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Underground Cable Fault Distance Locator over GSM Technology

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Abstract - Underground cabling system is much preferred system of cabling. In this system cables carrying electricity or data are buried under the earth surface. This makes it secure as the wires are not open to get in touch with humans directly. Direct contact can harm human in case of electricity and they also may get damaged if they get intact with something rigid or hard. The proposed system is developed to locate the faults which underground cabling systems experience. The proposed system will locate the errors automatically which is time saving process and also uses GPS to track the exact location of the error and uses GSM to send this information of the area of the fault and at what wire the fault has occurred. This makes proposed system beneficial for underground cabling scenarios so that just sitting at a remote location the exact wire and its exact fault location is tracked and the administration is informed about it.

Keywords: underground cabling, fault, location tracking, GSM; GPS

INTRODUCTION

Although there has been vast developments in every technological aspect but we still are in an era where transmission lines and power lines are dependent on cables (Khavari, Dashti, Shaker, & Santos, 2020; Rafi, Rennie, Larsen & Bauman, 2020; Rynjah, Lyngdoh, Sun & Goswami, 2019). Two types of cabling scenarios are very much used specially in transmission of power or electricity which are overhead cabling and underground cabling (Ippolito, Massaro & Musca, 2019; Arifin,Hasan, Mahyudin & Arshad, 2020). Overhead cabling (shown in figure 1) is preferred where terrains are not suitable for underground cabling (shown in figure 2) (Jones, & McManus, 2010). It is some time also dangerous in terrible climates especially in rainy weather and windy weather because of the fact that wires could fall making lives in danger (Yuchun, Yinghong, Kun & Zhuang, 2011). When overhead cabling is carried out then there is a small land of soil which is used where pylons need to get erected.


Figure 1: Overhead Cabling System (Google Images)


Figure 2: Underground Cabling System (Google Images)

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In contract underground cabling has an advantage of providing better stability in these circumstances. The aim of deployment is dependent on many factors like cost of deployment, feasibility and most important is fault tracking. This links to various parameters like framework quality, fast locating of faults and maintenance cost. In metropolitan cities, safely related areas and scenarios of airbases and airports underground systems are valuable.

In underground cabling excavation is needed. After the excavation cabling system is performed completely the land surfaces now can be used for any work like making of roads, houses, agricultural purposes. There exists some restriction that any work if carried around is excavated up to protective extent and not more than that because that will damage the cabling system.

Aim of the study is restore the transmission by repairing the system fast, making system execution and accessibility improve and reduce the maintenance cost as well as time required for the maintenance.

In this paper we are making a project in which we are targeting underground cabling system for if there may exists any fault then it may not need extra effort to locate that fault,

This system will be able to locate the place of fault occurrence and then display this information and also send this information to the operator using GSM technology.

LITERATURE REVIEW

Le Hong Lam and others have presented their research in which has targeted many different methods for underground fault cabling system (Quan, Van Tan & Hieu, 2018). The algorithms which they have tested are Personal Algorithm, Resistance Based, Modified Tagaki and Tagaki Saga Algorithms. They initially have tested these algorithms in MATLAB SIMULINK and then have applied on two underground cables in real time scenarios. This real testing for performed in Vietnam.

Researchers have proposed a discrete wavelet transform based analysis scheme for fault tracking for power cables. They have used simulation of 400 kV underground cabling scenario. They have used Alternative Transients Program (ATP) which is basically a free version of EMTP (The Electromagnetic Transients Program) in short its ATP/EMTP. They have used Daubechies 8 wavelet (db8) in order to analyze faults to develop detection scheme (Zhao, Song & Min, 2000).

Gilany and khalil (2006) have proposed scheme to locate faults in multi-end cabling scenarios. This scheme works when corresponding fault data which is recorded be accessible at the terminals of the cabling system. They have proposed to use wavelet based singularity detection which is a strong signal processing system for estimating location of the fault. With the help of this waves that are traveling at both the ends of cables are identified easily. The proposed scheme they have applied is on modal coordinates. Their proposed scheme shows potential to remove the impact which occurs due to broadcast velocity change.

Researchers (Fan, Cao, Wang & Zhou, 2019) have presented a method to detect location of the fault either from receiving end or from transmitting end. It has an accuracy of a few meters. They have used Arduino kit in their experiment. The method they have used is Varley Loop in order to locate the exact location of error and its accurate distance.

METHODOLOGY

Methodology of our project is presented in figure 3 and the steps are further discusses as following

Step 1: System is tuned ON

In the first phase of the system initialization takes places. It means that systems gets started and calibrates itself for operation. When the system is ready it indicates this and now operations can be performed.

Step 2: The proposed system starts the operation to get the information about the lines and their errors (if any).

Step 3: This stage is linked to second stage for errors. The proposed system after completion of the inspection checks whether an error is found then it moves to next stage or if there is no error then the LCD is tuned ON and displays “All Wires are OK”

Step 4: In this stage categorization is performed. We have categorized wires as red, blue and green. There are six wires named as Red1, Red2, Green1, Green2, Blue1 and Blue2.

Step 5: This stage is divided into two sections. One is to display the error on the LCD and second is to activate GPS and track location and use GSM to send SMS to the number which is provided in the coding of Arduino.

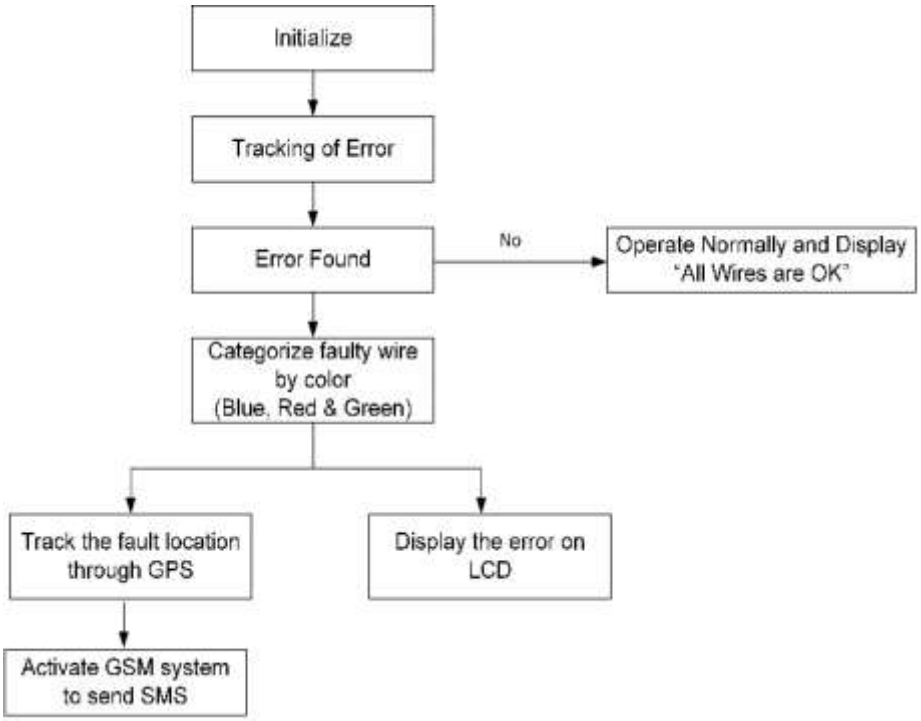

Figure 3: Methodology

HARDWARE AND CIRCUIT

In this section hardware components that are used in this project are discussed

A. Arduinomega 2560

It is an open-source electronics platform which is built on hardware and software which are easy be used. It is used in various projects due to its simple interface making it easier to use. Its operating voltage is 5 volts. It has 54 digital input/output pins as shown in figure 4. AC/DC adapter is connected to power it ON and it is connected to computer with a USB and can be used by downloading its interface that is its Integrated Development Environment (IDE).

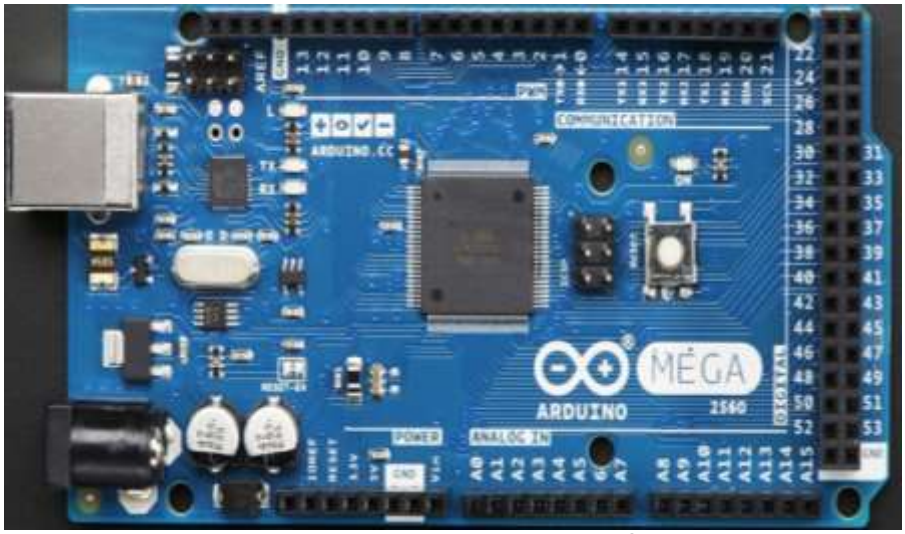

Figure 4: Arduino Mega 2560 [2]

[2] https://www.arduino.cc/

B. Buck Converter

It is also called step-down converter. It is a DC-to-DC power converter. Buck converter (shown in figure 5) is basically used to steps down voltage and step up current. They are mostly very efficient (more than 90%) which makes them very useful. It mostly converts 12 volts to 1.8 volts. These lower voltages are for Dynamic ram DRAM and USB for their operations.

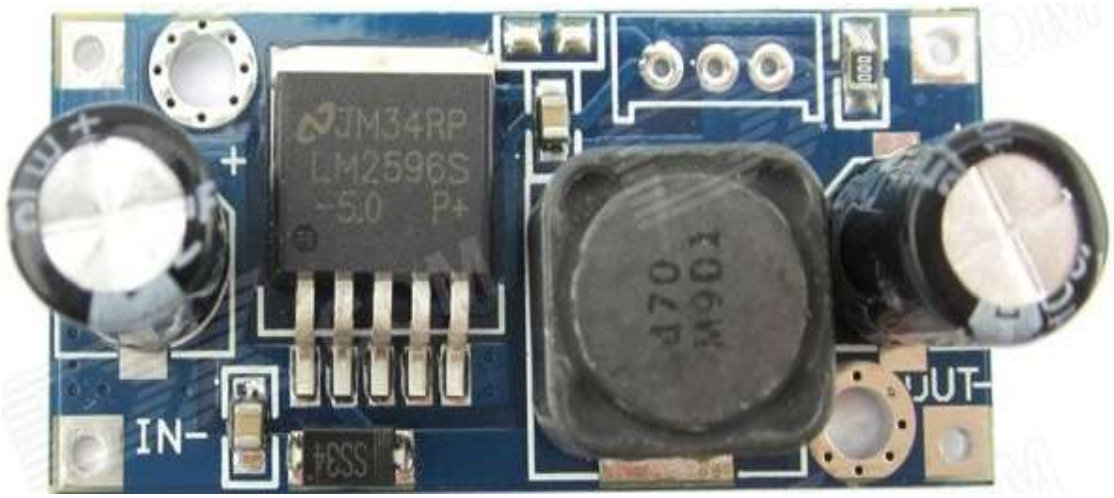

Figure 5: Buck Converter [Courtesy: Google Images]

C. GSM Module

The GSM module chip (shown in figure 6) which is responsible to create communication device (this could be either mobile or any other device) and a Global System for Mobile communication / General Packet Radio Services (GSM / GPRS) system. It provides functions in a circuit to transmit or receive short message service (SMS) based text messages and calls using GSM technology (Quan et al., 2018). The GSM module used in the proposed system is SIM900A Extension Module GSM 900/1800MHz Board Antenna Kit. It is a dual band module which works on 900/ 1800 MHz frequencies. This module searches these bands automatically.

Figure 6: GSM Module [Courtesy: Google Images]

Other hardware components are also used like power supply, rectifier, relay driver and relays.

D. Potentiometer

A potentiometer is a three terminal variable resistor with which the input voltage is formed into voltage divider. Potentiometer is used to control voltage levels so that the amount of current varies as per the need of the circuitry. Other components used are Liquid Crystal Display (LCD) for displaying the fault, Light Emitting Diodes (LED), batteries and programming language is C++.

WORKING MECHANISM

In this section we present the final and completed hardware of the proposed system. It can be observed in figure 7 that Arduino Mega, GSM Module, GPS Module, LCD, 2 BUCK Converters, Batteries and a manual fault creation system is there.

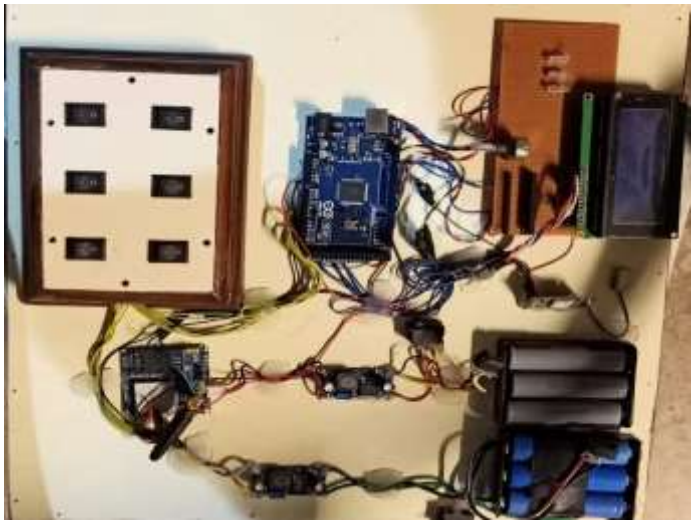

Figure 7: Completed Circuit

E. Case–I: No Fault Scenario

In this scenario it is shown in figure 8 that there is no any fault occurred. As it can be observed that there are six fault locations in the hardware so if all the links are working exactly in the right way then the LCD displays "All Wires Ok, No Fault".

Figure 8: Case of "No Fault"

Figure 9: LCD Displaying No Fault

In figure 9 the LCD is zoomed to show the displayed content clearly

F. Case–II: Fault Scenario

If there is a case that any of the wire has shown any error then the system generates two types of outputs. First is to activate LCD to show that the fault has occurred and second is to activate GPS and generate SMS using GSM Module. GPS is activated in order to track the exact location of the wire.

As in figure 9 the G1 link is broken. This automatically activated Arduino to activate GPS to find the coordinates and simultaneously it tries to find at what point error has been generated. As soon as it finds the fault, it displays that on the LCD the GPS coordinated are also displayed on the LCD as well, as shown in figure 10.

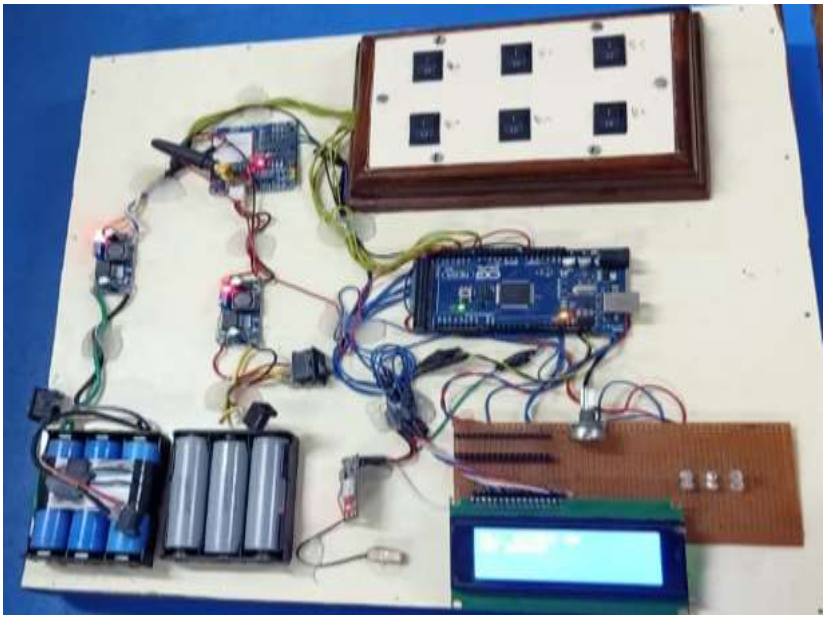

Figure 10: Fault Tracked

After that the fault is located then LCD displays that where the fault has occurred with exact location in terms of Latitude and Longitude as shown in figure 11.

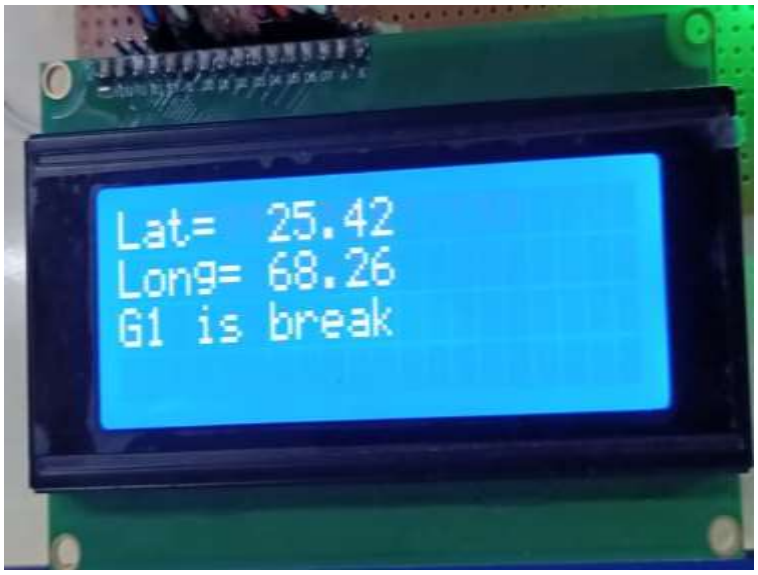

Figure 11: LCD displaying Fault and Location

The Arduino activates the GSM which already has a SIM having a SMS package to send messages to the number that is given in the coding of the Arduino. This SMS is sent continuously until and unless the fault is removed.

CONCLUSION

In this work we have made a hardware that is supposed to be used in underground cabling systems. These could be any time of systems that is telephone cabling, electricity cabling or any other system. As the cabling is under the ground then after implementing are very difficult to take care of. If there is a fault then all the lines have to be taken into account which is a time consuming process. With the help of the proposed system the lines and their errors can be easily tracked and located. The proposed system uses GSM technology as this is the best solution in Pakistan because 3G/4G and other technologies rely on GSM. This makes the proposed system better system to overcome manual system as it not only locates the fault but also sends GPS coordinates also so that the location is easily traced.

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APPENDIX

ATP	Alternative Transients Program
dB-8	Daubechies 8
DC	Direct Current
EMTP	Electromagnetic Transients Program
GPRS	General Packet Radio Services
GSM	Global System for Mobile
IDE	Integrated Development Environment
LCD	Liquid Crystal Display
LED	Light Emitting Diode
SMS	Short Message Service