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Mobile App Controlled Gas Detection and Smart Home Integration

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Abstract: *This paper presents the design and implementation of a mobile app-controlled gas detection and smart home integration system utilizing the Node MCU ESP8266 microcontroller, MQ6 gas sensor, DHT11 temperature and humidity sensor, relay module, and the Blynk platform. The system aims to enhance home safety by detecting gas leaks and enabling remote control of home appliances through a mobile application. The methodology involves sensor calibration, threshold setting, mobile app configuration, and relay control logic. The results demonstrate the system's effectiveness in real-time gas detection and appliance control, with user-friendly interface and reliable performance.*
This research contributes to the advancement of IoT-based smart home solutions for safety and automation.

Keywords: Real time gas detection, automatic exhaust fan control, mobile notification alerts, temperature monitoring, smart home automation

I. INTRODUCTION

Gas leaks pose significant safety hazards in residential areas, often leading to accidents and property damage. Traditional gas detection systems may lack real-time monitoring and remote control capabilities. This research aims to develop an IoT-based gas detection system integrated with smart home features, enabling real-time monitoring and control via a mobile application. The system utilizes the Node MCU ESP8266 microcontroller for Wi-Fi connectivity, the MQ6 gas sensor for gas detection, the DHT11 sensor for environmental monitoring, a relay module for appliance control, and the blynk platform for mobile app interface.

II. LITERATURE REVIEWS

Smart Gas Booking & LPG Leakage Detection System (2020) Authors: Purva Duggal, Akshay Pawar, Poorva Kalkatte

Overview: This system utilizes MQ-2/MQ-6 gas sensors to detect LPG leaks and monitors the gas level in cylinders. When the gas level drops below a certain threshold or a leak is detected, the system sends notifications to users via an Android application, facilitating both safety and automated gas booking.

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LPG/CNG Gas Leakage Detection System with GSM Module (2020) Authors: Alan M John, Bhavesh Purbia
Overview: This project employs an Arduino microcontroller and gas sensors to detect LPG/CNG leaks. Upon detection, the system uses a GSM module to send SMS alerts to designated mobile numbers, ensuring prompt notification to users.
GSM-based Gas Leakage Detection and Ventilation System using Arduino and Servo Motor (2020) Authors: Atkia Samiha, Farhad Hossain Sarker
Overview: Integrating GSM technology, this system detects gas leaks and sends text message alerts to users' phones. Additionally, it employs a servo motor to control ventilation mechanisms, enhancing safety by maximizing the range of people notified.
Automated Unified System for LPG using Load Sensor (2019)
Authors: Gokula Kaveeya S, Gomathi S, Kavipriya K, Kalai Selvi A, Sivakumar S
Overview: This system combines MQ-5 gas sensors and load cells to detect LPG leaks and measure gas levels in cylinders. It automates the gas booking process when the gas level falls below a predefined threshold, enhancing user convenience.
Gas Leakage Detection and Smart Alerting and Prediction Using IoT (2020) Authors: Asmita Varma, Prabhakar S, Kayalvizhi Jayavel
Overview: Leveraging IoT technology, this system detects gas leaks and alerts users through calls, SMS, and emails. It also performs data analytics to predict potential hazardous situations, aiming to prevent accidents proactively
LPG Gas Leakage Detection Using IoT (2017) Authors: Dr. Chetana Tukkoji, Prof. Sanjeev Kumar
Overview: This IoT-based system classifies LPG leakage into three categories: LOW, MEDIUM, and HIGH, based on concentration levels. It provides real-time monitoring and alerts, enhancing safety measures in residential and industrial settings.
Gas Leakage and Fire Detection Using Raspberry Pi (2019) Authors: Sourabh Jamadagni, Nikita Chougule**,** Priyanka Sankpal
Overview: This industrial monitoring system utilizes Raspberry Pi and MQ-2 sensors to detect gas leaks and fires. It emphasizes real-time monitoring and alerting, aiming to enhance safety in industrial environments

III. SYSTEM DESIGN AND ARCHITECTURE

Hardware Components:

- **Node MCU ESP8266**: Serves as the microcontroller with Wi-Fi capabilities, enabling communication between sensors, relay modules, and the mobile application.
- **MQ6 Gas Sensor:** Detects the presence of gases such as LPG, methane, and carbon monoxide, providing analog output proportional to gas concentration.
- **DHT11 Sensor:** Measures temperature and humidity levels, providing digital output for environmental monitoring.
- **Relay Module**: Controls home appliances by switching them on or off based on sensor inputs.
- **Buzzer and LEDs**: Provide auditory and visual alerts for gas detection and system status.

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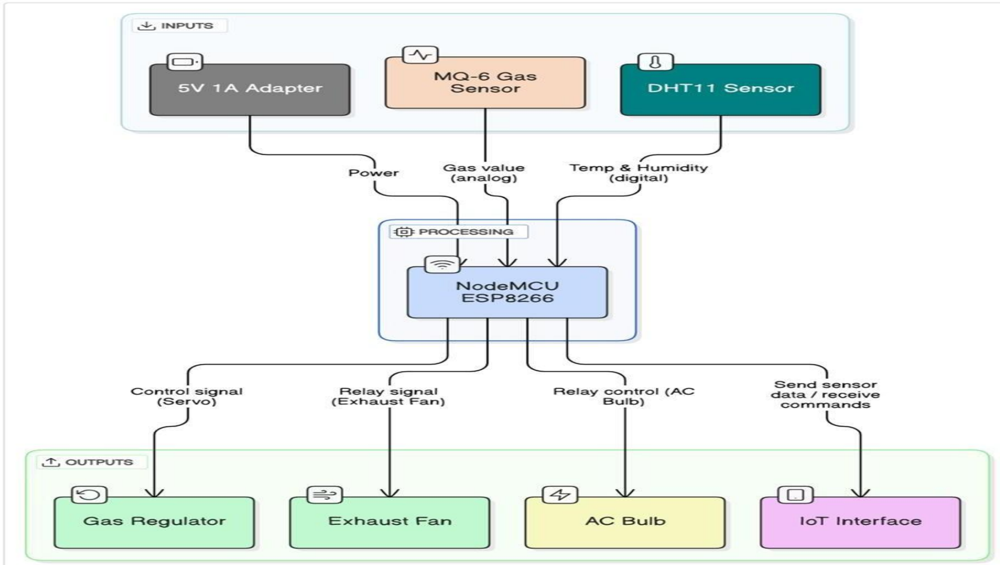

Software components:

- **Arduino IDE:** Used for programming the Node MCU microcontroller
- **Blynk App:** Provides a mobile interface for monitoring sensor data and controlling appliances
- **Blynk Cloud Server:** Facilitates communication between the NodeMCU and the Blynk app

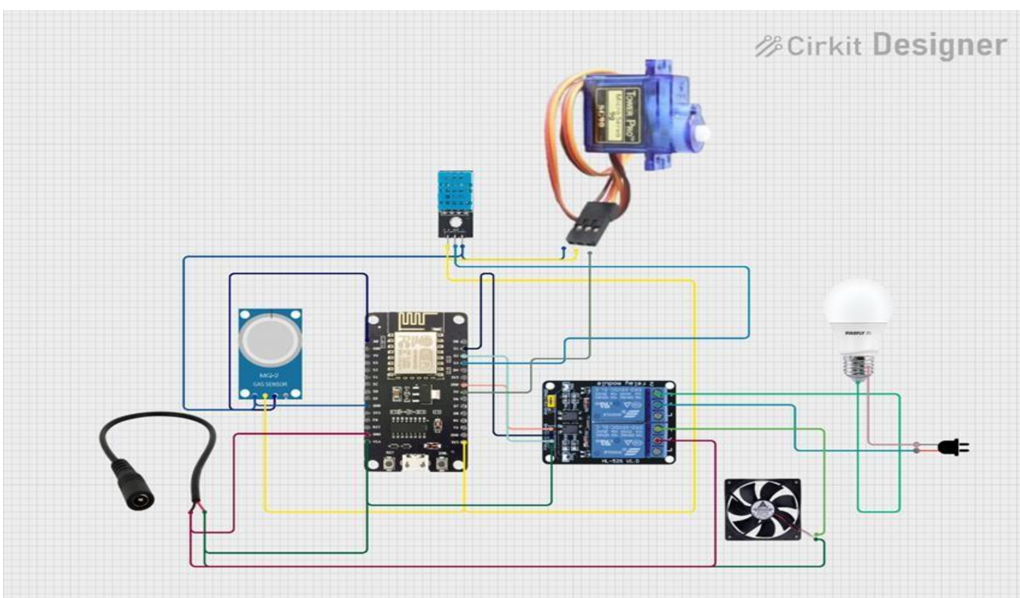

Fig. Circuit Diagram

IV. METHADOLOGY

Sensor Calibration**:**

MQ6 Gas Sensor: Calibrated by exposing it to known concentrations of gases and adjusting the sensor's output accordingly to ensure accurate readings.

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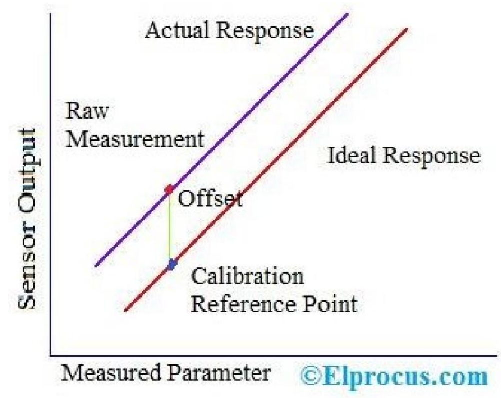
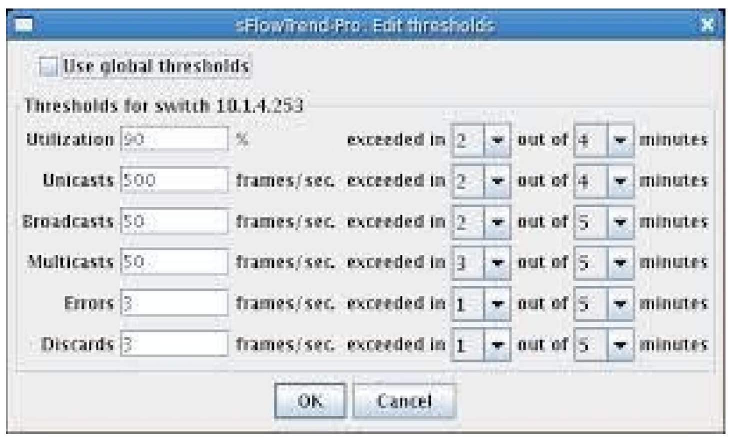
DHT11 Sensor: Factory-calibrated with coefficients stored in OTP memory. Additional calibration can be performed using saturated salt solutions to verify and adjust readings.



Threshold Setting:
Threshold values for gas concentration and environmental conditions were determined based on safety standards and sensor specifications.



Mobile App Configuration
The Blynk app was configured by creating a new project, selecting the Node MCU ESP8266 as the device, and assigning virtual pins to widgets such as Value Display for gas concentration and Button for relay control.

- **Relay Control Logic**: Implemented logic to control appliances based on sensor inputs. For example, if gas concentration exceeds a predefined threshold, the relay is activated to shut off the gas supply.
- **Data Logging and Analysis**: Data from sensors were logged and Analysed to evaluate system performance and identify patterns in gas concentrations and environmental conditions.
- **Security Measures**: Implemented encryption for data transmission between the Node MCU and the Blynk app to protect user privacy. Established authentication mechanisms to prevent unauthorized access to the system. Regularly updated the firmware of the Node MCU to patch vulnerabilities and improve system performance

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V. RESULTS AND DISCUSSION

System Performance and Accuracy

The IoT-based gas detection system demonstrated commendable performance in detecting gas leaks and monitoring environmental conditions. The MQ6 gas sensor, known for its sensitivity to LPG, methane, and propane, effectively identified gas concentrations exceeding predefined safety thresholds. In controlled experiments, the system successfully triggered alerts and activated connected appliances through the relay module upon detecting gas leaks. The DHT11 sensor provided accurate measurements of temperature and humidity, contributing to a comprehensive environmental assessment. The Node MCU ESP8266 microcontroller processed data from both sensors and communicated with the Blynk platform, ensuring real-time monitoring and control. The system's responsiveness was evident, with minimal latency between gas detection and alert activation.

User Interface and Remote Monitoring

The integration with the Blynk platform facilitated a user-friendly mobile interface, allowing users to monitor sensor readings, receive notifications, and control appliances remotely. The mobile application displayed real-time data from the MQ6 and DHT11 sensors, providing users with up-to-date information on gas concentrations and environmental conditions. Push notifications alerted users to gas leaks, enabling prompt responses to potential hazards. Manual control features within the Blynk app allowed users to override automatic actions, such as turning off the gas supply or activating ventilation systems, enhancing user control over the smart home environment.

Reliability and Connectivity

The system exhibited stable Wi-Fi connectivity, ensuring continuous communication between the Node MCU microcontroller and the Blynk cloud server. Data transmission occurred without significant interruptions, and the system maintained consistent performance over extended periods. This reliability is crucial for safety-critical applications, where timely detection and response are paramount. Field tests conducted in various environmental conditions confirmed the system's robustness. The sensors maintained accuracy across different temperatures and humidity levels, and the system responded promptly to simulated gas leaks.

Limitations and Challenges

Despite its strengths, the system faced certain limitations. The MQ6 gas sensor's sensitivity can be influenced by environmental factors such as temperature and humidity, potentially affecting detection accuracy. Calibrating the sensor to account for these variables is essential to maintain reliable performance. Power consumption emerged as a consideration, especially in battery-operated setups. The Node MCU and sensors require a stable power supply for continuous operation. Implementing power-saving techniques or incorporating energy-efficient components could mitigate this issue Network connectivity is another critical factor. In areas with unstable Wi-Fi signals, data transmission may be delayed, impacting the system's responsiveness. Ensuring robust network infrastructure is necessary to support real-time monitoring and control.

Comparison with Existing Systems

When compared to traditional gas detection systems, the IoT-based approach offers significant advantages. Traditional systems typically provide local alerts without remote monitoring capabilities. In contrast, the proposed system enables users to receive notifications and control appliances from anywhere, enhancing safety and convenience. Additionally, the integration with the Blynk platform allows for data visualization and historical analysis, features not commonly found in conventional systems. This data-driven approach facilitates informed decision-making and proactive safety measures.

Future Enhancements

To further improve the system, several enhancements can be considered:

- **Sensor Calibration**: Implementing automatic calibration routines to adjust sensor readings based on environmental conditions can enhance accuracy.
- **Power Management**: Integrating low-power components and optimizing software algorithms can reduce energy consumption, extending battery life.
- **Multi-Sensor Integration**: Incorporating additional sensors, such as smoke detectors or carbon monoxide sensors, can provide a more comprehensive safety solution.
- **AI Integration**: Applying machine learning algorithms to analyze sensor data can enable predictive maintenance and early detection of potential issues.

These enhancements can contribute to a more robust and intelligent gas detection and smart home integration system, aligning with the evolving demands of modern residential safet

VI. CONCLUSION

The integration of IoT technologies into gas detection systems has significantly enhanced safety measures in residential settings. By employing the Node MCU ESP8266 microcontroller, MQ6 gas sensor, DHT11 sensor, Relay module, and the Blynk platform, this project demonstrates a comprehensive approach to monitoring and controlling gas leaks in real time. The system's ability to detect hazardous gas concentrations, coupled with automated responses such as appliance control and user notifications, underscores its potential to prevent accidents and ensure household safety. The user-friendly interface provided by the Blynk mobile application allows for seamless interaction, enabling users to monitor sensor data and receive alerts remotely. This accessibility is crucial for timely interventions, especially in scenarios where immediate action is required to mitigate risks. While the system has shown promising results, future enhancements could focus on improving sensor calibration, optimizing power consumption, and expanding the range of detectable gases. Additionally, integrating artificial intelligence could further refine detection capabilities and predictive maintenance, leading to a more intelligent and responsive system. In conclusion, this project exemplifies the transformative impact of IoT in creating safer and more efficient living environments. As smart home technologies continue to evolve, the integration of advanced gas detection systems will play a pivotal role in safeguarding residents and property.

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