Three Phase Transmission Line Fault Detection and Protection Using IoT

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Abstract: **This paper presents an IoT based system for detection and protection of faults in a three phase transmission line. The system continuously monitors electrical parameters and identifies abnormal conditions such as line to ground faults or short circuits. Sensors measure voltage and current values which are processed using a microcontroller. Once a fault is detected, the system determines the approximate distance of the fault using predefined line sections and immediately transmits the information to an IoT cloud platform. A relay mechanism is also used to isolate the faulty section and protect equipment. The proposed model enables real time monitoring and faster fault response compared with traditional methods. The system is economical and suitable for modern smart grid monitoring.**

Keywords: **IoT, Transmission Line Fault Detection, Smart Grid, Relay Protection, Fault Location**

I. INTRODUCTION

Electrical power systems consist of generation, transmission, and distribution networks that ensure continuous delivery of electricity to consumers. Among these components, transmission lines play a crucial role in transferring electrical energy over long distances. However, transmission lines are exposed to various environmental conditions such as lightning, storms, insulation failure, and equipment malfunction, which may cause faults.

Faults in transmission lines can lead to power outages, equipment damage, and reduced system reliability. Therefore, early detection and isolation of faults are essential for maintaining a stable power system. Traditional fault detection techniques rely on protective relays and manual monitoring systems, which may take longer time to identify the fault location.

With the advancement of Internet of Things (IoT) technology, real-time monitoring and remote supervision of electrical systems have become possible. IoT allows different devices and sensors to communicate through the internet and transmit real-time data to remote monitoring platforms. In this project, an IoT-based transmission line fault detection system is proposed to detect faults, identify their type, and determine their location.

II. LITERATURE REVIEW

Several methods have been developed for transmission line fault detection and protection. Conventional protection techniques include overcurrent relays, differential protection, and distance protection schemes. These methods detect faults by measuring abnormal current or impedance values in the transmission line.

Distance protection relays are commonly used in high-voltage transmission systems to determine the location of faults. However, these systems require complex equipment and are expensive to implement.

Recent research focuses on integrating IoT technology with power system monitoring. IoT-based systems allow real-time monitoring of electrical parameters and enable remote access to system information. These systems improve reliability and reduce the response time during fault conditions. The proposed system aims to develop a low-cost IoT-based fault detection and protection system for three-phase transmission lines.

III. PROPOSED METHODOLOGY

The proposed system consists of sensors connected to a microcontroller which continuously measures electrical parameters of a three phase transmission line. When abnormal conditions are detected, the system identifies the fault type and its approximate location based on resistance values representing different line sections. The microcontroller sends the detected fault information to an IoT cloud platform using wireless communication.

The system consists of the following major components:

- Microcontroller (Arduino based controller)
- Current sensors for phase monitoring
- NodeMCU ESP8266 Wi Fi module for communication
- GPS module for location identification
- LCD display for local monitoring
- Buzzer and indicators for alerts

IV. SYSTEM BLOCK DIAGRAM

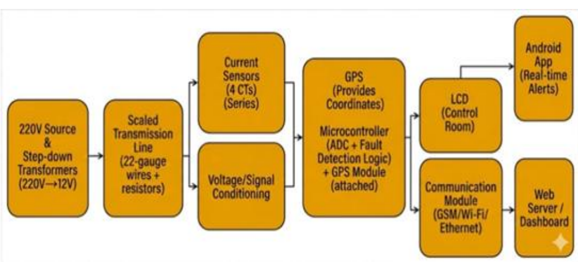

Fig 4.1, Block Diagram of IoT Based Transmission Line Fault Detection System

The system consists of a power supply unit, transmission line model, current sensors, voltage sensing circuit, microcontroller, communication module, LCD display, and Android application. The sensors measure the electrical parameters of the transmission line and send them to the microcontroller. The microcontroller processes the data and identifies faults. The detected fault information is displayed on the LCD and transmitted to the IoT platform for remote monitoring.

V. SYSTEM FLOWCHART

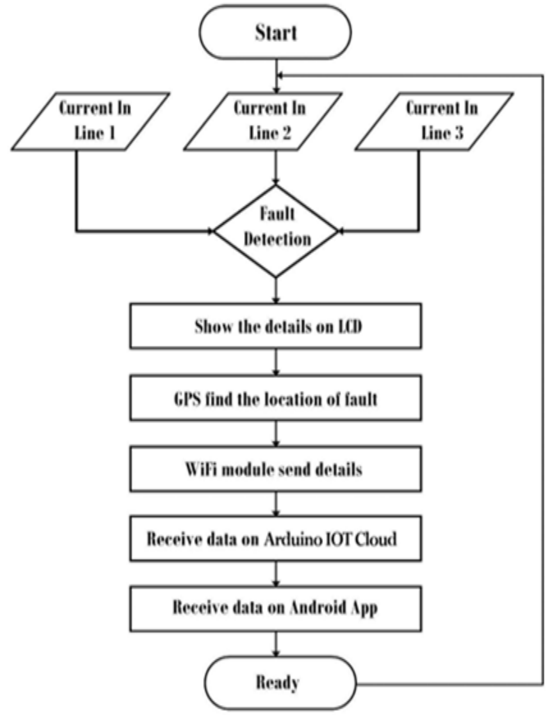

Fig 5.1, Flow chart of operation

The system starts by continuously monitoring the current in all three transmission lines (Line 1, Line 2, and Line 3) using current sensors. The microcontroller compares the current values from each line to detect any abnormalities or faults, such as short circuits or line breaks. When a fault is detected, the system immediately displays the fault details on the LCD screen for local monitoring.

Simultaneously, the GPS module identifies the exact geographical location of the fault. The gathered data—including fault type, line number, and location coordinates—is then transmitted via the Wi-Fi communication module. This information is sent to the Arduino IoT Cloud for remote access and also displayed on the Android application, allowing real-time alerts and monitoring. Once all data is transmitted successfully, the system returns to a ready state, prepared to detect the next fault event.

VI. CIRCUIT DIAGRAM & HARDWARE IMPLEMENTATION

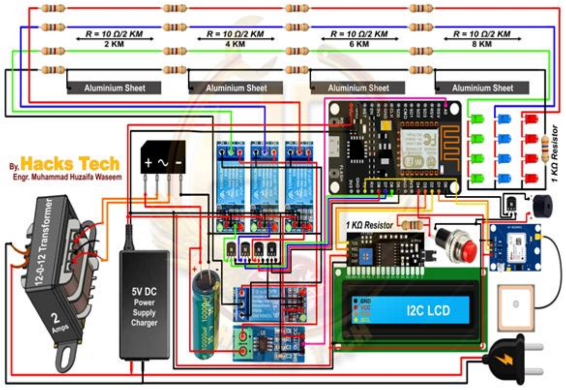

Fig. 6.1. Circuit diagram of IoT based transmission line fault detection system

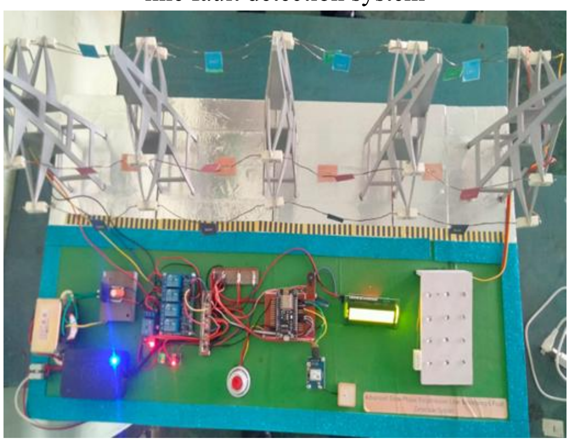

Fig. 6.2. Hardware prototype of the three-phase transmission line fault detection system

The circuit diagram of the proposed Three Phase Transmission Line Fault Detection and Protection System using IoT is shown in Fig. 6.1. The system is built around a microcontroller-based control unit which continuously monitors the condition of the transmission line and detects faults.

A step-down transformer (220V–12V) is used to convert the AC supply into a lower voltage which is further rectified and regulated to obtain a 5V DC power supply for the electronic components. The transmission line model is created using resistors arranged in series, representing different distances of the transmission line such as 2 km, 4 km, 6 km, and 8 km. These resistors simulate the line impedance and help in identifying the approximate location of the fault.

A relay module is used to isolate the faulty section of the line whenever an abnormal condition occurs. The Arduino/NodeMCU microcontroller
processes the input signals and controls the relays accordingly. An LCD display module is used to show the fault type and the location of the fault on the transmission line.

To enable remote monitoring, a Wi-Fi based IoT module is integrated with the microcontroller. This module transmits real-time fault information to a mobile application or cloud platform. Additional components such as LED indicators, push buttons, and sensors are used to simulate and indicate different fault conditions.

The hardware prototype of the system includes transmission towers, conductor lines, and control circuitry mounted on a demonstration board, allowing clear visualization of fault detection and protection in a three-phase transmission line.

VII. RESULTS AND DISCUSSION

The proposed system was tested under different fault conditions by introducing faults at various points along the simulated transmission line. The sensors detected abnormal current values when a fault occurred. The microcontroller successfully identified the type of fault and displayed the fault location on the LCD screen.

The IoT module transmitted the fault information to the mobile application, allowing real-time monitoring of the system. The relay protection unit isolated the faulty section quickly, preventing further damage to the system. The experimental results demonstrate that the proposed system provides accurate fault detection and effective protection.

VIII. ADVANTAGES

- Real-time fault monitoring
- Low-cost implementation
- Remote monitoring using IoT
- Faster fault detection
- Improved system reliability

IX. FUTURE SCOPE

- Integration with smart grid systems
- Implementation of machine learning for fault prediction
- Monitoring of large-scale transmission networks
- Use of advanced communication technologies

X. CONCLUSION

This paper presented an IoT-based system for three-phase transmission line fault detection and protection. The proposed system continuously monitors electrical parameters and detects faults in real time. The integration of IoT technology allows remote monitoring and quick response to fault conditions. The system also provides automatic isolation of faulty sections using relay protection. The results demonstrate that the proposed system is efficient, reliable, and suitable for modern power system monitoring.

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