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Design and Development of Underground Cable Fault Detection and Alerting System using GSM and GSM Module

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Abstract —With the growth of the power system grid, underground cables have been extensively used. Due to the underground environment, wear and tear, and rats, underground cables are vulnerable to a wide range of problems. Since the entire line must be dug in order to check for faults at cable lines, locating the root of the problem might be challenging. Only that section needs to be dug up to find the source of the fault because the repairmen are aware exactly which part is defective. Thus, it makes underground cable lines possible faster and saves a great deal of time and money. The objective of the paper is to calculate the distance in kilometres (km) between base stations and underground cable faults. The proposed method uses a microcontroller with algorithm to identify defects and unusual changes in underground wire, GPS to locate the fault position and GSM to alert the user.

Keywords — Underground, Fault, Detection, GSM, GPS, Node MCU

I. INTRODUCTION

The amount of civilized land is growing daily as India begins to emerge as a thriving nation. Although most lines are put overhead, underground lines are used in large places like hospitals, colleges, and other buildings because they provide safety. Due to its clear advantages, the idea of UG cable is developed for power transmission. However, since flaws are invisible, it might be challenging to discover them when they do arise. A procedure used in advance to avoid digging out cables without first knowing the precise position of the cable issue.

Across the nation, cables are strung a million miles in the air. But now, as opposed to an earlier manner, it is buried underground. Because of harsh weather conditions like pollution, heavy rain, snow, and storms, etc. do not impact underground wires. However, due to not knowing the specific location of the cable, it is extremely challenging to locate the exact location of the fault when a cable problem arises.

The world is growing more and more digital every day, so this paper proposes to locate the defect in a digital manner. However, the process of mending that specific cable is highly challenging. Numerous factors might contribute to a cable fault. They are: inconsistency, any flaw, cable brittleness, insulation failure, and conductor breakage. Here is a proposed methodology called the underground cable fault distance locator that may be used to locate the fault in an underground cable in order to troubleshoot the fault.

II. LITERATURE REVIEW

Mohammed Basha, Govind, P. Gurumurthy Reddy have presented the paper “Arduino Based Underground Transmission Cable Fault Location Systems” [1]. The transmission line fault detection requires intense human efforts and resources. Typically, this process is time consuming and while digging the cable there is a risk of damaging the insulation. This paper provides a simple and safe alternative by automating the process of fault detection and location. The Project uses a simple concept of OHM’s law where a low DC Voltage is applied at the feeder end through a series resistor.

Priya H. Pande, Mandar H. Polade, Prof. Pragati D. Pawar have presented the paper “Underground Cable Fault Detection Using Microcontroller” [2].

This paper proposes a fault location model for underground power cable using raspberry pi and the Internet of Things which is based on the internet, which means the information will be transferred through the internet access. The aim of this method is to determine the distance of the underground cable fault from the base station in kilometres and also find the location of that faulty place. This paper uses the simple concept of Current Transformer Theory (CT Theory). When any fault like short circuit occurs, voltage drop will vary depending on the length of fault in cable; since the current varies Current. Transformer is used to calculate the varying current. The signal conditioner manipulates the

change in voltage and a microcontroller is used to make the necessary calculations so that the fault distance is displayed by IOT devices. These fault details are then sent to any access point through the internet and displayed.

Haider Samet, Mohsen Tajdinian, Saeed Khalegian, Teymoor Ghanbhari have presented the paper "A statistical-based criterion for incipient fault detection in underground power cables established on voltage waveform characteristics" [3]
The proposed method is designed for inception fault detection in the underground power cables while the robustness of the method is guaranteed from different events in the network. The proposed method is conducted in two general stages: First finding change in the signal that triggers detection algorithm and second, applying a detection algorithm to discriminate of the incipient fault from capacitive switching and sudden load variations, harmonic loads, and short circuit fault events. The key point of implementing the proposed algorithm is to calculate the difference between the original signal and the estimated fundamental component of the signal.

Mr. Ankit S. Gaulkar, r. Karunesh V. Gaurkar, r. Karunesh V. Gaurkar, Ms. Prachita K. Yerane, Prof. Nisha Warambhe have presented "AUTOMATIC UNDERGROUND CABLE FAULT DETECTOR
USING IOT"[4].
The proposed system is intended to detect the Location of fault in a digital way. In the A-frame method, a pulsed direct current (DC) is injected into the faulty cable and earth terminal to locate the ground fault. The DC pulse will flow through the conductor and return via earth from the earth fault location back to the ground stake. The flow of pulsed DC through the ground will produce a small DC voltage. A sensitive voltmeter is used to measure the magnitude and direction of the DC voltage in segments of the earth along the cable route. Analyzing the results of the measuring voltage along the route, the location of the fault in the cable can be pinpointed.

FH Md Arifin, MZ Hasan, Mahyudin have presented "Development of fault distance locator for underground cable detection" [5].
The concepts of Ohm's law are used in this project and are placed underground with short circuit type fault conditions. If any fault occurs, the voltage drop will vary depending on the length of fault in the cable since the current varies. Tracer method is used to detect faults by walking through the cable lines. Fault point is traced by the audible signal or electromagnetic signal. The distance of underground cable fault from the base station is in kilometers as the system will detect the faulted cable underground and will send the information to the control room by using a relay.

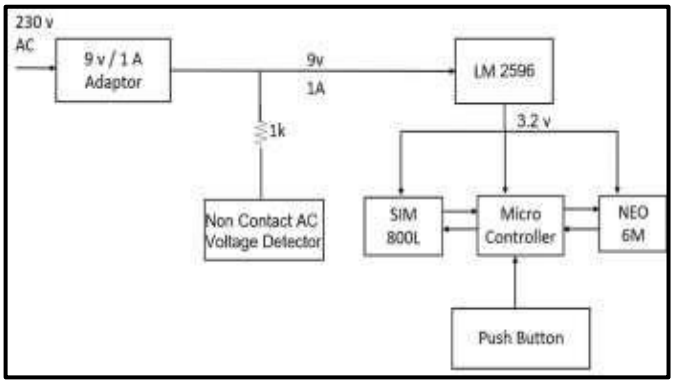
Shreya Pal, Shubham Verma, Shashank Yadav have presented "Development of a Prototype of a GSM based Underground Cable Fault Detector" [6].
This paper proposed a method of detection of the location of short circuit faults in the underground cables originating at the base station, in kilometers using AT mega-16 microcontroller. This prototype uses the simple concept of Ohm's law to locate faults and uses a GSM module to keep track of the fault distance through a specified server and a specified mobile number.

III. PROPOSED METHODOLOGY

A. BLOCK DIAGRAM

230v AC voltage will be supplied to adaptor having 9v and 1A. A non-contact AC voltage detector is built, which will flow the current from copper wire to detect the change in voltage. We have used buck converter i.e., LM2596 to convert to 3.3v because system need to be operated on 3.3v as shown in figure-1.
The system uses sim800L GSM module for communication and NEO 6m GPS module to get exact location.
Push button is used for safety purpose because this system is very sensitive to current that it will detect even the minute change in current anytime. Hence to avoid this problem we have used push button so that the system will only detect the system when push button is switched on

Figure 1: Block diagram of system



B. COMPONENTS

Software:
Arduino compiler MC Programming language: C

The Hardware components required for the proposed method is as below:
NodeMCU ESP8266
Cables and connectors
GPS module (Neo 6M)
GSM (SIM 800L)
PCB
Power supply (9V)
Buck converter (LM2596)

Node MCU:
NodeMCU is an open-source platform based on ESP8266 which can connect objects and let data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC, UART, etc. It gathers the information from GPS sensor module, processes it and sends a message alert to the mobile.

GPS module:
Neo 6M GPS module is preferred which can track up to 22 satellites over 50 channels and achieve the industry's highest level of tracking sensitivity i.e. -161 dB, while consuming only 45 mA current. The main function of this module is to transmit location data to the NodeMCU. The connection between NodeMCU and GPS module is set by connection to transmit pin Tx of GPS to NodeMCU Rx pin.

GSM module:
The SIM800L GSM module is preferred for this project for communication purposes. To make communication between GSM mobile and NodeMCU, we had only used the Rx pin of the GSM module and the Tx pin of the NodeMCU pin.

Buck converter:
LM2596 is a step-down voltage regulator, also known as buck converter, mainly used to step down the voltage or to drive load under 3A with excellent line and load regulation.

C. FLOW CHART

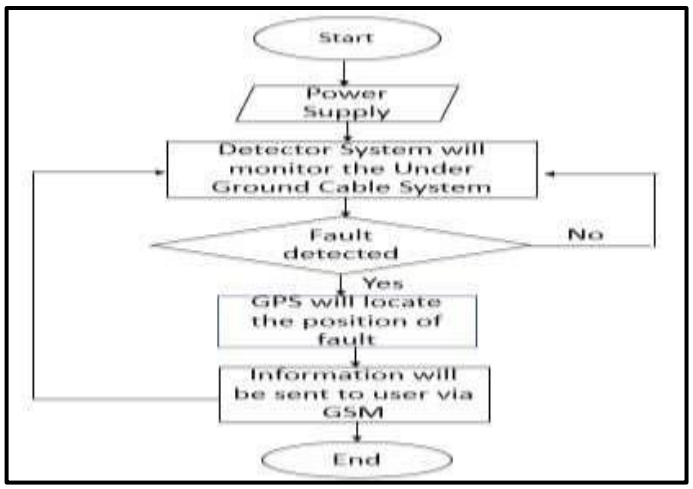


Figure 2: Flow Chart of proposed method

D. CIRCUIT DIAGRAM

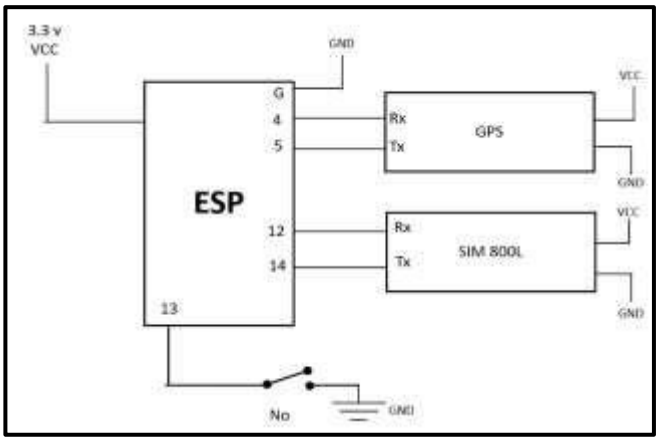


Figure 3: Circuit Diagram

E. WORKING

Working of this project is divided into four parts – DC power supply Part, cable part, controlling part, display part. DC power supply part consists of 230v AC then it is step down using transformer, buck convertor converts ac signal to dc & voltage regulator 7805 is used to produce constant dc voltage. The set of resistors denote the cable part along with switches. The set of resistors & switches are used as fault creators to indicate the fault at each location shown by

the current sensing part of the cable. The change in current is sensed by this part by sensing the voltage drop. Controlling part uses the analog to digital (ADC) to convert the input current sensing signal from the current generating circuit to the voltage drop into digital signal and supply the Microcontroller. The microcontroller makes necessary calculations regarding the distance of the fault. The driver is run by the microcontroller and controls the switching of the relays for proper connection of the cable at each phase. After this if fault detected then using GPS module system will locate the real time location of fault. And then GSM will send it to the users mobile.

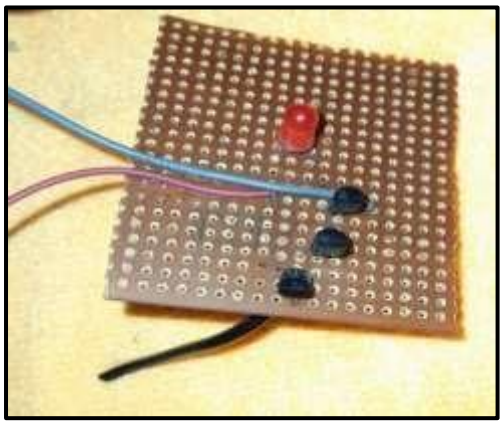


Fig.4: Non- Contact Voltage Detector as Fault Detector

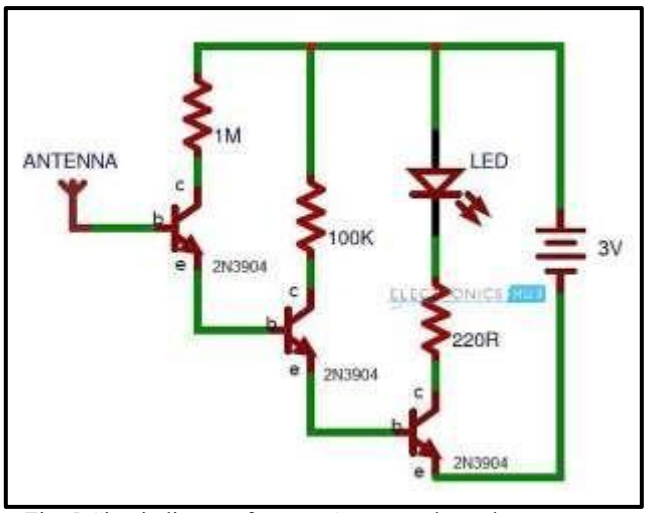


Fig. 5 Circuit diagram for non- Contact voltage detector

In the whole system, fault detector plays an important role. It is based on the principle of non contact voltage detector. A non-contact AC voltage detector detects the changing magnetic field around AC energized objects. This non-contact AC voltage detector uses NPN type transistors in order to detect voltage. A transistor has three terminals - collector, emitter and base. Collector to emitter current is controlled by the base current. Non-contact voltage testers work by sensing a very small amount of current that is capacitively coupled from the live circuit to the tester and back to ground. Non-contact voltage testers light up when they detect this current without needing to make direct contact.

IV. RESULTS AND DISCUSSIONS

A. RESULTS

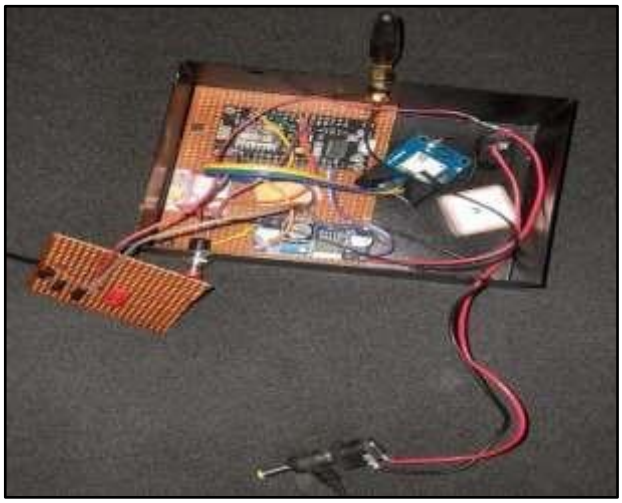


Figure 6: Actual Circuit

In fig.6, the actual circuit of the project is shown. It includes Fault detector system, locator system and Indicator system. Collaboration of these three main components the Fault Detection system is able to get desired red output.

Angular value requires time to read so some delay occurs.

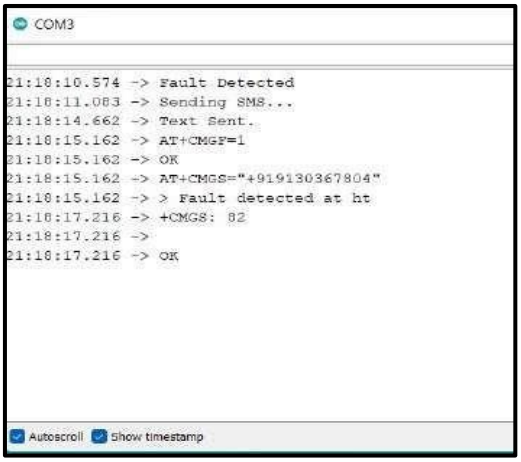


Fig. 7: Output 1

V. CONCLUSION

It's a difficult task to find the faults in underground cables. This paper is intended to study how to detect the exact location of circuit fault in the underground cables from the feeder end in by using an ESP8266. The microcontroller work is based on the output of the cable resistance. As soon as fault occurs in the cable using GSM the message of fault detection is sent to the base station. GPS will help

to locate the real time position of fault in system.

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VI. FUTURE SCOPE

In this project detection of the exact location of short circuit faults in the underground cable from the feeder end in km by using an ESP 82666 is done. In future, this project can be implemented to calculate the impedance by using a capacitor in an AC circuit and thus measure the open circuit fault.

VII. AKNOWLEDGEMENT

This work was done as EDI project by group 7 [B1] from IC-B under the guidance and help of Prof.

shown in the figure number 7.

User will get exact location of fault as you see in "Arduino Based Underground Transmission Cable Fault fig 8 and can easily take action over it by looking Location Systems", June 2017, Volume 5, Issue 6, ISSN at exact fault location. The system is Precise 2349-4476 accuracy in determining the location of fault. Consumes low power in Nano watts. Compact size, Easy to handle. Serial on Pawar, "Underground Cable Fault Detection Using board programming. No external programming Arduino Microcontroller", IETE Zonal Seminar "Recent voltage needed. Less maintenance cost. Trends in Engineering & Technology" – 2017

It has higher efficiency. Safe and secure to use. It is fast, effective & flawless service. Highly reliable and efficient to use. Useful for all types of systems public safety has improved. The microcontroller and other components require 5V DC Supply. Relay requires 12V dc. Sometimes network Problems for rural areas may happen.

[1] Mohammed Basha, Govind, P. Gurumurthy Reddy, Electric Power System Research, Volume 197, August 2021, 107303

[2] Priya H. Pande, Mandar H. Polade, Prof. Pragati D. Pawar, "Underground Cable Fault Detection Using Arduino Microcontroller", IETE Zonal Seminar "Recent Trends in Engineering & Technology" – 2017

[3] Haider Samet, Mohsen Tajdinian, Saeed Khalegian, Teymoor Ghanbhari, "A statistical-based criterion for incipient fault detection in underground power cables established on voltage waveform characteristics",