IOT BASED INDUSTRIAL SAFETY SYSTEM

A Project Report

Submitted by

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Under the guidance of

Mrs. Sanghamitra Layek

HOD, Department of ECS

In partial fulfillment of the award for the degree of

Bachelor of Technology

In

Electronics and Instrumentation Engineering

Narula Institute of Technology

81, Nilgunj Road, Agarpara, Kolkata 700109

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CERTIFICATE OF APPROVAL

This is to certify that the following students have submitted this project report on ***"IOT Based Industrial Safety System"*** in partial fulfillment of the award for the Degree of Bachelor of Technology in Electronics and Instrumentation Engineering of MAKAUT in the year 2024 under my supervision.

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ABSTRACT

The IoT-based industrial safety system, designed with Arduino Uno and a GSM module, provides real-time monitoring and alerting for various industrial hazards, ensuring worker safety and operational efficiency. The system is equipped with multiple sensors to detect fire, gas leaks, high temperatures, and low light conditions, automatically triggering responses to mitigate risks.

The fire sensor detects the presence of smoke or flame and triggers a buzzer to alert personnel. Simultaneously, the GSM module sends an SMS to designated mobile numbers, notifying relevant authorities of the fire risk. Similarly, the gas sensor monitors air quality for dangerous gases, such as carbon monoxide or methane. When a hazardous gas is detected, the buzzer sounds, and an alert message is sent via GSM to inform workers and emergency responders.

The temperature sensor plays a crucial role in maintaining safe working conditions. If the temperature exceeds a set threshold, the system activates a DC fan to cool the environment, preventing potential overheating or fire hazards. Additionally, the LDR (Light Dependent Resistor) sensor detects low light levels in the industrial area. When the space becomes too dark, the LDR automatically turns on an LED light, ensuring adequate visibility and reducing the risk of accidents.

Together, these sensors work seamlessly to protect industrial environments by providing immediate alerts and automatic safety responses.

CONTENTS

LIST OF FIGURES

CHAPTER 1
(Introduction)

1.1. INTRODUCTION

The IoT-based industrial safety system is an innovative approach to enhancing safety within industrial environments by leveraging modern technology to detect potential hazards and provide real-time alerts. With the increasing

complexity of industrial operations and the associated risks, it has become essential to implement advanced safety systems that can promptly detect threats like fire, gas leaks, high temperatures, and inadequate lighting. This system integrates multiple sensors with an Arduino Uno microcontroller, GSM module, and other components to create a responsive, automated solution for workplace safety.

The heart of this system is the use of various sensors, each designed to monitor specific environmental parameters. A fire sensor, typically based on smoke or flame detection technology, constantly scans for signs of fire. The system immediately reacts by activating a buzzer to alert personnel and sends an SMS notification through the GSM module to a mobile phone, ensuring that those in charge are informed without delay. The gas sensor operates in a similar way, continuously monitoring the air for harmful gases such as carbon monoxide, methane, or propane. If a dangerous concentration is detected, the sensor triggers the buzzer and sends an SMS alert to the mobile phone, notifying the relevant authorities and allowing them to take necessary action to prevent any accidents.

Temperature regulation is another critical aspect of industrial safety, as overheating can lead to equipment failure or fire hazards. The temperature sensor in this system monitors the environmental temperature, and if it exceeds a predefined threshold, the system activates a DC fan to cool the space, preventing any potential overheating. This proactive approach to temperature control is vital in maintaining a safe working environment and protecting sensitive equipment from damage.

Another crucial feature of the system is the Light Dependent Resistor (LDR) sensor. In many industrial settings, visibility can be limited by insufficient lighting, leading to accidents or mistakes. The LDR sensor detects when the area becomes too dark and automatically activates an LED light to ensure that workers have adequate visibility. This not only improves safety but also helps enhance productivity by providing a well-lit workspace.

By integrating these sensors and using the Arduino Uno for processing and the GSM module for communication, the system ensures continuous monitoring of the industrial environment. It offers real-time responses to any detected hazards, reducing the likelihood of accidents and improving overall safety standards. The use of IoT technology in this context provides a seamless, efficient, and automated safety solution, empowering industries to protect both their workforce and assets. This project represents a significant step forward in ensuring industrial safety, making it a vital tool for any modern industrial facility.

CHAPTER 2
(Literature Survey)

2.1. LITERATURE REVIEW:

Flame Sensors and Fire Detection

Flame sensors play a critical role in detecting fire hazards in industrial environments. A flame sensor works by detecting the infrared (IR) radiation emitted by a flame, and when the intensity of this radiation exceeds a certain threshold, it triggers an alert. The integration of flame sensors with IoT and GSM technology allows real-time fire detection with instant messaging alerts.

Research: A study by Kiran et al. (2019) demonstrates the use of flame sensors connected to a microcontroller (like Arduino) to detect fire hazards in industrial settings. When a flame is detected, the system automatically activates a fire alarm and sends a notification to the plant operators via GSM.

Implementation: The flame sensor sends data to the Arduino, which processes it and, if the flame intensity is above the predefined threshold, the Arduino triggers the GSM module to send a message to predefined phone numbers, alerting workers or security teams.

Gas Sensors for Leak Detection

Gas leaks are one of the most dangerous risks in industrial environments, especially in factories where combustible gases like methane, LPG, or carbon monoxide are used. Gas sensors are designed to detect the presence of these gases and send early warnings to prevent explosions or poisoning.

Research: A study by Kumar and Verma (2020) discusses the use of MQ-6 Gas Sensor (a commonly used sensor for detecting gases like LPG, methane, and butane) in an IoT-based industrial safety system. The system provides immediate alerts to workers when hazardous gas concentrations are detected, preventing accidents.

Implementation: The gas sensor, when integrated with Arduino, continuously monitors the gas concentration in the air. If the concentration exceeds the preset threshold, the system sends an alert via GSM, notifying workers and safety personnel of the risk.

Light-Dependent Resistor (LDR) for Ambient Light Control

In industrial environments, lighting control is important for both safety and energy efficiency. An LDR sensor can be used to detect ambient light conditions, and when it becomes too dark, the system can automatically turn on the lights (LEDs in this case).

Research: According to a study by Sreenivasa et al. (2018), LDRs are widely used for controlling lighting systems in buildings and industries. The sensor works by varying its resistance based on light intensity, and this change can be used to trigger an automatic response, such as turning on or off lights.

Implementation: In this IoT-based safety system, when the LDR sensor detects insufficient light levels, the Arduino sends a signal to activate an LED light, ensuring visibility and safety in low-light environments.

Temperature Sensors for Overheating Detection

Temperature sensors, such as LM35 or DHT11, are essential in monitoring the thermal conditions in industrial environments, particularly in places with high-powered machinery. Overheating can lead to machinery failure, fires, or other hazardous situations. A temperature sensor can trigger an automatic response when the temperature exceeds a critical level.

Research: In their research, Yadav and Singh (2019) highlight the use of LM35 temperature sensors in industrial applications to prevent overheating. The system sends notifications when the temperature crosses a set threshold, and a cooling system or DC fan can be turned on automatically to prevent damage.

Implementation: When the temperature exceeds a predefined limit, the Arduino system can automatically trigger a relay to activate a DC fan, reducing the risk of overheating and potential fires. Additionally, the system can send an alert via GSM to alert technicians or security personnel.

GSM Module for Real-Time Alerts

The GSM module is an integral component in IoT-based systems, allowing communication between the system and external devices, such as mobile phones. When any abnormal conditions are detected, the system sends a real-time alert via SMS to ensure prompt action.

Research: Research conducted by Sharma et al. (2021) demonstrates the successful integration of GSM technology with safety systems in industries. The GSM module provides reliable communication to personnel on-site or off-site, enabling real-time monitoring and fast responses in critical situations.

Implementation: The GSM module is connected to the Arduino, and when sensors detect a hazard (fire, gas leak, temperature anomaly, etc.), the module sends an SMS alert to the preconfigured phone numbers of safety officers or managers.

CHAPTER 3

(Project Description)

3.1. PROJECT OVERVIEW

The IoT-based industrial safety system integrates multiple sensors with an Arduino Uno and GSM module to enhance workplace safety. It monitors environmental factors like fire, gas leaks, temperature, and lighting. A fire sensor

triggers an alarm and sends SMS alerts if smoke or flames are detected. The gas sensor does the same in case of dangerous gas levels. The temperature sensor activates a DC fan when the temperature exceeds a threshold to prevent overheating. The LDR sensor automatically turns on LED lights in low light conditions. This system provides real-time alerts and automated responses to ensure a safe industrial environment.

3.2. PROJECT OBJECTIVES

The objective of the IoT-based industrial safety system is to enhance safety and security in industrial environments by integrating multiple sensors with an Arduino Uno and GSM module. The system aims to detect potential hazards such as fire, gas leaks, high temperatures, and low light conditions. It triggers alarms and sends real-time SMS alerts to mobile devices to inform personnel and authorities of any detected risks. Additionally, the system automatically takes corrective actions, such as activating a fan for high temperatures or turning on LED lights in dark areas, ensuring a safer and more responsive industrial workplace.

3.3. COMPONENTS USED FOR THE PROJECT

1. Flame Sensor
2. Gas Sensor
3. Temperature sensor
4. LDR sensor
5. Arduino Uno Microcontroller
6. Sensor Shield
7. Gsm Module 900A
8. Dc Fan
9. Led Light
10. Connecting Wire (As Per Requirement)
11. Breadboard

DETAILS OF COMPONENTS:

1.ARDUINO UNO: The Arduino Uno is a popular microcontroller board based on the ATmega328P chip, widely used in electronics and IoT projects. It features 14 digital input/output pins, 6 Analog inputs, a USB connection for programming, and a power jack for external power sources. The board operates at 5V and can be powered via USB or

an external adapter (7-12V). It also includes a 16 MHz quartz crystal, a reset button, and an integrated development environment (IDE) for easy programming. Arduino Uno is compatible with a wide range of sensors, motors, and communication modules, making it ideal for DIY and industrial applications**.**

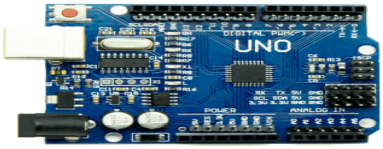


Fig. 1. Arduino UNO

2.Sensor Shield: A Sensor Shield is an expansion board designed to simplify the process of connecting sensors and actuators to an Arduino or other microcontroller. It provides a variety of pin headers and connectors for different types of sensors, including digital, Analog, and PWM devices. The shield eliminates the need for complex wiring and facilitates easy prototyping by offering a standardized interface for sensors, motors, and other components. It is compatible with various Arduino boards and makes it easier to design and build projects such as home automation, robotics, and industrial monitoring systems, ensuring a seamless integration of sensors into the project.

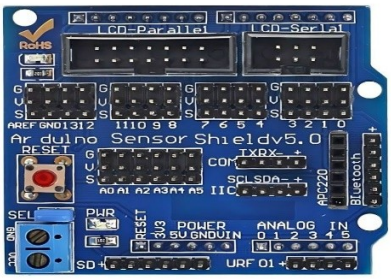


Fig. 2. Sensor Shield

3.GSM MODULE 900A: The GSM Module 900A is a communication device used to enable wireless data transfer via GSM (Global System for Mobile Communications) networks. It operates on 900 MHz frequency and allows the Arduino or microcontroller to send and receive SMS, make voice calls, and establish internet connections using a SIM card. The module is widely used in IoT projects for remote monitoring and control applications. It features a UART (Universal Asynchronous Receiver/Transmitter) interface for communication with microcontrollers and has low power consumption. The GSM 900A is ideal for industrial automation, safety systems, and Remote control applications, offering seamless connectivity.

Fig. 3. Gsm Module 900A

4.FLAME SENSOR: A Flame Sensor is a device used to detect the presence of fire or flames within a specific area. It works by sensing infrared light emitted by flames. Typically, the sensor consists of an infrared photodiode or a thermopile, which detects the heat and light produced by flames. The sensor outputs a digital signal that can be interpreted by a microcontroller, such as an Arduino, to trigger an action, like activating an alarm or sending a notification. Flame sensors are commonly used in fire detection systems, industrial safety, and fire prevention applications, offering quick and reliable fire detection.

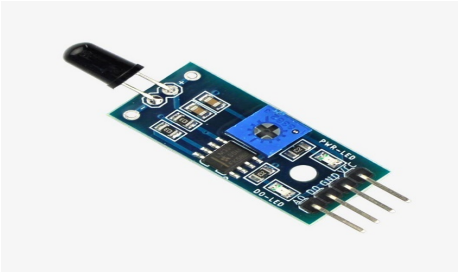


Fig. 5. Accelerometer (MPU6050)

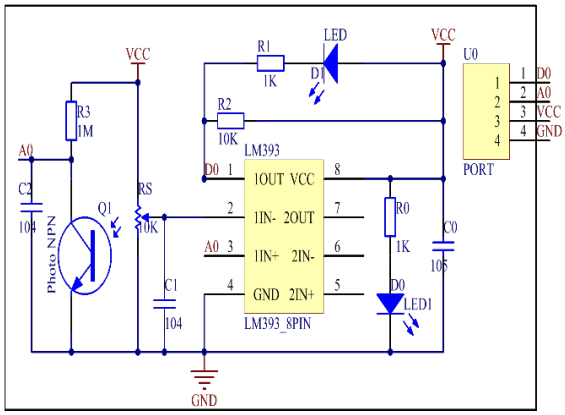


Fig.6. Flame Sensor Circuit Diagram

5.GAS SENSOR: A Gas Sensor is a device used to detect the presence of specific gases in an environment, such as carbon monoxide (CO), methane (CH4), or LPG (liquefied petroleum gas). It works by detecting changes in the concentration of gases in the air, often using metal oxide semiconductor (MOS) technology or electrochemical sensing. The sensor provides an Analog or digital output, which can be processed by a microcontroller like Arduino. Gas sensors are widely used in safety systems for detecting hazardous leaks, ensuring air quality, and preventing explosions or poisoning. They are essential in industrial, domestic, and environmental monitoring applications.

Fig. 7. Gas Sensor

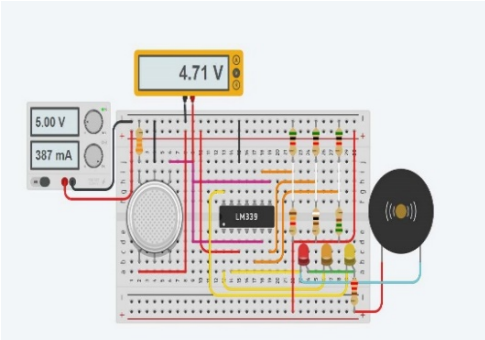


Fig. 8. Gas Sensor Circuit Diagram

6.TEMPERATURE SENSOR: A temperature sensor is a device used to measure temperature in a given environment and convert it into an electrical signal that can be interpreted by a microcontroller, such as Arduino. Common types of temperature sensors include thermistors, thermocouples, and digital sensors like the DHT11 or LM35. These sensors work by detecting temperature changes and altering their resistance or output voltage accordingly. Temperature sensors are widely used in applications such as climate control, industrial automation, and safety systems. In industrial settings, they help monitor equipment and prevent overheating, triggering actions like turning on fans or activating alarms when high temperatures are detected.

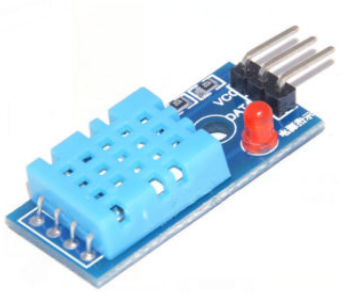


Fig. 9. Temperature Sensor DH11

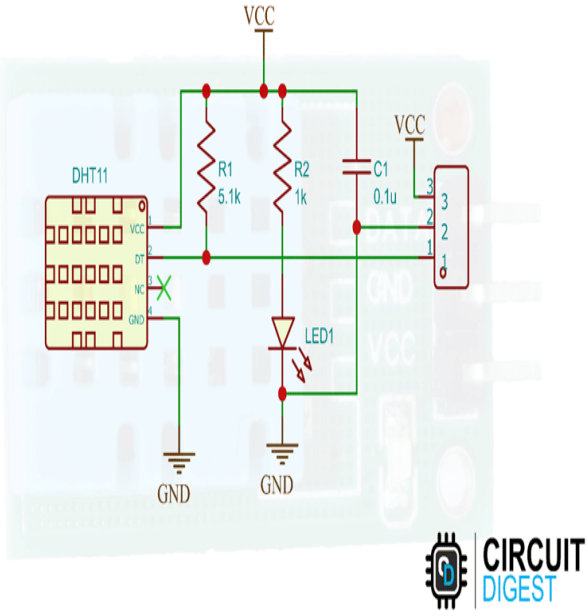


Fig.10. Temperature Sensor Circuit Diagram

7.LDR SENSOR: An LDR (Light Dependent Resistor) is a type of photoresistor that changes its resistance based on the amount of light falling on it. In bright light, the resistance decreases, while in darkness, it increases. LDR sensors are commonly used to detect light intensity and are widely applied in light-sensitive devices. In electronics, LDRs are often used with microcontrollers like Arduino to automate actions based on ambient light levels. For example, in industrial safety systems, an LDR can automatically turn on lights in dark areas or adjust brightness in response to varying light conditions, enhancing safety and energy efficiency.

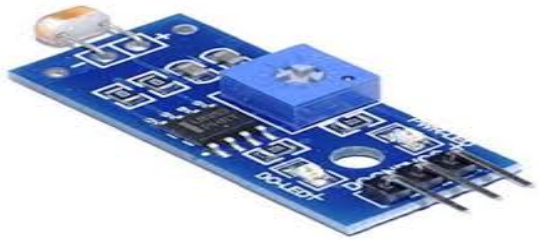


Fig. 11. LDR Sensor

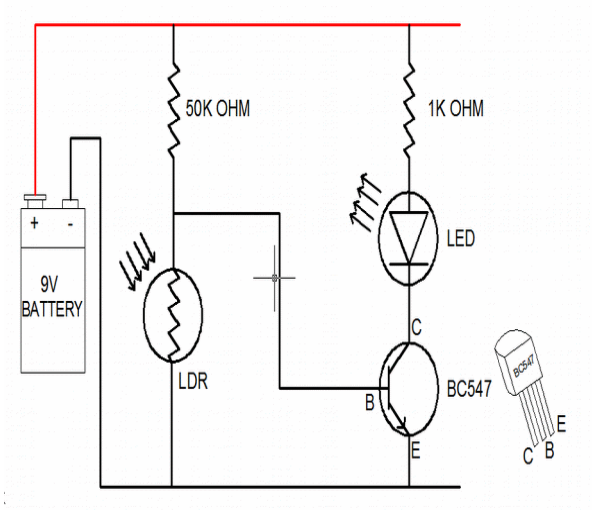


Fig.12. Temperature Sensor Circuit Diagram

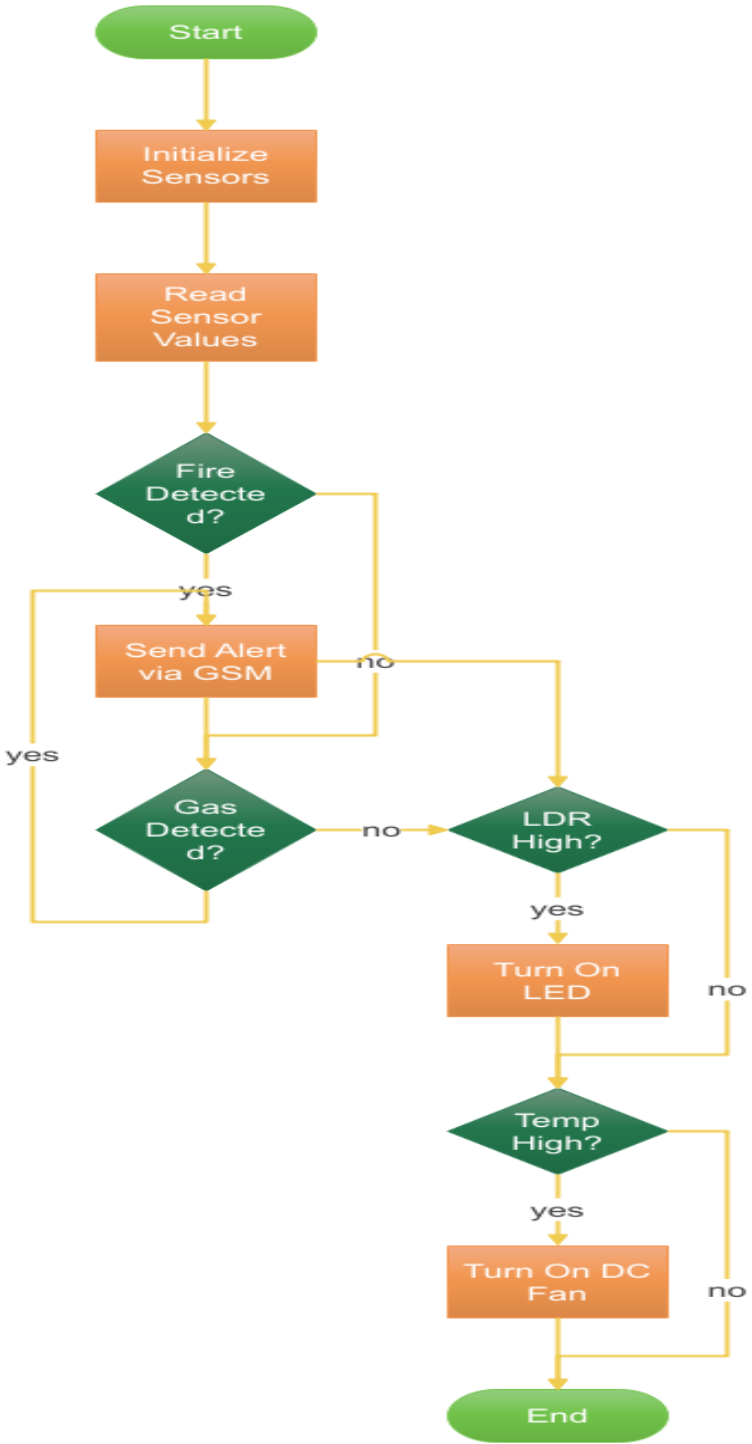
8.DC FAN: A DC fan is an electric fan powered by direct current (DC) voltage, typically from a battery or power supply. It consists of a motor, blades, and a controller. The DC motor drives the blades, generating airflow to cool or ventilate an area. DC fans are more energy-efficient compared to AC fans and offer variable speed control, which can be adjusted by modifying the voltage. They are widely used in applications requiring low power consumption, such as in cooling systems for electronics, industrial equipment, and home appliances. DC fans are compact, reliable, and ideal for systems with limited power resources.

Fig.13. DC Fan

9.LED LIGHT: An LED (Light Emitting Diode) light is a semiconductor device that emits light when current passes through it. It is energy-efficient, durable, and has a long lifespan compared to traditional lighting solutions like incandescent bulbs. LEDs operate on low voltage and produce minimal heat, making them ideal for applications where power efficiency and longevity are essential. Available in various Colours and brightness levels, LED lights are commonly used for displays, home lighting, automotive, and industrial applications. In industrial safety systems, they can be used to indicate operational status or illuminate areas when light levels fall below a certain threshold.

Fig.14. LED Light

CHAPTER 4
(Methodology)



4.1. FLOW CHART OF THE PROJECT :

The flowchart for the IoT-based Industrial Safety System begins with system initialization (Arduino, sensors, GSM module). It reads data from sensors (Flame, Gas, LDR, Temperature). If fire is detected, it sends an SMS alert. If gas is detected,

it sends an SMS. If LDR sensor is High, the LED light is turned on. If temperature is high, the DC fan is turned on. Finally, the system either ends or repeats the monitoring process to ensure continuous safety.

Fig. 7. Flow Chart of the Prototype

4.2. BLOCK DIAGRAM OF THE PROJECT:

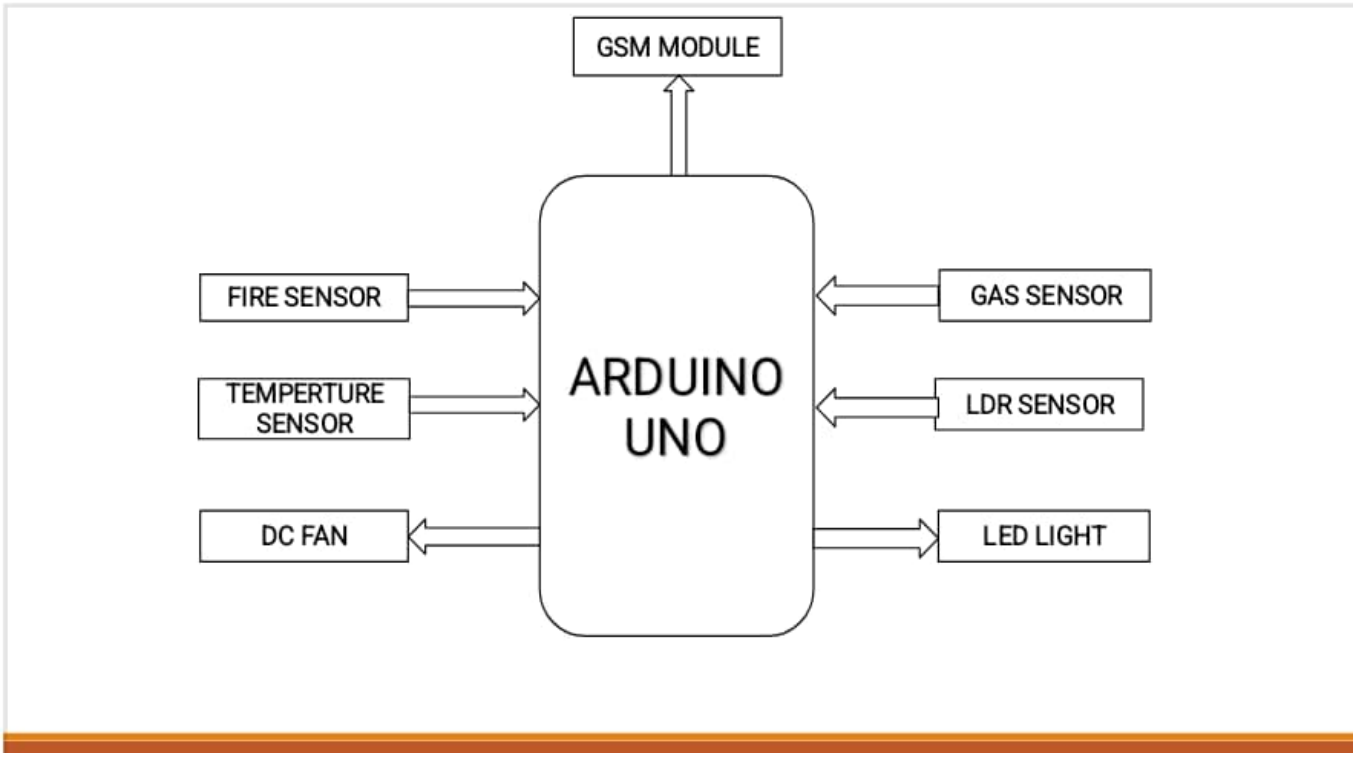


Fig. 8. Block Diagram of the Prototype

The project block diagram consists of an Arduino Uno connected to various sensors: a Fire Sensor, Gas Sensor, Temperature Sensor, and LDR Sensor. The sensors provide data to the Arduino, which triggers a Buzzer and sends SMS alerts through the GSM Module. The DC Fan and LED Light are activated based on sensor readings.

4.3. CIRCUIT DIAGRAM OF THE PROJECT :

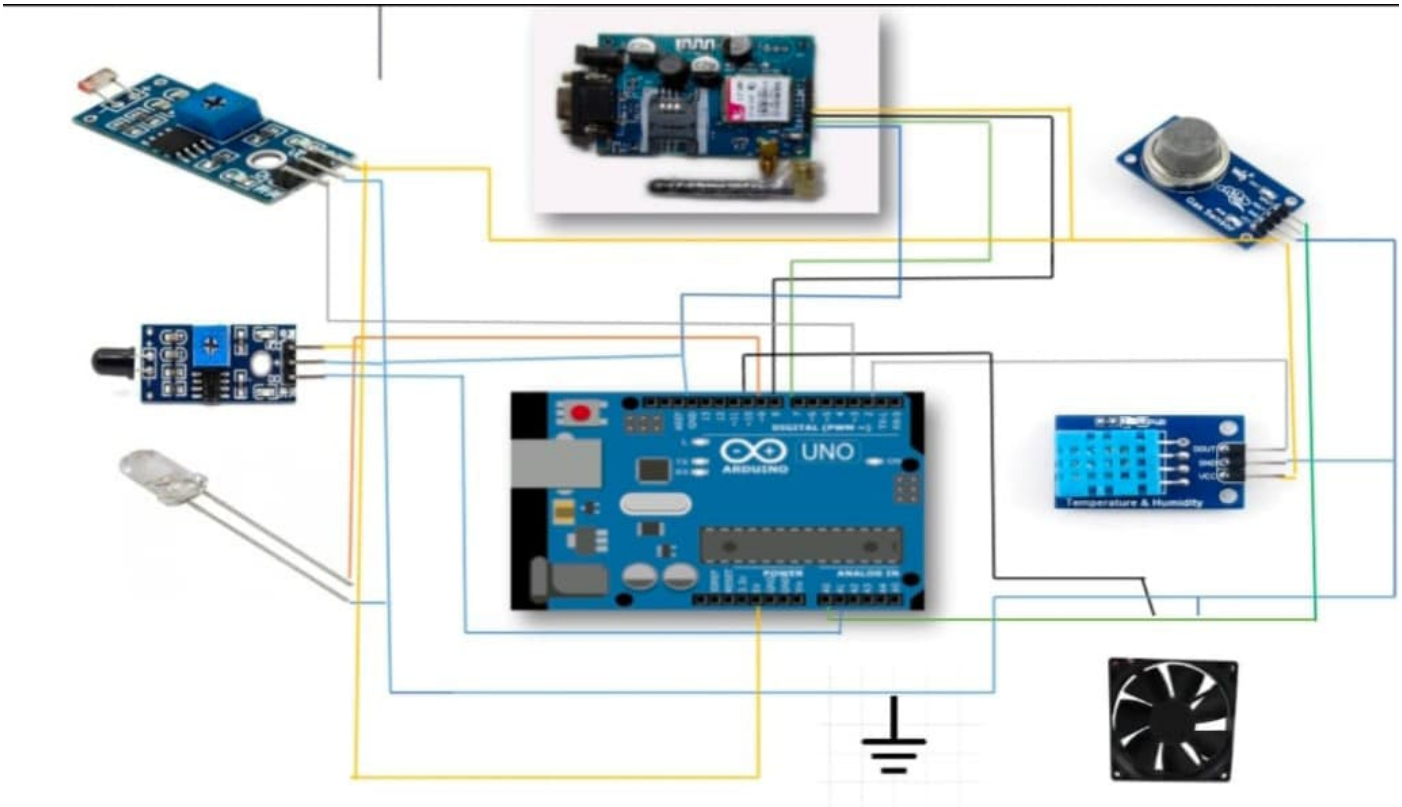


Fig. 9. Circuit Diagram of the Prototype

The IoT-based industrial safety system circuit connects multiple sensors to an Arduino UNO to monitor fire, gas leaks, light levels, and temperature. The flame sensor detects fire, while the gas sensor identifies dangerous gases like LPG. The LDR detects low light, and the temperature sensor monitors overheating. When dangerous conditions are detected, the Arduino processes the sensor data and activates a GSM module to send SMS alerts. It also triggers an LED for immediate visual notification and activates a DC fan if the temperature exceeds safe levels. The system works autonomously to ensure real-time safety monitoring and alerts in industrial environments.

CHAPTER 5

(Result & Discussion)

5.1. RESULT ANALYSIS

The result analysis of the IoT-based industrial safety system demonstrates its effectiveness in ensuring real-time monitoring and response to various hazards in industrial environments. When the fire or gas sensors detect dangerous conditions, the system successfully activates an alarm (buzzer) and sends SMS alerts via the GSM module to notify personnel. The temperature sensor ensures the environment remains safe by triggering the DC fan if temperatures rise above a predefined threshold. The LDR sensor enhances visibility by automatically turning on LED lights in dark areas.

The system's real-time alerting mechanism and automatic safety measures contribute significantly to reducing risks, improving worker safety, and preventing potential accidents. Its ability to monitor multiple environmental factors continuously, combined with the GSM notifications, ensures a quick response to threats, leading to a more secure and efficient industrial setting. The integration of IoT technology enables the system to function remotely, providing safety alerts even when personnel are off-site, making it an invaluable tool for industrial safety management.

Overall, the project successfully meets its objectives of enhancing industrial safety through automation and real-time monitoring, demonstrating the practicality and reliability of IoT-based safety systems in industrial applications.

CHAPTER 6

(Application & Future Scope)

6.1. APPLICATIONS OF THE PROJECT

The IoT-based industrial safety system has several applications in various industries, ensuring a safer and more efficient working environment.

1. **Industrial Safety Monitoring**: The system can be implemented in manufacturing plants, factories, and warehouses to monitor fire, gas leaks, temperature fluctuations, and light conditions, ensuring the safety of workers and equipment.
2. **Oil and Gas Industry**: In environments where gas leaks can be hazardous, this system can detect gas leaks, activate alarms, and send alerts to prevent explosions and safeguard personnel.
3. **Chemical Industries**: Gas and fire sensors help monitor hazardous chemical reactions, and temperature sensors prevent overheating of equipment, reducing the risk of chemical accidents or fires.
4. **Warehouse and Storage Facilities**: The system can detect dangerous conditions like fire or gas leaks, ensuring that goods and inventory are not damaged, and workers are kept safe.
5. **Smart Buildings**: The IoT safety system can be used in smart buildings to automate lighting and temperature control, ensuring safety and energy efficiency.
6. **Remote Monitoring and Control**: With GSM notifications, the system allows remote monitoring, enabling personnel or management to respond quickly to safety alerts, even when they are not physically present at the site.
7. **Home Automation and Security**: The system can be adapted for use in smart homes for fire, gas, and environmental monitoring, providing security alerts to homeowners or authorities in case of emergencies.

6.2. FUTURE SCOPE OF THE PROJECT

The future scope of the IoT-based industrial safety system is vast, with potential for further enhancements and applications.

1. **Integration with Advanced AI**: By integrating Artificial Intelligence (AI) and machine learning algorithms, the system could predict potential hazards based on historical data, improving proactive safety measures and reducing false alarms.
2. **Remote Monitoring and Control via Mobile App**: The system can be further developed with a mobile application for real-time monitoring, where users can access sensor data, receive alerts, and control safety features from anywhere.
3. **Integration with Cloud Computing**: Cloud-based platforms can be used to store sensor data, enabling real-time analytics and generating detailed reports for better decision-making. This would also allow for scalability and easy integration with other systems.
4. **Advanced Sensors**: Future versions of the system could integrate more advanced sensors, such as vibration sensors (for detecting machinery malfunctions), humidity sensors (for environments sensitive to moisture), and CO2 sensors (for enhanced air quality monitoring).
5. **Integration with Industrial Automation Systems**: The system could be integrated with Industrial IoT (IIoT) platforms, allowing automated responses such as shutting down machinery or activating emergency protocols when a critical hazard is detected.

CHAPTER 7
(Conclusion)

7.1.CONCLUSION:

In this project, the IoT-based industrial safety system developed using Arduino Uno, sensors, and a GSM module offers an innovative and efficient solution to enhance safety in industrial environments. By continuously monitoring critical factors such as fire, gas leaks, temperature, and lighting, the system ensures timely alerts and automatic

responses to potential hazards, minimizing the risk of accidents and damage to both personnel and equipment. The integration of real-time SMS notifications further improves the system's effectiveness, enabling remote monitoring.

This project demonstrates the practicality and reliability of IoT technology in industrial safety, highlighting its potential for real-world applications across industries such as manufacturing, chemical plants, and oil and gas. With further enhancements in AI, cloud computing, and advanced sensors, the system's capabilities can be expanded to offer even greater efficiency, predictive maintenance, and seamless integration with other industrial automation systems. Ultimately, the IoT-based industrial safety system serves as a crucial tool for improving workplace safety, operational efficiency, and risk management, paving the way for a smarter, safer industrial future.

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7. **Online Courses:**

  - Udemy, “Internet of Things (IoT) for Industrial Safety,” Udemy, 2023. [Online]. Available: https://www.udemy.com/course/iot-industrial-safety. [Accessed: Dec. 27, 2024].
  - Coursera, “Advanced IoT Solutions for Industrial Applications,” Coursera, 2024. [Online]. Available: https://www.coursera.org/learn/iot-industrial. [Accessed: Dec. 27, 2024].

8.Datasets:

  - Kaggle, “Industrial IoT Safety Datasets,” *Kaggle*, 2024. [Online]. Available: https://www.kaggle.com/datasets. [Accessed: Dec. 27, 2024].

Notes:

- Depending on your project requirements, you can include specific references to academic articles, books, and online sources that you consulted during the development of the project.
- Make sure to cite the exact sources and properly format them according to the citation style you are following (APA, IEEE, MLA, etc.).

Summary of the IoT-Based Industrial Safety System Project:

This project involves the development of an IoT-based industrial safety system using an Arduino Uno microcontroller, various sensors, and a GSM module for real-time alerts. The system aims to monitor and protect industrial environments from hazards such as fire, gas leaks, temperature extremes, and poor lighting. The core components of the system include:

1. **Fire Detection**: A **fire sensor** (such as a flame or smoke detector) is used to detect the presence of fire. When a fire is detected, the system triggers a buzzer and sends an alert via SMS through the GSM module to notify workers and supervisors.
2. **Gas Detection**: **Gas sensors** (e.g., MQ-series sensors) detect dangerous gas leaks, such as methane or carbon monoxide. If a gas leak is detected, the system activates the buzzer and sends a warning message through GSM.
3. **Lighting Control**: A Light Dependent Resistor (LDR) sensor is used to monitor ambient light conditions. When the light falls below a set threshold (indicating darkness), the system automatically turns on an LED light to ensure safety and visibility in the area.
4. **Temperature Monitoring**: A temperature sensor (like LM35 or DHT11) is used to monitor the temperature. If the temperature exceeds a predefined threshold, the system activates a DC fan to cool down the environment and prevent overheating or damage to machinery.

The system ensures safety by continuously monitoring environmental parameters and responding to dangerous conditions in real time. When any sensor detects a hazardous event, the system activates alarms (e.g., a buzzer) and sends immediate SMS alerts to personnel via the GSM module, enabling fast responses to prevent accidents.