

IoT Based Industrial Safety Monitoring System

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Abstract –

Industrial environments contain hazards such as gas leakage, fire, and high temperature that can lead to serious accidents if not detected early. This paper presents an IoT Based Industrial Safety Monitoring System designed to monitor different sections of an industry using gas, temperature, and flame sensors. The sensors collect environmental data and send it to an ESP32 microcontroller for processing. When any parameter exceeds the safety limit, the system generates an alert through a buzzer and sends notifications to a cloud-based application for remote monitoring. The proposed system provides real-time monitoring, early hazard detection, and improves overall industrial safety in a cost-effective and reliable way.

Keywords: IoT, Industrial Safety, ESP32, Gas Sensor, Flame Sensor, Temperature Monitoring.

1. INTRODUCTION

Industrial environments such as factories, chemical plants, and manufacturing units often involve hazardous conditions like gas leakage, fire, and high temperature. If these conditions are not detected at an early stage, they can lead to serious accidents, equipment damage, and risks to human life. Therefore, continuous monitoring of industrial environments is essential to ensure worker safety and smooth operation.

Traditional safety systems mainly rely on manual inspection and basic alarm systems, which are not always effective for real-time monitoring. With the advancement of Internet of Things (IoT) technology, industries can now use smart sensors and wireless communication to monitor environmental conditions continuously.

The proposed IoT Based Industrial Safety Monitoring System uses sensors such as gas sensors, temperature sensors, and flame sensors to detect abnormal conditions in different sections of an industry. The sensor data is processed by an ESP32 microcontroller, and when any dangerous condition is detected, the system generates alerts through a buzzer and sends notifications to an IoT application for remote monitoring. This system helps improve industrial safety by providing early detection of hazards and timely alerts.

2. BODY OF PAPER

2.1 Literature Review

Literature Survey No. 1

Title of Paper: Research on Safety Monitoring System of Workers in Dangerous Operation Area of Port

Journal/Conference Name: International Research Paper on Port Safety and Monitoring Systems

Publisher/Volume: China Waterborne Transport Research Institute, Beijing, China

Author: Haibo Li

What is Given in the Paper: This paper presents a smart safety monitoring system for workers working in dangerous port operation areas. Traditional safety systems mainly focus on machine safety and ignore the safety of workers. To overcome this problem, the paper proposes a system that continuously monitors the location, movement, and health condition of workers in real time.

Literature Survey No. 2

Title of Paper: Industrial Monitoring System

Journal/Conference Name: International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Publisher/Volume: IJARSCT, Volume 4, Issue 1, July 2024

Author: Amrutha T

What is Given in the Paper: This paper explains an industrial monitoring system that continuously observes industrial parameters such as temperature, pressure, vibration, and humidity. It focuses on real-time monitoring, predictive maintenance, and safety compliance to improve productivity and reduce downtime.

Literature Survey No. 3

Title of Paper: Industrial Safety System Using Internet of Things

Journal/Conference Name: International Journal of Scientific Research & Engineering Trend (IJSRET)

Publisher/Volume: IJSRET, Volume 6, Issue 3, May–June 2020

Authors: Prajwala Gavuji, Niharika Kaza

What is Given in the Paper: This paper presents an IoT-based industrial safety system to detect fire, gas leakage, smoke, and abnormal temperature. It aims to reduce accidents and protect human life and industrial property using real-time monitoring.

Literature Survey No. 4

Title of Paper: Integrated System for Control and Monitoring Industrial Wireless Networks for Labor Risk Prevention

Journal/Conference Name: Journal of Network and Computer Applications

Publisher/Volume: Elsevier Ltd. Volume 39, 2014, Pages 233–252

What is Given in the Paper: This paper presents an integrated platform for monitoring and managing wireless sensor networks in industrial environments. The system focuses on worker health and safety by continuously monitoring environmental conditions and workers' safety status using ICT and wireless technologies.

Literature Survey No. 5

Title of Paper: An IoT-Based Autonomous System for Workers' Safety in Construction Sites with Real-Time Alarming, Monitoring, and Positioning Strategies

Journal/Conference Name: Automation in Construction

Publisher/Volume: Elsevier B.V. Volume 88, 2018, Pages 73–86

What is Given in the Paper: This paper proposes an IoT-based autonomous safety system for construction workers. It detects workers near danger zones and provides real-time alerts to prevent accidents such as collisions with

vehicles and falls.

2.2 Problem Definition

Industrial environments contain multiple sections where hazardous conditions such as gas leakage, fire, and abnormal temperature rise can occur. If these conditions are not detected at an early stage, they may lead to serious accidents, equipment damage, and risk to human life.

Traditional safety systems mainly rely on manual monitoring and basic alarm mechanisms, which are not capable of providing continuous real-time monitoring. Due to this limitation, dangerous situations may remain undetected until the condition becomes critical. In addition, many industries do not have integrated systems that can monitor multiple environmental parameters simultaneously. The absence of a smart monitoring system increases the chances of industrial accidents and operational downtime.

Therefore, there is a need for an IoT based industrial safety monitoring system that can continuously monitor industrial conditions using sensors and provide immediate alerts during abnormal situations to improve worker safety and industrial reliability.

2.3 Objectives

- To design an IoT based industrial safety monitoring system.
- To monitor gas leakage, fire, and temperature in industrial environments.
- To provide real-time monitoring using IoT technology.
- To generate alerts during dangerous conditions.
- To improve worker safety and reduce industrial accidents.

2.4 Methodology

The proposed IoT Based Industrial Safety Monitoring System is designed to continuously monitor different sections of an industry and detect hazardous conditions such as gas leakage, fire, and abnormal temperature. The system mainly consists of sensors, a microcontroller, an alert mechanism, and an IoT cloud platform for remote monitoring.

The system uses gas sensors, temperature sensors, and flame sensors to monitor the environmental conditions inside industrial areas. These sensors are installed in different sections of the industry so that each section can be monitored continuously. The gas sensor detects the presence of harmful or combustible gases, the temperature sensor measures the surrounding temperature, and the flame sensor detects the presence of fire.

All sensors are connected to the ESP32 microcontroller, which acts as the main processing unit of the system. The ESP32 continuously reads the data from the sensors and converts it into digital values. These values are then compared with predefined safety threshold limits programmed in the system.

If the sensor values remain within the safe limit, the system continues normal monitoring. However, if any sensor detects abnormal conditions such as high temperature, gas leakage, or fire, the ESP32 immediately triggers the alert mechanism. A buzzer and LED indicator are activated to provide a local warning so that workers in the nearby area can take immediate action.

At the same time, the ESP32 sends the sensor data to an IoT cloud platform using Wi-Fi communication. The data can be viewed on a mobile application or web dashboard, where users can monitor real-time industrial conditions. If a dangerous situation occurs, the system also sends notifications to the application so that supervisors or safety officers can take quick action even if they are not physically present at the location.

Table -1: Sample Hardware Components

Sr. No.	Component	Description
1	ESP32 Microcontroller	Main control unit that processes sensor data and sends data to the IoT platform.
2	MQ Gas Sensor (MQ-2 / MQ-135)	Detects harmful gases, smoke, and gas leakage in industrial areas.
3	Temperature Sensor (LM35 / DS18B20)	Measures environmental temperature and detects overheating.
4	Flame Sensor	Detects the presence of fire or flame in the industrial sector.
6	Buzzer	Generates an audible alert during dangerous conditions.
7	LED Indicator	Provides visual alert when abnormal conditions occur.
8	Connecting Wires & PCB	Used for connecting and assembling electronic components.

3. ARCHITECTURE

The architecture of the IoT Based Industrial Safety Monitoring System consists of several interconnected layers that work together to monitor industrial safety conditions. The system begins with different sensors such as the MQ gas sensor, temperature sensor, and flame sensor, which are responsible for sensing environmental conditions like gas leakage, high temperature, and fire. These sensors continuously collect real-time data from the industrial environment and convert the physical parameters into electrical signals.

The collected sensor data is then sent to the ESP32 microcontroller, which acts as the central processing unit of the system. The ESP32 analyzes the incoming data and

compares it with predefined safety threshold values. If any abnormal condition such as excessive gas concentration, high temperature, or fire is detected, the microcontroller immediately activates the alert system.

The alert system, which includes a buzzer and LED indicators, provides immediate audible and visual warnings to workers in the surrounding area so that they can take quick action and prevent accidents. At the same time, the ESP32 uses its built-in Wi-Fi connectivity to transmit the sensor data to an IoT cloud platform.

Through the IoT platform or mobile application, authorized users can monitor the industrial environment remotely. The system allows real-time monitoring, data visualization through graphs, and instant notifications when dangerous conditions occur. This architecture ensures continuous monitoring, quick hazard detection, and improved safety management in industrial environments.

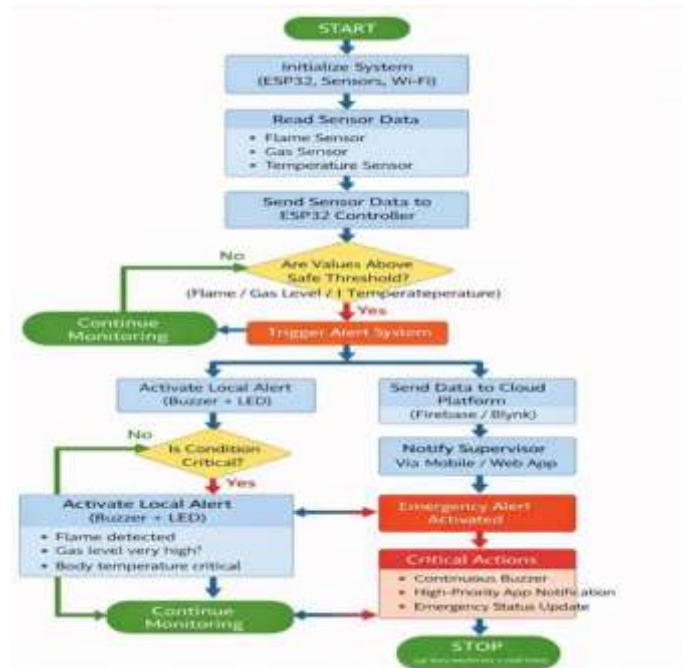


Fig -1: Figure

4. WORKING PRINCIPLE

The process begins when the system starts and initializes the ESP32 controller, sensors, and Wi-Fi connection. After initialization, the ESP32 reads data from the flame sensor, gas sensor, and temperature sensor to continuously monitor the surrounding environment. The collected sensor data is then sent to the ESP32 controller for analysis and processing.

The controller compares the received sensor values with predefined safe threshold levels. If the values remain within the safe range, the system continues normal

monitoring. However, if any value exceeds the threshold such as detecting a flame, high gas concentration, or increased temperature—the system automatically triggers the alert system to indicate a potential danger.

When the alert system is activated, a local alert (buzzer and LED) warns people nearby, while the sensor data is also sent to a cloud platform such as Firebase or Blynk. The system then notifies the supervisor through a mobile or web application. If the condition becomes critical, an emergency alert is activated, which includes continuous buzzer sound, high-priority notifications, and emergency status updates, while the system continues real-time monitoring.

5. RESULTS

- The system successfully detects gas leakage, fire, and temperature changes.
- Real-time monitoring of industrial environmental conditions is achieved.
- Immediate alerts are generated using buzzer and LED during dangerous situations.
- Sensor data is transmitted to the IoT cloud platform through Wi-Fi.
- Supervisors can monitor industrial safety remotely using a mobile or web application.
- The system improves worker safety and helps prevent industrial accidents.

6. CONCLUSIONS

The IoT Based Industrial Safety Monitoring System provides an effective solution for improving safety in industrial environments. The system continuously monitors important parameters such as gas leakage, temperature, and fire using different sensors. These sensors send real-time data to the ESP32 microcontroller, which processes the information and detects any abnormal conditions.

When a hazardous situation occurs, the system immediately activates alerts through a buzzer and LED indicators, helping workers take quick action and prevent accidents. Additionally, the IoT connectivity allows remote monitoring of industrial conditions through a mobile or web platform.

Therefore, the proposed system helps reduce industrial risks, improves worker safety, and enables real-time monitoring of hazardous environments. This project demonstrates how IoT technology can be effectively used to create a smart and reliable industrial safety monitoring system.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to our project guide Miss P. N. Salunkhe for her valuable guidance, continuous support, and encouragement throughout the development of this project. Her suggestions and technical knowledge helped us successfully complete our work.

We are also thankful to the Department of Electronics and Telecommunication Engineering, Adarsh Institute of Technology & Research Centre, Vita, for providing the necessary facilities and resources required for the completion of this project.

We would also like to thank our Principal, Head of Department, and all teaching and non-teaching staff members for their support and cooperation. Finally, we express our heartfelt thanks to our parents and friends for their motivation and encouragement during the completion of this project.

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