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Transmission and Distribution Line Fault Tracking and Assessment System

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Abstract: *Every power system has transmission and distribution lines, which should be fault free for effective and reliable operation of the system. In this paper, a novel technology which helps in detecting the faults and determining the location of faults on transmission lines and their causes is presented. The implementation of such technologies, including IoT and Big Data, is a great helping hand in increasing the grid resilience and minimizing the durations of outages. The system assists in recognizing fault conditions such as short circuits, line faults and prepares in detailing the report to enable quick fault's restoration. The conducted simulations and tests demonstrate the effective system performance in various fault conditions which can be useful in developing advanced and reliable power grids.*

Keywords: Fault detection, fault analysis, transmission lines, distribution lines, power systems, smart grids

I. INTRODUCTION

We make use of electricity almost every day of our lives, and the power system incurs various faults due to natural phenomena such as lightning or tree branches coming into contact with transmission lines. These faults can cause overloads, which in turn, can lead to occurrences such as short circuits or different varieties of faults such as line-to-line, line- to-ground, double line-to-ground, three phase and fire. Of these, the most serious is the double line-to-ground fault because it can damage electrical equipment and requires prompt attention. Line-to-ground faults are the more prevalent in occurrence, comprising about 80% of the faults in a power system. One of the major problems for electrical engineers is finding these faults for they have to be rectified as quickly as possible in order to maintain power supply to users. In this paper, the author cites the introduction of a system for the detection of faults and their analysis in the transmitted and distributed lines, which enables such engineers to perform their tasks more effectively.

System Components.

The proposed system consists of the followingkey components:

Transformer (12V, 800mA)

Converts AC voltage to 12V DC, providing power for the circuit.

CB (MCB - Miniature Circuit Breaker) protects the circuit from overcurrent and short circuits, ensuring safe operation

ACS712 Current Sensor

Measures the current flowing through the circuit, allowing for real-time monitoring

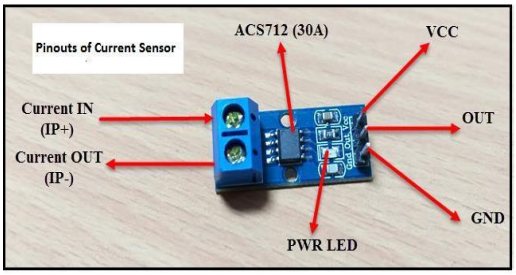

Fig 1. ACS712 Current Sensor

Channel Relay Module

Switches devices on/off based on Arduino/NodeMCU commands, controlling external loads.

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LED Display
Shows status messages, error codes, or measurement data, providing visual feedback.

Arduino UNO Mega
Primary microcontroller processing and controlling the circuit, reading sensors and driving outputs.

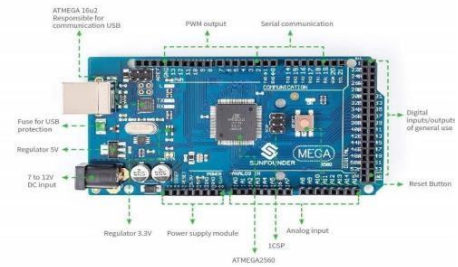

Fig 2. Arduino UNO Mega

10 ohm, 5 watt Resistor
Limits current, divides voltage, or matches impedance in various circuit applications
Red, Blue, Green LED
Indicatesdifferent states: Red: Error/Fault- Blue: Normal/On- Green: Ready/Off
5V DC Supply
Powers Arduino, NodeMCU, and other components, providing stable DC voltage.
Push Button Switch
Allows user input, triggering actions or changing states.
NodeMCU ESP8266Adds
Wi-Fi connectivity for:-Remote monitoring- Control via internet- Data logging

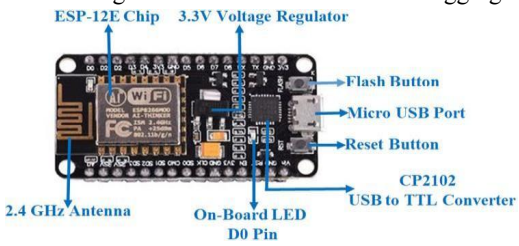

Fig3. NodeMCU ESP8266Adds

GPS Module GPS NEO-6M
Provides location data: - Latitude- Longitude- Altitude Speed

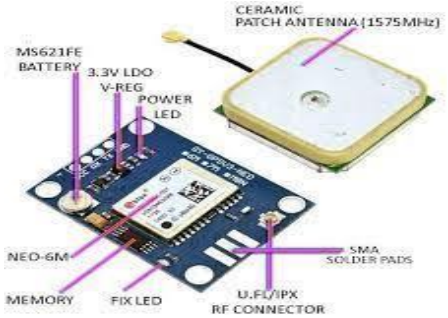

Fig 4. GPS Module GPS NEO-6M

5V Piezo Buzzer
Generates alarm sounds for: - Alerts- Notifications- Warnings.

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Circuit Diagram

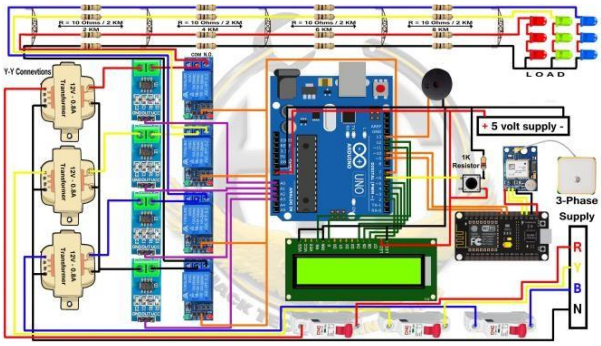

Fig 6. Transmission and Distribution Line Fault Tracking and Assessment System

Working Mechanisms

Fault Detection

- **Sensors:** Devices are installed on power lines to monitor key parameters like voltage, current, and temperature.
- **Abnormality Detection:** When something unusual happens (e.g., a sudden drop in voltage or increase in current), the system identifies it as a potential fault

Fault Classification

- **Types of Faults:** The system can determine what kind of fault occurred (e.g., wire touching the ground or wires shorting together).
- **Smart Analysis:** It uses data patterns and machine learning models to classify faults accurately.

Fault Localization

- **Finding the Fault:** The system calculates the exact location of the fault using techniques like:
- **Pulse Reflection:** Sending a signal through the line and checking how long it takes to bounce back.
- **Wave Analysis:** Measuring how fault waves travel through the line.

Fault Assessment

- **Severity Check:** It measures how serious the fault is— whether it's minor or needs immediate attention.
- **Context Awareness:** Factors like weather conditions and past faults are considered to better understand the situation.

Communication and Alerts

- **Quick Alerts:** The system sends real-time alerts to the control room or maintenance teams via email, SMS, or monitoring dashboards.
- **Monitoring Platform:** Operators can see fault details on a centralized system, including location and severity.

Maintenance and Optimization

- **Recommendations:** The system suggests actions like isolating the faulty section or dispatching repair crews.
- **Long-Term Learning:** It tracks recurring issues and suggests upgrades to improve reliability.

Features

Real-Time Monitoring

Constantly keeps an eye on power lines to spot issues like voltage drops or current spikes.

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Fault Location
Accurately finds where the fault has occurred so it can be fixed quickly.

Fault Type Identification
Identifies the type of problem (e.g., broken wire, short circuit, or ground fault).

Severity Check
Assesses how serious the fault is to prioritize repairs.

Instant Alerts
Sends quick notifications to maintenance teams with details about the fault.

Centralized Dashboard
Displays all information about faults in one place for easy tracking and management.

Data Storage
Keeps records of past faults to identify patterns and prevent future issues.

Fast Communication
Uses reliable communication systems to send data quickly between sensors and the control centre.

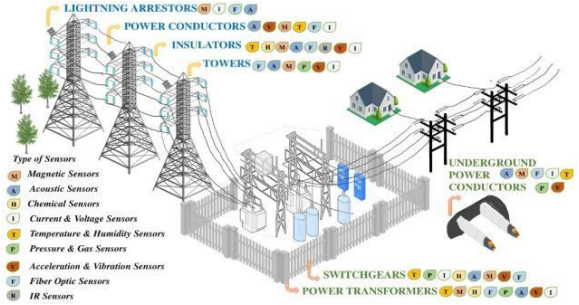

Fig 5. Sensor Technologies for Transmission and Distribution Systems

Advantage
Fault Detection
Identifies problems in power lines instantly, reducing response time.
Accurate Fault Location
Pinpoints the exact spot of the issue, making repairs faster and easier.
Improved Grid Reliability
Keeps the power system stable and ensures consistent electricity supply.
Prioritized Repairs
Helps focus on critical issues first by assessing the severity of faults.
Real-Time Alerts
Sends instant notifications to operators and repair teams for quick action.

Parameter	Transmission Line	Distribution Line
Used Sensors	Advanced and expensive Sensors.	Simple and cheaper sensors.
Detection of Fault	Uses complex methods to detect faults over long distances.	Uses basic methods for faults in small areas.
Reliability of System	Highly reliable and robust.	Highly reliable and robust.
Time of Delay	Slightly slower to detect faults.	Quicker to detect faults.

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II. CONCLUSION

The suggested T&D Line Fault Tracking and Assessment System provides a clear means to improve the reliability of the entire grid system. It helps in reducing service interruption as well as enhances maintenance strategies through its real time monitoring and smart fault diagnosis. It provides accurate information on the nature of the fault, its approximate distance from the consumer, and the nearest available repair shop which leads to faster restoration of service. In addition, the system is modular and thus easily integrable with advanced smart grid technologies. Also, the ability to process past records aids in undertaking predictive maintenance and system improvement over a long time period thereby increasing the overall efficiency and reducing operational costs.

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