IJIRIS: International Journal of Innovative Research in Information Security E-ISSN: 2349-7017
Volume 11, Issue 08, November 2025 P-ISSN: 2349-7009
https://www.ijiris.com/archives
https://doi.org/10.26562/ijiris.2025.v1108.07

IoT-Based Smart Underground Cable Fault Detector & Notification System

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Publication History
Manuscript Reference No: IJIRIS/RS/Vol.11/Issue08/OCIS10086
Research Article Open Access| Double-Blind Peer-Reviewed| Article ID: IJIRIS/RS/Vol.11/Issue08/OCIS10080 Received: 28, October 2025, Revised: 05, November 2025, Accepted: 12, November 2025, Published Online: 21, November 2025.
https://www.ijiris.com/volumes/Vol11/iss-08/07.OCIS10086.pdf
Citation: Prof.Jenifer,Karthikeya,Rohit,MohithKumar,NithinKumar(2025),IoT-Based Smart Underground Cable Fault Detector & Notification System, IJIRIS: International Journal of Innovative Research in Information Security, Volume 11, Issue 08 of 2025 pages 343-347 **Doi:>** https://doi.org/10.26562/ijiris.2025.v1108.07
BibTeX Key: Prof.Jenifer@2025IoT
IJIRIS papers should be cited as IJIRIS (International Journal of Innovative Research in Information Security, AM Publications, India 2025, ISSN 2349-7017, https://doi.org/10.26562/ijiris.2025.v1108.07 The journal's official abbreviation is IJIRIS. Orcid: https://orcid.org/0009-0004-9398-7488

Abstract: Underground power lines are everywhere these days, and honestly, finding faults in buried cables is way tougher than dealing with over head wires. That's why we need better ways to spot problems fast. Here, I'm introducing a system that uses a microcontroller specifically, an Arduino to pinpoint where a cable has failed, based on how resistance changes along its length. The Arduino pulls in resistance readings from sensors, runs them through its built-in ADC, and figures out roughly where the fault is. You get the results right away on an LCD screen. Plus, with things like GSM alerts and a buzzer, you can get notified whether you're on-site or checking in from somewhere else. Forget the old manual tracing methods. This setup finds the faulty section quickly without shutting down the rest of the line, so there's less down time and less hassle for repairs. It's affordable, flexible, and works for both power and communication networks. Basically, it's a step toward smarter, tougher systems for the future.
Keywords: Internet of Things, cable fault detector, Ohm's law, microcontroller, cloud database

I. INTRODUCTION

Cities are growing fast, and industries aren't slowing down either. That puts a lot of pressure on power distribution systems to stay reliable. More and more, people are burying cables underground instead of stringing them up over head. It looks better, it's safer butlet's be real, there's a catch. When something goes wrong with an underground cable, it's a paint of find the problem. You can't just look up and spot a broken wire. Instead, crew sends up spending hours, sometimes days, walking the lines, trying to figure out where things went wrong. All that wasted time means longer black outs, higher costs, and bigger headaches for everyone. Sure, there are high-tech ways to find faults things like reflectometry or impedance analysis. They work well, but they're pricey, complicated, and just not practical if you're working with a tight budget or a small project. So, there's a real need for something simpler. Something cheap, quick, and easy to use without a suit case full of fancy gear. That's where this system comes in. It uses an Arduino at its core, and the idea's pretty clever. Cable resistance goes up with length, so when a fault happens, the microcontroller reads the change in resistance and calculate show far down the line the problem is. You get the result right there on an LCD screen. No guess work. On top of that, there's a GSM module that sends instant alerts to operators plus a buzzer for local alarms, so no one misses what's going on. Bottom line, this setup keeps costs low and makes it was easier to find and fix faults fast. It's accurate, doesn't need much training, and works for both power and communication cables. If you're looking to build smarter, tougher infrastructure without breaking the bank, this is a solid step in that direction.

II. LITRATURE REVIEW

[1] J.Bhure and his team built an IoT-based system for finding underground cable faults. Instead of just waiting for problems to show up, their setup constantly checks current and voltage changes. With wireless communication, they made it possible to monitor cables remotely and spot issues much faster. The result? Less downtime and quicker fixes, which means the whole system runs more reliably. Their work really show combining IoT with electrical

measurements can make real-time cable monitoring way more effective.

[2] R.Vinay and his colleagues took a similar path, but they focused on using sensors paired with microcontrollers.

[3] Their system watches cable conditions in real time and sends out alerts the moment it detects a problem. This fast response makes it easy to pinpoint exactly where things went wrong, so repairs happen sooner and faults don't linger. By mixing sensors with smart tech, they made underground cable monitoring more accurate and efficient.

[4] P.Priya and her group went for a straight forward solution. They used Ohm's Law just simple resistance measurements to detect faults in underground cables. Their system stands out because it's cheap and easy to scale up, which is great if you want to use it everywhere. It runs on common hardware like Arduino and ESP8266,so setting itup isn't a hassle. The key take away from their work: you don't need fancy or expensive gear to get reliable cable fault detection.

[5] K.S.Md.Khairuddin and his team also leaned on IoT, but they put extra emphasis on automation and precision. Their system uses microcontrollers and sensors to find cable faults remotely, and it's pretty spot-on with its results. The automation side speeds up the process and cuts down on mistakes. This study really supports the idea that modern embedded systems and IoT are changing the game when it comes to maintaining electrical infrastructure.

[6] S.Shinde and his team explored a basic setup a simple Arduino-based cable fault locator. This project is more for learning than real-world repairs. It measures resistance to figure out how far along the cable a problem has occurred. The design is cheap, easy to build, and perfect for students to tinker with on a breadboard. But, there's no GPS or GSM, so it can't send alerts or share locations. It's a great training tool, just not ready for utility companies.

[7] R.Mehra and A.Singh took a different approach by using GSM technology. Their system pairs a microcontroller and voltage sensors with a GSM module that sends SMS alerts as soon as it spots a fault. That means technicians hear about problems right away, even if there's no internet connection. This cuts down on downtime and service disruptions. The down side? It can't tell you exactly where the fault is or isolate the issue, since there's no GPS. So, it's fast, but not perfect for big or complex cable networks.

[8] M.Sharma,etal.: "Short Circuit and Open Circuit Fault Detection in Underground Cables," International Journal of Innovative Technology and Exploring Engineering (IJITEE), 2019. This paper introduces a simple fault detection system for underground cables. It spots both short and open circuit faults using basic electronics and shows the fault info on an LCD screen. The system alerts users with a buzzer as soon as it picks up a problem, so you know right away if something's wrong. It's pretty straight forward to use perfect for student demos or lab experiments. The device tracks voltage drops in different cable sections and even tells you how far down the cable the fault is. On the downside, it doesn't include wireless alert features like GSM or GPS, and it can't automatically cutoff the bad cable segment. Because of these limits, it's not really suitable for real-time use in cities or heavy-duty industrial settings.

[9] D. Patil, et al.: "Underground Cable Fault Detection Using Microcontroller," International Journal of Scientific &Engineering Research (IJSER), 2018. This research lays out a microcontroller-based system that finds faults in underground cables by checking the voltage drop. It figures out how far along the cable the problem is, using the linear resistance method, and displays the distance on an LCD. The setup is great for showing the basic idea of cable fault detection, but it only works for single-point faults. It's cheap, easy to build, and a go-to for student projects. Still without GPS or GSM, it can't send alerts or map the fault location. It also can't tell different types of faults a part or catch more than one fault at a time.

[10] A.Verma and S.Rajput:"Integration of GPS with Cable Fault System," International Conference on Electronics, Communication and Aerospace Technology (ICECA),2021. Here, the authors take fault detection up a notch by adding GPS. Now, the system can give you the exact geographic spot of the fault, so maintenance crews can head straight to the right place no guessing or manual searching. Pairing GPS with an Arduino makes the tech a lot more useful, and real-time SMS alerts mean teams can react fast when there's an outage. The GPS feature also lets you plot faults on a map. But GPS signals often struggle underground or in crowded city areas, and the upgrade pushes up the price.

[11] L.Thomas and R. Bansal: "GSM-Based Underground Fault Notification System," International Journal of Engineering Trends and Technology (IJETT),2022. This paper looks at a system that uses GSM to send cable fault notifications. When the system finds a problem, it texts maintenance teams with the details. It's built to scale, so it can handle large power grids and fits well with decentralized setups. The ability to send alerts quickly help steams fix issues faster and reduces the need for manual checks. It doesn't have fault isolation or GPS for pinpointing the spot, though. Plus, if the mobile network is down or spotty like in remote areas alerts might not get through. Even with these gaps, the system offers a practical mix of affordability and functionality.

Year	Author	Methodology	Technic/ Module Used
2023	R.Vinayet al.	They built an IoT-based system to spot Underground cable faults in real time. The setup uses sensors and microcontrollers to find faults quickly and send out alerts right away	Arduino, IoT Sensors, Microcontroller, LCD Display

2023	P.Priyaetal.	Their design uses the basics of Ohm's Law and Real-time monitoring to detect cable faults. It's simple, affordable, and gets the job done using resistance measurements	Arduino,ESP8266, Resistor Network
2022	J.Bhureetal.	This team put together an IoT system that keeps An eye on current and voltage changes. When it spots something odd, it uses wireless communication to report cable faults.	Current/Voltage Sensors, IoT Module, Microcontroller
2022	K.S.Md. Khairuddin et al.	They came up with a remote fault detection Model. It runs on a micro controller and relies on sensors and automation top in point faults from a distance	IoT Sensors, GSM Module, Arduino
2021	S.Shinde et al.	Their Arduino proto type checks voltage changes Across resistors to find where a fault is. It's mainly meant to teach student show these systems work	Arduino Uno, Resistor Network
2020	R.Mehra & A.Singh	Their system uses GSM to send out real-time SMS alerts about cable faults. It senses voltage drops and notifies users right away	Micro controller, GSM Module
2019	M. Sharma et al.	They put together a basic circuit to spot short And open cable faults. When something goes wrong, a buzzer sounds and the LCD shows what's happening.	LCD Display, Buzzer, Voltage Divider Circuit
2018	D.Patil et al.	This model measures fault distance based on Resistance, then shows the resul to nanLCD. It's all run by a microcontroller.	Micro controller, LCD Display, Resistor Network
2021	A.Verma& S.Rajput	They combined GPS and GSM to find the exact Fault location and send out real-time alerts with geographic info.	Arduino, GPS Module, GSM Module
2022	L.Thomas & R.Bansal	Their GSM-based notification system is built to handle big electrical grids, sending out fault alerts as soon as they happen	GSM Module, Arduino Microcontroller

III. OBJECTIVES

1. Design and build an IoT system that spots faults in underground electrical cables using sensors.
2. Quickly figure out exactly what kind of fault it is short-circuit, open-circuit, or line-to-ground and which cable phase got hit, all in real time.
3. Pin point the fault's location with voltage and resistance readings, so there's no need to dig things up or inspect cables by hand.
4. Use GPS to grab the exact coordinates of the fault ,making it easy for field crews to find the problem spot.
5. Set up automated messages through the GSM module, so the maintenance team gets instant SMS alerts with details and Google Maps links.
6. Build an IoT dash board for remote monitoring and logging, so the team always has a clear view of underground cable health.
7. Boost maintenance speed and reliability for power networks by cutting down time and helping crews fix faults faster.

IV. METHODOLOGY

This system spots faults in underground power cables automatically. It uses IoT tech to detect, locate, and send out alerts when something goes wrong. The setup combines Arduino-based sensors with GPS and GSM modules, so it can pinpoint problems and communicate updates in real time.

Here' show it works:

Everything starts with Ohm's Law (V=I×R).Since the resistance in a cable changes with its length, you can figure out where a fault is by measuring voltage drops across set sections of the cable. If there's a short or open circuit, the voltage changes in those spots. The Arduino picks up on these changes and calculates how far the fault is from the base station. Let's break down the process:

1. Power Supply Unit
   The power supply takes the standard 230VAC and turns it into a steady5VDC the circuit needs .It uses a transformer, rectifier, filter, and a 7805 voltage regulator to keep everything running smoothly. This powers the Arduino and all the sensors.
2. Arduino Microcontroller
   The Arduino runs the show. It reads analog voltage data from the sensors, converts it to digital using its ADC, and figures out the fault's location in real time.

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3. Current Sensing Circuit
   Resistors line up in series along the simulated cable. When a fault hits, the voltage across these resistors shifts. These shifts reveal both the type and the exact spot of the problem. The Arduino reads these signals and does the math.

4. Analog-to-Digital Conversion(ADC)
   The Arduino's built-in ADC turns the analog voltage from the sensing circuit into digital numbers. This makes it easier to analyze the data, spot resistance changes, and precisely calculate how far the fault is from the base station.
5. Fault Location Computation
   Using Ohm's Law, the Arduino compares measured voltage drops to the total voltage over the entire cable length. From there, it calculate show many kilometers away the problem is.
6. Display and Alerts
   Once the system knows where the fault is, it shows the distance and status on a 16x2LCD.At the same time, a buzzer sounds off, so maintenance crews don't need to stare at the display to know there's an issue.
7. IoT-Based Notification System
   The GSM module steps in to send SMS alerts directly to the maintenance team. Each message includes the fault type, distance, and GPS coordinates, so crews know exactly where to go and what to expect. This speeds up response and repair times.
8. Relay and Isolation System
   Finally, the relay driver circuit keeps the rest of the network safe. If the Arduino detects a fault, it triggers the relay to disconnect the damaged section, stopping current leaks and further damage. The buzzer also sounds, making sure everyone's aware of the problem right away.

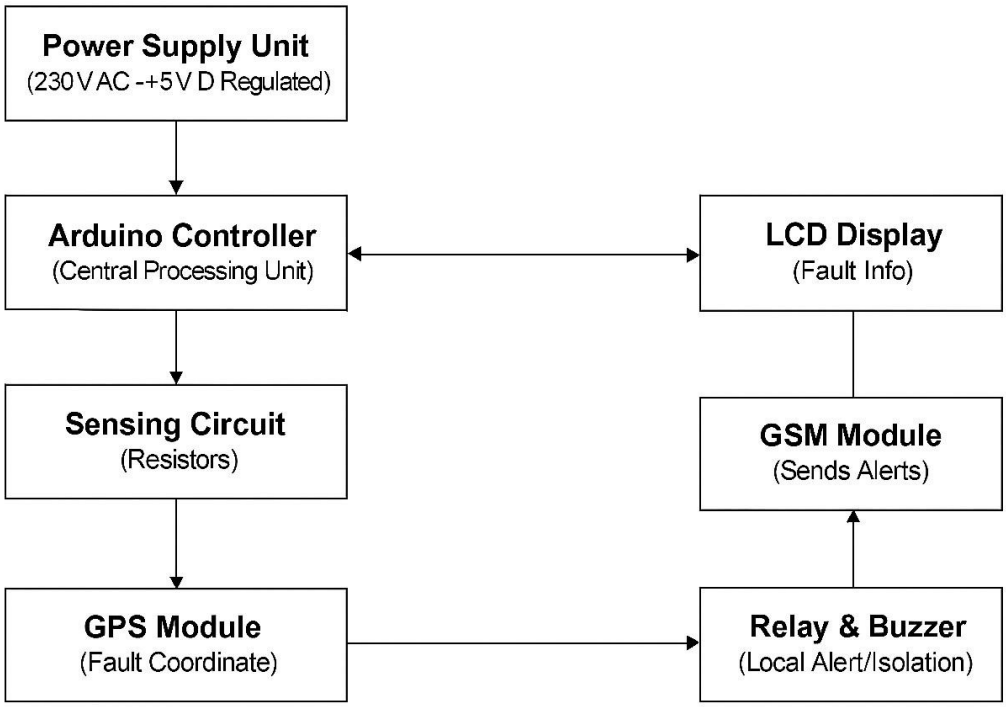

Fig.1 Block diagram

V. RESULTS

We built a working prototype of the underground cable fault detection system and put it through it spaces in a controlled test. The setup had everything: an Arduino microcontroller, some sensing resistors, GSM and GPS modules, a relay driver circuit, and a 16×2 LCD for feedback. To simulate faults ,we just created short-circuit and open-circuit conditions at specific spots along the test cable. The system didn't miss a beat. It not only spotted faults right away but also figured out how far they were from the base station. The Arduino read voltage changes across the resistors, crunched the numbers, and showed the distance straight on the LCD. The results lined up almost perfectly with the actual fault locations any small errors seemed to come down to component tolerances. So, this resistance-based approach really does the job when it comes to pinpointing faults. On top of that, the IoT features worked just as planned. The GPS module nailed

down the location, making it easy for maintenance teams to find the fault without hunting around. The relay cut off faulty sections, and the buzzer gave a loud, instant alert. All in all, the system delivers accurate, real-time in foon underground cable faults and cuts down on manual work. Compared to the old inspection methods, this setup saves time, boosts safety, and makes cable maintenance a whole lot more efficient.

VI.CONCLUSION

This Arduino-based underground cable fault detection system makes it a lot easier and cheaper to find faults in buried cables. It tracks changes in resistance, runs the data through a micro controller, then shows the exact fault distance right on an LCD. At the same time, its ends out SMS alerts with the GSM module and triggers a buzzer so you know there's a problem right away. With this setup, you cut down on downtime, avoid all that tedious manual inspection, and keep maintenance running smoothly. It just works, and it fits perfectly into today's power distribution and communication networks.

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