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ARDUINO UNO AND LORAWAN-BASED SMART INDUSTRIAL MONITORING SYSTEM FOR A THERMAL POWER PLANT

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Abstract: To guarantee safe and effective operation, thermal power plants need constant monitoring of vital parameters including temperature, vibration, voltage, and pressure. In big industrial settings, traditional cable monitoring systems are expensive and challenging to maintain. This article describes the design and implementation of an Arduino Uno and LoRaWAN-based smart industrial monitoring system. Sensors like the MAX6675 K-type thermocouple sensor, vibration sensor, voltage sensor, and pressure sensor provide real-time data to the system. LoRaWAN is used to send the gathered data wirelessly across great distances. The suggested system offers dependable data transfer, minimal power consumption, and long-range communication (up to 2 km). The technology is appropriate for thermal power plant applications since experimental findings show precise sensing and consistent communication.

Index Terms - Smart Monitoring, LoRaWAN, Arduino Uno, MAX6675, Vibration Sensor.

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.

LITERATURE REVIEW

Prior studies on industrial monitoring systems were primarily concerned with:
GSM-based monitoring systems are more power-intensive and have a restricted range. Wi-Fi-based systems require a lot of maintenance and electricity. Zigbee-based connectivity (limited scalability but moderate range). According to recent research, LoRaWAN offers:

1) Communication across long distances (up to 1.8 km).
2) Minimal power use.
3) Improved scalability.

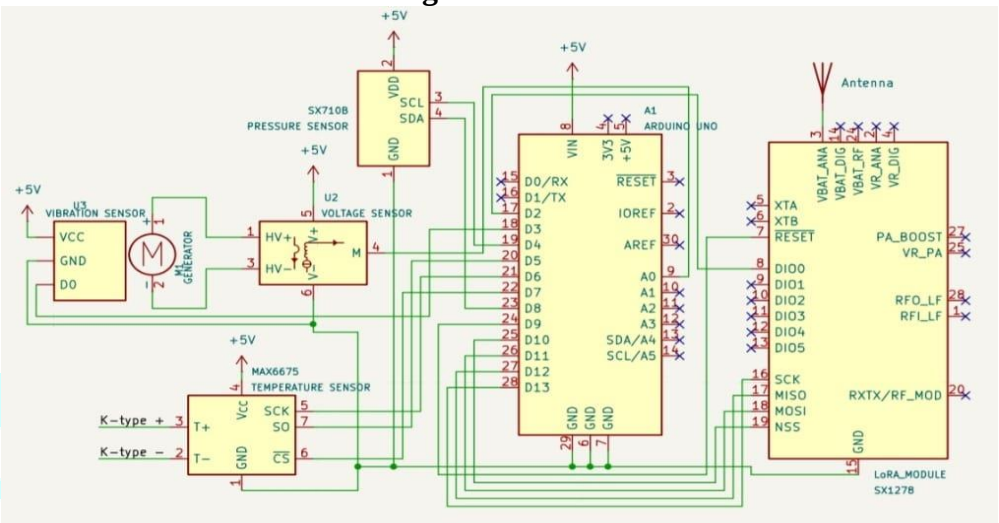
Nevertheless, multi-parameter monitoring in thermal power plant contexts is lacking in many current systems. By combining temperature, vibration, voltage, and pressure monitoring into a single, inexpensive design, the suggested system outperforms earlier models.

PROPOSED SYSTEM ARCHITECTURE

The system consists of:

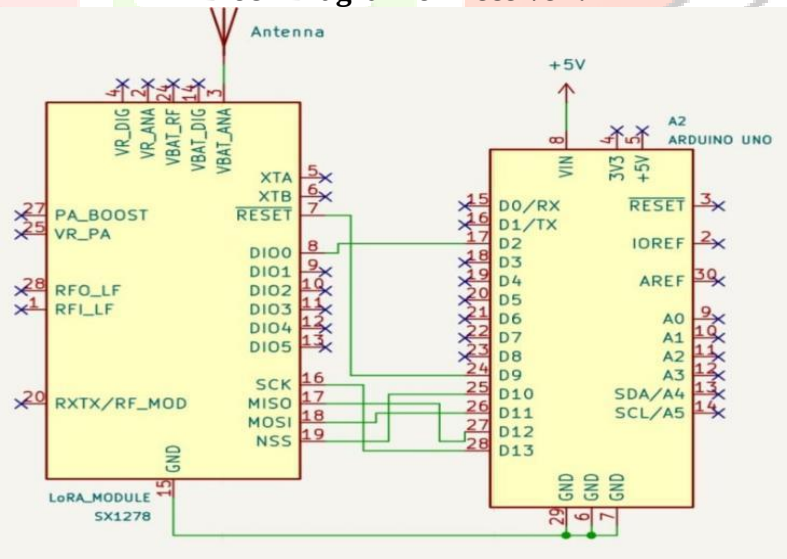
- **Transmitter side**
  1. Arduino Uno.
  2. MAX6675 Temperature sensor.
  3. Vibration sensor.
  4. Voltage sensor.
  5. Pressure sensor.
  6. LoRa SX1278 Module

Block Diagram of Transmitter.



- **Receiver Node**
  1. LoRa SX1278.
  2. Arduino Uno.
  3. Display / Serial Monitor.

Block Diagram of Receiver .



WORKING FLOW

The suggested system uses an Arduino Uno and LoRaWAN technologies to provide a smart monitoring solution for an industrial thermal power plant. This system continually monitors critical factors including temperature, gas levels, humidity, and air quality by installing multiple sensors at different locations around the facility. These sensors gather environmental data in real time and transform it into electrical impulses. Through its input pins, the Arduino Uno, which serves as the primary controller, receives this data. The Arduino's built-in Analog-to-Digital Converter (ADC) transforms analog sensor outputs into digital format. After that, it analyzes the data using predetermined criteria, such identifying dangerous gas concentrations or unusual temperature increases.

Following processing, a LoRa module set up for LoRaWAN connection receives the data from the Arduino. Long-range wireless communication with extremely low power consumption is made possible by LoRaWAN, making it ideal for large-scale industrial settings like thermal power plants. A distant LoRaWAN receiver or gateway receives the transmitted data, gathers it, and sends it to a monitoring system like a computer, cloud server, or control room dashboard. The data is kept for logging and analysis at the receiving end in addition to being shown for real-time observation. This system aids in the ongoing monitoring of vital parameters in a thermal power plant, enabling early hazardous condition identification, enhancing safety, lowering manual labor, and facilitating effective 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

Software Design

Software is developed using Arduino IDE.
Steps:

1. Sensor initialization
2. Data acquisition
3. Data conversion into readable format
4. LoRa transmission
5. 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

1. Long-range communication
2. Low power consumption
3. Low installation cost
4. Easy scalability
5. Real-time monitoring

CONCLUSION

This paper describes an inexpensive and effective smart industrial monitoring system that makes use of Arduino and LoRaWAn. The technology effectively communicates and monitors a variety of industrial metrics across extended distances. Thermal power plants and other heavy businesses can use the suggested method.

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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