Contents:

Introduction:

- Concerning worker safety and health, underground mining operations are a dangerous business. These dangers result from the various methods used to extract the various minerals. The risk increases with the depth of the mine.
- These safety concerns are quite important, particularly for the coal industry. Therefore, whether mining for coal or any other commodity, worker safety should always be a top priority. Due to ventilation issues and the possibility of a collapse, underground coal mining entails a higher risk than open pit mining.
- In opencast and underground mining, modern mines frequently adopt a number of safety processes, worker education and training, and health and safety requirements, which result in significant changes and improvements.
- In India, coal has traditionally been the main source of energy, which has greatly aided in the nation's quick industrial growth. Because of this, coal is essential to the energy industry and accounts for over 70 percentage of all power generation. However, the process also creates additional byproducts, which pose a possible risk to the environment and the nearby population. Instead, this study makes a sincere effort to assess the seriousness and create a real-time monitoring system of detection by using LORA technology.

Literature survey:

[1] Kumar, G. Ravi, and B. Keerthi Reddy. "Internet of things based an intelligent helmet for wireless sensor network." Int J Eng Sci Res Technol (IJESRT) 7, no. 6 (2018): 88-92.

- The paper focuses on creating a smart helmet designed to improve safety awareness among miners by addressing challenges such as noisy environments and discomfort associated with traditional safety gear.
- Each miner will carry a unique tag for identification, and the helmet will use IR sensors to detect its presence, ensuring that workers are wearing their helmets properly.
- The helmet is equipped with a gas sensor to detect hazardous gases in the mining environment. If dangerous gases are detected, a voice notification will alert the miner via a speaker.
- A MEMS sensor is used to detect head injuries, and all sensor data, including gas detection and injury alerts, is transmitted to a PC using ZIGBEE transceivers for real-time monitoring and response.

[2] Manohara, K. M., DC Nayan Chandan, S. V. Pooja, P. Sonika, and K. I. Ravikumar. "Iot based coal mine safety monitoring and alerting system." International Journal of Engineering Research and Technology (ijert) ICEI–2022 10, no. 11 (2022).

- Coal mines are critical industries, as they provide fuel for steel and cement production, essential for extracting iron and creating cement.
- It is crucial to monitor various parameters like methane gas, high temperature, and fire incidents regularly in the underground mining environment to ensure safety.
- The mining environment is complex, and the variety of activities performed in coal mines requires constant monitoring of safety conditions to prevent accidents.
- system has been developed that monitors basic safety measures, including gas leaks, temperature, humidity, and fire sensors, with all sensors assembled into a single unit and placed in the coal mine for real-time monitoring.

[3] Rudrawar, Mangesh, Shivam Sharma, Madhuri Thakur, and Vivek Kadam. "Coal mine safety monitoring and alerting system with smart helmet." In ITM Web of Conferences, vol. 44, p. 01005. EDP Sciences, 2022.

- Traditional monitoring systems in coal mines are difficult to install, hazardous, and challenging to power, making them unreliable for ensuring the safety of mineworkers.
- Due to the complexity of the mining environment and the range of operations, it is essential to continuously monitor critical parameters in the background to improve efficiency and safety.
- This research presents a ZigBee-based wireless monitoring system using a smart helmet, capable of detecting and transmitting critical parameters such as methane gas, temperature, humidity, and fire, with distress signals transmitted in case of emergency.
- In emergency situations, a buzzer sounds, and the monitored parameters are displayed on a user interface machine. The system wirelessly transmits data to the control room for real-time safety monitoring, and experiments have proven the system's reliability and stability.

[4] Deokar, S. R., V. M. Kulkarni, and J. S. Wakode. "Smart helmet for coal mines safety monitoring and alerting." International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE) 6, no. 7 (2017).

- Real-Time Hazard Monitoring: Detects harmful gases (CO, CH4, LPG) and monitors temperature to ensure air quality and safety.
- Emergency Alert System: Detects miner falls or unconsciousness and sends alerts to supervisors for quick response.
- Helmet Compliance Check: Uses a limit switch to detect if a miner removes their helmet, ensuring safety compliance.
- Wireless Communication: Utilizes Zigbee technology for data transmission and provides emergency switches for alerts.

[5] Paulchamy, B., C. Natarajan, A. Abdul Wahith, PV Madhu Sharan, and R. Hari Vignesh. "An intelligent helmet for miners with air quality and destructive event detection using zigbee." Glob. Res. Dev. J. Eng 3, no. 5 (2018): 41-46.

- An intelligent helmet is designed to enhance miner safety in the mining industry, where harmful events can cause severe injuries or fatalities.
- LED miner's helmets, though lightweight and energy-efficient, only provide illumination without improving safety.
- ZigBee wireless sensor networks are used to collect and transmit sensor data, ensuring real-time monitoring of hazardous conditions.
- The ZigBee-based system is cost-effective and shares data with a central control unit, enabling quick responses to emergencies.

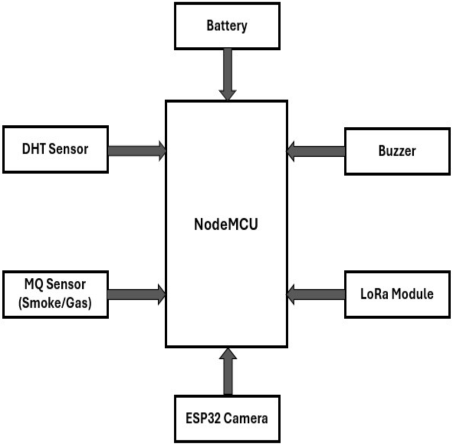
Aim of the Project:

The primary aim of a "Coal Mine Safety Intelligent Monitoring Based on Wireless Sensor Network" is to enhance safety in coal mines by continuously monitoring critical parameters liketemperature, gas concentration, water level, relative humidity, and fire detection.

Objectives:

- To Design and implementing security and detection of hazards inside a coal mine.
- To Monitor critical environmental parameters such as methane gas levels, temperature, humidity, and air quality in real time. Detect early signs of fire, gas leakage, and equipment malfunctions.
- Collect and store real-time and historical data for analysis, enabling proactive identification of risks and improved safety protocols.
- Enable miners and the control center to exchange critical messages through the LoRa network during emergencies.
- Automatically trigger alarms or notifications to miners and the control center in case of hazardous conditions, such as toxic gas leaks, high temperatures, or structural instability.

TRANSMITTER SIDE:



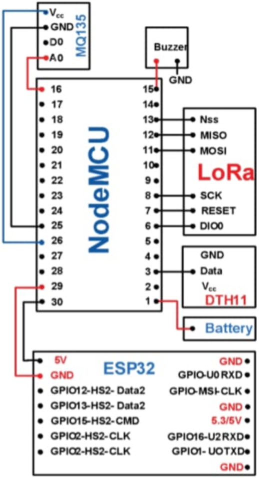


Figure 1: TRANSMITTER SIDE

RECEIVER SIDE:

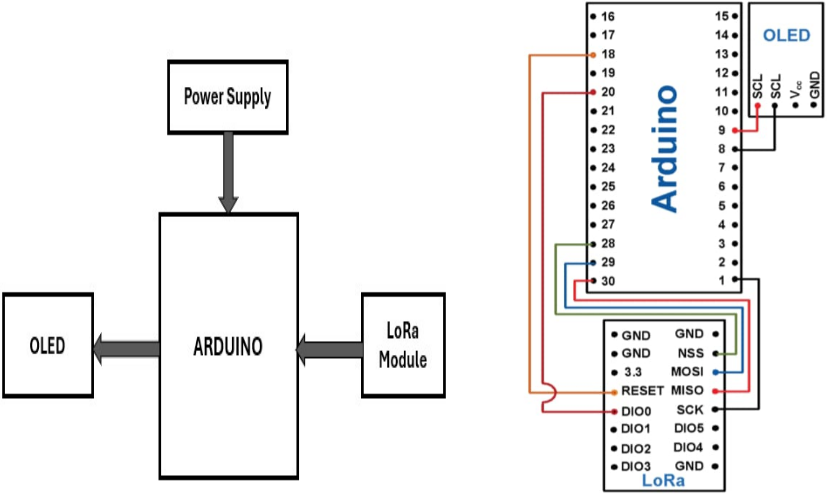


Figure 2: RECEIVER SIDE

Flow Chart:

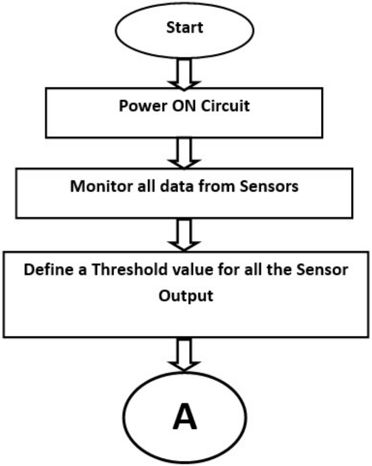


Figure 3: Flow diagram 1

Flow Chart:

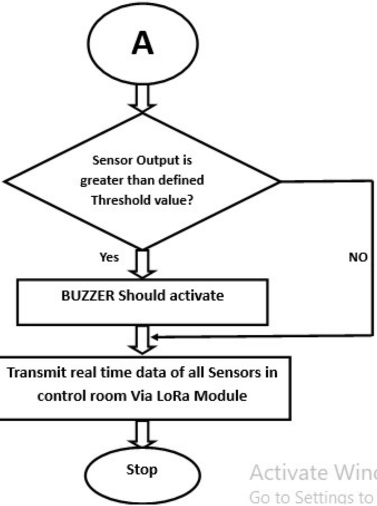


Figure 4: Flow diagram 2

Methodology:

System Design:

- The system is divided into two main units— a transmitter unit worn by miners and a receiver unit located in the control room. The transmitter unit includes sensors, a NodeMCU (ESP8266) for data collection, and an ESP32 camera for image capture.
- The receiver unit, connected to the control room, receives and displays data in real-time, allowing mine operators to monitor conditions continuously and remotely.

Data Collection:

- The transmitter unit gathers key environmental data using sensors: temperature (to detect overheating), humidity (to assess air moisture), and gas levels (such as benzene or ammonia).
- This data is essential for identifying dangerous conditions like excessive heat or toxic gas presence in the mining environment. The ESP8266 controller processes the data before it is transmitted to the control room.

Data Transmission:

- Using LoRa (Long Range) technology, the system enables efficient, low-power, and long-distance data transmission from the miner's location to the control room.
- LoRa is especially suitable for underground environments, as it works well in areas where internet connectivity is limited, ensuring reliable data flow in remote and hard-to-reach areas of the mine.

Alert Mechanism:

- When sensor readings exceed safe thresholds (e.g., high gas levels or dangerous temperature spikes), an alert is triggered automatically.
- The ESP32 camera captures an image of the environment, which is then sent via email to authorized personnel. This early alert system allows quick response actions, potentially saving lives and preventing accidents.

Data Display and Analysis:

- In the control room, sensor data is displayed in real-time on an OLED screen for continuous monitoring. Additionally, the data is sent to ThingSpeak, an IoT analytics platform, which aggregates, stores, and visualizes the information.
- This setup enables operators to observe trends and historical data, which can help in identifying potential risks and improving preventive measures.

Software Implementation:

- The system is programmed using Arduino IDE, which allows for easy integration and configuration of microcontrollers and sensors.
- ThingSpeak serves as the data storage and visualization platform, enabling cloud-based data analysis and providing real-time insights into mine conditions. This combined software approach supports remote monitoring and enhances decision-making based on live data.

Hardware Requirements:

1). Arduino Uno:

- Arduino is an open-source electronics prototyping platform that uses flexible hardware and software to sense the environment through sensors and interact with surroundings.
- Arduino UNO, based on the 8-bit ATmega328P microcontroller, features 14 digital I/O pins (6 PWM), 6 analog inputs, a 16 MHz crystal oscillator, USB connection, power jack, ICSP header, and reset button.

2). NodeMCU ESP12E Microcontroller:

- The NodeMCU ESP12E is a development board based on the ESP8266 Wi-Fi module, offering built-in Wi-Fi, low cost, and ease of use, making it ideal for IoT projects.
- It features a 32-bit microprocessor running at 80 MHz, 4 MB flash memory, GPIO pins for digital and analog I/O, and an integrated USB-to-serial adapter for easy programming with the Arduino IDE.

3). Temperature Sensor:

- LM35 is a precision integrated circuit temperature sensor that provides an output voltage proportional to the surrounding temperature.
- It measures temperatures from -55°C to 150°C, with a 0.01V (10mV) increase per °C, and sends ambient temperature data to the microcontroller for monitoring.

4). MQ135 Gas Sensor:

- MQ gas sensors are used to detect specific gases like methane, carbon monoxide, LPG, alcohol, and smoke, making them suitable for various applications.
- They feature a heating element and an electrochemical sensor that changes resistance upon gas exposure, offering low-cost, easy integration with microcontrollers, and both analog and digital outputs.

5). Flame Sensors:

- Flame sensors detect the presence of a flame or fire by sensing infrared (IR) or ultraviolet (UV) light emitted during combustion.
- They are widely used for fire detection in safety systems due to their quick response, high sensitivity, and compatibility with microcontrollers for monitoring and alerts.

6). OLED:

- OLED (Organic Light Emitting Diode) is a display technology that uses organic compounds to produce light when an electric current is applied.
- It offers high-quality, energy-efficient displays with vibrant colors, deep blacks, and wide viewing angles. OLEDs are commonly used in various devices such as smartphones, wearables, and smart appliances.

7). LoRa Module:

- The LoRa (Long Range) module is a wireless communication technology designed for long-range, low-power data transmission.
- It operates in sub-GHz frequency bands and is ideal for IoT applications, offering a range of several kilometers, low power consumption, and the ability to handle large amounts of data over long distances with minimal infrastructure.

Software Requirments:

1. Microcontroller Programming Environment.
2. Control Algorithms.
3. Simulation Software.

Results and Discussions:

Here we are going to discuss the results obtained through our project journey.

Figure 5: Transmitter side connections connected to Helmet

Results and Discussions:

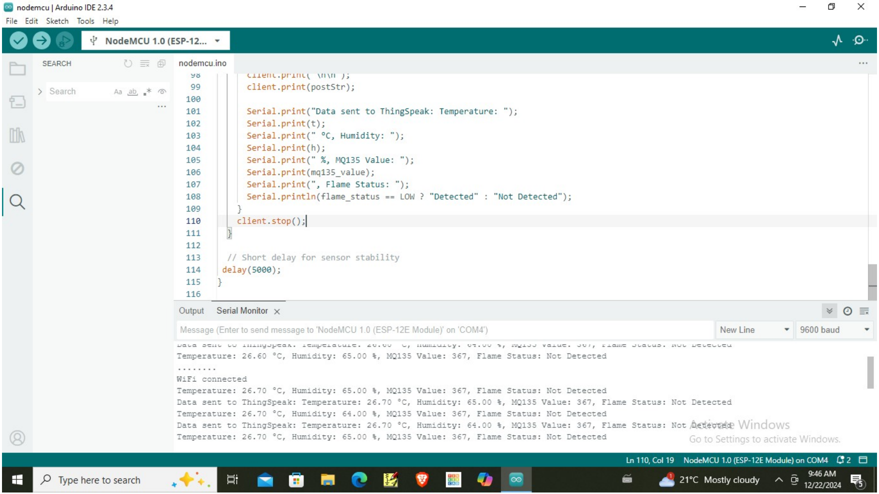


Figure 6: Transmitter output in Serial Monitor, all the Sensors are not detected

Results and Discussions:

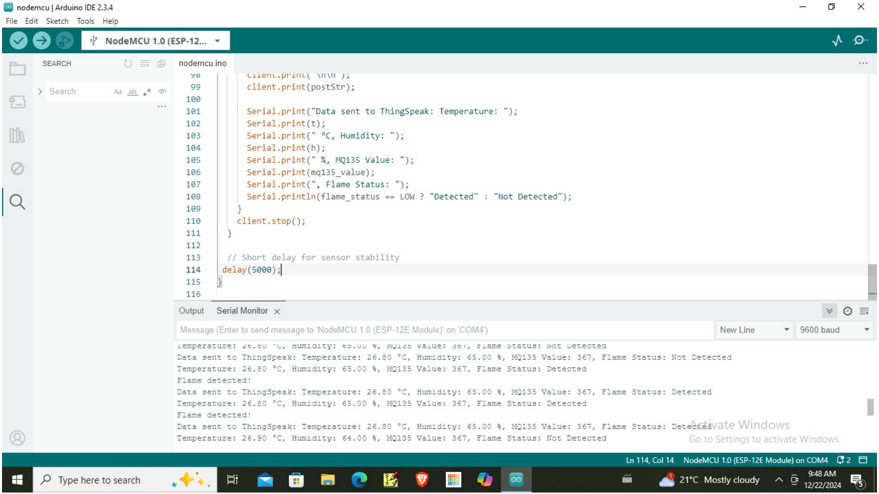


Figure 7: Transmitter output in Serial Monitor, all the Sensors are detected

Results and Discussions:

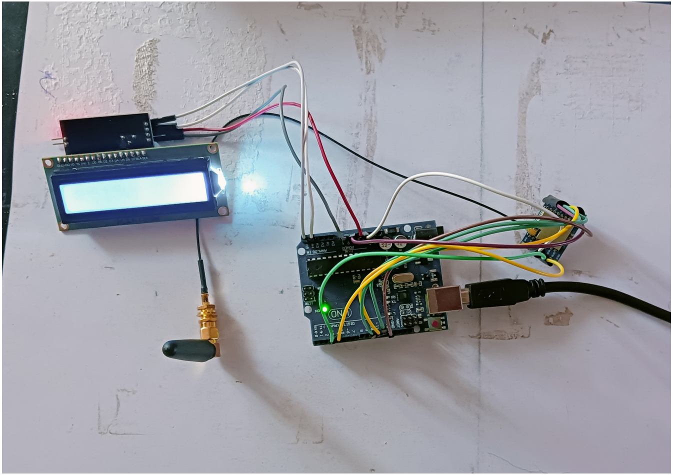


Figure 8: Receiver side connections

Results and Discussions:

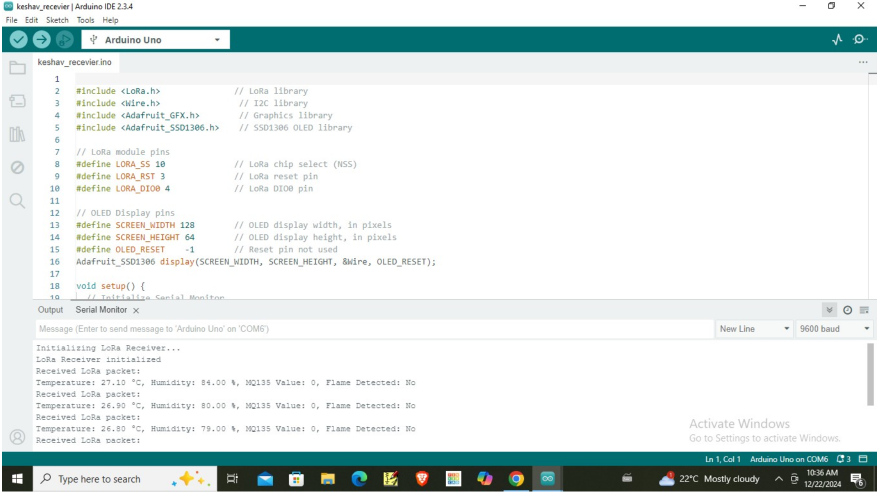


Figure 9: Receiver output in Serial Monitor, Data received from Transmitter

Results and Discussions:

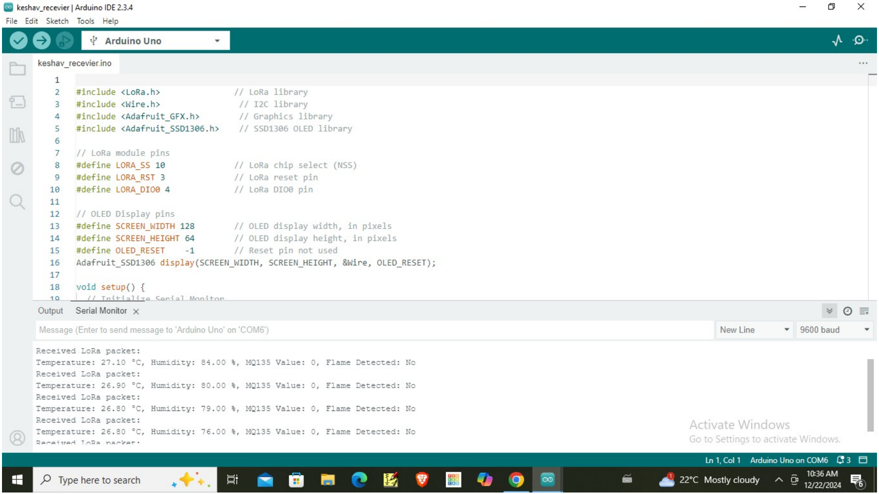


Figure 10: Receiver output in Serial Monitor, all the Sensors are not detected

Graph generated using Thingspeak:

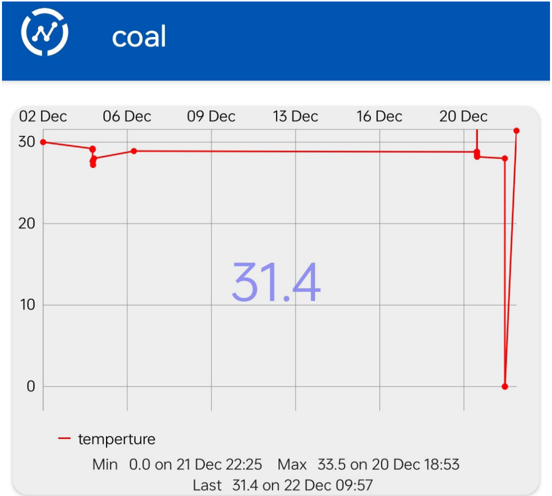


Figure 11: Temperture

Graph generated using Thingspeak:

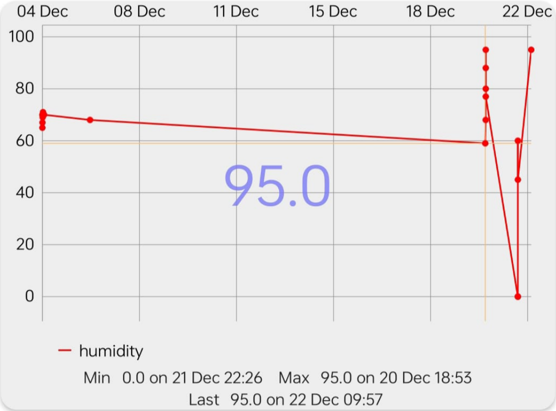


Figure 12: Humidity

Graph generated using Thingspeak:

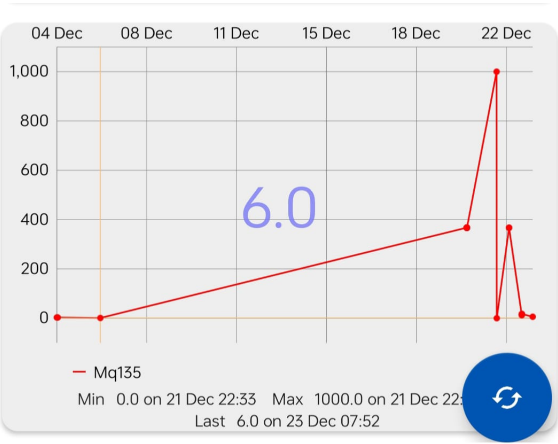


Figure 13: MQ135 gas

Conclusion:

1. The wireless communication network enables real-time monitoring of environmental parameters, enhancing safety in coal mines.
2. It provides reliable communication between miners and the control center, ensuring seamless information exchange.
3. Automated alerts and tracking systems help in identifying hazards quickly and responding to emergencies effectively.
4. The system reduces the risk of accidents by continuously monitoring gas levels, temperature, and other critical factors.
5. Implementation of this technology improves safety standards and operational efficiency in coal mining operations.

Action Plan:

Sl. No.	Tasks to be performed	Deadline (Expected date/week of completion)
1.	Literature Survey	Completed on 20/09/2024
2.	Synopsis Submission	Submitted on 30/09/2024
3.	Submission of Report	Submitted on 00/00/2024
4.	Objective 1	Completed on 22/10/2024
5.	Objective 2	Completed on 04/11/2024
6.	Objective 3	Completed on 11/11/2024
7.	Objective 4	Completed on 23/11/2024
8.	Objective 5	Completed on 06/12/2024
9.	Testing & Result Analysis	Completed on 13/12/2024
10.	Documentation of Project Report	In progress

References:

[1] Kumar, G. Ravi, and B. Keerthi Reddy. "Internet of things based an intelligent helmet for wireless sensor network." Int J Eng Sci Res Technol (IJESRT) 7, no. 6 (2018): 88-92.

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