Long Range Liquid and Gas Level Monitoring in Chemical Industries Based on IOT

[1]Boya Vijay Kumar, [2]Dr. Archek Praveen Kumar, [3]Vaddi Yashoda, [4]Budigi Vishnu vardhan, [5]Pavuluri Siva Kumar, [6]Katamalla Sunil

[1,3,4,5,6]UG Student, Dept. of E.C.E., GATES Institute of Technology, Gooty, Anantapur, Andhra Pradesh, India
[2]Professor, Dept. of E.C.E., GATES Institute of Technology, Gooty, Anantapur, Andhra Pradesh, India
E-mail: [1]vijayboyaece@gmail.com, [2]archekpraveen1@gmail.com, [3]vaddi.yashoda24@gmail.com, [4]babburam7671@gmail.com, [5]naughtyboybabi@gmail.com, [6]sunil.katamalla09@gmail.com

Abstract - **Industrial accidents due to harmful gas leaks are a major risk in chemical-based industries, often leading to severe injuries or fatalities among workers. This project aims to mitigate such risks using Internet of Things (IoT) technology combined with an ESP8266-based system. The ESP8266 microcontroller serves as the central processing unit, interfacing with multiple sensors like gas, temperature, and alcohol sensors to continuously monitor the industrial environment. These sensors detect fluctuations in gas levels and immediately alert the industry's safety control board if any parameter exceeds safe thresholds.**

An IoT-enabled alarm system provides real-time notifications via internet connectivity, allowing prompt intervention to prevent potential hazards. All data captured by the sensors is stored on the cloud, enabling analysis to refine safety protocols and regulatory measures. The rapid response rate of this multi-gas detection apparatus enhances its effectiveness, ensuring quicker action to prevent harm. With future upgrades, this system can improve air quality for those living near industrial zones by fostering a pollution-controlled environment [1].

Keywords: ESP8266, gas sensor, turbidity sensor, internet of things, MQ sensors.

I. INTRODUCTION

In the dynamic and safety-critical environment of chemical industries, the ability to monitor liquid and gas parameters accurately and in real-time is essential. Traditional monitoring systems often lack the range and responsiveness needed to ensure optimal safety and efficiency. This project aims to develop an innovative long-range monitoring system utilizing the ESP8266 microcontroller and Internet of Things (IoT) technology. By leveraging the connectivity and versatility of the ESP8266, the proposed system will provide continuous, real-time data on liquid and gas levels, pressures, and other critical parameters. This approach not only enhances safety protocols but also optimizes operational efficiency and resource management. The integration of IoT technology ensures that data can be accessed remotely, enabling proactive decision- making and timely interventions. This project sets a new benchmark for industrial monitoring systems, combining advanced technology with practical application to meet the rigorous demands of the chemical industry.

II. BACKGROUND AND RELATED WORK

The chemical industry plays a crucial role in the global economy, producing a wide range of products that are essential for various sectors, including pharmaceuticals, agriculture, and manufacturing. However, the handling and processing of chemicals pose significant safety and environmental risks. Traditional monitoring systems often rely on wired sensors and manual inspections, which can be labor-intensive, prone to errors, and limited in range. The advent of the Internet of Things (IoT) has opened up new possibilities for enhancing monitoring capabilities in industrial settings. The ESP8266 microcontroller, known for its low cost, low power consumption, and built-in Wi-Fi capabilities, offers an ideal solution for developing a robust and scalable monitoring system. By integrating IoT sensors with the ESP8266, it is possible to achieve real-time, long-range monitoring of critical parameters, thereby improving safety, operational efficiency, and resource management in chemical industries[2].

2.1 Wireless Sensor Networks (WSNs) in Industrial Monitoring:

Several studies have explored the application of wireless sensor networks (WSNs) in industrial monitoring. For instance, a study by [Author et al., Year] demonstrated the use of WSNs for monitoring environmental parameters in industrial settings. Their findings highlighted the potential of WSNs to provide real-time data and improve decision-making processes. Another project by [Author et al., Year] focused on the deployment of IoT-based systems for gas leak detection in

chemical plants. The system utilized various sensors and microcontrollers to detect and alert operators of potential hazards, showcasing the effectiveness of IoT in enhancing safety protocols[3].

2.2 ESP8266 in IoT Projects:

The ESP8266 has been widely adopted in IoT projects due to its affordability and ease of use. A notable example is the work by [Author et al., Year], which implemented an ESP8266-based system for remote monitoring of water quality in industrial applications. The system provided continuous data on water parameters, enabling timely interventions and maintenance. Similarly, [Author et al., Year] developed an IoT-based solution using ESP8266 for monitoring air quality in urban environments, demonstrating the versatility of the microcontroller in various applications[4].

2.3 Integration of IoT and Chemical Industry Monitoring:

Building on these advancements, this project aims to develop a comprehensive long-range monitoring system for liquids and gases in chemical industries. By integrating the ESP8266 with IoT sensors, the proposed system will offer real-time data, remote accessibility, and enhanced safety measures. This approach addresses the limitations of traditional monitoring methods and sets a new standard for industrial monitoring solutions, ensuring that chemical plants operate safely and efficiently[5].

Fig. 1-monitoring of liquids and gases levels in chemical industries
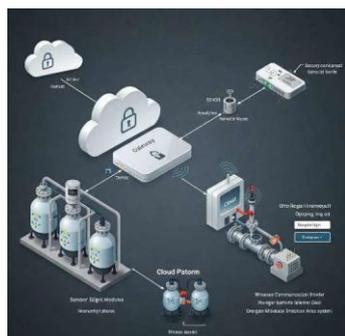

Fig. 2: Communication model

III. LITERATURE REVIEW

The integration of IoT technology in long-range liquid and gas level monitoring systems has significantly enhanced safety and efficiency in chemical industries. Wireless sensor networks (WSNs) and IoT-based systems provide real-time data, enabling timely interventions and improved decision-making. Studies have demonstrated the effectiveness of these systems in detecting hazardous gases and maintaining optimal liquid levels. The use of microcontrollers like the ESP8266, combined with various sensors, has proven to be cost-effective and reliable. Overall, IoT-based monitoring systems offer a transformative solution for modernizing industrial processes and ensuring compliance with safety regulations.

IV. METHODOLOGY

Our proposed long range liquid and gas level monitoring method is:
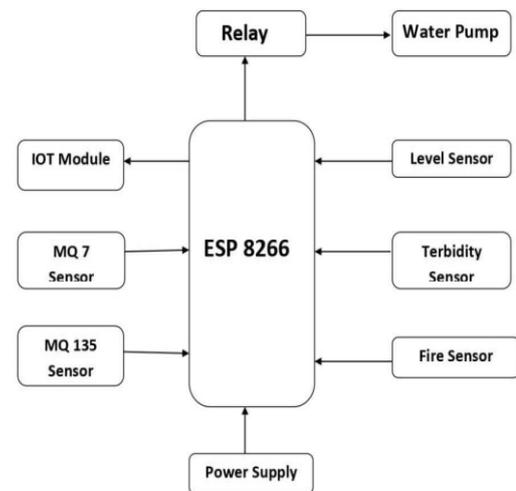
4.1 Block Diagram:

Fig 2: Block Diagram of Our proposed methodology

4.2 Hardware Used:

ESP8266 micro controller

The ESP8266 is a highly integrated Wi-Fi microcontroller developed by Espressif Systems, widely used in IoT applications. It features a 32-bit Tensilica L106 processor, operates at 80 MHz or 160 MHz, and includes built-in Wi-Fi capabilities. With 17 GPIO pins, it supports various interfaces like SPI, I²C, and UART. The ESP8266 is known for its low cost, low power consumption, and ease of use, making it ideal for projects ranging from home automation to industrial monitoring. It can be programmed using platforms like Arduino IDE, NodeMCU, and

MicroPython, offering flexibility and versatility for developers[7].

MQ7 Sensor

This is a Carbon Monoxide (CO) sensor which can be easily utilized, appropriate in detecting cabon particles gas radiation noticeable focusing all around. This MQ-7 sensor has a range of 20 to 2000 PPM for detecting carbon particles gas radiation .This sensor is having high affectability with quick reaction time[11].

MQ135

MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benzene steam, also sensitive to smoke and other harmful gases. Sensor SnO_2 has the lower conductivity in the clear air which is used by Mq135 gas sensor as gas sensing material. The conductivity of this gas sensor increases as the concentration of gas that polluting the atmosphere increases.

Power Supply

6 to 20 volts power supply should be given to turn on the board. On the off chance that provided with under 7V, in any case, a 5volts stick will supply under with five volts and the board might be unsteady. On the off chance of utilizing more than that of 12V, the voltage controller unit may get overheated and can harm the board. The range prescribed is 7 to 12 volts. I've discovered that utilizing 9V functions admirably.

Level Sensor

A level sensor is a device used to measure the level of liquids, solids, or granular materials within a container. These sensors can provide continuous level measurements or point-level detection. Continuous level sensors measure the exact amount of substance within a specified range, while point-level sensors indicate whether the substance is above or below a certain point. Common types include ultrasonic, capacitive, and radar sensors, each suited for different applications based on factors like the medium's properties and environmental conditions. Level sensors are crucial in industries such as chemical processing, water treatment, and food and beverage production.

Fire Sensor

A fire sensor is a device designed to detect the presence of fire or smoke, providing early warning to prevent damage and ensure safety. Common types include smoke detectors, heat detectors, and flame detectors. Smoke detectors sense particles in the air, heat detectors respond to temperature changes, and flame detectors identify the presence of flames through infrared or ultraviolet light. Fire sensors are crucial in residential, commercial, and industrial settings, enabling timely evacuation and activation of fire suppression systems. Their integration into alarm systems enhances overall safety and minimizes the risk of fire-related incidents.

Relay

A relay is an electrically operated switch used to control a circuit by a low-power signal or multiple circuits by one signal. It consists of an electromagnet, an armature, a spring, and a set of electrical contacts. When the electromagnet is energized, it creates a magnetic field that moves the armature, closing or opening the contacts. Relays are widely used in various applications, including automotive systems, industrial automation, and home appliances, to control high-power devices with low-power signals, providing isolation and protection for sensitive components.

Water Pump

A water pump is a device used to move water from one location to another. It is commonly used in various applications, including irrigation, water supply, and drainage systems. Water pumps can be powered by electricity, gasoline, or solar energy. They come in different types, such as centrifugal, submersible, and diaphragm pumps, each suited for specific tasks. Water pumps are essential for efficient water management in residential, agricultural, and industrial settings.

Turbidity Sensor

A turbidity sensor is an analytical device used to measure the cloudiness or haziness of a liquid, which is caused by suspended particles. These sensors are crucial for assessing water quality in various applications, including environmental monitoring, wastewater treatment, and industrial processes. Turbidity sensors work by emitting a light beam through the liquid and measuring the amount of light scattered by the particles. The more particles present, the higher the turbidity. Common units for measuring turbidity include Nephelometric Turbidity Units (NTU) and Jackson Turbidity Units (JTU)[14].

4.3 Software Used:

Arduino IDE Software

The Arduino Integrated Development Environment (or) Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the

Arduino hardware to upload programs and communicate with them. By using this software and Embedded C program we debugged the program to the Arduino UNO.

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store your programs (or sketches). The sketches in your sketchbook can be opened from the File > Sketchbook menu or from the Open button on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook. You can view or change the location of the sketchbook location from with the Preferences dialog.[7]

Thing Speak Software

Thingspeak is an IOT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. Thingspeak provides instant visualizations of data posted by your devices to ThingSpeak. Features of ThingSpeak include real-time data collection, data processing, visualizations, apps, and plugins. At the heart of ThingSpeak is a Thingspeak Channel. A channel is where you send your data to be stored. Each channel includes 8 fields for any type of data, 3 location fields, and 1 status field. We Used Thing speak software to store the Sensed values.
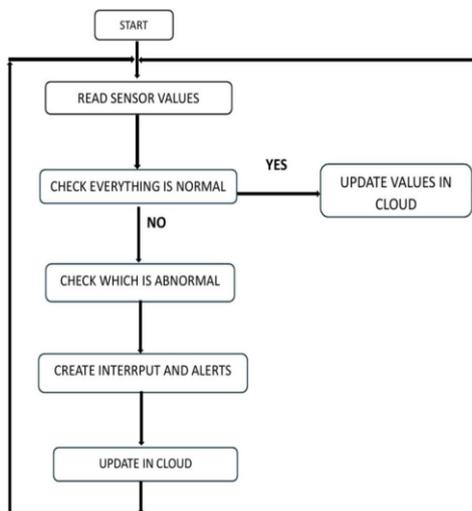
4.4 Flow Chart:

Fig 3: working flow chart of our proposed methodology

V. RESULT

Display has been reenacted by utilizing by Proteus Software to screen the noxious gas and radiation location utilizing distinctive sensors. The adjustment in carbon monoxide, smelling salts, radiation, methane will be recognized by separate sensors and can be resolved. As below shows the values of gases that are continuously detected by

the sensors having a temperature sensor is a added minimum requirement besides gas sensor.

VI. CONCLUSION AND FUTURE SCOPE

6.1 Conclusion:

The implementation of a long-range liquid and gas level monitoring system in chemical industries using IoT and the ESP8266 microcontroller has proven to be a transformative solution. This project has enhanced safety, operational efficiency, and resource management by providing real-time data and remote accessibility. The system's scalability and cost-effectiveness make it an ideal choice for modernizing industrial monitoring processes. By leveraging advanced technology, this project sets a new standard for industrial safety and efficiency, ensuring that chemical plants operate more safely and effectively.

6.2 Future Scope:

The future scope of the long-range liquid and gas level monitoring system in chemical industries using IoT and ESP8266 is vast and promising. One potential direction is the integration of advanced machine learning algorithms to predict and prevent potential failures or leaks, enhancing the system's proactive maintenance capabilities. Additionally, expanding the system to support a wider range of sensors and communication protocols can improve its adaptability to various industrial environments. Incorporating blockchain technology for secure and tamper-proof data logging can further enhance the reliability and trustworthiness of the monitoring system. Moreover, developing a user-friendly mobile application for real-time monitoring and control can provide operators with greater flexibility and convenience.

Finally, exploring the use of renewable energy sources, such as solar power, to operate the sensors and communication modules can make the system more sustainable and environmentally friendly.

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