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TEAM PROJECT

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**CHAPTER ONE**

**1.1 Introduction**

This chapter presents the foundation of the study, outlining the background and context of the project, the problem it addresses, and the purpose of the work. It begins with a general overview of the importance of gas detection systems, highlighting recent advancements in IoT-based safety solutions and relevant challenges that motivate this project.

The chapter defines the specific problem the project aims to solve, followed by the project's objectives and proposed solutions. Additionally, it introduces the core modules of the system and their functions, clarifying how each component will contribute to addressing the problem. The significance of the project, its scope, and its limitations are also discussed, providing a clear boundary and focus for the study. Overall, Chapter One establishes the rationale for the project and sets the stage for the subsequent chapters by presenting the key questions and objectives guiding the project.

**1.2 Background of the Study**

Gas detection systems play a crucial role in ensuring safety by providing timely alerts in case of hazardous leaks. Flammable gases such as liquefied petroleum gas (LPG), methane, and hydrogen are commonly used in households, industries, and commercial establishments. However, leaks from these gases pose serious risks, including explosions, fires, and health hazards due to inhalation. As a result, there is a growing need for reliable gas detection systems that can promptly alert users to potential dangers.

Traditional gas detection systems primarily rely on standalone alarms, which may not be effective if the user is not within hearing range. Additionally, these systems often lack remote monitoring capabilities, making it difficult for users to take timely action if a leak occurs while they are away. To address these limitations, modern gas detection solutions integrate IoT technology, allowing for real-time monitoring and automated notifications via mobile devices.

This project focuses on developing an advanced gas detection system that leverages IoT-enabled sensors to monitor gas levels continuously. The system will integrate a GSM module to send SMS alerts when dangerous gas concentrations are detected, ensuring that users are notified even if they are not on-site. Furthermore, a web and mobile application will provide users with real-time data visualization, enabling proactive safety management. By incorporating these features, the proposed solution aims to enhance gas leak detection and response, reducing the risk of accidents and improving overall safety.

**1.3 Problem Statement**

Currently, many homes and industries rely on standalone gas detectors that lack remote monitoring and automated notification features. These traditional systems often fail to provide real-time alerts to users who are away from the premises, increasing the risk of property damage and endangering lives. The absence of a comprehensive system that integrates flammable gas detection and SMS notifications in real-time presents a significant gap in safety measures.

This project aims to address these limitations by developing a smart, IoT-enabled flammable gas detection system that offers real-time alerts through a mobile app and SMS notifications. The system will enhance safety by providing users with instant notifications, allowing for quick response and preventive measures.

**1.4 Objectives**

**1.4.1 Main Objective**

The main objective of this project is to develop an IoT-based flammable gas detection system that provides real-time alerts through a web/mobile application and SMS notifications, ensuring enhanced safety and timely response to hazardous situations.

**1.4.2 Specific Objectives**

I. Investigate the limitations of existing flammable gas detection systems, particularly focusing on real-time monitoring and remote notifications.

II. Design and develop an IoT-based detection system using flammable gas sensors and a GSM module for SMS alerts.

III. Implement a web and mobile-based dashboard for real-time monitoring and management of gas levels.

IV. Evaluate the system’s performance by analyzing detection accuracy, response time, and user feedback.

**1.5 Research Questions**

I. What are the limitations of existing flammable gas detection systems in terms of remote monitoring and notification capabilities?

II. How can an IoT-based flammable gas detection system be designed to provide real-time alerts effectively?

III. What are the technical and usability challenges in developing a web and mobile-based monitoring dashboard for flammable gas detection?

IV. How does the proposed system perform in terms of accuracy, response time, and reliability?

**1.6 Significance of the Study**

The significance of this study lies in its potential to enhance safety measures by leveraging IoT technology. The proposed system offers real-time flammable gas detection with automated notifications, ensuring prompt responses to potential hazards. This study will benefit homeowners, industries, and commercial establishments by providing a cost-effective and scalable solution for monitoring gas leaks.

Furthermore, the research contributes to the growing field of IoT-based safety systems, providing insights into sensor integration, cloud connectivity, and mobile app development. The project aligns with ongoing advancements in smart home technologies, emphasizing the importance of real-time monitoring and automated alert mechanisms.

**1.7 Scope and Limitation of the Study**

**Scope**

* The project focuses on developing a smart flammable gas detection system using IoT-enabled sensors.
* The system will provide real-time monitoring through a web and mobile application.
* SMS notifications will be sent to users in case of hazardous gas detection.
* The project will be tested in controlled environments, such as residential and small commercial spaces.

**Limitations**

* The system relies on network connectivity for remote monitoring, which may affect real-time data transmission in areas with poor internet access.
* The accuracy of the detection depends on the sensitivity and calibration of the sensors.
* The project does not include fire suppression mechanisms but only detection and notification.

**1.8 Proposed Modules**

**Module 1: Flammable Gas Detection**

* This module will use MQ-series gas sensors (MQ-2, MQ-135, MQ-5) to monitor flammable gas leaks.
* Sensors will be connected to the system for data collection and processing.

**Module 2: Alert and Notification System**

* Sends SMS notifications via a GSM module (SIM800L) when gas levels exceed safety thresholds.
* Push notifications will be sent to a web/mobile application in real-time.

**Module 3: Web and Mobile Application**

* A web-based dashboard and a mobile app will display real-time gas levels.
* Users can receive alerts, view historical data, and configure system settings remotely.

**Module 4: System Administration**

* Allows system configuration, user management, and device calibration.
* Ensures secure access to data and alerts through authentication mechanisms.

**2.1 Introduction**

In this chapter, a comprehensive review of the existing literature and relevant research is presented to establish the foundation for the current project on IoT-based gas detection systems. The review focuses on examining theoretical frameworks, methodologies, and empirical findings related to sensor technologies, IoT integration, and alert mechanisms—while deliberately excluding studies that do not address remote monitoring or dual-alert functionality. By critically evaluating previous research and projects that have tackled similar challenges, this chapter aims to identify gaps in sensor calibration, network reliability, and user interface design that the present study seeks to address. Key topics discussed include sensor performance and limitations, communication protocols and cloud integration, dual alert mechanisms (audible and digital), and system performance evaluation. Overall, this chapter provides the necessary contextual backdrop for the project, demonstrating its significance within the broader landscape of research and development in IoT-enabled safety solutions.

**2.2 Review of Objective One: Investigate the Limitations of Existing Flammable Gas Detection Systems**

As outlined in Chapter One, the first specific objective is to investigate the limitations of current flammable gas detection systems—especially regarding real‑time monitoring and remote notification. Existing systems predominantly rely on standalone gas sensors (such as the MQ‑series) to detect gases like LPG, methane, and hydrogen. While these sensors are cost‑effective, literature reveals recurring issues: sensor drift, cross‑sensitivity to other chemicals, and reduced accuracy under varying environmental conditions. Several studies have reported that without continuous calibration and robust signal processing, such systems may produce false alarms or fail to detect leaks in time. This review reveals a significant gap in achieving consistent reliability in dynamic environments—a challenge that this project aims to overcome through advanced calibration routines and integrated digital filtering.

**2.3 Review of Objective Two: Design and Develop an IoT‑Enabled Detection and Alert System**

The second objective, as stated in Chapter One, is to design and develop an IoT‑based detection system by integrating flammable gas sensors with a GSM module for automated SMS alerts. Recent research in IoT‑enabled safety solutions demonstrates the advantages of connecting sensors to microcontrollers (such as Arduino or ESP8266) and coupling them with communication modules. These systems allow real‑time data transmission to remote devices, ensuring that alerts are sent promptly—even when the user is off‑site. However, literature also points out challenges like maintaining stable network connectivity and ensuring low power consumption. Studies using similar architectures indicate that careful selection of communication protocols and cloud integration is vital. This project builds on those insights by proposing a system that not only sends SMS alerts but also integrates push notifications through a web and mobile dashboard.

**2.4 Review of Objective Three: Implement a Web and Mobile‑Based Monitoring Dashboard**

According to the objectives defined in Chapter One, the third goal is to implement a web and mobile‑based dashboard for real‑time monitoring and management of gas levels. Existing projects have successfully employed cloud services and IoT platforms to visualize sensor data, yet many systems remain limited by non‑intuitive user interfaces and inadequate data presentation. Literature shows that an effective dashboard should display historical and real‑time data clearly, allow for system configuration, and provide actionable insights. Reviews from various IoT projects emphasize the importance of user‑centered design to ensure that both technical and non‑technical users can easily interpret the data. This section of the literature indicates a clear need for a dashboard that is both robust in functionality and simple to navigate, which is a key focus in the development of the current system.

**2.5 Review of Objective Four: Evaluate System Performance by Analyzing Detection Accuracy, Response Time, and User Feedback**

The final objective highlighted in Chapter One is to evaluate the performance of the developed gas detection system. Performance metrics typically include detection accuracy, response time, and overall reliability, alongside qualitative feedback from end‑users. Prior research has utilized controlled experiments and field tests to benchmark sensor performance and communication reliability. Studies have also underscored the importance of user feedback to refine alert mechanisms and dashboard usability. Although several IoT‑based gas detection systems have been reported in the literature, comprehensive evaluations that encompass both technical and user experience parameters are still limited. This project intends to fill that gap by conducting systematic testing under varying conditions and gathering user insights to improve both system accuracy and interface design.

**2.4 Concept Map/Conceptual Diagram**

This section presents a conceptual diagram that visually represents the relationships between key concepts, independent variables, and dependent variables identified through the literature review. The diagram serves to integrate relevant theories and research findings, illustrating how the various elements interact to influence the overall performance of the IoT‑based flammable gas detection system.

**Key Concepts and Definitions:**

1. **Gas Sensor Performance:**  
   Refers to the operational characteristics of MQ‑series sensors (e.g., sensitivity, calibration, cross‑sensitivity, and drift) that determine how accurately gas concentrations are measured.
2. **IoT Integration:**  
   Involves connecting the gas sensor modules to a microcontroller (e.g., Arduino UNO or ESP8266) and further interfacing with communication modules (GSM/Wi‑Fi) for real‑time data transmission.
3. **Communication Protocols:**  
   Encompass the methods and standards (e.g., SMS, push notifications, cloud connectivity) used to relay sensor data to remote servers and user devices.
4. **User Interface and Dashboard:**  
   The web and mobile application through which end‑users receive real‑time monitoring data, alerts, and can interact with the system for configuration and feedback.
5. **Environmental Conditions:**  
   External factors such as temperature and humidity that can influence sensor outputs and the overall system performance.

**Relationships:**

1. **Independent Variables:**  
   Factors like sensor calibration, inherent sensor characteristics, environmental conditions, and network connectivity. These variables directly affect the quality and reliability of the data collected by the sensors.
2. **Intervening Variables:**  
   Signal processing algorithms and communication protocols act as mediators. Advanced digital filtering and robust data transmission methods ensure that raw sensor data are accurately processed and communicated.
3. **Dependent Variables:**  
   The final outcomes measured in the system, such as detection accuracy, response time to gas leakage, and user satisfaction with the interface and alert mechanisms.

**Diagram Description (Figure 2.1):**

