

Design and Implementation of Smart Industrial Monitoring System for Thermal Power Plant using LoRaWAN and Arduino Uno.

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Abstract: *Thermal power plants require continuous monitoring of critical parameters such as temperature, vibration, voltage, and pressure to ensure safe and efficient operation. Conventional wired monitoring systems are costly and difficult to maintain in large industrial environments.*

This paper presents the design and implementation of a Smart Industrial Monitoring System using LoRaWAN and Arduino Uno. The system collects real-time data from sensors such as MAX6675 K-type thermocouple sensor, vibration sensor, voltage sensor, and pressure sensor. The collected data is transmitted wirelessly over long distances using LoRaWAN.

The proposed system provides low power consumption, long-range communication (up to 2 km), and reliable data transmission. Experimental results demonstrate accurate sensing and stable communication, making the system suitable for thermal power plant applications..

Keywords: Smart Monitoring, LoRaWAN, Arduino Uno, MAX6675, Vibration Sensor

I. INTRODUCTION

Thermal power plants operate under high temperature and high voltage conditions. Continuous monitoring of industrial parameters essential to prevent equipment failure and accidents.

Traditional wired systems have limitations such as:

- High installation cost
- Complex wiring
- Limited flexibility

LoRaWAN (Long Range Wide Area Network) is a low-power wireless communication technology that supports long-distance data transmission.

In this project, Arduino Uno is used as the main controller, and multiple sensors are integrated to monitor industrial parameters. The system transmits real-time data wirelessly to a remote monitoring station.

II. LITERATURE REVIEW

Previous research in industrial monitoring system mainly focused on:

- GSM-based monitoring systems (limited range and higher power consumption).
- Wi-Fi based system (high maintenance and high-power consumption).
- Zigbee-based communication (moderated range but limited scalability).

Recent studies show that LoRaWAN provides:

- Long range communication (up to 1.8 km).



- Low power consumption.
- Better scalability.

However, many existing systems lack, multi-parameter monitoring in thermal power plant environments. The proposed system improves upon previous models by integrating temperature, vibration, voltage, and pressure monitoring in a single low-cost architecture.

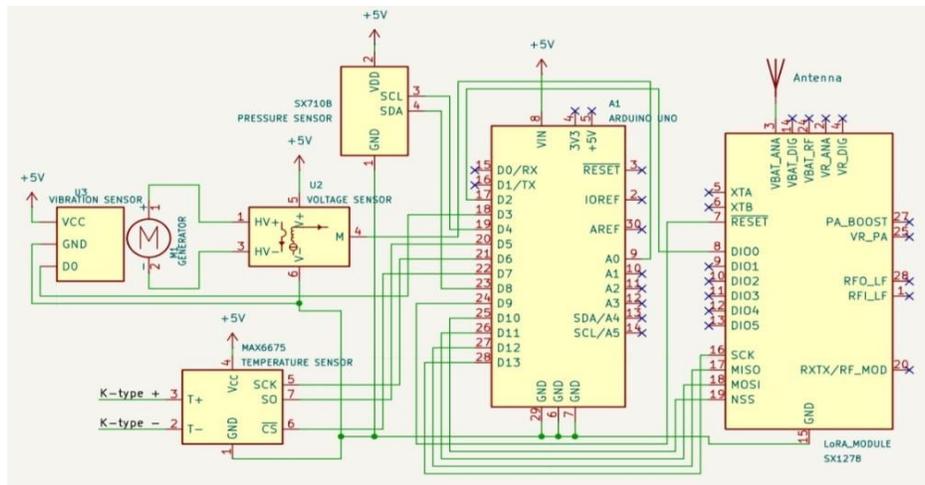
Proposed System Architecture

The system consists of:

Transmitter side

- Arduino Uno.
- MAX6675 Temperature sensor.
- Vibration sensor.
- Voltage sensor.
- Pressure sensor.
- LoRa SX1278 Module

Block Diagram of Transmitter.

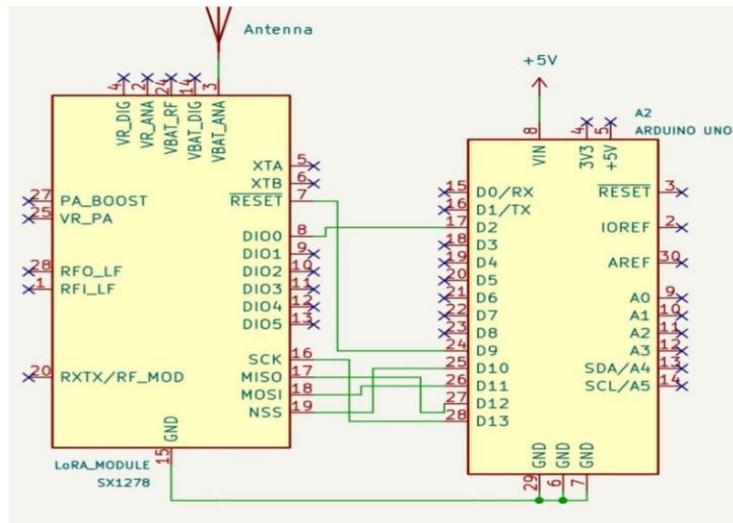


Receiver Node

- LoRa SX1278.
- Arduino Uno.
- Display / Serial Monitor.



Block Diagram of Receiver .



Working flow:

The proposed system represents a smart monitoring solution for an industrial thermal power plant using **LoRaWAN technology and an Arduino Uno**. In this system, different sensors are installed at various points in the plant to continuously monitor important parameters such as temperature, gas levels, humidity, and air quality. These sensors collect real-time data from the environment and convert it into electrical signals. The Arduino Uno acts as the main controller, receiving this data through its input pins. If the sensor outputs are analog, the Arduino converts them into digital form using its internal Analog-to-Digital Converter (ADC). It then processes the data by applying predefined conditions, such as detecting abnormal temperature rise or harmful gas levels.

After processing, the Arduino sends the data to a LoRa module configured for LoRaWAN communication. LoRaWAN enables long-range wireless transmission with very low power consumption, which is highly suitable for large-scale industrial environments like thermal power plants. The transmitted data is sent to a remote LoRaWAN receiver or gateway, which collects the information and forwards it to a monitoring system such as a computer, cloud server, or control room dashboard. At the receiver end, the data is displayed for real-time observation and is also stored for logging and analysis.

This system helps in continuous monitoring of critical parameters in a thermal power plant, allowing early detection of hazardous conditions, improving safety, reducing manual effort, and enabling efficient data-driven decision-making.

Hardware design

Main controller

- Arduino Uno.
- ATmega328P based microcontroller.

Communication Module

- SX1278 LoRa Module.
- Frequency: 433 MHz
- Long-range communication.



Sensors used

- Max6675 (Temperature sensor)
- Vibration sensor
- Voltage sensor Module
- Pressure sensor
- The hardware is powered using a regulated 5V supply.

Software Design

Software is developed using Arduino IDE.

Steps:

- Sensor initialization
- Data acquisition
- Data conversion into readable format
- LoRa transmission
- Receiver side data decoding

Communication Parameters:

- Baud Rate: 9600
- Frequency: 433 MHz

Data Packet Format:

Temperature | Vibration | Voltage | Pressure

Experimental Results and Analysis

- Testing was conducted under laboratory conditions.

Observed results:

- Temperature readings were accurate within +1 C or -1 C
- Vibration sensor detected turbine vibration successfully
- Voltage sensor measured up to 25 V AC
- LoRa communication range tested up to 1.8 km (practical open area test)

The system showed:

- Stable communication
- Low packet loss
- Low power consumption

Advantages

- Long-range communication
- Low power consumption
- Low installation cost
- Easy scalability
- Real-time monitoring



III. CONCLUSION AND FUTURE SCOPE

This paper presents a low-cost and efficient Smart Industrial Monitoring System using LoRaWAN and Arduino. The system successfully monitors multiple industrial parameters and transmits them over long distances. The proposed system is suitable for thermal power plants and other heavy industries.

Future Scope:

- Cloud integration (IoT dashboard)
- Data logging and analytics
- AI-based fault prediction
- Mobile application monitoring
- Encryption for secure transmission.

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