

AI Based Smart Industrial Safety and Monitoring System Using IIOT

1. Mr. Rohit D. Kamble (sd24_kamble rohit@mgmcen.ac.in)
2. Ms. Neha H. Muneshwar (s23_muneshwar neha@mgmcen.ac.in)
3. Mr. Yogesh D. Shriramwar (sd24_shriramwar_yogesh@mgmcen.ac.in)
4. Ms. Maithili V. Mangalagiri (mangalagiri_maithili@mgmcen.ac.in)

ABSTRACT-

The rapid advancement of industrial automation has increased the need for intelligent monitoring and safety systems. Traditional industrial systems rely heavily on manual supervision, which can lead to delayed responses and increased risk of accidents. To address these challenges, this project proposes an AI-based industry monitoring and safety system using Industrial Internet of Things (IIoT). The system is designed to continuously monitor critical environmental and operational parameters to ensure a safe and efficient working environment. The proposed system utilizes the ESP32 DevKit V1 micro controller as the central processing unit due to its built-in Wi-Fi capability and high processing efficiency. Various sensors such as temperature, gas, flame, and vibration sensors are integrated to collect real-time data from the industrial environment. This data is processed by the ESP32 and transmitted to a cloud platform, enabling remote monitoring and data visualization through web or mobile applications. Artificial Intelligence is incorporated into the system to analyze the collected data and detect abnormal patterns or potential hazards. Machine learning algorithms help in identifying anomalies such as sudden temperature rise, gas leakage, or unusual machine vibrations. Based on the analysis, the system can generate alerts and initiate automatic safety actions such as activating alarms or shutting down machinery, thereby preventing accidents and minimizing damage. Overall, the developed system enhances industrial safety by combining real-time monitoring, cloud connectivity, and intelligent data analysis. It reduces human intervention, improves response time, and provides a scalable solution for modern smart industries. This project demonstrates the potential of integrating AI with IIoT technologies to create a reliable and efficient industrial safety system.

INTRODUCTION-

The proposed IoT-based system utilizes various sensors, microcontrollers, and communication technologies to collect data from industrial equipment and the surrounding environment. Parameters such as temperature, humidity, gas concentration, vibration, and machine status are continuously monitored and transmitted to a cloud platform for analysis. The collected data can be accessed remotely through web or mobile applications, enabling managers and operators to make informed decisions in real time. Furthermore, the integration of IoT with smart monitoring helps industries reduce maintenance costs, improve worker safety, minimize downtime, and increase operational efficiency. The system also supports predictive maintenance by identifying abnormal conditions before they lead to equipment failure. As industries move toward Industry 4.0, IoT-based monitoring systems play a vital role in creating intelligent, connected, and automated industrial environments.

LIERATURE REVIEW-

AI-based smart factory safety monitoring systems represent a major shift in industrial safety practices, moving from reactive responses to proactive prevention. Traditional safety relied heavily on manual inspections and post-incident measures, but with Industry 4.0, factories now integrate IoT sensors, machine learning, and digital twins to enable real-time hazard detection and predictive maintenance. These systems continuously monitor variables such as temperature, gas leaks, vibrations, and worker movements, while computer vision ensures compliance with protective equipment and identifies unsafe behaviors. Predictive analytics allow managers to anticipate equipment failures before they occur, reducing downtime and preventing accidents. Wearable devices further enhance worker safety by tracking health indicators like fatigue or exposure to harmful substances. Emergency response systems powered by AI can automate fire suppression and guide evacuations,

while optimization algorithms reduce unsafe energy loads and improve efficiency. The literature emphasizes significant benefits, including proactive risk management, improved compliance, and better decision-making. However, challenges remain, such as ethical concerns over worker privacy, regulatory gaps in AI safety standards, and vulnerabilities to cyberattacks. Scholars argue that robust governance frameworks and interdisciplinary collaboration are essential to ensure trustworthy AI deployment. In summary, AI-based safety monitoring systems offer transformative potential, but their success depends on balancing efficiency with ethical responsibility and worker well-being.

HAEDWARE IMPLIMENTATION-



The hardware implementation of the proposed AI-Based Smart Factory Monitoring and Safety System is carried out 2 using an ESP32 Microcontroaller as the central controller. The system continuously monitors various industrial parameters such as temperature, humidity, gas leakage, fire hazards, and machine status. The collected sensor data is processed and displayed locally on an LCD and can also be transmitted to IoT platforms for remote monitoring. Based on your prototype image, the hardware components used are:

1. Microcontroller ESP32 Acts as the main processing unit. Reads data from all sensors and controls output devices.
2. DHT11 Temperature and Humidity Sensor Measures ambient temperature and humidity inside the factory. Helps maintain optimal environmental conditions for machines and workers.
3. MQ-2 Gas Sensor Detects harmful gases, smoke, and LPG leakage. Generates an alert when gas concentration exceeds a predefined threshold.
4. Bluetooth Module (HC-05/HC-06) Enables wireless communication between the system and a smartphone. Allows real time monitoring and control through a mobile application.
5. Relay Module Controls industrial loads such as exhaust fans, alarms, emergency lights, and motors. Automatically activates safety devices during abnormal conditions.

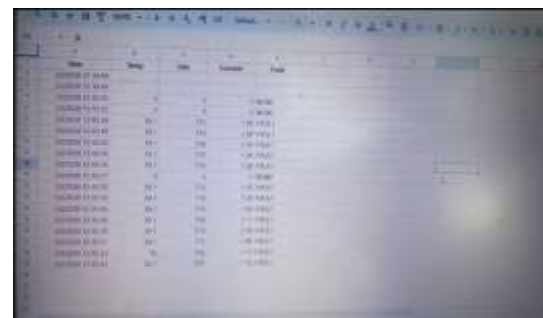
6. LCD Display Displays real-time sensor readings and system status. Shows temperature, humidity, gas levels, and alert messages.

7. Buzzer Provides an audible warning during emergency situations such as gas leakage or fire detection.

8. L298N Motor Driver Module Controls DC motors or ventilation systems. Can automatically start exhaust fans when hazardous gases are detected.

9. Power Supply microcontroller is powered through USB or adapter. External battery pack supplies power to motors and relays.

SOFTWARE IMPLIMENTATION-



The software design involves programming the ESP32 and integrating it with cloud platforms and AI systems. The code is developed using Arduino IDE with Embedded C/C++. The software handles tasks such as sensor data acquisition, Wi-Fi connectivity, cloud communication, and alert generation. The program is structured into different modules for better organization and maintainability. These modules include sensor reading functions, data processing logic, communication protocols, and control mechanisms. The software continuously monitors sensor data and compares it with predefined threshold values to detect abnormalities. Additionally, the We used an Excel sheet display and record real time data from temperature ,gas, flame,smoke and vibration sensors along with Corresponding time and date .The software design ensures smooth operation, real-time response, and efficient system performance.

LIMITATION AND FUTURE SCOPE-

AI-based Smart Factory Monitoring and Safety Systems improve industrial efficiency and worker safety, but they have some limitations. These include high installation costs, dependence on internet connectivity, cybersecurity risks, maintenance requirements, and the need for skilled operators. Environmental conditions such as dust, heat, and poor lighting can also affect system performance and accuracy. The future scope of

these systems is highly promising. Advances in AI, IoT, 5G, and cloud computing will enable predictive maintenance, real-time decision-making, and improved safety monitoring. Future smart factories will use digital twins, autonomous systems, and advanced analytics to increase productivity, reduce downtime, and support Industry 4.0 manufacturing.

RESULTS AND DISCUSSION-

AI-based smart factory safety monitoring systems have demonstrated strong results in reducing workplace accidents and improving operational efficiency. Studies show that real time monitoring through IoT sensors and computer vision can detect unsafe behaviors and environmental hazards before they escalate, while predictive analytics minimize downtime by forecasting equipment failures. Wearable devices further enhance worker safety by tracking health indicators such as fatigue and exposure to harmful substances. In discussion, scholars highlight that these systems enable proactive risk management and better decision-making, but they also raise concerns about privacy, regulatory gaps, and cybersecurity. Overall, AI-based monitoring offers transformative potential, provided ethical and governance challenges are addressed.

CONCLUSION-

In conclusion, AI-based smart factory safety monitoring systems mark a significant advancement in industrial safety by enabling proactive risk management, predictive maintenance, and real-time hazard detection. They integrate IoT sensors, machine learning, computer vision, and wearable technologies to safeguard workers and optimize operations. The literature consistently shows that these systems reduce accidents, improve compliance, and enhance decision-making. However, challenges such as privacy concerns, cybersecurity risks, and regulatory gaps must be addressed to ensure sustainable adoption. Ultimately, the success of AI-driven safety monitoring depends on building trustworthy frameworks that balance efficiency, ethical responsibility, and worker well-being.

REFERENCES-

1. Espressif Systems, <https://www.espressif.com>
2. Arduino IDE and Programming Guide, <https://www.arduino.cc>
3. ThingSpeak Documentation, <https://thingspeak.com>
4. Blynk IoT <https://docs.blynk.io> Platform, Blynk Documentation.
5. DHT11 Sensor Datasheet, Temperature and Humidity Sensor Specifications

6. MQ-2 Gas Sensor Datasheet, Gas Detection Sensor Specifications.
7. IEEE Research Papers, Industrial IoT and Smart Monitoring Systems
8. OpenAI, ChatGPT: AI-assisted technical guidance and documentation support, OpenAI, 2025.
9. Book: Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill.

BIOGRAPHIES-

Mr.Rohit D. Kamble

I have pursued Diploma in Electrical Engineering, from MSBTE Board, Mumbai. currently am pursuing my graduation in B.tech Electronics and Telecommunication Engineering, from MGMs College of Engineering, Nanded.

Ms.Neha H. Muneshwar

currently am pursuing my graduation in B.tech Electronics and Telecommunication Engineering, from MGMs College of Engineering, Nanded.

Mr.Yogesh D. Shriramwar

I have pursued Diploma in civil Engineering, from Government Polytechnic college, nanded. currently am pursuing my graduation in B.tech Electronics and Telecommunication Engineering, from MGMs College of Engineering, Nanded.

Ms.M.V.Mangalagiri (Assistant Professor)

Department of Electronics and Telecommunication, MGMs college of Engineering ,Nanded.