

Multiple Fault Detection and Analysis in Transmission Line Using IOT

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ABSTRACT

Faults in transmission and cable networks can result in power interruptions, equipment damage, safety hazards, and increased maintenance costs. Conventional fault identification methods may require manual inspection and considerable time to determine the fault condition and location. This paper presents an IoT-enabled multiple fault detection and localization system for cable transmission networks. The proposed system uses an Arduino Uno as the central controller and integrates a DC voltage sensor, ACS712 current sensor, DHT11 temperature and humidity sensor, GPS module, GSM module, LCD display, and dedicated fault detection inputs. The system monitors electrical and environmental parameters continuously and identifies conditions such as low voltage, high temperature, line-to-ground fault, line-to-line fault, short circuit, and cable faults at 2 km and 4 km locations. When a fault is detected, the Arduino processes the sensor information and activates an alert mechanism. The GPS module obtains the geographical coordinates, while the GSM module transmits an SMS containing the fault information and location through a Google Maps link. Experimental testing reported successful identification of the considered fault conditions, with fault detection occurring within approximately 1–2 s and SMS notification within approximately 3–4 s. The proposed system provides real-time monitoring, rapid notification, and location-based fault information, making it suitable for power distribution and other cable-based infrastructures.

Keywords— Internet of Things, transmission line, fault detection, fault localization, Arduino Uno, GSM, GPS, real-time monitoring.

INTRODUCTION

Electrical transmission and cable networks are essential for reliable power delivery and communication infrastructure. However, these networks are susceptible to several fault conditions, including low voltage, short circuits, line-to-ground faults, line-to-line faults, cable faults, overload conditions, and excessive temperature. Such faults can interrupt service, damage electrical equipment, increase maintenance requirements, and create safety risks. Therefore, early detection and rapid identification of abnormal operating conditions are important for improving the reliability and safety of electrical networks. The project report identifies real-time fault detection and accurate fault localization as the major requirements of the proposed system.

Conventional approaches often depend on manual inspection, periodic maintenance, or delayed identification of failures. These approaches can increase outage duration and make it difficult to identify the precise location of faults in long cable networks. The proposed system addresses this problem by continuously monitoring important electrical and environmental parameters and processing the sensor outputs using an Arduino Uno microcontroller. The system combines voltage and current monitoring with temperature and humidity sensing and dedicated digital inputs for different cable fault conditions.

An important feature of the proposed system is the integration of GPS and GSM technologies. When a fault is detected, the GPS module provides latitude and longitude information, and the GSM module sends an SMS notification containing the fault type and geographical location. A Google Maps link is also included to assist maintenance personnel in reaching the fault location. A local LCD interface provides continuous information about voltage, temperature, humidity, current, and fault status.

The objective of this work is therefore to develop a low-cost embedded and IoT-based system capable of detecting multiple fault conditions, providing real-time status information, localizing the fault, and notifying maintenance personnel. The developed prototype was tested for low-voltage, 2 km and 4 km cable faults, line-to-ground faults, line-to-line faults, short circuits, and high-temperature conditions.

LITERATURE SURVEY

Several techniques have been investigated for detecting faults in electrical transmission and distribution systems. Bhatti and Abide [1] proposed a three-phase fault detection approach using wavelet transform and neural networks, demonstrating the application of signal-processing and intelligent techniques for identifying abnormal conditions. Govindarajan [2] developed an Arduino-based three-phase fault detection and protection system, showing the suitability of low-cost microcontrollers for monitoring electrical faults. Osman [3] investigated fault detection in three-phase induction motors using Arduino and sensors, highlighting the use of sensor-based monitoring for identifying electrical abnormalities. These studies establish the potential of combining embedded controllers and sensing techniques for real-time fault detection.

Santiago-Perez *et al.* [4] presented a low-cost Arduino-based three-phase multi-fault detection system using Blynk, demonstrating the use of IoT-oriented platforms for monitoring multiple fault conditions. Although such approaches provide effective monitoring, the proposed system in this work extends the concept by combining multiple electrical and environmental sensors with GPS-based localization and GSM-based SMS notification. The developed system detects low voltage, high temperature, line-to-ground, line-to-line, short-circuit, and predefined cable faults at 2 km and 4 km, while providing the fault location to maintenance personnel. This integration enables both real-time local monitoring and remote fault notification.

PROBLEM STATEMENT

Cable and transmission networks are exposed to multiple electrical and environmental faults that can cause outages, equipment damage, and safety problems. Traditional fault identification methods may require manual inspection and may not provide immediate information about the fault type and location.

OBJECTIVES

1. To develop a real-time system for detecting multiple transmission-line faults, including low voltage, short circuit, line-to-ground, line-to-line, and cable faults.
2. To localize the detected fault and provide immediate notification using GPS and GSM technology, including the fault type and location through SMS.

PROPOSED SYSTEM

The proposed system consists of an Arduino Uno microcontroller, voltage sensor, ACS712 current sensor, DHT11 temperature and humidity sensor, GPS module, GSM module, 16×2 LCD display, fault detection inputs, buzzer, regulated power supply, and supporting electronic components. A step-down transformer and bridge rectifier provide the required low-voltage DC supply to the electronic circuit.

The Arduino Uno acts as the main processing unit. Sensor data are continuously acquired and compared with predefined thresholds. The voltage sensor is used to identify low-voltage conditions, while the DHT11 sensor monitors temperature and humidity. The ACS712 sensor provides current information for monitoring the cable current. Digital fault detection inputs are provided for 2 km and 4 km cable faults, line-to-ground faults, line-to-line faults, and short circuits.

When a fault occurs, the Arduino identifies the corresponding condition and updates the LCD display. Simultaneously, the GPS module provides the current geographical coordinates. The GSM module then sends an SMS to the predefined mobile number containing the fault type, latitude and longitude, and a Google Maps location link. This enables maintenance personnel to obtain fault information remotely and respond rapidly.

BLOCK DIAGRAM

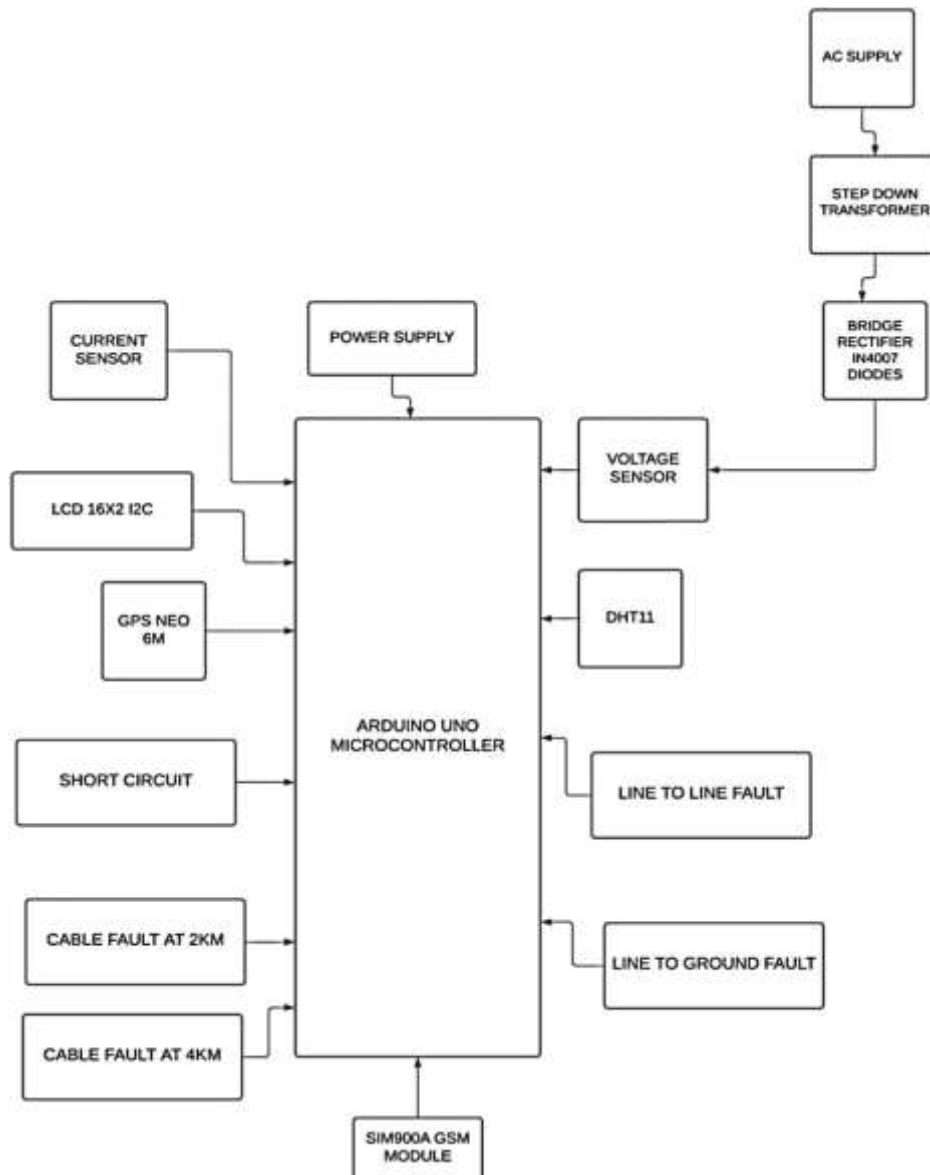


Figure 1Block Diagram of Multiple fault Detection & Analysis of Transmission line using IOT

CIRCUIT DIAGRAM

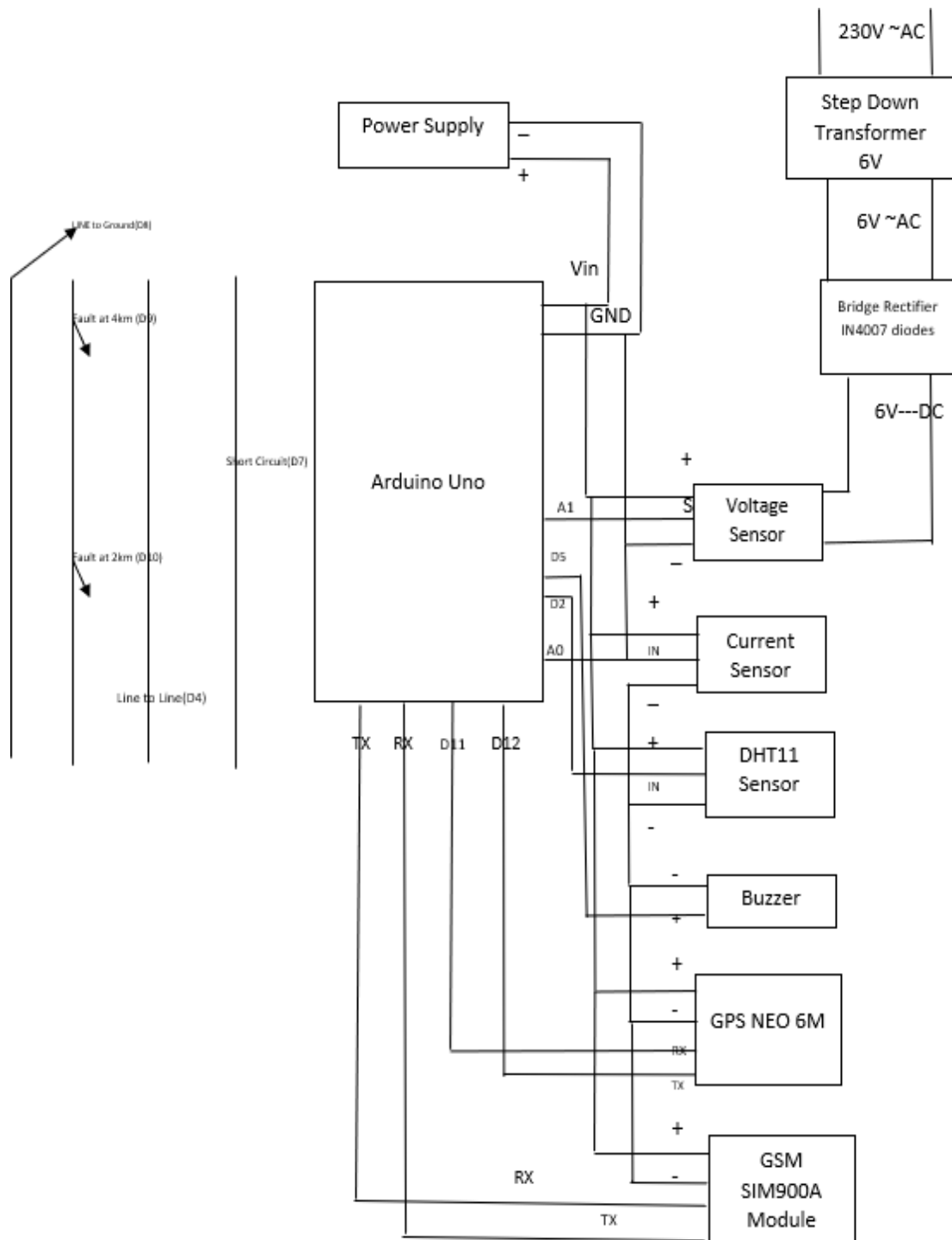


Figure 2 Circuit Diagram of Multiple Fault Detection & Analysis in Transmission line using IOT

METHODOLOGY

The proposed Multiple Fault Detection and Analysis system uses an Arduino Uno as the central controller to continuously monitor the electrical and environmental conditions of a transmission/cable network. A DC voltage sensor, ACS712 current sensor, and DHT11 temperature and humidity sensor are interfaced with the Arduino to acquire the required parameters. Dedicated fault-detection inputs are used to identify cable faults at 2 km and 4 km, line-to-ground faults, line-to-line faults, and short-circuit conditions. The measured parameters are compared with

predefined threshold conditions; for example, a low-voltage condition is detected when the sensed voltage falls below the specified limit, while excessive temperature indicates a high-temperature fault.

When a fault is detected, the Arduino identifies the fault type and immediately updates the 16×2 LCD and activates the buzzer. The GPS module acquires the latitude and longitude of the fault location, and the GSM module sends an SMS containing the fault information and geographical coordinates along with a Google Maps link to the designated mobile number. During normal operation, the LCD continuously displays temperature, humidity, voltage, and current values. The system follows the sequence of initialization, continuous sensor monitoring, fault identification, GPS location acquisition, LCD/buzzer indication, GSM-based SMS notification, and continuous monitoring. This approach provides real-time fault detection, remote notification, and location information for faster maintenance response.

RESULTS AND DISCUSSION

The developed multiple fault detection system was tested under different simulated fault conditions to evaluate its detection capability, response time, communication, and stability. The system successfully detected low-voltage faults, cable faults at 2 km and 4 km, line-to-ground faults, line-to-line faults, short-circuit faults, and high-temperature conditions. During normal operation, the LCD displayed the measured temperature, humidity, voltage, and current values, while the corresponding fault message was displayed whenever an abnormal condition was detected.

The system demonstrated a fault-detection response time of approximately 1–2 s, while SMS alerts were transmitted within approximately 3–4 s after fault detection. The GSM module successfully sent the fault type and GPS coordinates, and the generated Google Maps link assisted in identifying the fault location. The Arduino, sensors, GPS, and GSM modules also operated consistently during extended testing. Tests under varying voltage, temperature, humidity, and simulated cable-fault conditions demonstrated reliable operation of the prototype.

The experimental results indicate that integrating sensor-based monitoring, Arduino processing, GPS localization, and GSM communication provides an effective approach for rapid fault identification and notification. The system reduces the need for continuous manual inspection and can help maintenance personnel respond more quickly to cable faults. However, the present prototype primarily demonstrates predefined fault locations such as 2 km and 4 km; therefore, future work can focus on continuous-distance fault localization and advanced intelligent fault-classification techniques.

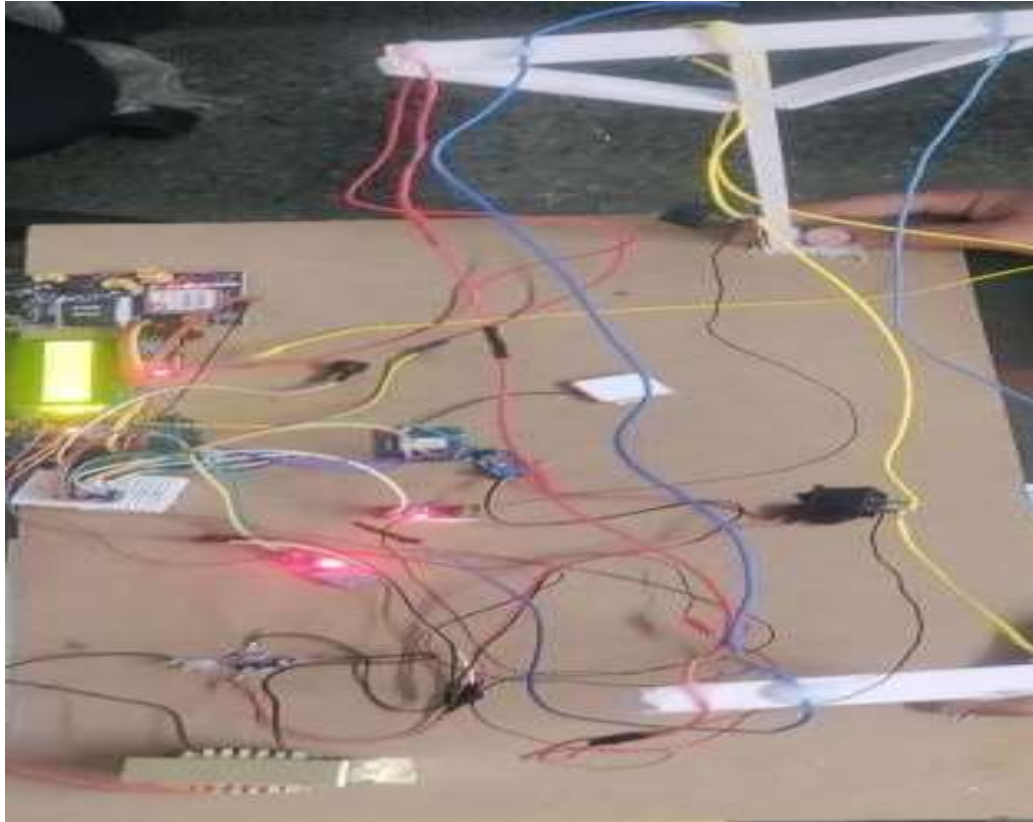


Figure 3 hardware setup of Multiple Fault Detection & Analysis in Transmission line using IOT

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