Using IoT Applications for Detection and Monitoring of Underground Cable Fault

Faisal T. Abed*1, and Haider T. ALRikabi

1Department of Electrical Engineering, College of Engineering, Wasit University, Wasit, Iraq

*Corresponding author: ftheyab@uowasit.edu.iq

Abstract. Due to underground environments, wear and tear, rats, etc., underground cables are vulnerable to a large range of faults. It’s difficult to diagnose the cause of the fault and the whole cable must be separated from the ground to inspect and repair faults. The project work is intended to use the ESP32 controller for detecting the fault location in underground cable lines from the base station in kilometres. The cable needs to be checked for faults to find a fault in the cable. The basic principle of Ohms law is used in this prototype. The current will vary based on the cable’s fault length. In big cities, instead of overhead wires, the electrical cables run underground. It is hard for detecting the precise location of the fault for the repairing phase of that specific cable if the fault occurs in it underground cable. The suggested device finds the precise the fault position. The system is designed with a group of resistors representing cable length in km and a set of switches are generated to cross check the accurateness of the same at any known distance. The voltage across series resistors changes accordingly in the case of a problem, which can then be transferred to an ADC to produce accurate digital data by using programmed C++ that further displays fault position in the distance. The distance, phase, & time of the fault is shown on a computer or mobile device using the internet. The IoT is used to show information on the internet by using ESP32 WiFi module. The website is generated using HTML coding and the fault information is displayed on the website.

Keywords: Arduino, fault of underground cable, Internet of Things.

1. Introduction

Power distribution networks have been increasingly increasing and their efficiency has been increasing. The whole network is built with a large number of modules that can disturb and interrupt the power supply of the end user[1, 2]. For several globally controlled low voltage- and medium voltage distribution lines, underground cables have been employed for several decades. High-voltage cables in the underground have become ever more used because of the weather, storms, wind, rain and pollution. While the cable production technology is continuously improving, during testing and service, factors still can cause the cables to fail. The Internet of Things (IoT) is the extension of Internet access into daily items and physical devices. A cable that is in good shape will last around 30 years for a lifetime[3-5]. These devices can communicate and interact through the internet with others and are monitor able and remotely controlled, embedded in electronics, Internet networking and other hardware( such as sensors)[6-11]. IOT businesses in a wide range of sectors are using more and more to improve customer experience, improve decision-making and increase the profitability of the organization. IOT companies may also have deeper understanding.
2. Literature Survey

Some experiments and articles were presented and the WSN was discussed. Kevin Ashton, co-originator of MIT's AutoID Center, initially talked about the Internet of Things (IoTs) in a presentation he gave in 1999 to Procter & Gamble (P&G). In 1999, when the stuff beginning with feeling, also emerged in 1999, the new movement of MIT Professor Neil Gershenfeld did not use the precise term but offered simple insights into where IoT was going. Wireless technology, micro-electromechanical systems (MEMS), multiple networks and the Internet has evolved as a result of IoT. This integration helps to break down the silos from OT and IT, enabling analysis of unstructured device-generated data in order to drive information and understanding. While Ashton's had been the primary mention of IoT, since the 1970s the concept of connected devices was built on the Internet and on computer. For example, in the early 1980s, the first Internet appliance had been a coke machine at Carnegie Mellon University. Using the web, programmers can check the status of their machines and determine if a cold drink awaits them, if they wish to make their way to the machine. IoT has been evolved from communication between machines (M2M), specifically from machines that link to one another through a web without human intervention[12-16]. M2M means the connection, handling and collection of data of a computer to the cloud. IoT is a network of trillions of intelligent devices linking individuals, systems and other applications for collecting and exchange data from M2M to the following level. M2M provides a connectivity for IoT as its base. The Internet of things is also a natural extension of SCADA, an application software for process control, collecting data from remote locations in real-time to control equipment. SCADA systems contain elements of the hardware and software. The hardware collects and transmits the data to a device that installs SCADA software, where it is handled and displayed promptly. The SCADA growth is such that SCADA schemes of lately generation have developed into IoT systems of first generation[17-20]. Nevertheless, it was not until mid-2010 that the idea of the IoT ecosystem came into its own. While in part, the Chinese Government announced that it would create IoT an intentional priority in its 5-year plan.

3. Components of the circuit operation Relay

Relays are electric or electronically opening and closing switches. Closing and opening contacts in another circuit monitor the relay on an electric circuit. When a contact with a relay is usually open (NO) as seen in the Relay diagrams, an open contact occurs when the reaction is not triggered. If a relay contact is usually closed (NC), the relay cannot have functioned by a closed contact. If electric current is smeared to the contacts, their condition may change. Relaxes are typically used to turn smaller current in a control circuit and normally do not regulate power consuming units with the exception of small motors and Solenoids with low amplifications. However, relays can "control" larger voltages and amperes with an increasing influence, as a low applied voltage to the relay spiral can result in the contacts switching on a large voltage. Relays can avoid damage to the machinery, including over current, undercurrents, spikes and reverse currents, by detecting electrical anomalies. Relays also are commonly used for heating elements, pilot lights and audible warning systems.

Figure 1. The relay which used in this paper.
3.1. Espressif Systems (ESP32)

It's a 2.4 GHz combo chip for WiFi and Bluetooth with a very powerful 40-nm TSMC technology. It was considered for achieving optimum efficiency and RF, with stable, scalable and reliable applications and power scenarios for many different applications. The ESP32 chip series has been designed for smartphone, wearable, and IoT applications, including ESP32-D0WDQ6, ESP32-D0WD, ESP32-D1WD and ESP32-S0WD. All advanced features of low-powered chips include fine-grained clock gating, multiple power modes and dynamic power scale. ESP32 is stirred up regularly and just if an identified circumstance has identified in a low-compatibility IoT sensor hub scenario. The low-cost cycle can be employed for minimizing the energy consumed by the chip. A performance of a power amplifier can correspondingly be modified such that the communication field, data rate and power consumption are optimally reconciled. With about 20 external modules, ESP32 can be a fully incorporated solution for Bluetooth, Wi-Fi as well as IoT applications. ESP32 contains an antenna switch, RF-balun, filters, low-noise amplifier, power amplifier and modules for power control. This means that the whole solution covers a small region of the PCB. In addition to the integration of advanced tuning circuits, ESP32 uses CMOS to eliminate external cycle imperfections or adapt to changes in external conditions for a single-chip fully integration of radio and baseline bands. As a result, mass manufacturing of ESP32 solutions requires no costly specialist Wi-Fi test equipment[21-23].

![Figure 2. Espressif Systems (ESP32).](image2)

3.2. Voltage level converter

You know it can be the challenge, if you try to connect a 3.3V unit to a 5V machine. A tiny system that safely moves down the 5V signal to 3.3V and raises from 3.3V to 5V by bidirectional CJMCU logic level shifter. This module is available in various 3.3V and 5.0V devices and serves as a bridge to detect the physical conditions that are interested [24].

![Figure 3. Voltage level converter.](image3)
3.3. Resistance
Resistors with different values were used in the design of this project in accordance with the requirements of the electronic circuit for detecting faults. The values of the resistors used 1Ω and 2 Ω.

3.4. Strip Board
The Strip Board is a sheet of electrical current insulation material, which is fitted to electronic elements by welding on one hand with the copper bands, with hole in the strips and the insulation material. The diaphragm plates can be used in various ways, including integrated circuits. The gap between strips and the lumps is 0.1 cm and the hole diameter is 0.04 cm which matches discreet elements. The width is 0.15 inches between the strips and the holes, with a diameter of 0.052 inches. Both types in different sizes for small or large circuits can be found on the market.

![Strip Board Image]

Figure 4. The Strip Board

4. Types of Faults in Cables

- Open Circuit Fault: The cable's open circuit failure is related to when there is a break in the cable's conductor. Megger can control the open circuit fault. To do this, the 3-core cable conductors at the far end are shortened and tiled.

- Short circuit failure: The short circuit defect is called if two conductors of a multi-core cable come into electrical contact because of insulating failure. The two megger terminals are attached to two drivers. If the megger gives zero read, it means that these two conductors have a short circuit fault.

Earth failure: When the cable conductor comes into contact with the surface, the Earth defect is called an earth error or ground fault. The leader is connected to one megger terminal and to Earth the other terminal is connected to detect this error. If Megger demonstrates null reading, the conductors is grounded.

4.1. Actual application of the work

The circuit shown in Figure (5) represents the practical use of the Esp32 project, which represents the control component. The keys indicate the wire extension representing the turning the wire connects to the other wire and the relay is a key component of the circuit.
4.2. Software detection of under Ground Cable

This model is shown in the figure 6, the cable control section, in which the form is composed of three cables. There is a certain color in of cable. You should verify this. The four points representing the touch points are included in each cable. As for CA1, CA2, CA3 and CA4 for the first cable seen. In a format which indicates the exact cable interruption date such as the interruption date. The main thing is that the control screen will decide when the cable can be examined. There has been a cutoff of 15 minutes. And there are four points of contact for the possibility of adding any number of cables since this project is not limited to three lines.

4.3. Fault of a Cable

Figure 8 displays the first, second and third wires, each consisting of four conductors. Three wires are shown. In the first cable, a failure takes place at points CA2, CA4, and in the second cable, CB3 and CB4, as well as in the third cable, CC2 and CC4. Figure 9 indicates the cable break time 21:54:05 and the cut date 2019-04-02. It is also integrated into the form where the fault can be handled after it has been identified. The accuracy of the work and so on is what characterizes this project. The time and date of the failures are outlined by its readers as well as the repair time and date.
5. Conclusions
The works on detecting faults in the cables using the IOT. The electronic circuit containing the Esp32, which acts as a control unit, which contains the Wi-Fi, sends and receives data via the Wi-Fi through the internet, where the circuit is fed by 3V volts and the control voltage On the conversion of the bean the from 3-5V to operate the relay, which acts as an electrical switch to the circuit where in case of a cut in the cable will send a signal to the micro controller in turn sent by the wife to the recipient, either to the computer or mobile and the characteristics of the project was set date and time Unplug the cable and time and date of repair.

References
[1] Das C K, Bass O, Kothapalli G, Mahmoud T S, Habibi D J R and Reviews S E 2018 Overview of energy storage systems in distribution networks: Placement, sizing, operation, and power quality 91 1205-30
[2] Moreno-Muñoz A 2007 Power quality: mitigation technologies in a distributed environment: Springer Science & Business Media)
[3] Borgia E J C C 2014 The Internet of Things vision: Key features, applications and open issues 54 1-31
[4] Greengard S 2015 The internet of things; MIT press)
[5] Zubaidi S L, Al-Bugharbee H, Muhsin Y R, Hashim K and Alkhaddar R 2020 Forecasting of monthly stochastic signal of urban water demand: Baghdad as a case study. In: IOP Conference Series: Materials Science and Engineering: IOP Publishing) p 012018
[6] Yahya O H, ALRikabi H T, Al_airaji R a M and Faezipour M 2020 Using Internet of Things Application for Disposing of Solid Waste International Journal of Interactive Mobile Technologies 14 4-18
[7] Patel K K, Patel S M J I j o e s and computing 2016 Internet of things-IOT: definition, characteristics, architecture, enabling technologies, application & future challenges 6
[8] Mainetti L, Patrono L and Vilei A 2011 Evolution of wireless sensor networks towards the internet of things: A survey. In: SoftCOM 2011, 19th international conference on software, telecommunications and computer networks: IEEE) pp 1-6
[9] Hussien N A, Daleh Al-Magsoosi A A, AlRikabi H T and Abed F T J I J o I M T 2021 Monitoring the Consumption of Electrical Energy Based on the Internet of Things Applications 15
[10] Al-dabag M, ALRikabi H S and Al-Nima R 2021 Anticipating Atrial Fibrillation Signal Using Efficient Algorithm International Journal of Online and Biomedical Engineering (iJOE) 17 106-20

[11] Roa'a M A a, Aljazaery I A, Al_Dulaimi S K, Alrikabi H T S and Informatics 2021 Generation of High Dynamic Range for Enhancing the Panorama Environment Bulletin of Electrical Engineering 10

[12] Montori F, Bedogni L, Di Felice M, Bononi L J P and Computing M 2018 Machine-to-machine wireless communication technologies for the Internet of Things: Taxonomy, comparison and open issues 50 56-81

[13] Zhou Z, Gong J, He Y and Zhang Y J C M 2017 Software defined machine-to-machine communication for smart energy management 55 52-60

[14] Abed F T, ALRikabi H T S and Ibrahim I A 2020 Efficient Energy of Smart Grid Education Models for Modern Electric Power System Engineering in Iraq. In: IOP Conference Series: Materials Science and Engineering: IOP Publishing) p 012049

[15] Tuama H, Abbas H, Alseelawi N S and ALRikabi H T S 2020 Bordering a set of energy criteria for the contributing in the transition level to sustainable energy in electrical Iraqi Projects Periodicals of Engineering and Natural Sciences 8 516-25

[16] Zubaidi S L, Abdulkareem I H, Hashim K S, Al-Bugharbee H, Ridha H M, Gharghan S K, Al-Qaim F F, Muradov M, Kot P and Al-Khaddar R J W 2020 Hybridised Artificial Neural Network Model with Slime Mould Algorithm: A Novel Methodology for Prediction of Urban Stochastic Water Demand 12 2692

[17] Maglaras L A and Jiang J 2014 Intrusion detection in SCADA systems using machine learning techniques. In: 2014 Science and Information Conference: IEEE) pp 626-31

[18] HAKIM D L, ABDULLAH A G, MULYADI Y J o E S and Technology 2020 SCADA APPLICATION FOR GEOTHERMAL POWER PLANT 15 1018-31

[19] ALRikabi H T S, Nasser K W and Alaidi A H M 2020 The application of wireless communication in IOT for saving electrical energy International Journal of Interactive Mobile Technologies 14

[20] Mohammed B K, Mortatha M B, Abdalrada A S, ALRikabi H T S J P o E and Sciences N 2021 A comprehensive system for detection of flammable and toxic gases using IoT 9 702-11

[21] Hala A. Naman N A H, Mohand Lokman Al-dabag, Haider Th.Salim Alrikabi 2021 Encryption System for Hiding Information Based on Internet of Things International Journal of Interactive Mobile Technologies (iJIM) 15

[22] Alaidi A H M, Aljazaery I A, AlRikabi H T S, Mahmood I N and Abed F T 2020 Design and implementation of a smart traffic management system controlled wirelessly by arduino International Journal of Interactive Mobile Technologies 14 32-40

[23] Hashim K S, Ewand H M, Muhsin A A, Zubaidi S L, Kot P, Muradov M, Aljeferiy M, Al-Khaddar R J W S and Technology 2021 Phosphate removal from water using bottom ash: Adsorption performance, coexisting anions and modelling studies 83 77-89

[24] Diao F, Li Y, Wang Z, Wu Y and Zhao Y 2020 A Computational Efficient Space-Vector Modulation Scheme for A Hybrid Seven-Level Converter for Medium Voltage Grid-Tied Applications. In: 2020 IEEE Applied Power Electronics Conference and Exposition (APEC): IEEE) pp 1786-90