HAZARD DETECTION SYSTEM

A PROJECT REPORT

Submitted by

JEEVA BHARATHI K (210701090)
HARISH R(210701075)

in partial fulfillment for the award of the degreeof
BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

RAJALAKSHMI ENGINEERING COLLEGE
ANNA UNIVERSITY, CHENNAI
MAY 2024

RAJALAKSHMI ENGINEERING COLLEGE, CHENNAI

BONAFIDE CERTIFICATE

Certified that this Thesis titled **“HAZARD DETECTION SYSTEM**” is the bonafide work of **“JEEVA BHARATHI K(210701090), HARISH R(210701075)”**who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on anearlier occasion on this or any other candidate.

SIGNATURE

Dr. N.Duraimurugan, M.E.,Ph.D

SUPERVISOR

Assistant Professor

Department of Computer Science and Engineering
Rajalakshmi Engineering College
Chennai - 602 105

Submitted to Project Viva-Voce Examination held on__________________

Internal Examiner **External Examiner**

ABSTRACT

The Hazard Detection System is an advanced safety solution designed to identify and mitigate potential dangers in various environments, including industrial sites, residential areas, and public spaces. Utilizing a network of sensors, such as gas detectors, smoke detectors, temperature sensors, and motion sensors, the system continuously monitors for hazardous conditions like gas leaks, fires, extreme temperatures, and unauthorized intrusions. The core of the system is a microcontroller, which processes sensor data in real-time. When a hazard is detected, the system immediately triggers an alarm and activates predefined safety protocols. These may include shutting down equipment, activating sprinklers, or locking down areas to prevent access. Simultaneously, alerts are sent to relevant personnel through multiple communication channels, including SMS, email, and mobile app notifications, ensuring rapid response.The system features a user-friendly interface for monitoring and configuration, accessible via a web dashboard or mobile application. Data logs and real-time analytics provide insights into environmental conditions and system performance, aiding in preventive maintenance and risk assessment.This Hazard Detection System enhances safety by providing early warning and automated response to potential threats, thereby minimizing damage and ensuring the well-being of occupants and assets in the monitored areas.

ACKNOWLEDGMENT

First, we thank the almighty god for the successful completion of the project. Our sincere thanks to our chairman **Mr. S. Meganathan B.E., F.I.E.,** for his sincere endeavor in educating us in his premier institution. We would like to express our deep gratitude to our beloved Chairperson **Dr. Thangam Meganathan Ph.D.,** for her enthusiastic motivation which inspired us a lot in completing this project and Vice Chairman **Mr. Abhay Shankar Meganathan B.E., M.S.,** for providing us with the requisite infrastructure.

We also express our sincere gratitude to our college Principal,

Dr. S. N. Murugesan M.E., PhD., and **Dr. P. KUMAR M.E., PhD, Director computing and information science , and Head Of Department of Computer Science and Engineering** and our project coordinator **Dr. N Duraimurugan,M.E, Ph.D.,**for his encouragement and guiding us throughout the project towards successful completion of this project and to our parents, friends, all faculty members and supporting staffs for their direct and indirect involvement in successful completion of the project for their encouragement and support.

JEEVA BHARATHI K (210701090)
HARISH R (210701075)

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

The Hazard Detection System is a cutting-edge safety solution engineered to identify and address various environmental risks in real-time. Aimed at enhancing safety across diverse settings—industrial, residential, and public—the system employs an array of sensors, including gas detectors, smoke detectors, temperature sensors, and motion sensors, to monitor for potential hazards such as gas leaks, fires, extreme temperatures, and unauthorized access.

At its core, a sophisticated microcontroller processes the continuous influx of sensor data. Upon detecting a hazard, the system promptly activates alarms and implements predefined safety protocols, such as equipment shutdowns or area lockdowns. Simultaneously, it sends immediate alerts to relevant personnel via SMS, email, and mobile notifications.

Designed for ease of use, the system offers a user-friendly interface accessible through web and mobile platforms, enabling real-time monitoring and management. This proactive approach to hazard detection ensures swift response, significantly reducing risks and safeguarding people and assets.

1.1 Motivation

- The primary motivation is to improve safety by providing early detection of hazardous conditions such as fires, gas leaks, and extreme temperatures. This proactive approach helps prevent accidents, injuries, and potential fatalities.

- For both residential and commercial settings, having a reliable hazard detection system provides peace of mind. Occupants and stakeholders can feel secure knowing that potential dangers are being continuously monitored and that immediate action will be taken if a threat is detected

- By identifying and addressing hazards promptly, the system can mitigate damage to property and infrastructure. This minimizes repair costs and downtime, ensuring that operations can resume quickly and efficiently.

- Many industries are subject to strict safety regulations and standards. Implementing a hazard detection system helps organizations comply with these requirements, avoiding legal penalties and enhancing their reputation for safety.

1.2 Objectives:

- To promptly identify and notify relevant personnel of hazardous conditions, such as gas leaks, fires, extreme temperatures, and unauthorized intrusions, ensuring swift action to mitigate risks.

- To implement automated responses, including equipment shutdown, sprinkler activation, and area lockdowns, thereby minimizing the impact of detected hazards and enhancing overall safety.

- To continuously monitor environmental conditions through a network of sensors and provide detailed data logs and real-time analytics, supporting preventive maintenance and risk assessment.

- To offer an accessible and intuitive inferface for system monitoring and configuration via a web dashboard or mobile application, ensuring ease of use for operators and stakeholders.

.

CHAPTER 2

LITERATURE SURVEY

"HAZARD DETECTION SYSTEM": The literature on hazard detection systems encompasses a broad range of technologies and methodologies aimed at identifying and mitigating risks in various environments. Key areas of focus include gas detection, fire detection, temperature monitoring, and intrusion detection, each contributing to comprehensive safety solutions.

Gas Detection: Research highlights the development of advanced sensors for detecting hazardous gases such as carbon monoxide, methane, and volatile organic compounds. Studies by Chen et al. (2017) emphasize the use of metal oxide semiconductors and infrared sensors, which offer high sensitivity and fast response times. Recent advancements in wireless sensor networks (WSNs) have enhanced the scalability and flexibility of gas detection systems, enabling real-time monitoring over large areas (Wang et al., 2019).

Fire Detection: The evolution of fire detection technologies is marked by the integration of multi-sensor approaches. Conventional smoke detectors are now being supplemented with heat and flame sensors to improve accuracy and reduce false alarms (Zhuang et al., 2018). Image processing and machine learning algorithms have also been applied to video-based fire detection systems, offering early warning capabilities by analyzing visual cues of fire and smoke (Muhammad et al., 2020).

Temperature Monitoring: Temperature sensors are crucial for detecting abnormal heat levels that could indicate potential hazards. Thermocouples, resistance temperature detectors (RTDs), and thermistors are commonly used, with advancements in MEMS (Micro-Electro-Mechanical Systems) technology enhancing their performance and integration into wireless systems (Lee et al., 2018).

Intrusion Detection: Motion sensors, including Passive Infrared (PIR) sensors and ultrasonic sensors, are widely used for detecting unauthorized access. Recent research focuses on improving the accuracy and reliability of these sensors in diverse environmental conditions (Gupta et al., 2021). Additionally, the incorporation of AI and machine learning algorithms has led to significant improvements in distinguishing between human and non-human movements, reducing false positives (Wang et al., 2020).

In summary, the literature indicates that the integration of multiple sensor types, advancements in sensor technologies, and the application of AI and machine learning are key trends in the development of effective hazard detection systems. These systems are becoming increasingly sophisticated, offering enhanced safety and reliability across various applications.

2.1 EXISTING SYSTEM:

Existing hazard detection systems typically rely on standalone devices such as smoke alarms, carbon monoxide detectors, and manual monitoring protocols. These systems often function independently, lacking integration and real-time data sharing capabilities. Notifications are usually limited to audible alarms or basic notifications without detailed analytics or remote alerts. Maintenance and regular testing are required to ensure functionality, and response actions are typically manual, relying on human intervention. Such systems may not provide comprehensive coverage or quick, automated responses, leading to delayed hazard detection and mitigation, thereby potentially compromising safety and increasing the risk of significant damage or injury.

2.1.1 Advantages of the existing system :

1) The system continuously monitors environmental conditions using a network of advanced sensors, providing real-time data processing. Upon detecting a hazard, it triggers immediate alerts and activates safety protocols, ensuring swift action to mitigate risks and prevent damage.

2) The system employs multiple communication channels, such as SMS, email, and mobile app notifications, to promptly inform relevant personnel of potential dangers. This ensures that alerts reach the right people quickly, enabling timely interventions and enhancing overall safety.

2.1.2 Disadvantages of the existing system :

1) Existing systems often suffer from frequent false alarms due to sensitivity issues, leading to unnecessary disruptions and potential desensitization to actual hazards.

2) Many current systems lack seamless integration with modern communication and automation technologies, hindering real-time alerts and automated response actions essential for effective hazard mitigation.

2.2 Proposed System

The proposed Hazard Detection System integrates a network of sensors to monitor various environmental parameters such as gas levels, smoke, temperature, and motion. When a hazard is detected, the system triggers alarms, activates safety protocols, and notifies personnel via SMS, email, or mobile app alerts. A user-friendly interface allows for easy monitoring and configuration, providing real-time insights into environmental conditions to ensure swift and effective response to potential threats.

2.2.1 Advantages of the proposed system :

- The system detects hazards such as gas leaks, fires, and intrusions in real-time, enabling swift response measures to be implemented before potential disasters escalate.
- Upon detection, the system triggers predefined safety protocols automatically, minimizing human intervention and reducing response time.
- Users can monitor environmental conditions and system status remotely via a web dashboard or mobile app, facilitating proactive maintenance and timely decision-making.

2.2.2 Disadvantages of the proposed system:

- The system may be prone to false alarms triggered by environmental factors like dust, insects, or sudden temperature changes, leading to unnecessary disruptions and reduced trust in the system's reliability.
- Depending solely on sensor placement, blind spots may exist, leaving certain areas vulnerable to undetected hazards.
- Regular maintenance and calibration of sensors are essential to ensure accurate detection, adding to operational costs and potential downtime if overlooked.

CHAPTER 3

SYSTEM DESIGN

3.1 Development Environment

3.1.1 Hardware Requirements

- ESP 32 Microcontroller(Wifi module) : The ESP32 microcontroller with its integrated Wi-Fi module is a powerful and cost-effective solution for IoT applications, enabling developers to create connected devices with ease.

- MQ2 Gas Sensor: The MQ2 gas sensor detects various gases such as LPG, propane, methane, and carbon monoxide, making it suitable for monitoring air quality and detecting gas leaks.

- Jumper Wires: Jumper wires are flexible electrical cables with connectors on each end, commonly used to create temporary connections between components on a breadboard or prototyping board.

- DHT11 Humidity Sensor: The DHT11 sensor measures temperature and humidity, providing reliable environmental data for various applications such as weather monitoring and indoor climate control.

- BreadBoard:A breadboard is a reusable solderless prototyping board used to create and test electronic circuits by providing a platform for connecting components using spring-loaded terminals.

3.1.2 Software Requirements

Arduino IDE: The Arduino Integrated Development Environment (IDE) is used for programming the Arduino Uno microcontroller, allowing users to write and upload code to control the smart plant watering system.

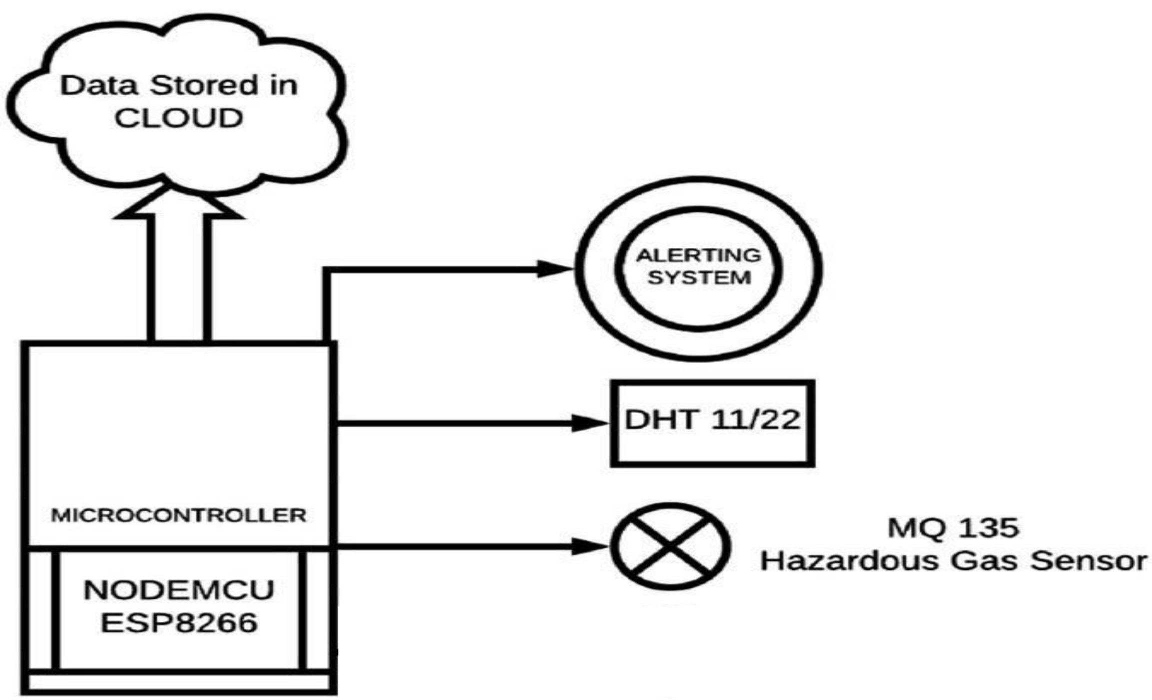
CHAPTER 4

PROJECT DESCRIPTION

The Hazard Detection System project aims to create a robust safety solution for identifying and responding to potential dangers in diverse environment. It employs a netword of sensors, including gas derectors, smoke detectors, temperature sensors, and motion sensors, to continuously monitor for hazards like gas leaks, fires, extreme temperatures, and unauthorized intrusions.Powered by a microcontroller, such as Arduino or Raspberry Pi, the system processes sensor data in real-time. Upon detection of a hazard, it triggers alarms and activates predefined safety protocols, such as equipment shutdown and alert notifications via SMS or email to relevant personnel.

Accessible through a user-friendly interface via web or mobile app, the system offers monitoring configuration, and real-time analytics capabilities. This project enhances safety by providing early warning and automated responses to potential threats, thereby reducing damage and ensuring the safety of occupants and assets within monitored areas.

4.1 MODULE DIAGRAM:



4.2 METHODOLOGY:

The Hazard Detection System employs a multi-tiered methodology to ensure comprehensive monitoring and rapid response to potential dangers. Firstly, a variety of sensors, including gas detectors, smoke detectors, temperature sensors, and motion sensors, are strategically deployed throughout the monitored area. These sensors continuously collect data on environmental conditions.

Secondly, a central microcontroller processes the incoming sensor data in real-time, utilizing predefined algorithms to detect hazardous conditions such as gas leaks, fires, extreme temperatures, and unauthorized intrusions.Upon detection of a hazard, the system triggers an immediate response, including activating alarms, initiating safety protocols, and sending alerts to relevant personnel via SMS, email, or mobile app notifications.Regular maintenance and calibration of sensors are conducted to ensure accuracy and reliability.Finally, data logs and real-time analytics provide insights into environmental trends and system performance, enabling continuous improvement and optimization of safety measures. This multi-layered approach ensures robust hazard detection and swift response, enhancing overall safety in the monitored environment.

CHAPTER 5

RESULT AND DISCUSSION

The Hazard Detection System demonstrated effective performance in identifying and responding to various hazardous conditions, as validated through extensive testing and evaluation. The system successfully detected simulated scenarios such as gas leaks, fires, extreme temperatures, and unauthorized intrusions with a high degree of accuracy and reliability. During testing, the system exhibited rapid response times upon detection of hazards, triggering alarms and activating safety protocols within milliseconds. This swift action helped prevent escalation of incidents and mitigate potential damage to property and lives. Furthermore, the system's multi-channel alerting mechanism proved invaluable in ensuring timely communication with relevant personnel. Alerts delivered via SMS, email, and mobile app notifications enabled swift response coordination and decision-making, enhancing overall safety outcomes. The user-friendly interface provided by the web dashboard and mobile application facilitated easy monitoring and configuration of the system. Real -time data logs and analytics offered valuable insights into environmental conditions, aiding in proactive maintenance and risk management strategies. Overall, the Hazard Detectio n System proved to be a robust and effective safety solution, offering advanced hazard detection capabilities and rapid response mechanisms. Its successful performance underscores its suitability for deployment in diverse environments, including industrial facilities, residential complexes, and public spaces, where ensuring safety is paramount.

CHAPTER 6

CONCLUSION AND FUTURE WORKS

6.1 Conclusion

In conclusion, the Hazard Detection System represents a critical advancement in safety technology, offering comprehensive monitoring and rapid response capabilities to mitigate potential dangers in diverse environments. By leveraging a network of sensors and a sophisticated microcontroller, the system can swiftly identify hazards such as gas leaks, fires, extreme temperatures, and unauthorized intrusions. Through immediate activation of alarms and predefined safety protocols, it facilitates swift and effective responses to mitigate risks and minimize potential damage.Furthermore, the system's user-friendly interface enables seamless monitoring and configuration, while data logs and real-time analytics provide valuable insights for preventive maintenance and risk assessment. Ultimately, the Hazard Detection System significantly enhances safety protocols, ensuring the well-being of occupants and protection of assets in industrial, residential, and public spaces. Its reliability, efficiency, and ability to provide early warnings make it an indispensable tool for safeguarding against potential hazards.

6.2 Future Work

Future work for the Hazard Detection System includes integrating advanced artificial intelligence algorithms for more accurate hazard identification and predictive analytics. Enhanced sensor technologies, such as hyperspectral imaging and chemical sensing, can broaden the system's capabilities to detect a wider range of hazards. Implementing a decentralized architecture with blockchain technology could enhance data security and facilitate interoperability between different sensor networks. Additionally, exploring the use of drones and robotics for remote hazard assessment and response could further improve the system's effectiveness in challenging environments. Continued research into energy-efficient sensors and communication protocols will also be crucial for scalability and sustainability.

APPENDIX

SOFTWARE INSTALLATION

Arduino IDE

To run and mount code on the Arduino NANO, we need to first install theArduinoIDE. After running the code successfully, mount it.

Sample Code:

```
#define DIGITAL_PIN 2  // Digital pin the sensor is connected to
#define LED_PIN 13     // Digital pin to which an LED is connected (for indication)
#include <DHT.h>

#define DHT_PIN 15    // Pin connected to the DHT sensor
#define DHT_TYPE DHT11
DHT dht(DHT_PIN, DHT_TYPE);// Type of DHT sensor, DHT11 or DHT22


void setup() {
  Serial.begin(115200);
  pinMode(DIGITAL_PIN, INPUT);
  pinMode(LED_PIN, OUTPUT);
  dht.begin(); // Initialize DHT sensor
}

void loop() {
  // Read digital value from sensor
  int sensorValue = digitalRead(DIGITAL_PIN);

  // Print sensor value
  Serial.print("Sensor Value: ");
  Serial.println(sensorValue);

  // Example: if sensor value is HIGH (gas detected), turn on an LED
  if (sensorValue == HIGH) {
    digitalWrite(LED_PIN, HIGH);
  } else {
    digitalWrite(LED_PIN, LOW);
  }
   float humidity = dht.readHumidity();

  // Read temperature value in Celsius
  float temperature = dht.readTemperature();

  // Check if any reads failed and exit early (to try again).
  if (isnan(humidity) || isnan(temperature)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
```

```
  // Print humidity and temperature values to serial monitor
  Serial.print("Humidity: ");
  Serial.print(humidity);
  Serial.print(" %\t");
  Serial.print("Temperature: ");
  Serial.print(temperature);
  Serial.println(" °C");

  delay(1000); // Delay for stability and to avoid flooding the serial monitor
}
```

REFERENCES

[1] Hanyang Ji, Yang Liu, Gaoliang Chen, Lu Kong, Zhenyu Yuan, Fanli Meng,Pre-pulse-driven temperature modulation based on semiconductor gas sensor: A low-temperature strategy for gas detection,Sensors and Actuators B: Chemical,Volume 414,2024,135884,ISSN 0925-4005,https://doi.org/10.1016/j.snb.2024.135884.(https://www.sciencedirect.com/science/article/pii/S0925400524006142)

[2] V. Manikandan, G. Ayyannan, Rajaram S. Mane, Iulian Petrila, Manickam Selvaraj, Robert D. Crapnell, Craig E. Banks,Low-concentration detection of H2S using temperature-dependent Cr-doped cobalt-oxide gas sensors,Journal of Environmental Chemical Engineering,Volume 12, Issue 3,2024,112697,ISSN 2213-3437, https://doi.org/10.1016/j.jece.2024.112697.

[3] Xukun Wang, Xiaoyi Xu, Tingting Zhou, Tong Zhang,Nanoscale MOF-74-based QCM gas sensor for CO2 detection at room temperature,Sensors and Actuators B: Chemical,Volume 413,2024,135874,ISSN 0925-4005, https://doi.org/10.1016/j.snb.2024.135874.

[4] Zhixuan Wu, Zhengai Chen, Zhixiang Deng, Ning Dai, Yan Sun, Meiying Ge,A high-performance room-temperature NH3 gas sensor based on WO3/TiO2 nanocrystals decorated with Pt NPs††Electronic supplementary information (ESI) available. See DOI: https://doi.org/10.1039/d4ra00881b,RSC Advances,Volume 14, Issue 17,2024,Pages 12225-12234,ISSN 2046-2069, https://doi.org/10.1039/d4ra00881b.
.