INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD)
© 2026 IJNRD | Volume 11, Issue 5, May 2026 | ISSN: 2456-4184 | IJNRD.ORG

Industry Protection System Using ESP32, GSM Module, MQ-2 Sensor and DHT22 Sensor EMG

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Abstract:-

Safety in industry is a necessity in contemporary industries due to possible leakage of harmful gases, overheating, and fire incidents which may pose significant danger to both human life and machinery used in these processes. However, existing safety mechanisms tend to be very costly, hard to maintain, and do not offer any capability for real-time monitoring. The paper proposes an IoT based solution that would use ESP32 microcontroller, gas sensor (MQ-2), temperature/humidity sensor (DHT22), GSM modem, and buzzer alarm.

This system keeps monitoring the environmental parameters like gas, temperature, and humidity present within the industrial premises. The MQ-2 sensor is used for sensing the presence of flammable gases and smoke, whereas the DHT22 sensor senses the temperature and humidity levels. These parameters are processed by the ESP32 microcontroller which further checks them against the preset limit values. If any abnormality is observed, then an alarm is triggered and SMS notifications are sent using the GSM module.

The developed system is inexpensive, dependable, simple to deploy, and can be used for small and medium industries. Results from experimental testing reveal that the designed system offers quick response time, precise detection of hazards, and instant generation of alerts. The suggested approach enhances safety at industries, minimizes risks of accidents, and facilitates effective environmental monitoring through IoT.

Keywords: ESP32, GSM Module, MQ-2 Sensor, DHT22 Sensor, Industrial Safety, IoT, Gas Leakage Detection, Real-Time Monitoring, SMS Alert System.

1.Introduction:-

Industrial safety has been one of the topmost priorities in today's industries owing to the rising number of hazardous gas usage, equipment operating at high temperatures, and automation within industries. Chemical plant, oil and gas refineries, manufacturing industries, warehouse industries, and food-processing industries operate under the risk of fire accidents, gas leaks, overheating, and other environmental risks. Such hazardous operations pose threats to industrial equipment, monetary losses, and even the loss of life if timely precautions are not taken.

The traditional way of ensuring industrial safety includes manual monitoring along with wired safety systems. While such approaches have been helpful until now, they suffer from the drawback of being expensive, complex, and not being able to give timely warnings to the operators in times of crisis. Many cases have seen incidents in which the industrial operators are not able to take necessary actions at times of emergencies because of a lack of communication or timely alerts.

With the advancements in the IoT technology, the use of embedded systems, wireless communication, and sensors has made industrial monitoring systems much more effective and economical. Systems based on IoT technologies enable industrialists to monitor the safety parameters in real-time and gain access to important data via their smartphones and the internet.

An Industry Protection System based on ESP32 microcontroller, MQ-2 Gas Sensor, DHT22 temperature and humidity sensor, GSM module, and buzzer alarm is proposed. The ESP32 serves as the main control unit that continually monitors the surrounding environment. MQ-2 sensor is used to sense the combustible gases and smoke whereas DHT22 measures the temperature and humidity level in the surroundings. When any of the parameters exceed the pre-set safety threshold limit, an SMS alert is sent along with activation of buzzer alarm using GSM module.

The system is cost-effective, reliable, user-friendly, and suitable for applications related to industrial safety.

2 Technical Introduction

Hazardous conditions in industrial environments include those like gas leakage, smoke, high temperature, and variation in humidity level. This may result in fire incidents, explosions, equipment failure, as well as cause harm to workers' lives. In order to ensure safety from such hazards, monitoring of different parameters in industries is necessary. Industrial protection systems are now becoming intelligent with the help of embedded systems and IoT-based monitoring.The proposed Industry Protection System is designed based on ESP32, MQ-2 gas detector, DHT22 temperature and humidity sensors, GSM, and buzzer.

The MQ-2 sensor detects explosive gas concentration and smoke, whereas the DHT22 sensor detects environmental temperature and humidity level in the surroundings. The ESP32 unit will gather sensor inputs and process the input data in accordance with the preset safety limits. As soon as any irregular parameter values are detected, the alarm buzzer goes off.The proposed Industry Protection System is designed based on ESP32, MQ-2 gas detector, DHT22 temperature and humidity sensors, GSM, and buzzer. The MQ-2 sensor detects explosive gas concentration and smoke, whereas the DHT22 sensor detects environmental temperature and humidity level in the surroundings.

The ESP32 unit will gather sensor inputs and process the input data in accordance with the preset safety limits. As soon as any irregular parameter values are detected, the alarm buzzer goes off.. The GSM module plays an important role in facilitating wireless. communication through sending SMS alerts to the concerned individuals in case of emergencies. The operators can thus receive alerts on real time even if they are not within the vicinity of the industrial site. The entire system is an economical, efficient, and effective means of ensuring industrial safety. Through the combination of IoT technology, sensor monitoring, and GSM communication, industrial safety is improved and enhanced

. 2.Literature Survey:-

Sr. No.	Author(s)	Research Paper Title	Key Findings / Contributions
1.	A.Anurupa, M. Gunasekaran,M.Amsave ni	Efficient Gas Leakage Detection and Control System Using GSM Module	Proposed a gas Leakage detection system using GSM communicatio n For sending emergency SMS alerts during hazardous conditions
2.	Pratima S.Kabadi,Ankita M.patil,Pranita A.Patil	Security Against Gas Leakage using GSM Modem	Developed a GSM-based safety system For detecting gas leakage and improving industrial protection.
3.	Nadeem pasha, Varun Koushik K. M, shahbaaz Ahmed P, Sufia Begum Shaikh	Smart Home Automatio n and Security using GSM and ARM7	Introduced remote monitoring and automation using GSM technology for safety and security applications.
4.	Amit Sachan	GSM Based SCADA Monitoring and Control System Substation Equipment .	Presented a Monitoring and Control System using GSM communicatio n For industrial and substation applications.
5.	Sheela Chinchmalatpure, Anurag Sagar, Rounak Lohe	Iot Based Smart Fire Detection and Control System using GSM Module	Proposed an Iot-based fire detection and alert system using GSM technology for real-time industrial safety monitoring.

3. Proposed Methodology:-

The recommended Industry Protection System will be responsible for continuous supervision of any hazards within an industrial environment, including gas leakage, overheating, and excessive humidity. The proposed system comprises an ESP32 controller as the central node, together with the MQ-2 gas sensor, DHT22 temperature/humidity sensor, GSM, and the buzzer. The mentioned sensors will consistently acquire the environmental parameters and transmit the obtained information to the ESP32 microcontroller.
The MQ-2 sensor will detect the presence of any explosive and smoking gas in the environment, whereas the DHT22 sensor will measure temperature and humidity levels. The ESP32 microcontroller will constantly receive readings from the sensors and compare them against preset thresholds. In case the parameters exceed their maximum safe levels, the microcontroller will immediately recognize the hazard.

Following the recognition of any hazardous situation, the ESP32 microcontroller will activate the buzzer alarm as a means of local notification. Simultaneously, SMS alerts will be delivered to the pre-programmed contact numbers through the GSM module. The suggested approach ensures instant response to emerging threats, as well as effective communication with the necessary stakeholders.

4. System Block Diagram :-

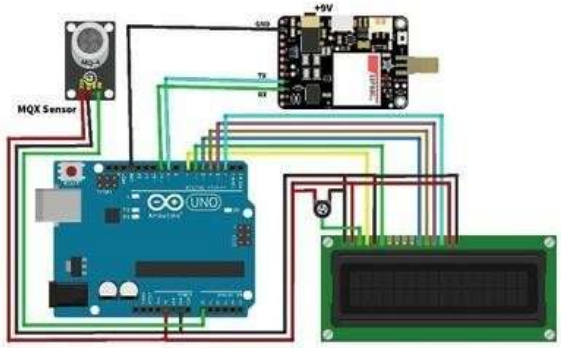


Figure-1: System block diagram

5. Implementation Details:-

The incorporation of the suggested industry protection system will be performed via hardware and software systems to ensure real-time monitoring of the industry operations and detecting any hazards. The whole design is constructed based on the ESP32 microcontroller, which serves as the main processor and controller of the system. The microcontroller collects data from all sensors, analyzes the obtained data by comparing it with preset limits and controlling the warning devices in case of any hazardous situations.

The hardware part of the system consists of MQ-2 combustible gas sensor, DHT22 environmental temperature and humidity sensor,

GSM module, buzzer alarm, and the stabilized voltage source. The MQ-2 gas sensor is interfaced with the ESP32's analog input port and detects the presence of any combustible gases including liquefied petroleum gas, methane, propane, hydrogen, and smoke. It senses the surrounding air composition and provides the analog output value corresponding to the combustible gas content. Meanwhile, the DHT22 sensor is connected with ESP32's digital GPIO port and determines the temperature and humidity parameters.

The GSM modem (SIM800L/SIM900) is interfaced to the ESP32 board via UART serial communication via TX and RX pins. The GSM modem sends out the alert message via SMS to authorized persons whenever any abnormal condition arises. As the current draw of the GSM module is high during the time of transmission, therefore, a separate power supply for the GSM modem is required to make sure of its reliable operation. An alarm device (buzzer) is interfaced to the ESP32 board via a digital output pin.

Arduino IDE is used for developing the software part of this project. The ESP32 board keeps on receiving values from the MQ-2 and DHT22 sensors at regular intervals. The received data is then compared with predefined threshold limits. When any sensor value becomes greater than its threshold limit, then it means that an abnormal condition exists, and the ESP32 triggers the buzzer alarm. At the same time, an AT command is issued by the ESP32 for sending out SMS notification to pre-assigned mobile numbers.

The system algorithm works in a cycle of monitoring operations that include acquiring the sensor reading, comparing with the thresholds, raising an alarm, and communicating the data. In addition, the software has functions for managing delays, initializing sensors, and checking errors to ensure the stability of the system operation. In the experiments conducted, the system was able to identify the presence of gases, smoke, and abnormal temperatures within a short period and with steady GSM communications.

The developed system is cost-effective, efficient, and reliable. It enhances hazard detection, allows for real-time monitoring, minimizes accidents, and responds swiftly to emergencies.

6. Result

The designed Industry Protection System proved to be highly efficient since the design, implementation, and testing were conducted successfully for performance evaluation under various hazard conditions. The monitoring process involved real-time observation of the environmental factors including the gas level, temperature, and humidity through MQ-2 gas sensor and DHT22 temperature-humidity sensor. ESP32 microcontroller analyzed the sensor data and issued alert notifications based on any unusual situation.

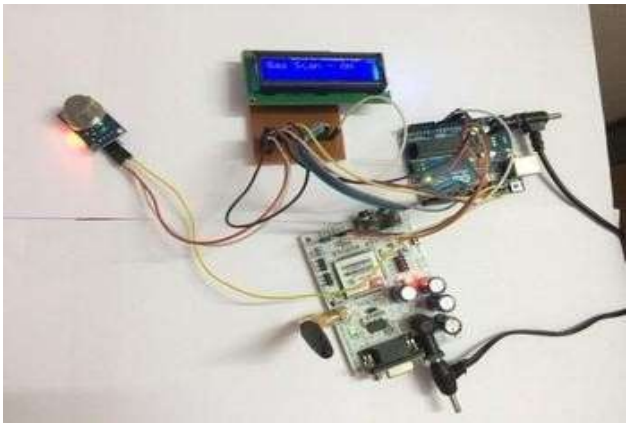
As for the testing of the gas leakage detection system, the MQ-2 sensor effectively sensed the presence of hazardous gases including LPG, methane, and smoke. There was a significant rise in the sensor output upon reaching the defined threshold values. As a result, the ESP32 detected the dangerous situation and immediately triggered the buzzer alert mechanism. Additionally, SMS alerts were sent to specified mobile phones through the GSM module to ensure prompt local action. The content of the SMS included details about the detected hazard, helping users take necessary preventive actions. In general, the response time for the system is quite fast to be used in industrial settings.The performance of the DHT22 sensor was analyzed during tests for temperature and humidity monitoring in an environment. Stable sensor readings were received both in standard and abnormal conditions. During tests for the detection of a hazardous situation when the temperature surpassed the defined safe level, the ESP32 detected such situations and raised an alert. Moreover, humidity monitoring allowed the proper control of the situation within industrial premises.

Preliminary tests of both the GSM Module(SIM800L/SIM900) and communication link were stable throughout testing. The GSM Module(SIM800L/SIM900) was able to send out SMS alerts through its mobile network to users registered in Imminent Hazard Status each time Imminent Hazard Status was present. SMS delivery times were generally between several seconds; however, they did depend on mobile network signal availability. The ESP32 was able to establish and keep successful communication with the GSM Module(SIM800L/SIM900) through UART serial connection for the duration of the testing period.

The local buzzer alarm provided immediate audio warning when any Imminent Hazard Status was detected. This allowed nearby workers to quickly identify that there was an emergency situation and take the necessary safety measures. This use of both local buzzer and SMS notification combined to produce a higher level of success for the overall safety system.

The ESP32 was able to continuously monitor and process data from the displacement, temperature sensors, compare this data with pre-established threshold values to determine whether an emergency had occurred and communicate all required actions without interruption throughout the duration of the testing. During long-duration testing, the ESP32 consistently exhibited stable performance and used very low power, making it well suited for practical industrial applications.

The complete system for protecting industry shown to produce reliable real time monitoring and rapid detection of hazards with the same high level of performance of all sensors within the system, and very effective means to communicate information. In conclusion, the prototype was shown to improve safety in the industrial workplace by reducing response times during emergency situations as well as allowing for continuous monitoring of the environment. Based on these results, the proposed system appears to provide a cost-effective, scalable, and efficient approach to both industrial protection and using IoT Safety applications.



Final Result Of GSM Model

7 Conclusion and Future Scope

This Industrial Protection System is a practical way to monitor for industrial safety hazards (using, esp32 and other sensors) The proposed Industrial Protection System combines ESP32 (micro-

controller) and other sensors to monitor for industrial safety hazards continuously (in real-time) through the use of MQ-2 gas sensor/analog/ digital, DHT22 temp/humid and GSM (global system mobile communication) communication technology to detect unsafe conditions that present danger/has occurred.

The results of the implementation show that the industrial protection system can successfully monitor (detect) unsafe conditions i.e. combustible gases and/or environmental changes and perform reliably, with respect to response time. Upon occurrence of any unsafe condition (detected by either of the above mentioned), the buzzer alarm will provide local indication and the gsm module will send short message service (SMS) text alerts to authorized personnel, enabling efficient identification of emergency situations, as well as their location, thus improving safety at the workplace, reducing risk of accidents, and facilitating rapid emergency response.

Our affordable, easy-to-adopt, and expandable solution gives you the ability to automate your manufacturing processes without the need for human intervention and consequently reduces the potential risks associated with an unsafe working environment. IOT (internet of things) technology enables ongoing monitoring of hazardous working environments and improves equipment safety and reliability.

In the near future, we will add additional sensors (flame sensors, vibrational sensors, pressure sensors, and smoke detectors) to provide more effective accident monitoring. The next phase of the IoT platforms will bring the ability to remotely access and analyze historical data with cloud-based IoT platforms and mobile apps. This will allow users to perform predictive maintenance on equipment using real-time data visualizations. With artificial intelligence (AI) and machine learning algorithms, this system will allow for accurate hazard prediction and automated decision-making.

Another enhancement option for this system would be to develop additional features such as a wireless sensor network, automatic emergency shutdown systems, voice alerts, and other automated manufacturing procedures for larger manufacturing operations. The Industry Protection System demonstrates how IOT and embedded technologies can improve the industrial environment by reducing dangers to a level below the threshold of tolerable risk.

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