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# IoT Based Under Ground Cable Fault Detection with Cloud Storage

Devarajan R
Professor - EEE,
Vinayaka Mission's Kirupananda Variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed to be University), Salem, Tamil Nadu, India.
devarajan@vmkvec.edu.in

Prabakaran N
PG Student, M.E - PSE,
Vinayaka Mission's Kirupananda Variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed to be University), Salem, Tamil Nadu, India.
n_prabakaran02@yahoo.co.in

Vinod Kumar D.
Professor, Biomedical Engineering,
Vinayaka Mission's Kirupananda variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed to be University), Salem, Tamil Nadu, India.
vino.kd@gmail.com

Umasankar P
Professor, Electrical Engineering,
Mahendra Engineering College, Namakkal, Tamil Nadu, India
pumaieee@gmail.com

Venkatesh R
Professor - EEE,
Annapoorana Engineering College, Salem, Tamil Nadu, India
arkvenki@gmail.com

Shyamalagowri M
Associate Professor, EEE
Erode Sengunthar Engineering College, Perundurai, Tamil Nadu, India
mshyamalagowri2011@gmail.com

***Abstract*— Determining the origin of the fault presents a challenge, necessitating the complete removal of the cable from the ground for thorough inspection and repair of any faults. The fundamental concept involves the utilization of a subunit to remotely measure the voltage. Hence, the fault is detected by utilizing the secondary unit. This implementation utilizes three sub-units within a transmission line and employs a switch to establish the transmission line. In the event of a fault, subsequent slave units will be unable to update their status. The error will occur between the specified point and the subsequent secondary unit. The status of all units within a shared Internet of Things (IoT) application can be accessed globally from any location. In order to identify a fault in a cable, it is necessary to conduct a fault test on the cable. This test involves utilizing a series of switches positioned at predetermined intervals along the cable's length to induce the occurrence of the fault. The communication link is established between two substations. During a fault occurrence, the voltage experiences a decrease and subsequent fluctuations. This altered voltage is then transmitted to the ESP32 device that has been programmed accordingly. The ESP32 device then proceeds to exhibit the received information on the LCD screen. The Internet of Things (IoT) utilizes the ESP32 Wi-Fi module to transmit and present data over the internet. The website is developed utilizing HTML coding, and it presents information regarding fault occurrences. Alternatively, users may opt to utilize an Android application for accessing this information.**

***Keywords—Fault Detection, IoT, Underground Cable, Transmission Line***

## I. INTRODUCTION

The assessment of Internet of Things (IoT) within the electricity industry has significantly transformed conventional operational practises. The Internet of Things (IoT) has experienced a notable surge in the utilisation of wireless technologies for the purpose of establishing connectivity between assets and infrastructure within the energy industry. This connectivity aims to effectively diminish energy consumption and associated costs. The applications of the Internet of Things (IoT) are not confined to particular domains, but encompass a diverse array of sectors, including but not limited to energy systems, households, industry, cities, logistics, healthcare, agriculture, and others. Power grids are currently recognised as a crucial component of infrastructure that plays a vital role in supporting and sustaining modern society. Ensuring a continuous and uninterrupted power supply, free from any disruptions or losses, is of utmost importance. The discrepancy between generated power and consumed power at the endpoint, resulting from multiple sources of loss, presents a challenging aspect that is not easily comprehensible. The ramifications of being without electricity for a single minute are even more challenging to envision. Power outages are the result of short circuits. The aforementioned action incurs significant expenses due to its impact on industrial production, business operations, and consumer lifestyles. Both government entities and independent energy providers are continuously engaged in the exploration of various solutions aimed at guaranteeing high power quality, optimising grid reliability, minimising energy consumption, enhancing grid operational efficiency, and eliminating occurrences of outages, power losses, and theft.

## II. LITERATURE REVIEW

This article presents a fault location model for underground power lines, which utilises a microcomputer comprising a single chip [1]. The purpose of this project is to determine the distance, measured in kilometres, between an earth fault and the station that serves as the operational reference point [2]. The application of Ohm's Law is simplified and implemented through the utilisation of this function. In the event of a cable malfunction, such as a short circuit, the electrical current will exhibit fluctuations, and the extent of signal loss will be contingent upon the length of the issue [3]. The distance calculations are performed by a microcontroller, while voltage regulation is achieved through the use of an analogue-to-digital converter. The resistor set is employed to symbolise the cable, with DC voltage being acquired from one end of the cable [4]. The error message can be observed on the LCD panel of higher quality [5].The primary objective of this investigation is to identify and locate broken ground lines. This project incorporates fundamental concepts from the field of philosophy of information technology. The variable "current CT" is utilised in the calculation of changes that occur when a defect, such as a short circuit, takes place. Consequently, the voltage drop will exhibit variability in accordance with the length of the power line [6]. The reason for this is due to the ongoing calculation of the change. The cooling signal is responsible for controlling the voltage fluctuation and instructing the microcontroller to perform the necessary calculations for the Internet of Things device to ascertain the distance to the root cause [7]. Ohm's Law is a fundamental principle that is employed in the following equation. The length of the fault cable will impact the current flow through it. The design incorporates a collection of resistors that correspond to the cable length in kilometres, along with a group of switches that introduce known errors at specific kilometre intervals. This setup allows for the evaluation of measurement accuracy. The microcontroller with a 16X2 LCD interface displays both the distance travelled and the error generated. [8] The read-only memory (ROM) of a single-chip microcomputer is responsible for storing the programme. The power supply's step-down transformer operates at 230 volts and 12 volts to increase the voltage to 12 volts AC. The utilisation of a bridge rectifier facilitates the process of converting alternating current (AC) to direct current (DC) [9]. A capacitive filter is employed for the purpose of mitigating ripple. Subsequently, a 7805 generator is utilised to establish a voltage of +5 volts [10]. This voltage is necessary to power not only the microcontroller but also other components. Subterranean power lines have long been the prevailing approach for the transmission of electricity. The reason for their suitability in subterranean connections, enhanced protection against criminal activities and theft, and resistance to adverse climatic conditions like storms and hurricanes has been identified [11]. These products are not only cost-effective but also require minimal maintenance, making them advantageous for the environment. This solution effectively reduces both operational and maintenance expenses, along with mitigating the financial impact of storm-related damages. Furthermore, the risk of storm-induced damage is eliminated through the burial of electricity lines [12, 13].

The utilisation of underground cable systems is a prevalent practise in numerous urban areas. In the event of a fault occurring, the repair process for the specific cable in question becomes challenging due to the lack of precise location information. The cable fault detector is a sophisticated technique utilised for the purpose of identifying the precise location of faults within cables. In the present situation, the identification of fault origins poses a challenge, necessitating the excavation of the entire line for comprehensive inspection and subsequent repairs. The primary objective of our project is to determine the precise location of the fault, thereby minimising the time required for resolution. By implementing this approach, the need for excavating the entire line can be circumvented. The implementation of this project effectively minimises the required effort and enhances overall work efficiency.

## III. EXISTING SYSTEM

In this work, the principles of Ohm's law and the voltage-divider rule are being employed. The utilisation of ADC and PIC microcontrollers is prevalent in the field of voltage monitoring and fault detection. Upon completion of the fault detection calculations utilising the analog-to-digital converters (ADCs) and programmable integrated circuit (PIC) microcontrollers, the LCD panel will display the distance to the identified issue. The SIM 800 GSM module employs AT instructions for the purpose of data transmission. The current systems are associated with several drawbacks, such as lengthy procedures, slow operations, a need for increased manpower, elevated costs, and ineffective problem localization.

## IV. PROPOSED SYSTEM

The line failure in the custom-built system can be efficiently and easily identified by utilising the ESP32 Wi-Fi connection module. The problem is accurately identified using a three-dimensional approach. To fulfil this objective, a voltage and current sensor is employed. The Wi-Fi 32 module accurately determines the precise location of the issue. The improvement of underground line fault identification involves the application of a technique to the B phase findings of the LG fault, followed by the repetition of the procedure for the Y B phase results of the LL fault. This report presents the findings of a comprehensive analysis conducted to evaluate the consequences resulting from the failure of LL. The ESP32 necessitates the generation of a continuous 12 V DC voltage from the graded DC power source. The voltage drop resulting from a short circuit exhibits variability in proportion to the length of the fault in the line. Consequently, the buzzer will emit sound at varying intervals due to the fluctuation in current within the line. The ESP32 Wi-Fi module within the IoT web application facilitates the automated transmission of defect data to the cloud. The IOT module is considered essential due to its capability to efficiently update the status of the Internet of Things (IOT) and multiple substations through a unified IOT application. The suggested system offers several benefits including time and cost savings, compatibility with various cable types, reduced software requirements, a minimal learning curve, and user-friendly operation. This approach aims to achieve reduced complexity and precise fault localization at the partial level.

## V. SYSTEM FUNCTIONING

### *A. Block Diagram*

The block diagram in Fig. 1 illustrates the implementation of an Internet of Things (IoT)-based cloud storage system designed specifically for the purpose of locating underground cable faults. The block diagram consists of several components, including WIFI hardware, an LCD display, an AC input 230-volt supply, an AC input 230-volt to 12-volt transformer, a DC linear 5-volt supply, cloud storage, and a mobile application. A rectifier is employed to convert the 230-volt AC input into a 12-volt DC output. In order to generate direct current (DC) power, an alternating current (AC) to DC converter is employed to convert the 230V AC input into a 12V AC output.

The voltage regulator is responsible for decreasing the supplied voltage from 12 volts to 5 volts, which is the operational voltage for the WiFi gadget. All operations will be conducted through the WiFi device. The LCD screen functions as a visual output device. The WiFi device is connected to the relay. The router has been successfully connected. ThinkSpeak has the capability to generate an API key that can be used for cloud-based data storage. In the event of relay malfunctions, users will observe the manifestation of a red light and a zero graph within the cloud interface. When the wire is functioning properly, an indicator light will illuminate in green, accompanied by a graphical representation indicating a voltage of 5 volts. Downloadable.

CSV files enable the visualisation and analysis of data. In the event of a malfunction, the user shall be notified electronically. This feature enables prompt implementation of subsequent actions.

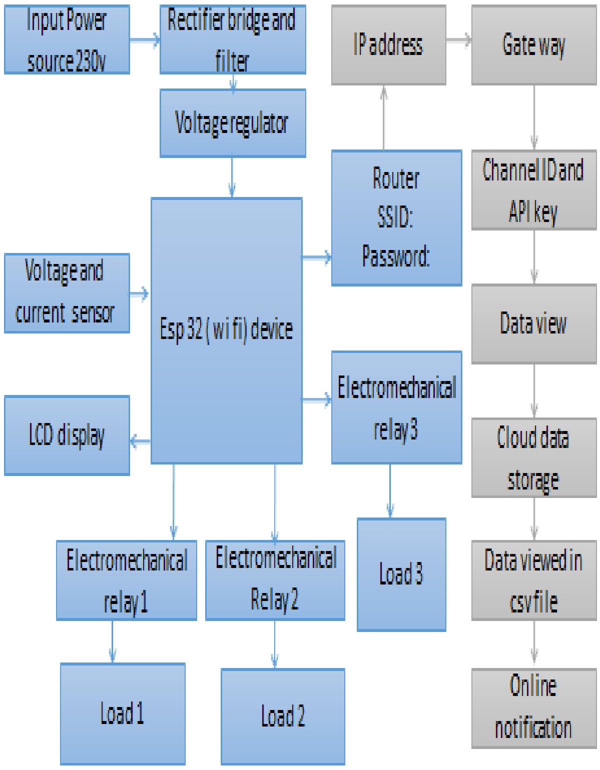


Fig. 1. Block Diagram

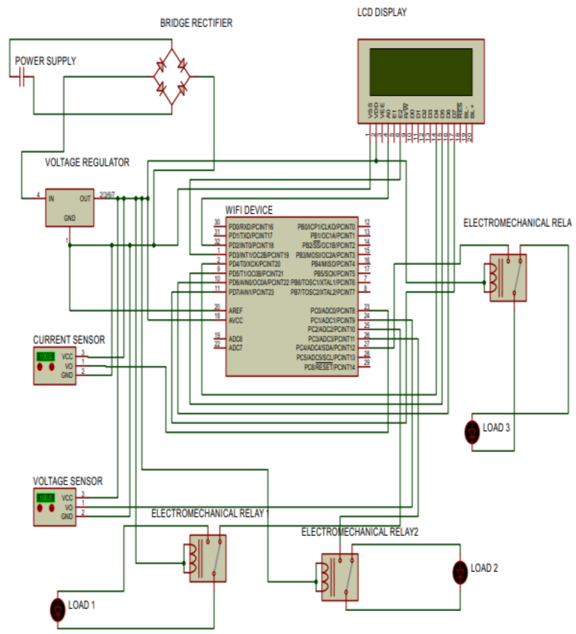


Fig. 2. Circuit Diagram

## *B. Circuit Diagram*

The circuit comprises of various components including light, voltage, and current sensors, an electromechanical relay, and a liquid crystal display. To establish a connection between the AVR controller and the LCD display, it is necessary to connect the digital pins D2, D3, D4, D5, D6, and D7 on the AVR controller to the corresponding pins on the LCD display. Additionally, it is essential to connect the 5 volts and ground pins on the controlling board to their respective counterparts on the LCD display. The alternating current (AC) transformer is responsible for providing electrical power to the AC to direct current (DC) converter. To convert the controller into a regulator, a bridge rectifier is employed. The 12-volt power source is being reduced to 5 volts with the assistance of a voltage regulator. Subsequently, the controller board is equipped with a 5-volt power supply. The voltage/current sensor is a three-pin device. To establish the connection, ensure that the positive pin is connected to the 5 volt supply, the negative pins are connected to GND, and the data pin is connected to the analogue input on the controller. The relay has a pin configuration of 33. The signal pins that are currently accessible include a 12-volt pin, a ground pin (GND), and a 5-volt pin. The regulator's 12-volt pin is electrically connected to the ground pin, while the ground pin is physically connected to the digital pins of the controller. Additionally, the signal pin is also connected to the pins. The switch is connected to the load of the relay.

## VI. HARDWARE REQUIREMENTS

The ESP32 is an affordable System-on-Chip (SoC) that functions as the underlying technology for the WI-FI 32 (Node Microcontroller Unit) open software and hardware development platform. The ESP32, a computer system developed and manufactured by Espressif Systems, encompasses all essential components typically found in a computer. The central processing unit (CPU), random access memory (RAM), wireless network (Wi-Fi), and the latest operating system (OS) and software development kit (SDK) are all essential components for optimal system performance. The acquisition and programming of the ESP32 chip present challenges. To activate the power supply or transmit keystrokes to the "computer" on-chip, it is necessary to establish connections between cables carrying analogue voltages and the corresponding PINs. The task at hand necessitates the utilisation of low-level machine instructions that are comprehensible by the hardware component.

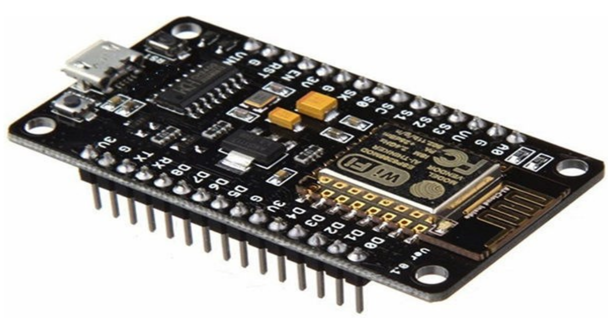

Fig. 3. WIFI Device

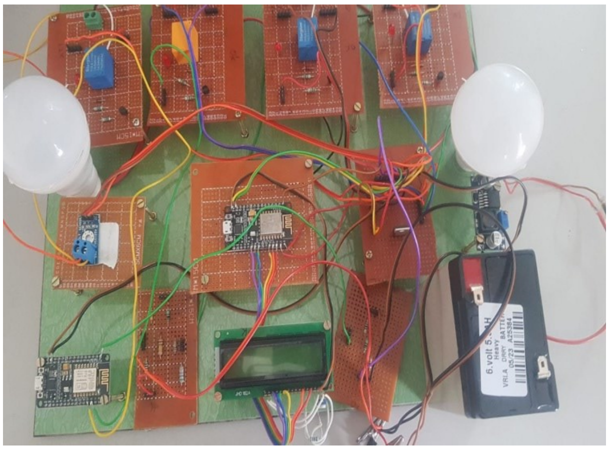

Fig. 4. Hardware Setup

The utilisation of the ESP 32 as a control chip in a prominent electrical device mitigates this integration challenge. However, it poses a substantial obstacle for individuals lacking expertise, hobbyists, or novice learners who aim to delve into the ESP 32 for their Internet of Things (IoT) undertaking. Figure 4 depicts the comprehensive hardware configuration of the underground cable fault detection system based on the Internet of Things (IoT) and utilising cloud storage. The implementation has effectively verified and validated critical results pertaining to various issues in subterranean cables.

## VII. RESULT AND DISCUSSION

Underground cables may encounter a range of issues due to the subterranean environment, wear and tear, and the presence of rats. Identifying the root cause of the issues is a challenging task, often necessitating the inspection and repair of the entire line as the sole viable solution. This article presents a cable fault detection solution utilising Internet of Things (IoT) technology. The proposed system accurately identifies the exact location of cable faults, thereby streamlining the repair process. The excavation process is limited to the damaged area, as the repair personnel possess prior knowledge of the precise location of the issue. This process expedites the maintenance of subterranean wires, resulting in significant time and resource savings. Our organisation leverages IoT technology to facilitate remote tracking and resolution of issues for government agencies. The cable is equipped with a potential dividing network that is responsible for detecting faults in the system. When two lines are connected, a voltage is generated as a result of the resistances present in the network. The microcontroller is responsible for monitoring and reporting the voltage to the user. This approach effectively reduces the time required for fault detection by minimising the probability of repeated occurrences.

## VIII. CONCLUSION

The identification and resolution of a short-circuit defect in an underground cable were accomplished by applying the fundamental principles of Ohm's Law. The experiment demonstrates the automatic display of phase, distance, and time of the problem on a web page using a voltage sensor, microcontroller, and Wi-Fi module. The issue will be identified within a few seconds. The advantages of fault data with a high accuracy rating include expedited repairs for power restoration, improved system performance, reduced operating costs, and enhanced fault location speed. It is feasible to incorporate support for open circuit faults, line-to-line shorts (LL), and double line faults (LLG). By incorporating a capacitor into the AC circuit, it becomes possible to detect an open-circuit defect by monitoring the variation in impedance and subsequently calculating the error.

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