# Transmission Line Monitoring System using IOT

**Shreyanshnath Shantinath Ingale**
M. Tech. Electronics and Communication Engg.
Walchand College of Engineering, Sangli,
Maharashtra, India.
shreyanshnath.ingale@walchandsangli.ac.in

**Sanjaykumar K. Parchandekar**
Associate Professor, Electronics Department
Walchand College of Engineering, Sangli,
Maharashtra, India.
sanjaykumar.parchandekar@walchandsangli.ac.in

Abstract— **The transmission of electricity in India is becoming increasingly important than ever thought of. It depends on high-voltage lines which at times has to cross kilometers of forests or mountains to reach a certain area, and a preventive check has to be done since even a single fault can interrupt power supply. To monitor each and every endpoint/transmission point for a specific area is too difficult which ultimately results in delay to repair the problem occurred. To address these challenges, this project aims to reduce power failure delays for both delay-sensitive and delay insensitive traffic. Proposed method offers the uninterrupted power supply and less maintenance time when problem occurred with advance alerts to the power-stations. Microcontroller is used as a primary device to which various types of sensors are attached like voltage sensor, wind speed sensor, load cell sensor, temperature sensor, and current sensor. These sensors measure the specific values of the transmission line and send it wirelessly to the power-stations so that they can get to know all the data related to power failure, reasons for power failure & the location point. In the proposed method, with the integration of IoT, we can directly automate various things which can be the future scope of this project.**

**Keywords - Transmission line, IoT, Sensor, Microcontroller**

## I. INTRODUCTION

The power system is one of the most primitive fields that have technologically advanced within Electrical Engineering. A traditional power system deals with three systems: generation, transmission, and distribution systems of electric power. It is called “traditional”, because the generation of electricity is centralized, which means that only a few large power plants are involved. Working on the generation system, the power plants will transform other forms of energy into electric power. These sources of power contain fossil fuels such as coal and natural gas, hydro, nuclear, solar, and wind power. Furthermore, the transmission system is made up of transmission lines that are in control of passing power from the power station where the power is transferred to the location of the consumers. The distribution system is the network that supplies power to the load that can be consumed by the user's apparatus. [1]

Transmission lines system is the part of the electric grid network which is responsible of transferring the power from the power station to the end user. Power failure problems in the power transmission lines occurred due to many environment factors such as temperature, strong winds and rain. In the transmission line monitoring system using internet of things (IoT), multiple sensors can be applied to overcome these problems in transmission lines. The idea of IoT was first proposed in 1999 in USA. After this date it has been proved useful in many countries. [2]

First, the types of transmission line depending on their length are: short transmission line which is about 50km and its voltage level is up to 20kV, the medium transmission line which is from 50km to 150km and its voltage level between 20kV and 100kV, and long transmission line where its length is more than 150km and its voltage is above 100kV. Second, the main practical types of transmission line depending on the conductors are a balanced two-wire line, coaxial cable, waveguide, microstrip, planer line, optical fibers. [1]

Wireless sensor based monitoring of transmission lines provides a solution for several of these concerns like real time structural awareness, faster fault localization, accurate fault diagnosis by identification and differentiation of electrical faults from the mechanical faults, cost reduction due to condition based maintenance rather than periodic maintenance, etc.. These applications specify stringent requirements such as fast delivery of enormous amount of highly reliable data. The success of these applications depends on the design of cost effective and reliable network architecture with a fast response time. [3]

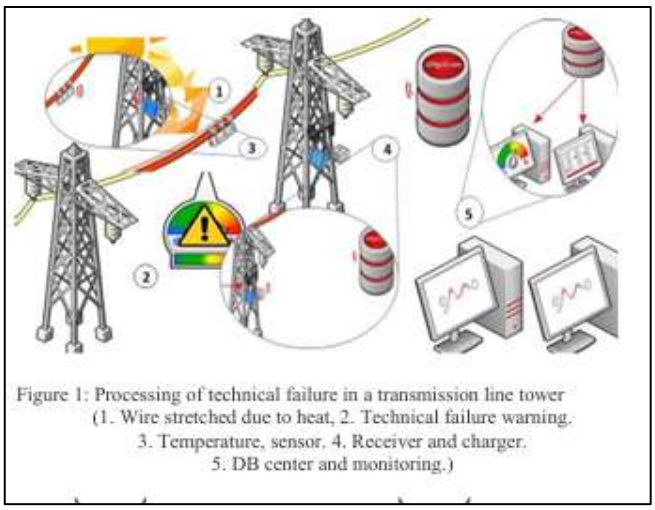



Figure 1: Processing of technical failure in a transmission line tower (1. Wire stretched due to heat, 2. Technical failure warning. 3. Temperature, sensor. 4. Receiver and charger. 5. DB center and monitoring.)

Fig. 1 illustrates the complete Processing of technical failure in a transmission line tower (1. Wire stretched due to heat, 2. Technical failure warning. 3. Temperature, sensor. 4. Receiver and charger. 5. DB center and monitoring.)

## II. TRANSMISSION LINE

The transmission lines are generally exposed in the air to the harsh environment of nature which leads to different types of failures including thundering, rain, lightning phenomena, flashover, and overheating. There are several problems relates to The Line. When a transmission line sags extremely, it causes power failure. An overheating electrical transmission line sagging into a tree sparked the greatest power failure in the Western United States in 1996. [2]

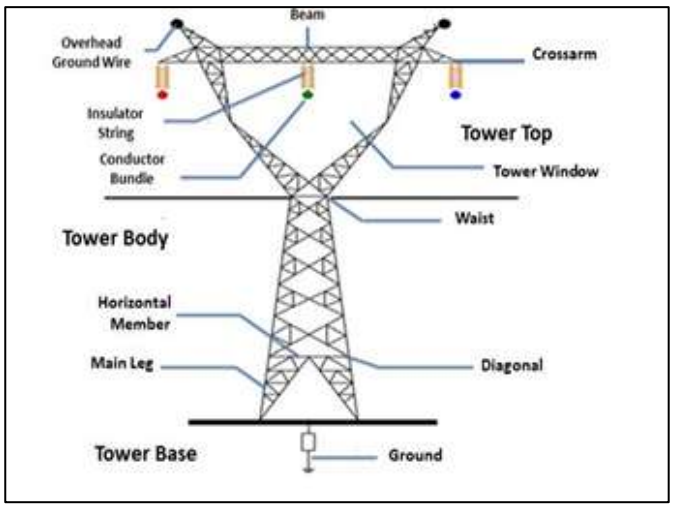



Fig.2: Transmission line tower

As the temperature increases, the outspread conductor length will increase and this will cause an increase in sag and decrease in conductor tension. Transmission lines that sag under heavy use and high temperatures are the devastations of transmission line operators. These lines are not only restricted in the volume of power they can transmit, but sagging lines run a higher risk of getting in touch with trees and shorting out. A sagging transmission line in Ohio is believed to be the event that triggered 2003 blackout. Traditionally, workers in power line will cut the power off as soon as they discover this problem in order to avoid fire incident, and then they will send the specialist to define and solve the problem which takes a lot of time and effort[1-2]

## TYPES OF TRANSMISSION LINE FAULTS

Electrical faults in three-phase power systems are mainly classified into two types, namely open and short circuit faults. These faults can be symmetrical and unsymmetrical faults. Let's discuss these faults.

A. Symmetrical Fault:

A symmetrical fault is a fault where all phases are affected so that the system remains balanced. A three-phase fault is a symmetrical fault. In this fault, all phases are short circuits to each other and often to earth. Such fault is balanced in the sense that the system remains symmetrical. [8]

B. Unsymmetrical Faults:

Unsymmetrical faults involve only one or two phases. In unsymmetrical faults the three-phase line becomes unbalanced. Such type of faults occurs between the line to ground or between lines. An unsymmetrical series of faults is between phases or between phase to ground. Whereas unsymmetrical shunt fault is unbalanced in the line impedance. [8]

## III. LITERATURE REVIEW

This literature review synthesizes 8 studies (2017–2025) There is a lot of research work aimed solely in improving the monitoring system of smart grid. Recently there are many published works that attempt to develop an efficient technology for monitoring the power transmission lines. Most of these works are classified in different criteria and are only focused on the temperature parameter and the others add one or more parameters while in the present proposed system many parameters were monitored. The published works in this field are also different in the types of monitoring strategies where some of them used wireless technology such as X Bee or GSM technology and some used IoT which provides advanced wireless monitoring system.

Ahmed S. Suliman [1] paper presents an IoT-based monitoring system for overhead power transmission lines using multiple sensors and GPS, enabling real-time fault detection and atmospheric condition tracking to enhance smart grid reliability. Heba [2] an IoT-based system using Arduino, sensors (PIR, flame, temperature, humidity), and ESP8266 Wi-Fi to monitor and control smart grid transmission lines, detecting, sag, overheating, intrusion, flashovers. Yizhao Zhang [3] The study proposes a transmission line monitoring system

using radar sensors, video analysis, and a DSP-based Gaussian model to detect, track, and classify intrusions.It accurately measures the distance and speed of foreign objects, triggering timely alarms to enhance grid safety.

Sheeraz Kirmani [4] highlighted that a sustainable power transmission line monitoring system integrating IoT, UAVs, and AI-based image analysis to detect faults, vegetation encroachment, structural issues. It enhances inspection efficiency, reduces costs, and supports proactive maintenance for improved grid reliability. Gustavo Costa Gomes de Melo [5] proposes an IoT-based system using sensors, Arduino, and cloud connectivity to monitor transmission line parameters such as temperature, sag, tilt intime. It improves fault detection speed, reduces downtime, and enhances smart grid reliability through continuous online monitoring. Joe-Air Jiang [6] it introduces a wireless IoT-based monitoring system for overhead transmission lines using sensors to detect parameters like sag, temperature, and conductor vibration. It enables real-time data transmission, early fault detection, and preventive maintenance to enhance power grid reliability.

## IV. METHODOLOGY

In this system we use four sensors; wind speed sensor, voltage sensor, temperature sensor, and current sensor. The controller units used Microcontroller responsible of connecting these sensors and processed the collected data then send it wirelessly through internet. The Wi-Fi transmitter and receiver are used to connect the circuit and the website wirelessly.

All the sensors measure the physical values continuously, and send it to the microcontroller unit. The microcontroller provides real time comparison of the obtained values from the sensors with the normal conditions. The microcontroller sends these readings to the transmitter, and the transmitter sends it to the receiver. At the receiver side the obtained results are shown in website channel

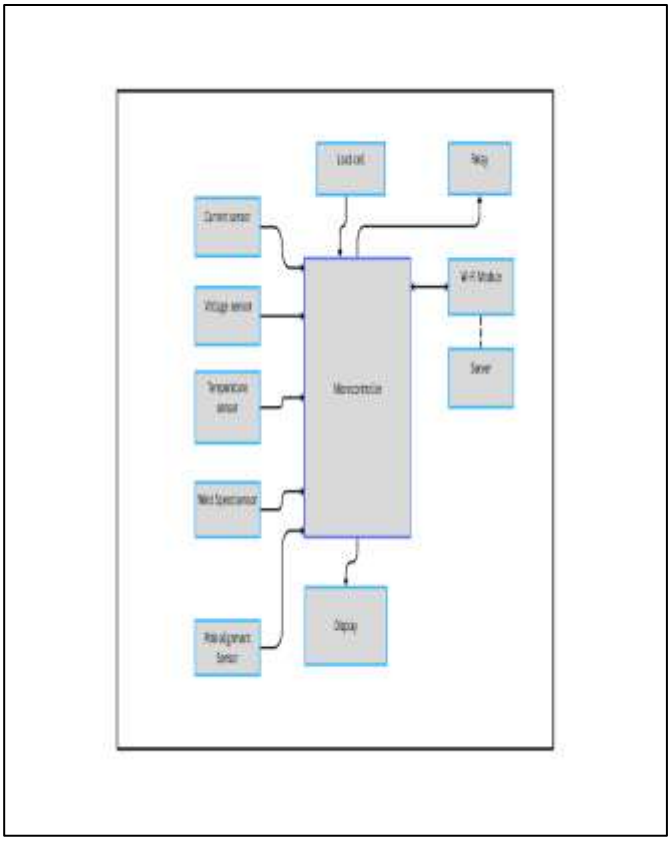


Fig.3: Block Diagram

**Key Components**

**Current Sensor:**
A **current sensor** is a device used to detect and measure the flow of electric current (AC or DC) in a conductor, and then convert it into a signal that can be easily read, monitored, or processed.

**Voltage Sensor:**
A **voltage sensor** is a device that measures the voltage in an electrical circuit and converts it into a signal (analog or digital) that can be read by controllers, monitoring systems, or microcontrollers

**Temperature Sensor:**
The **DHT series** are digital sensors that measure **Temperature** and **Relative Humidity**. They are widely used in IoT projects, weather monitoring, home automation.

**Internet of Things (IoT):**
A network of physical objects ("things") embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet.

**Wind speed Sensor:**
A **tachometer sensor is wind speed sensor** is an instrument used to measure the **rotational speed** of a shaft, disk, motor, or any rotating object. It usually shows the speed in **revolutions per minute (RPM)**

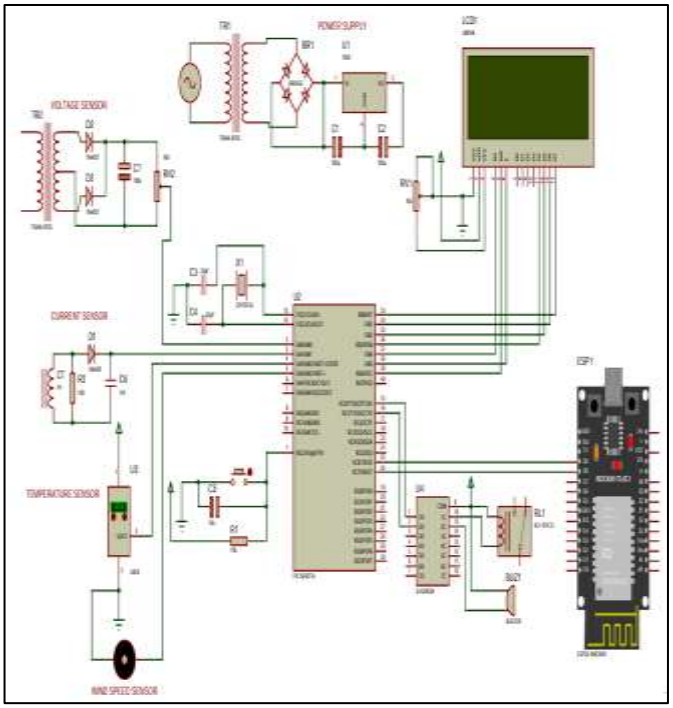


Fig.4(a): Circuit Diagram

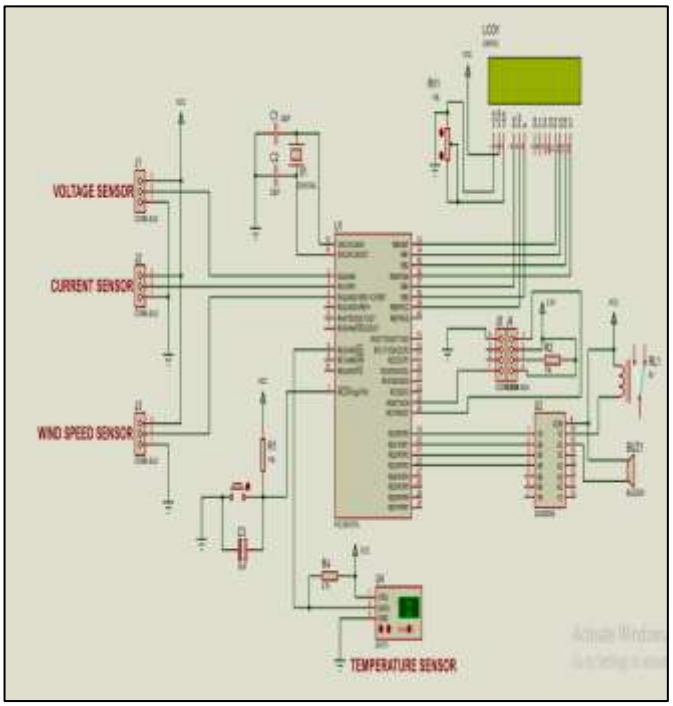



Fig. 4(b): Circuit diagram of Simulation in Proteus

A) Working

The implemented system makes use of one step-down transformer for dealing with the whole circuit below low voltage situations of 12V simplest to check. The three-segment fault evaluation. The primaries of 1 transformer are connected to a 3-segment deliver in a celeb configuration, while the secondary of the equation is also related in a star configuration.

The output of the transformer is rectified and filtered and is given to 3 relay coils. Fault switches, each one is connected across the relay coil, meant to create a fault situation both at big-name i.e. LL. Fault and 3-1. Fault, LED'S are Related to their output to signify their popularity. The Microcontroller is used which converts the analog value of the voltage to a virtual one which is displayed on a 16x2 liquid crystal display. If the fault is created by means of any fault switches The virtual price shown on the liquid crystal display will differ abnormally given the fault vicinity. If the fault is cleared in the detailed term, then it is going to be a brief Fault if it isn't then there may be a permanent journey. This Relay is supposed for disconnecting the burden to indicate fault Situations.

A) Component used in circuit

1. Power Transformer

That is a device that is used to convert power from one alternating contemporary (AC) voltage to another alternating current (AC) voltage with less lack of electricity. There are two types of transformers: Step-up transformers that increases the voltage, and Step-down transformers that decreases the voltage.

2. Voltage Regulator (LM7805)

It provides several fixed output voltages The LM7805 is an output +5 volts. It is a 3-pin IC; input pin for accepting incoming DC voltage, ground pin for establishing the ground for the regulator, and output pin that supplies the positive 5 volts

3. Relays

A relay is an operated switch that helps to protect the system from damage by detecting and isolating faults on transmission and distribution lines by opening and shutting the breaker

4. LCD (Liquid Crystal Display)

An Interface IC is used for the hectic task to handle with Assist of MCU. The IC is to get a function of the data from the MCU and process to display meaningful information onto the LCD screen. The liquid crystal display is normally utilized in different embedded projects because of its low cost, quick access, and adaptability to get programmed. There's a kind of liquid display that has sixteen columns and two rows so it's called 16 x 2 LCD modules.

5. (IoT) Internet Of Things

The Internet of things (IoT) provides an easy and secure connection for sending and retrieving data in real-time. This platform supports interactive, real-time data visualization that permits developers to increase the platform for personal customization when desired. It exists to empower the data from the device.

## V. Hardware Diagram

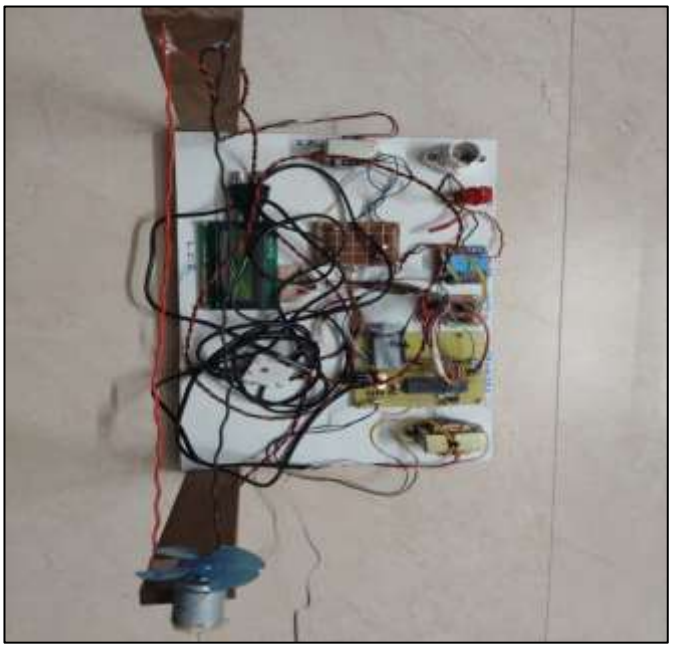


Fig.5: Hardware Connection of Proposed Solution

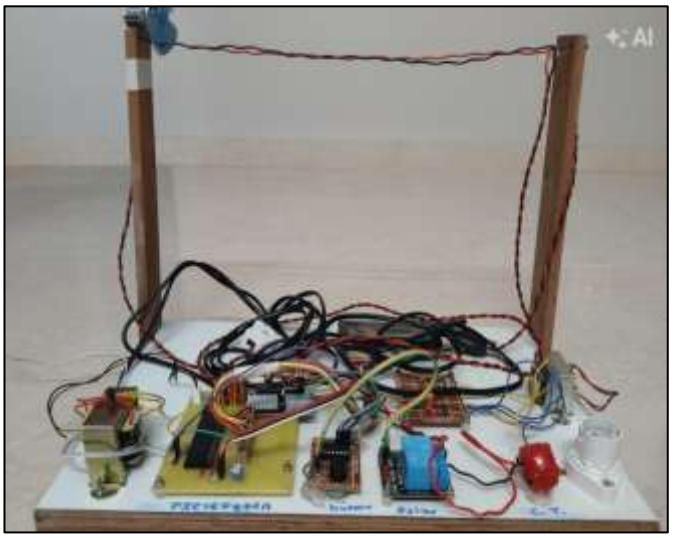


Fig.6: Final Hardware Model of Proposed Solution

## VI. Internet of Things Technology (IOT)

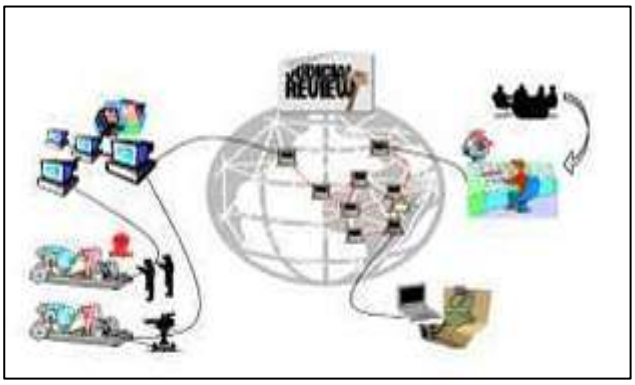


Fig.7: Internet of things

The user interface is through web pages that are created on the client-side, using HTML. JavaScript is used for validity checks of the information entered by the users. The client's browser parses the URL into a number of separate parts, including address, path name and protocol. A Domain Name Server (DNS) translates the domain name the user has entered into its IP address, a numeric combination that represents the site's true address on the Internet (a domain name is merely a "front" to make site addresses easier to remember). The browser now determines which protocol (the language client machines use to communicate with servers) should be used. Examples of protocols include FTP (File Transfer Protocol), and HTTP (Hyper Text Transfer Protocol). The browser sends a GET request to the Web server to retrieve the address it has been given.

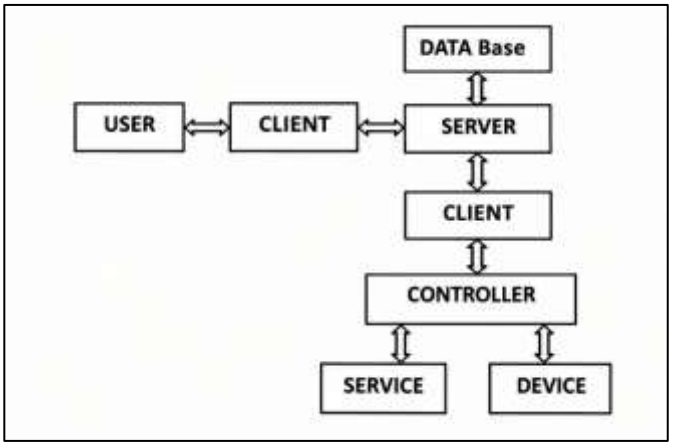



Fig.8: Client Server Architecture

The Internet is basically a client server system. In the retrieval of information that can be accessed using the internet, there are two important components: client, which requests the information and server, which stores it. Each side requires a piece of software to negotiate the exchange of data. During web page retrieval, at the client side, a browser like Netscape or internet explorer is used. [7]

## VII. Results and Discussion

1. All the four sensors will take readings and then it sends to thingspeak sever with the help of ESP32 Module.
2. Whenever any reading for any parameter exceeds above limit, it will create an alert and also shows it on server screen.




Fig.9: Channel Creation
This diagram represent the creation of IoT channel in thingspeak.

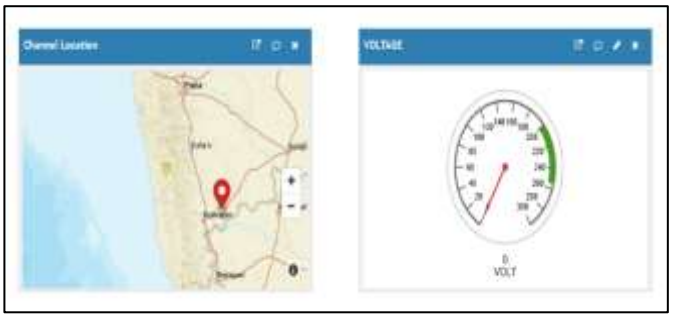



Fig.10: Voltage and Live Location
This diagram show the real time location and voltage.

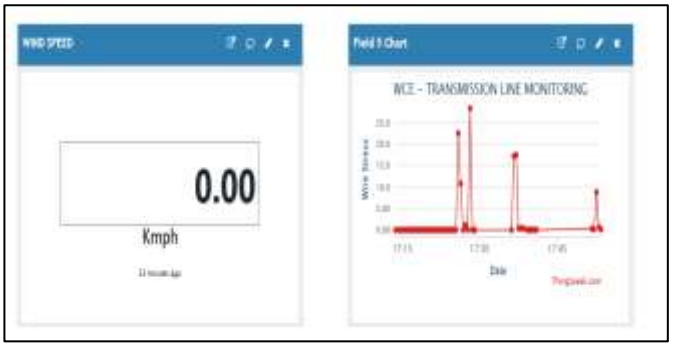



Fig.11: Load Cell
This diagram show the load cell tension.

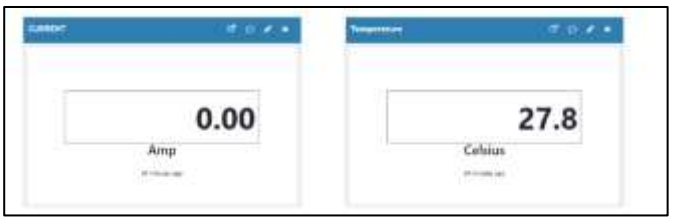



Fig.12: Temperature and Current
This diagram show real time current and temperature

## VIII. Research Gaps and Future Directions

Despite advances in IoT-based transmission line monitoring, existing systems often lack scalable architectures for large-scale grid deployment, exhibit limited energy efficiency in remote sensor nodes, and fail to guarantee secure, low-latency communication under varying network conditions. Additionally, many studies do not address robust fault classification under noisy environments or integration with predictive maintenance frameworks for real-time adaptive analytics.

Future research should focus on designing energy-aware IoT sensor networks with edge-AI for decentralized fault detection, enhancing cyber security protocols tailored to IoT power systems, and developing machine learning–enabled predictive maintenance models to improve reliability and reduce downtime. Furthermore, exploring 5G/LPWAN integration, digital twin frameworks, and real-world testbed validations will be critical for practical deployment in smart grid environment.

## IX. CONCLUSION

In this paper, we explored the application of IoT for monitoring transmission line system by introducing IoT which can lead to large-scale improvement in efficiency and performance.

Because we are not allowed to access any transmission line, a small system model is created to show the monitoring of transmission line outages. The circuit includes a microcontroller (Arduino), different sensors (PIR, relay for control, sensors for conductor galloping due to wind, meteorology, and temperature), and a mobile app connected using IoT. The software and hardware parts of the design are working properly.

the IoT-based transmission line monitoring system provides an efficient and cost-effective solution for real-time fault detection and condition monitoring in power systems. By integrating wireless sensor networks, embedded controllers, and smart communication technologies, the system enhances reliability, reduces outage time, and supports the development of intelligent smart grid infrastructure.

## X. REFERENCES

[1] Alhebshi, H. Alnabilsi, J. Alzebaidi, A. Bensenouci, T. Brahimi, and M.-A. Bensenouci, "Monitoring the operation of transmission line in a smart grid system through IoT," in Proceedings of the IEEE Conference, pp. 139–146.

[2] A. S. Suliman, B. M. Ahmed, M. B. Elareefi, E. A. E. Abd Elrahman, E. A. Arbab, and M. M. Abdulwahab, "Monitoring system for overhead power transmission lines in smart grid system using Internet of Things," University of Khartoum Engineering Journal (UofKEJ), vol. 12, no. 1, pp. 1–5, Feb. 2022.

[3] Yizhao Zhang (2019) Design and Application of Transmission Line Monitoring System.

[4] "A Survey on IoT-Enabled Smart Grids: Technologies, Architectures, Applications, and Challenges."

[5] "A Low-Cost IoT System for Real-Time Monitoring
of Climatic Variables and Photovoltaic Generation for Smart Grid Application

[6] On Real-Time Detection of Line Sags in Overhead Power Grids Using an IoT Based Monitoring System: Theoretical Basis, System Implementation, and Long-Term Field Verification."

[7] S. Suresh et al., "Transmission Line Fault Monitoring and Identification System by Using Internet of Things," International Journal of Advanced Engineering Research and Science (IJAERS), vol. 4, no. 4, Apr. 2017.

[8] C. S. Hiwarkar, S. S. Shinde, and A. J. Landge, "Fault Detection in Three-Phase Transmission Line by Using IoT," International Journal for Research in Applied Science & Engineering Technology (IJRASET), vol. 10, no. 4, pp. 2006–2008, Apr. 2022, doi: 10.22214/ijraset

[9] N. Karpagam, J. M. S. Sebatiny, R. Jeyapratha, and S. Shanmugapriya, "IoT based wireless communication of transmission line parameters," International Research Journal of Engineering and Technology (IRJET), vol. 11, no. 06, pp. 857–861, Jun. 2024