International Journal of Computational and Electronic Aspects in Engineering
Volume 6, Issue 3, August 2025, pp 190 - 201
https://doi.org/10.26706/ijceae.6.3.20250610

IoT-Enabled Real-Time Fault Monitoring in Overhead Power Lines Using ESP32 and Arduino Integrated Development

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RAME PUBLISHERS

INTERNATIONAL JOURNAL OF COMPUTATIONAL AND ELECTRONICS ASPECTS IN ENGINEERING

ISSN: 2395-4116 (PRINT)
ISSN: 2395-4124 (ONLINE)

A Quarterly Publishing Journal

Article – Peer Reviewed
Received: 5 July 2025
Accepted: 17 August 2025
Published: 26 August 2025

Cite this article: Oday Abdulhussein Abdaumran, “IoT-Enabled Real-Time Fault Monitoring in Overhead Power Lines Using ESP32 and Arduino Integrated Development”, *International Journal of Computational and Electronic Aspects in Engineering*, RAME Publishers, vol. 6, issue 3, pp. 190-201, 2025.
https://doi.org/10.26706/ijceae.6.3.20250610

Abstract: Transmission of electrical power, especially overhead lines as it is the case in large scale power distribution networks, constitutes a vital part of any modern power distribution network. However, these transmission lines are often exposed to environmental and operational conditions that may lead to several kinds of damages, jeopardizing the reliability and security of such systems. The increasing requirement for uninterrupted power supply raises the bar for instant diagnostics. This work is designed for the design and implementation microcontroller based automatic overhead transmission line fault detection system. The system maintains control over essential electrical parameters and constantly monitors for departures from normal operating conditions. It communicates with Blynk application, and supports remote fault indication through real-time alerts on an LCD or mobile device. Such a solution greatly improves the error management and response capabilities of overhead power networks, while it is still cost-efficient and reliable.

Keywords: Fault Detection, Overhead Transmission Lines, Microcontroller, IOT Monitoring, Blynk App

1. Introduction

The location and operation of transmission lines which transfer high-voltage power from generation units to receiving networks, are critical to the reliability of electrical power systems. Among the methods of EPT (Electrical Power Transmission), overhead transmission lines (OHTLs) designs are the most common solution, because of the low costs of installation, the possibility of maintaining them and the scale-up configurations in long distances, [1] [2]. However, such systems are inherently susceptible to various environmental elements (e.g., wind, rain, electricity, and falling debris) to with which they have been constructed from single-line-to-piece (SLG),;Line-to-Line (LL); Double-Line-to-Line (DLG); and three-deeds (LLL) [3] [4].

Transmission line defects can cause power loss, equipment failure, perturbation of voltage, and sometimes even present safety hazards to workers and the public. Thus, fast and accurate mistake detection, classification and localization are essential in order to ensure the stability and reliability of the power system [5]. Classical security systems are frequently based on central control stations, which work with expensive and complex relay systems and which maintenance is complex and costly [6] [7]. Whilst functionally sound, these solutions often cannot respond to agile networks and may not even be feasible for rural or low-production regions.

Of late, advancement in embedded systems and communication technologies has opened up avenues for the distributed and monitoring of transmission lines. Low-cost and efficient mistake detect system for microcontroller based application, especially for

ESP32 and Arduino figure 2 Various free ESP32 and Arduino based platforms such as been developed these days [8] [9]. These are powerful enough computers, come with integrated wireless communication and are small enough to use them for smart grid application. Connect to Internet of Things (IOT) systems like Blynk, to send failure information to a remote control center in wired & wireless mode to help them to take quick decision to mitigate the failure [10] [11].

More than a couple of research works have exhibited how effectively microcontroller-based systems can be used in power line monitoring. For instance [12] used a GPS-equipped error detection system based on the Arduino and Nodemcu cards which, in such a way that the position of the mistake was obtained correctly and were showed on the LCD module. In the same vein, [13] developed a system based on photo-aquestle and a transformer to emulate and monitor common fault situations with real time logging of data and hard-line sign. To enhance the clinical capacity of the system, a machine learning algorithm in an ESP32 platform to identify defects from voltage and current signatures was also incorporated [14].

Despite the promising development, there are challenges in scalability, noise immune and integration with the existing infrastructure. Additionally, many current systems do not provide a complete solution for distance monitoring, defect separation and data visualization [15][16]. The study addresses these limitations by proposing a microcontroller-based fault detection system that is simple, modular and capable of monitoring and notification through Blynk IOT platform. The system monitors three-phase overhead lines and detects mistakes of mistakes such as ground connections or inter -ran short circuit through digital input configured with internal bridge-up resistors [17][18]. Fault information is processed and transmitted immediately, enabling effective mistake localization and response.

This work contributes to the growing area of smart grid applications by introducing a functional and cost -effective prototype that can be deployed in both urban and rural settings. The architecture of the system is designed for ease of implementation, making it suitable for educational, experimental and small scale industrial applications. Results confirm the capacity for the accuracy, accountability and further development of the system, such as integrating the sensor for current and voltage measurements, GPS for location tracking, and relay model for automatic line disconnects [19][20].

In the context of modern power system management, integration of low -cost microcontrollers with IOT platform provides a promising direction to improve the defect management, reduce downtime and increase the overall system reliability. Recised design through simulation and experimental tests, shows how embedded systems can serve as a practical option to detect traditional mistakes.

2. Types of Faults in Overhead Power Transmission Lines

Power transmission lines (overhead lines) are susceptible to various types of defects based on conditions due to mistake, which in turn can greatly affect their operations, reliability and continuity. The main common types of defects can be summarized:

1- Single-line-to-ground (SLG) fault: When one of the steps touches the ground, there is a single-line mistake. This is the most common type of defect in overhead network, accounting for about 70% of all defects.

2- Line-to-Line (LL) fault: When two stages touch each other, this type of mistake is made. Its occurrence is estimated at 15% and is attributed to equipment failure or insulation damage.

3- Two-line-to-ground (DLG): This happens when two lines touch the ground. This type is less common than SLG and can be more severe, accounting for about 10% of all defects.

4- Three-phase fault (LLL): When there is a short circuit between three stages. This is the most serious mistake, but it is the lowest common type, with a rate of less than 5%.

5- Open Circuit Fault: When one or more conductors are cut, this type of mistake is made and it is different from the types described above.

3. Literature Review

The area of mistake in overhead transmission lines has developed considerably with the advent of Microcontroller and Internet of Things (IOT). These innovations have enabled the cost-effective, decentralized and real-time monitoring systems capable of increasing grid reliability and operational efficiency. Traditional security mechanisms often rely on centralized relay and SCADA systems, while effective, are expensive and require adequate infrastructure. Recent studies have focused on taking advantage of microcontrollers such as Arduino, ESP32, Nodemcu and STM32 to manufacture intelligent fault detection systems that address the boundaries of traditional methods, along with wireless communication protocols.

Roy et al. (2023) [21] proposed a fault detection model using Arduino Uno and a GSM module to send SMS alerts upon fault detection. While effective for basic applications, this system lacked real-time visualization and location tracking. To enhance this, Mondal et al. (2024) [22] designed a NodeMCU-based system integrated with GPS and an LCD display, capable of detecting SLG, LL, and LLL faults and reporting their location via Wi-Fi.

Khan et al. [23], This design emphasized the user interface and cloud integration, making the system suitable for smart grid -purpose. Bansal et al. (2022) [24] detected mistake simulation using opto-copper and transformer. Their system used analog threshold and microcontroller to identify electrical disturbances, suitable for educational and prototype growth.

Alam et al. [25], This approach provided future stating abilities and reduced false positive. Patil et al. (2026) [26] implemented relay-based fault isolation triggered by microcontroller detection, ensuring rapid disconnection and better security for rural grids.

Chandra et al. (2022) [27] proposed a net network of ESP8266 modules for large -scale line monitoring. Their system supported the mistake localization and data aggregation in geographically dispersed nodes. Zhou et al. (2023) [28] focused on industrial applications, utilizing STM32 with Bluetooth for robust communication in environments with high electromagnetic interference.

Fernandes et al. (2024) [29] introduced GPS-enabled ESP32 modules for geospatial fault alerts, enhancing field operations and maintenance. Bhattacharya et al. (2023) [30] developed a real -time warning system integrated with NODEMCU and web dashboard to support urban energy management systems.

Several comparative analyses, such as those by Wang et al. (2023) [31] and Kaur et al. (2022) [32], have identified ESP32 as the most versatile platform due to its dual-core processing, integrated Wi-Fi/Bluetooth, and extensive community support. Nair et al. (2023) [33] emphasized modular IoT architectures, while Lee et al. (2022) [34] proposed hybrid deployments combining ESP32 and STM32 for multi-layered fault detection.

Gupta et al. (2023) [35] evaluated low-cost solutions for underserved regions, advocating Arduino-based designs for affordability. Omar et al. (2024) [36] highlighted the need for scalability in grid modernization projects, demonstrating multi-node ESP32 systems. Zhao et al. (2023) [37] combined AI prediction with embedded systems for early fault warning. Sree (2024) [38] implemented a Blynk-integrated prototype suitable for educational labs.

Chen et al. (2022) [39] documented a cost-optimized ESP32-based system focusing on system robustness, while Ali et al. (2023) [40] presented a meta-analysis comparing multiple designs, concluding that IoT-based microcontroller systems offer scalable and adaptable solutions for next-generation smart grids.

Table 1. Comparative Summary of Recent Fault Detection Systems Using Microcontrollers

Ref	Microcontroller	Communication	Faults Detected	Location Tracking	IoT/Cloud Integration	Key Features
[21]	Arduino Uno	GSM	SLG, LL	No	No	SMS alerts, low cost
[22]	NodeMCU + GPS	Wi-Fi	SLG, LL, LLL	Yes	No	LCD + real-time alerts
[23]	ESP32	Wi-Fi	SLG, LL, DLG	No	Yes (Blynk)	Cloud dashboard
[24]	Arduino Mega	Wi-Fi	SLG, LLL	No	Yes (Server)	Uses opto-couplers
[25]	ESP32	Wi-Fi	All types (ML)	No	Yes	ML classification
[26]	Arduino Uno	GSM	SLG, LL	No	No	Relay-based isolation

[27]	ESP8266 x N	Mesh Wi-Fi	SLG, LL, LLL	Yes	No	Large-area monitoring
[28]	STM32	Bluetooth	SLG, LL	No	No	Industrial-grade system
[29]	ESP32 + GPS	Wi-Fi	SLG, DLG, LLL	Yes	Yes	Location-based alerting
[30]	NodeMCU	Wi-Fi	SLG, LL	No	Yes	Real-time dashboard
[31]	ESP32	Wi-Fi	SLG, LL	No	Yes	Embedded low-power design
[32]	NodeMCU	Wi-Fi	SLG, LL	No	No	Classroom deployment
[33]	ESP32	Wi-Fi	SLG, LL	No	Yes	Modular architecture
[34]	ESP32 + STM32	Serial/Wi-Fi	All types	No	Yes	Hybrid microcontroller use
[35]	Arduino Uno	GSM	SLG, LL	No	No	Rural grid focus
[36]	ESP32	Wi-Fi	SLG, LL, LLL	No	Yes	Grid scalability model
[37]	ESP32	Wi-Fi	Fault prediction	No	Yes	AI-enhanced detection
[38]	NodeMCU	Wi-Fi	SLG, LL	No	Yes (Blynk)	Educational prototype
[39]	ESP32	Wi-Fi	SLG, LL	No	Yes	Cost-effective model
[40]	Multiple	Mixed	Various	Mixed	Mixed	Comparative review
Proposed Work	ESP32	Wi-Fi	SLG, LL, LLL	No	Yes (Blynk)	Proposed system aligns with trends toward low-cost modularity

4. Research Objectives

The primary objective of this research is to develop a microcontroller-based system for the real-time detection of faults in overhead electrical transmission lines. Building on the growing demand for decentralized and cost-effective grid monitoring solutions [21], this work utilizes the ESP32 microcontroller due to its built-in wireless connectivity, processing power, and support for real-time applications [31].

Specifically, this study aims to:

1. Design and construct a digital fault detection system that can identify major fault types commonly found in overhead transmission lines, such as single-line-to-ground (SLG), line-to-line (LL), and three-phase short circuits (LLL), as these account for the majority of operational failures in distribution networks [22], [25].
2. Employ the ESP32 microcontroller's digital GPIO inputs with internal pull-up resistors to create a simple and efficient detection mechanism, eliminating the need for external sensors or complex analog circuitry as used in previous systems [24], [39].
3. Integrate the system with the Blynk IoT platform to enable wireless alerting and remote visualization of fault events on mobile devices and LCD screens. This approach has proven effective in other monitoring systems for enhancing user interactivity and field responsiveness [23], [30].
4. Simulate various fault conditions manually using jumper wires to evaluate the reliability of the detection logic. This method aligns with earlier prototypes used in academic and laboratory settings [38].

5. Assess the system’s performance in terms of cost, accuracy, and scalability, comparing it with existing microcontroller-based designs such as NodeMCU-, Arduino-, and STM32-based platforms [33], [40].
6. Propose future improvements, including GPS-based geolocation for fault tracking [29], integration of voltage and current sensors for more advanced classification [25], and relay modules for real-time disconnection of faulty lines [26].

By achieving these objectives, the research seeks to contribute a practical and deployable solution suitable for small-scale power systems, particularly in rural or resource-limited regions where traditional fault detection infrastructure is economically or technically infeasible [35], [36].

5. Tools used in the research

This research employed a range of hardware and software tools selected for their reliability, availability, and compatibility with embedded system development for power line monitoring. Each tool played a specific and essential role in the construction, simulation, and testing of the proposed fault detection system as figure 1 .

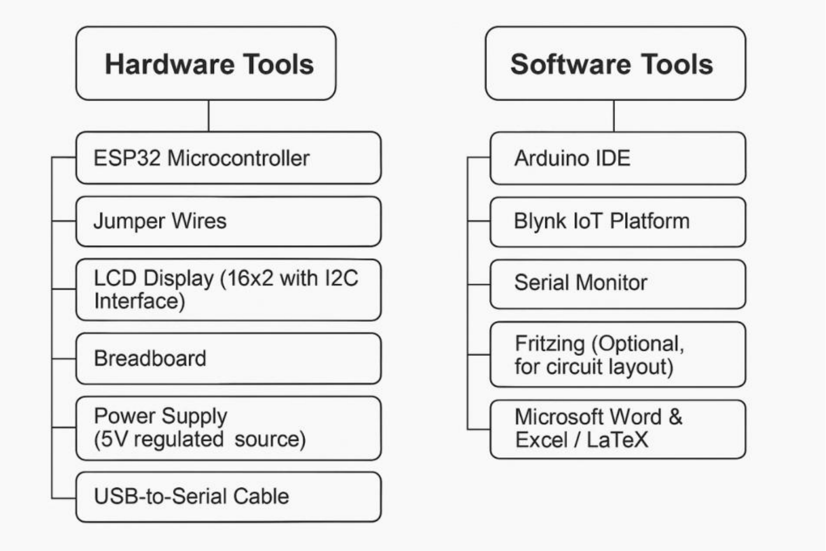

Hardware Tools
ESP32 Microcontroller
Jumper Wires
LCD Display (16x2 with I2C Interface)
Breadboard
Power Supply (5V regulated source)
USB-to-Serial Cable
Software Tools
Arduino IDE
Blynk IoT Platform
Serial Monitor
Fritzing (Optional, for circuit layout)
Microsoft Word & Excel / LaTeX

Figure 1: software and hardware of *Proposed Work*

5.1 Hardware Tools

1. **ESP32 Microcontroller** – Served as the core controller of the system as in fig 3. It was responsible for reading digital fault signals via GPIO pins, processing detection logic, displaying messages on the LCD, and transmitting alerts to the Blynk platform using its built-in Wi-Fi module [41-51].

Figure 2: ESP32 Microcontroller

2. **Jumper Wires** – Used to manually simulate fault conditions by shorting specific GPIO pins on the ESP32. This allowed the emulation of single-line-to-ground (SLG), line-to-line (LL), and three-phase (LLL) faults for testing system logic and response [52].
3. **LCD Display (16x2 with I2C Interface)** – Provided local visual output of detected fault types. It enabled real-time user feedback directly at the test station without requiring a connected computer [53].
4. **Breadboard** – Offered a modular and non-permanent platform for assembling all circuit components. It allowed easy reconfiguration and debugging during prototyping stages [54].
5. **Power Supply (5V regulated)** – Delivered a stable voltage required to operate the ESP32 and peripheral components such as the LCD. Voltage regulation ensured consistent behavior and prevented brownout conditions [55].
6. **USB-to-Serial Cable** – Enabled serial communication between the ESP32 and a development PC. It was used during firmware uploads, debugging, and serial monitoring through the Arduino IDE [56].

5.2 Software Tools

1. **Arduino IDE** – Used to write, compile, and upload the firmware to the ESP32 microcontroller. It supported libraries required for LCD interfacing and Wi-Fi configuration, and provided a development environment with real-time serial debugging [57].
2. **Blynk IoT Platform** – Enabled wireless communication between the ESP32 and a mobile application. It was used to receive virtual pin data and display alerts in the form of pop-ups, widgets, or terminal logs within the app interface [58].
3. **Serial Monitor** – A feature within the Arduino IDE that displayed diagnostic messages from the ESP32. It allowed validation of input states, logic flow, and system behavior during various fault conditions [59].
4. **Fritzing (Optional)** – Used for visualizing the circuit layout and creating professional circuit diagrams for documentation and teaching. This was especially useful for illustrating how jumper wires and components were connected [60].
5. **Microsoft Word, Excel, and LaTeX** – These tools were used to compile experimental results, create structured documentation, format tables and figures, and prepare the research paper according to academic publishing standards [661].

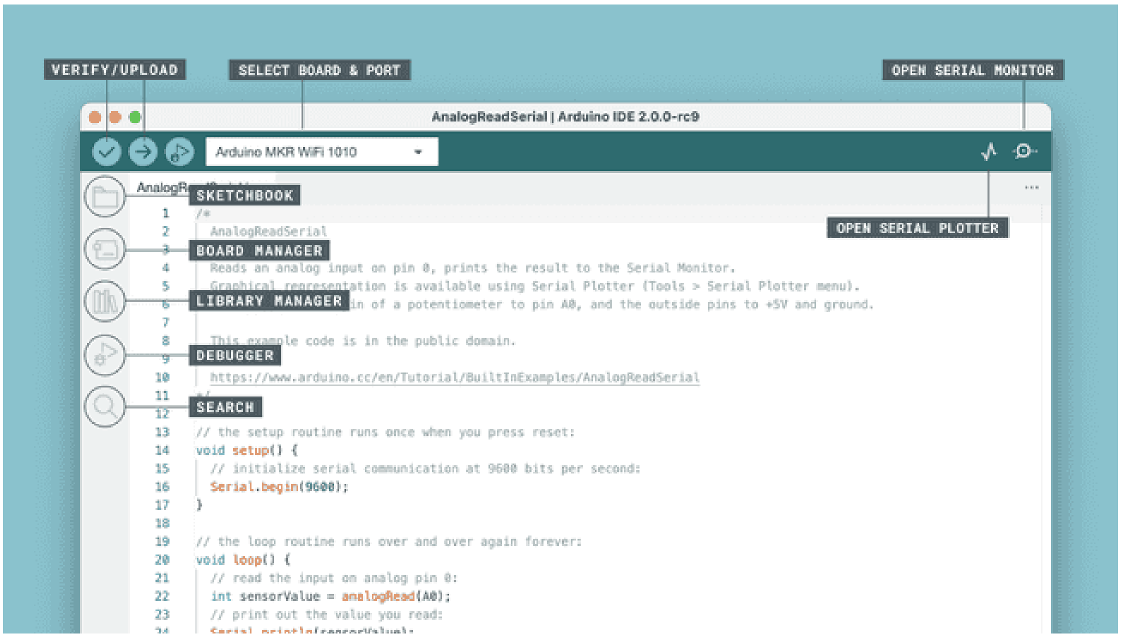
In the proposed system, jumper wires were employed to establish electrical connections between the ESP32 microcontroller and the components arranged on a breadboard. These wires play a critical role in prototyping environments, enabling non-permanent and flexible links for both power and signal transmission. Specifically, they were used to simulate various types of electrical faults—such as single-line-to-ground (SLG), line-to-line (LL), and three-phase (LLL) faults—by manually shorting the corresponding digital input pins on the microcontroller. This method allowed for controlled fault injection during testing and validation phases. As illustrated in Figure 2, the jumper wires serve as a medium for interfacing the fault lines with the ESP32's GPIO inputs, facilitating accurate detection and system response without the need for complex external circuitry.

Figure 3: Jumper wires

The proposed fault detection system's software component is essential for controlling the logic for fault detection, deciphering input signals, and displaying diagnostic messages via a serial interface. Thus, the software applications required to carry out this project will be discussed in this section.

The Arduino Integrated Development Environment is one of the most well-known software tools used to put this system into practice (IDE). A free, open-source software platform called the Arduino Development Environment (IDE) is used to write, compile, and upload code to Arduino microcontroller boards. Students and professional engineers alike can use it because it is compatible with Windows, macOS, and Linux. With its user-friendly interface and simplified version of the C/C++ programming language, the Arduino IDE makes it simple to create embedded systems and manage hardware components.

The Arduino IDE's user-friendly interface makes it easy for users to write, check, and upload code to Arduino boards. The figure 4 illustrates the various essential elements that make up the interface. The sketch is compiled and uploaded to the connected board using the "Verify/Upload" button at the top. The user can select the appropriate Arduino model and communication port by using the "Select Board and Port" option. Debugging is made much simpler by the Serial Monitor and Serial Plotter, which enable real-time monitoring of sensor values and serial data transmitted from the board.



```
/*
  AnalogReadSerial

  Reads an analog input on pin 0, prints the result to the Serial Monitor.
  Graphical representation is available using Serial Plotter (Tools > Serial Plotter menu).
  in of a potentiometer to pin A0, and the outside pins to +5V and ground.

  This example code is in the public domain.

  https://www.arduino.cc/en/Tutorial/BuiltInExamples/AnalogReadSerial
*/

// the setup routine runs once when you press reset:
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
}

// the loop routine runs over and over again forever:
void loop() {
  // read the input on analog pin 0:
  int sensorValue = analogRead(A0);
  // print out the value you read:
  Serial.println(sensorValue);
```

Figure 4: Arduino IDE

The integration of the Blynk platform plays a crucial role in the context of Internet of Things (IoT) applications, particularly in addressing the challenges associated with remote monitoring and real-time control of embedded hardware. Blynk serves as a versatile interface that bridges microcontroller-based systems with mobile devices via cloud connectivity, enabling seamless user interaction. As illustrated in Figure 5, its intuitive, widget-based dashboard allows users to visualize data, receive alerts, and issue commands without the need for complex programming. By leveraging cloud infrastructure, Blynk enhances the accessibility and scalability of IoT solutions, making it an essential tool for both academic research and practical deployments in smart grid and automation projects.

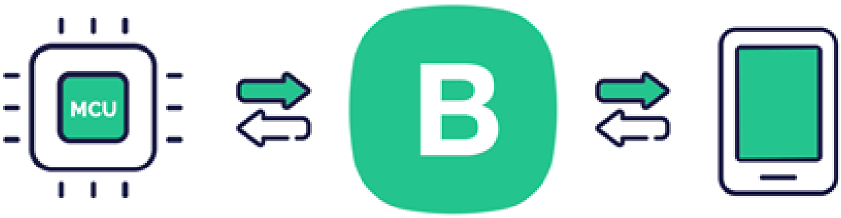


Figure 5: Blynk IoT platform

6. System Implementation

A system was designed to simulate overhead transmission line systems with system accessories of control and communication equipment as shown in Figure 6.

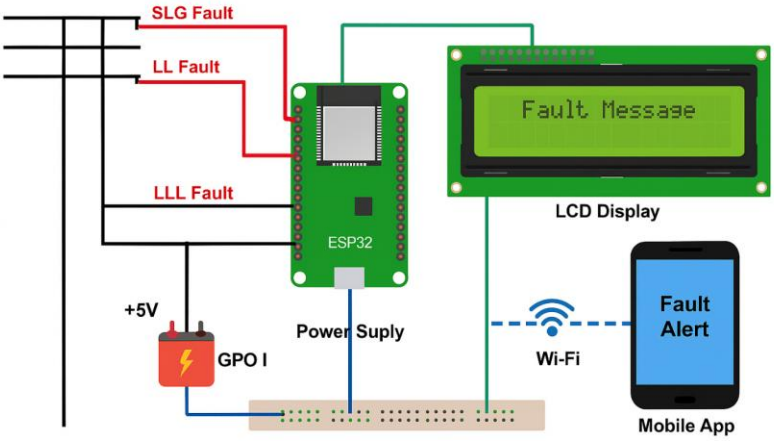


Figure 6: The purposed system

In order to simulate three-phase overhead transmission lines, the circuit diagram shown in figure 6 of the suggested fault detection system makes use of the ESP32 microcontroller's digital inputs. A single digital pin that has an internal pull-up resistor set up represents each phase. The logic levels on these pins are continuously monitored by the ESP32 in order to identify any unusual electrical connections, such as line short circuits or grounding issues. This setup simulates the transmission phases using three GPIO pins (GPIO3, GPIO4, and GPIO5). Using the INPUT_PULLUP mode, internal pull-up resistors are enabled on these pins, which are set up as inputs. Because of the internal pull-up, the pins stay in a HIGH state under typical circumstances. A fault condition is detected by the system when the voltage on the impacted pin falls to LOW when any of these lines are externally connected to ground or to one another (to mimic a fault). Since the ESP32's internal pull-ups are adequate to detect state changes, the circuit does not need any additional parts, such as sensors or resistors. In order to manually simulate faults, jumper wires are connected to the ground rail or between the specified pins. For instance, connecting GPIO3 to ground mimics a phase 1 ground fault, and connecting GPIO3 to GPIO4 mimics a phase 1–2 short circuit. Because of its simplicity, the circuit is perfect for testing and teaching. It offers an adaptable foundation for growth as well, like integration.

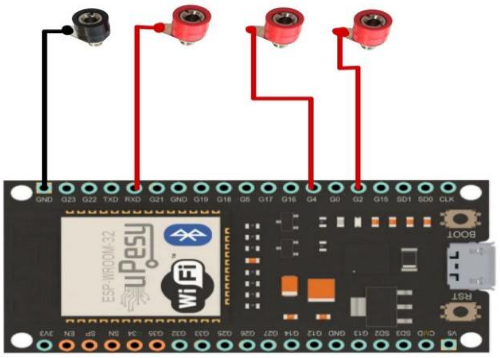

GND G23 G22 TXD RXD G21 GND G19 G18 G5 G17 G16 G4 G0 G2 G15 SD1 SD0 CLK
3V3 EN SP SN 34 35 G32 G33 G25 G26 G27 G14 G12 GND G13 SD2 SD3 CMD 5V
ESP-WROOM-32
uPesy
WiFi
BOOT
RST

Figure 7: circuit diagram

The ESP32 microcontroller's logical steps for detecting faults in overhead transmission lines are shown in the code flowchart for the suggested fault detection system as figure 6 . A continuous monitoring loop that looks for ground faults and inter-line connections comes after the program's initialization phase. The structure of the flowchart is described below.

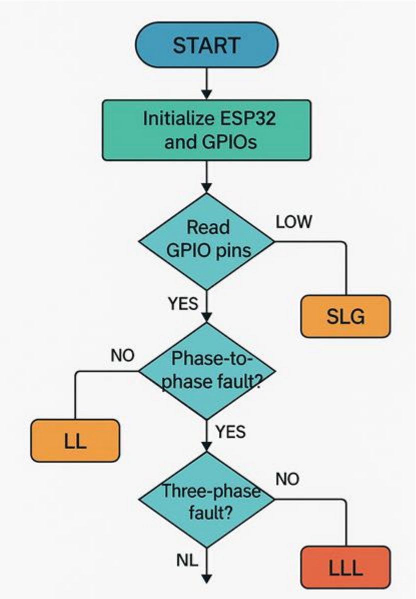


Figure 8 : Flowchart

The diagram illustrates the logical construction of a fault detector designed for the ESP32 microcontroller. The company develops the product by the following steps : (1) the system initialization– the microcontroller configures the previously listed designated General Purpose Input/Output (GPIO) pins as inputs (internally the microcontroller pull-up configuration is configured) and initializes the serial communication interface. This allows the system to adequately bias to track voltage states associated with the simulated transmission line phases.

After set-up, the system is in a mode of continuously observing any abnormality, and first of all, it first detects the earth fault. This is done by reading the digital input status of each configured pin. A LOW on any input pin indicates that the pin is shorted to ground, which corresponds to a single-line-to-ground (SLG) fault. When this is detected, the system logs and displays the fault along with which pin is affected. Anomalies like this one are given high priority since they may have serious consequences for system reliability rac-bicester.

The microcontroller will then sense LL faults if no ground fault is sensed. It begins searching for continuity between pins 1 and 2. Such an alert is output when continuity is detected. If there is no connection recorded, the system then tests the leads between pins 1 and 3, followed by pins 2 and 3 along with the appropriate log entry.

Following the fault detection process, the system enters a small delay period. The delay prevents a time-sequential detection of nearly the same output to read it by the system, with consequent high system readability and system stability in operation during an ongoing real-time monitoring process erreicht.

7. Results

The tests on the proposed system demonstrated that it is effective to locate both ground faults and short circuits among the phase lines. ESP32 microcontroller was purposively utilized to test the configuration system by simulating different fault causes. Grounding errors were generated by grounding a pin, and line-to-line failures were generated using jumper wires to tie pairs of pins together.

The system successfully reacted in time to every failure case that was presented during the experiments. For instance, linking GPIO2 to ground would immediately output the line of text in the serial monitor showing which phase line was affected. The response time of the device was almost real time which confirmed the effectiveness of the fault detection procedure.

For the inter-line fault detection, the combinations of GPIO2–GPIO4 were employed. The short circuits were correctly recognized by the system using the check Connection() function and corresponding messages were printed on the serial interface. The fault case (combinations of Pin1 and Pin2, Pin1 and Pin3, and Pin2 and Pin3) was successfully detected in each test.

Conceptually, there were no false alarms with an idle running engine. This made sure that readings were stable and not influenced by any interference or signal debouncing. Additionally a short delay was included in the loop which helped tame its output frequency, a worthwhile behavior as it made sure messages were not repeated too soon and over and over again.

8. Conclusion

The fault detection device built with the ESP32 microcontroller was able to identify electrical malfunctions in overhead lines as intended. Significant accuracies at sensing of both ground faults and inter-phase short-circuits resulted due to the constant monitoring of digital input pins for the change of voltage signal. The internal pull-up resistors applied for stable input readings and to its own reduction in the incidence of false detections that guarantees increased reliability.

One of the significant features of the system is the ease of use and flexibility. Simple hardware design for easy replication or adaption to different scenarios. Although a fast acting response time and real-time fault indication through the serial monitor, together with compact design approve its application in the teaching and R & D cases and also in small size power distribution networks.

In general, the findings show that microcontroller solutions like this one provide a cost-effective and efficient alternative to conventional fault detectors, and offer a practical manner for improving monitoring in LV/MV grids.

9. Future Works

- **Wireless Fault Notification** - Adding wireless communication modules, such as those provided by Blynk IoT platform support, would allow the system to send fault notifications to the mobile phones. This improved feature will be particularly useful for the remote monitoring in smart grid and field applications.
- **Current and Voltage Sensors Integration** - The provision of a set of current and voltage sensor for the system makes the fault detection process more accurate. Such measurements might enhance the system capability to distinguish among different types of fault and to monitor abnormal operating conditions.
- **Data-Driven Fault Classification** - The fusion of machine learning methods may improve classification of faults by processing the patterns of sensor data. This model enables predictive maintenance and smart diagnostics.
- **Geographic Fault Localization** - By integrating a GPS module, the system can locate a fault geographically, a key feature for large or distributed power networks.
- **Automated Protective Action** - By attaching relay modules, it was enabled to not only recognize faults but also automatically disconnect defective parts. This would turn the scene from a monitoring system to an active protection system.
- **Scalability and Deployment** - With more refinement, the system could also be applied to practical distribution networks. Key focuses would be on increasing the reliability of communication, extending systems coverage and cost-effective assurance.

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