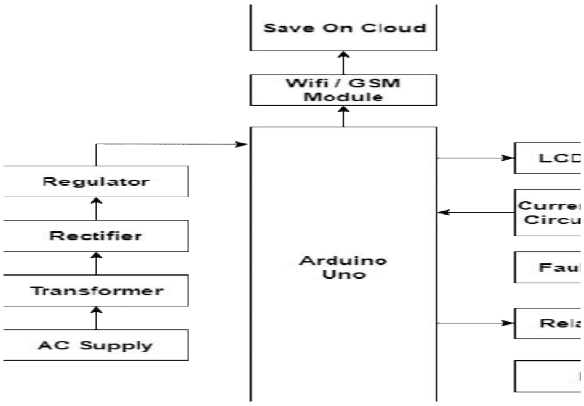

Fig.6: Architecture Diagram

The approach's block diagram can be seen in the figure up above. Designing is done in this method to make it possible to observe subsurface lines and to provide information about the identified problem. The power supply will be described first. Here, a transformer will step down the 230-voltage supply to 12 volts before converting it to AC. Afterward, a bridge rectifier can convert this to DC. After that, it is delivered to the voltage regulator, which filters out any noise, fluctuations, or ripples in the AC. The Arduino controller and the other chips used in the project receive the 5V output voltage from this regulator. The microcontroller will detect any errors if they occur. In the event of a problem, the controller receives this signal, analyses it, and instructs the GSM module to communicate the data to the appropriate person. When it comes to the transmission portion, the controller built into Arduino receives the voltage drop. Possibly included in this is a 16-bit analog-to-digital converter. The switch resistor arrangement's voltage is converted into a digitally valued signal by the 16-bit ADC. The controller then performs the necessary computations to identify the malfunction.

V. SCOPE

For open circuit fault, short circuit Line to Line Fault (LL), and double Line to Ground Fault, the job can be expanded (LLG). A capacitor in an ac circuit that monitors the change in impedance and determines the fault's distance can be used to find an open circuit fault. The next improvement will be the ability to gather this data, store it on a server in a database, and use it for additional analysis. We can also consider things like using extra security to access this system from a distance. We can provide security by designing a user interface with login restrictions for the admin and other authorized users only. Using this method, the user or supply company can quickly obtain the location and distance of the defect at their place of business via a specialized website.

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VI. RESULT

In this model, with the help of Node MCU Module Wi-Fi link, we can easily identify the fault happening of the line with very fast process. The work automatically updates the status of every substation on IoT. The time of occurrence of fault is determined with the help of microcontroller and ESP8266 Wi-Fi module in ThingSpeak's private channel. The system helps to quickly repair the fault and revive back the power system.

LCD Displaying no faults.

Fig.7: Result of Working Module

LCD displaying when fault occurs at particular line.

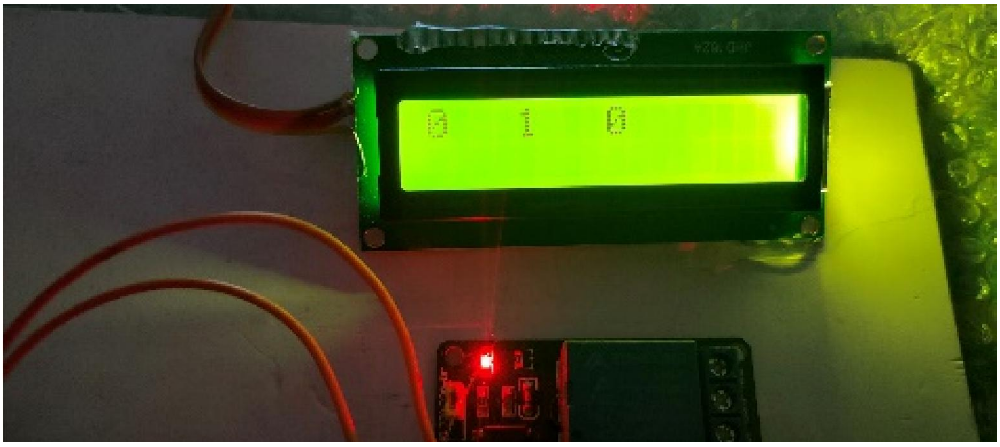

Fig.8: Result of Working Module

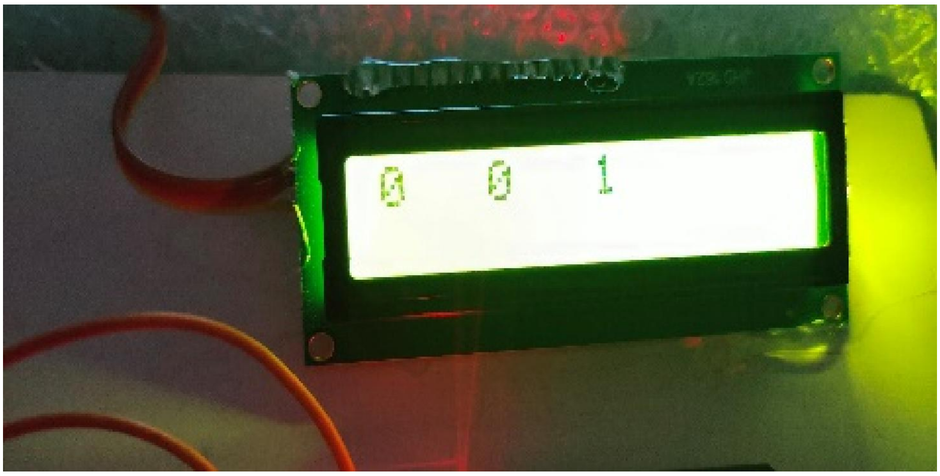

Fig.9: Result of Working Module

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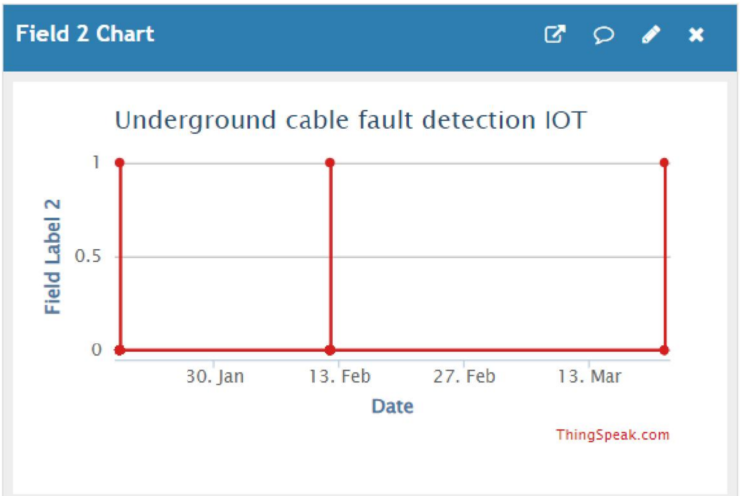
ThingSpeak showing voltage variation in each phase.



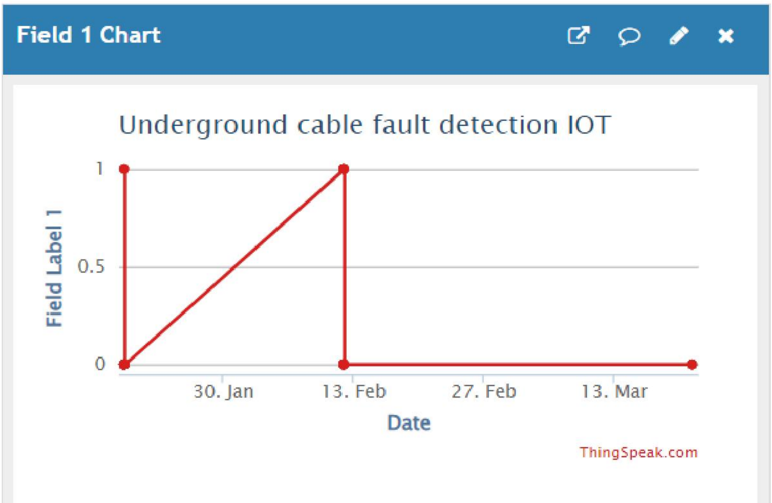


Fig.10: Graphical Representation in ThingSpeak

VII. CONCLUSION

Structured modelling was used in the project's design, and it can deliver the intended outcomes. With a few adjustments, it can be successfully used as a Real-Time system. Technology is constantly changing as a result of scientific discoveries and innovations in numerous domains. Further, most of the units can be produced on a single, together with a microcontroller, making the system compact and increasing the effectiveness of the current system. Implementing components with a wider range is necessary to make the system usable for real-time applications. The challenge of finding the fault in underground wires is handled in the proposed effort using the Node MCU Wi-Fi Module. For better detection of cable failures, we projected an IOT-based model. Through the Node MCU Wi-Fi module, we proposed a method to locate the defect from the subterranean wires. When compared to other approaches, this one had the best results and accuracy. For the continuity and stability of power quality, this technology is also given a very quick rate of operation.

REFERENCES

[1] Nikhil Kumar Sain, Rajesh Kajla, Mr. Vikas Kumar ―Underground Cable Fault Distance Conveyed Over GSM, http:// www.iosrjournals.org /2016/volume-11/ e-ISSN: 2278-1676, p-ISSN: 2320-3331, Volume 11, Issue 2 Ver. III (Mar. – Apr. 2016), PP 06-10.

[2] R.K. RaghulMansingh, R. Rajesh, S. Ramasubramani, G. Ramkumar, ―Underground Cable Fault Detection using Raspberry Pi and Arduino, http://www.ijeter.everscience.org/International Journal of Emerging Technologies in Engineering Research (IJETER), Volume 5, Issue 4, April (2017).

[3] Mane Tejasri, Pawar Prajakta, Sabale Nayan―Underground Cable Fault Detection. ‖, http:// www.ierjournals.org/InternationalEngineeringResearchJournal (IERJ)/Volume2/Issue2/Page417-419,2016/ISSN2395-1621.

[4] http://www.ijeter.everscience.org/International Journal of Emerging Technologies in Engineering Research (IJETER), Volume 5, Issue 4, April (2017).

[5] Association, National Rural Electric Cooperative, Underground Distribution System Design and Installation Guide, Washington D.C., 1993.

[6] Butler-Purry, M. J. Mousavi, and K. L, "Study of thermal aging effects on distribution transformer solid insulation," in 34th North American Power Symposium, Tempe, AZ, Oct. 2002.

[7] N. H. Malik, A. A. Al-Arainy, and M. I. Qureshi, Electrical Insulation in Power Systems, New York: Marcel Dekker, 1998.

[8] T. Sandri, Director, Cable Fault Locating Webinar. [Film]. PROTEC Equipment Resources.

[9] B. Anderson, Director, Fault Characteristics of Power Grids. [Film].

[10] G. Ojha, A. G. Roy, and R. Verma, "Underground Cable Fault Distance Locator," International Journal of Advance Research, Ideas and Innovations in Technology, vol. 3, no. 2.

[11] K. Padmanaban; G. Sanjana Sharon; K. Vishnuvarthini, "Detection of Underground cable fault using Arduino".

[12] Victory, Itodo Friday, "Design and Construction of Digital Underground Cable Fault Locator," University of Agriculture, Makurdi, Benue State, Nigeria, February 2012.

[13] Sawatpipat P., Tayjasanant T., "Fault Classification for Thailand's transmission lines based on discrete wavelet transform," in International Conference on Electrical Engineering/Electronics Computer Telecommunications and Information Technology (ECTI-CON), 2010.

[14] P.S. Pooja. M. Lekshmi, "Fault Detection and Technique to Pinpoint Incipient Fault for Underground Cables," International Journal of Engineering Research and General Science, vol. 3, no. 3, May - June 2015.

[15] M. Dhekale P., S. Bhise S., R. Deokate N., Prof. Survawanshi R., "Underground Cable Fault Distance Locator," International Journal of Innovations in Engineering Research and Technology, vol. 2, no. 4, 2015.

[16] "ELPROCUS,".Available: https://www.elprocus.com/what-are-the-different-types-of-faults-in-electrical-power-systems/[Accessed 02 03 2018].

[17] Swapnil Gaikwad, Hemant Pawar, Ajay Jadhav, Vidhut Kumar―Underground Cable Fault Detection Using Microcontroller ‖, IJARIIE-ISSN(O)-2395-4396, Vol-2 Issue-3 2016.

[18] Abdulkareem A., C.O.A Awosope, A.U Adoghe "Power line technical loss evaluation based online current from unbalanced faults". Research journal of applied Sciences, 11(18): 592-607, 2016.

[19] M. Dhekale P., S. Bhise S., R. Deokate N., Prof. Survawanshi R., "Underground Cable Fault Distance Locator," International Journal of Innovations in Engineering Research and Technology, vol. 2, no. 4, 2015.

[20] V. Kirubalakshmi, C. Muthumaniyarasi―IOT Based Underground Cable Fault Detector. Volume 8, Issue 8, August 2017, pp. 1299–1309, Article ID: IJMET_08_08_132, ISSN Print: 0976-6340 and ISSN Online: 0976-6359.

[21] S. Nagaprasad, D. L. Padmaja, YaserQuereshi, S.L. Bangare, Manmohan Mishra, Mazumdar B. D., "Investigating the Impact of Machine Learning in Pharmaceutical Industry", Journal of Pharmaceutical Research International (Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759), Volume 33, Issue 46A, Pages 6-14, Publisher: JPRI https://www.journaljpri.com/index.php/JPRI/article/view/32834.

[22] Ajay S. Ladkat, Sunil L. Bangare, Vishal Jagota, Sumaya Sanober, Shehab Mohamed Beram, Kantilal Rane, Bhupesh Kumar Singh, "Deep Neural Network-Based Novel Mathematical Model for 3D Brain Tumor Segmentation", Computational Intelligence and Neuroscience, vol. 2022, Article ID 4271711, 8 pages, 2022. https://doi.org/10.1155/2022/4271711.

[23] S.L. Bangare, "Brain Tumor Detection Using Machine Learning Approach", Design Engineering ISSN: 0011-9342,Scopus Index- Q4, EiCompendex, Volume 2021, Issue 7, Pages 7557-7566, Publisher Design Engineering.

[24] S. L. Bangare, and P. S. Bangare. "Automated testing in development phase." International Journal of Engineering Science and Technology 4.2 (2012): 677-680.

[25] Sunil L. Bangare, Deepali Virmani, Girija Rani Karetla, Pankaj Chaudhary, Harveen Kaur, Syed Nisar Hussain Bukhari, Shahajan Miah, "Forecasting the Applied Deep Learning Tools in Enhancing Food Quality for Heart Related Diseases Effectively: A Study Using Structural Equation Model Analysis", Journal of Food Quality, vol. 2022, Article ID 6987569, 8 pages, 2022. https://doi.org/10.1155/2022/6987569

[26] K. Gulati, M. Sharma, S. Eliyas, & Sunil L. Bangare (2021), "Use for graphical user tools in data analytics and machine learning application", Turkish Journal of Physiotherapy and Rehabilitation, 32(3), 2651-4451.

[27] P. S. Bangare, Ashwini Pote, Sunil L. Bangare, Pooja Kurhekar, and Dhanraj Patil, "The online home security system: ways to protect home from intruders & thefts." International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN (2013): 2278-3075.

[28] Xu Wu, Dezhi Wei, Bharati P. Vasgi, Ahmed Kareem Oleiwi, Sunil L. Bangare, Evans Asenso, "Research on Network Security Situational Awareness Based on Crawler Algorithm", Security and Communication Networks, vol. 2022, Article ID 3639174, 9 pages, 2022. https://doi.org/10.1155/2022/3639174.

[29] V. Durga Prasad Jasti, Enagandula Prasad, Manish Sawale, ShivlalMewada, Manoj L. Bangare, Pushpa M. Bangare, Sunil L. Bangare, F. Sammy, "Image Processing and Machine Learning-Based Classification and Detection of Liver Tumor", BioMed Research International, vol. 2022, Article ID 3398156, 7 pages, 2022. https://doi.org/10.1155/2022/3398156.