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INTEGRATED LPG LEVEL MONITORING AND ALERT SYSTEM USING IOT AND MACHINE LEARNING

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Abstract:

The "Integrated LPG Level Monitoring and Alert System Using IoT and Machine Learning" project leverages IoT and machine learning technologies to enhance safety and efficiency in managing LPG gas cylinders. The system integrates an Arduino UNO microcontroller with various sensors, including gas sensors for detecting leaks, a load cell for monitoring cylinder weight, and a buzzer for audible alerts. An LCD provides real-time display of sensor data, while a red LED visually indicates abnormal conditions. When low gas levels or gas leakage are detected, the GSM module sends instant SMS alerts to notify users of potential hazards. The collected data is transmitted to a Python-based system where a Random Forest algorithm predicts and classifies the LPG levels into good or bad categories. This integration of embedded systems with advanced data analysis ensures timely detection of issues and improves safety by providing proactive alerts and precise monitoring of LPG levels.

Key words: Monitoring, Prediction, Leakage, Hazards.

Introduction:

In today's world, the safety and efficient management of liquefied petroleum gas (LPG) is paramount, especially in residential and commercial settings. Traditional monitoring systems often fall short in providing real-time data and proactive alerts, which can lead to dangerous situations, such as gas leaks or running out of gas unexpectedly. To address these challenges, the "Integrated LPG Level Monitoring and Alert System Using IoT and Machine Learning" project harnesses the power of Internet of Things (IoT) and machine learning technologies. By integrating a variety of sensors with an Arduino UNO microcontroller, this innovative system enables comprehensive monitoring of LPG gas cylinders. It not only detects potential hazards but also provides timely notifications to users through SMS alerts. Furthermore, advanced data analysis utilizing a Random Forest algorithm enhances the system's predictive capabilities, classifying LPG levels and improving overall safety. This project represents a significant step forward in smart gas management, combining embedded systems with cutting-edge analytics to ensure a safer environment.

Literature Survey:

1. IoT-Based Smart LPG Monitoring System

A study by Kumar et al. (2020) proposed an IoT-enabled LPG monitoring system that utilizes gas sensors to detect LPG levels and leakage. The system uses Wi-Fi or GSM modules to send alerts to users via mobile applications. The findings highlight the real-time monitoring capabilities of IoT in improving safety and efficiency.

2. Machine Learning for Predictive Gas Leak Detection

Singh and Verma (2021) implemented machine learning model to predict potential LPG leaks based on historical sensor data. By using classification algorithms, the system was able to identify anomalies in gas usage patterns, significantly reducing false alarms and enhancing detection accuracy.

3. Wireless Sensor Networks in LPG Monitoring

A study by Rahman et al. (2019) explored the integration of Wireless Sensor Networks (WSNs) in LPG monitoring. The Research demonstrated how multiple sensor nodes placed around LPG cylinders can detect leaks from different angles and Improve reliability.

4. Mobile-Based LPG Level Alert System

Patel and Sharma (2018) developed an SMS and app-based alert system that notifies users when LPG levels drop below a Critical threshold. The system integrates an MQ-6 gas sensor and a NodeMCU microcontroller, providing an affordable solution for households and industries.

5. AI-Driven Smart LPG Management System

A recent study by Gupta et al. (2022) explored Artificial Intelligence (AI) techniques to analyze gas consumption trends and predict refill requirements. The system improves fuel efficiency and safety by learning user behavior and sending proactive alerts.

6. IoT and Cloud Integration for LPG Monitoring

Reddy and Thomas (2020) designed a cloud-based LPG monitoring system where real-time sensor data is stored and analyzed using cloud computing platforms like AWS and Google Firebase. The system offers data visualization dashboards, improving transparency for both consumers and suppliers.

7. LPG Leakage Detection Using Deep Learning

Chowdhury et al. (2021) applied deep learning techniques like Convolutional Neural Networks (CNNs) to analyze gas leak sensor data. The model demonstrated an accuracy of over 95% in detecting gas leaks under different environmental conditions.

8. GSM-Based LPG Safety System

A study by Bansal and Mehta (2017) explored a GSM-based gas safety system, where a SIM900 GSM module sends emergency alerts to authorities and users. The system also includes an automatic shut-off valve to prevent further leakage.

9. Smart LPG Cylinder with IoT and Weight Sensors

Das et al. (2019) proposed a smart LPG cylinder that integrates weight sensors to measure gas levels accurately. The system automatically orders a new LPG cylinder when the gas level reaches a critical point, reducing manual monitoring efforts.

10. Hybrid IoT-Machine Learning for LPG Monitoring

A hybrid approach by Mukherjee and Roy (2023) combined IoT, machine learning, and blockchain for an ultra-secure LPG monitoring system. The system ensures tamper-proof data logging, preventing gas theft and unauthorized usage.

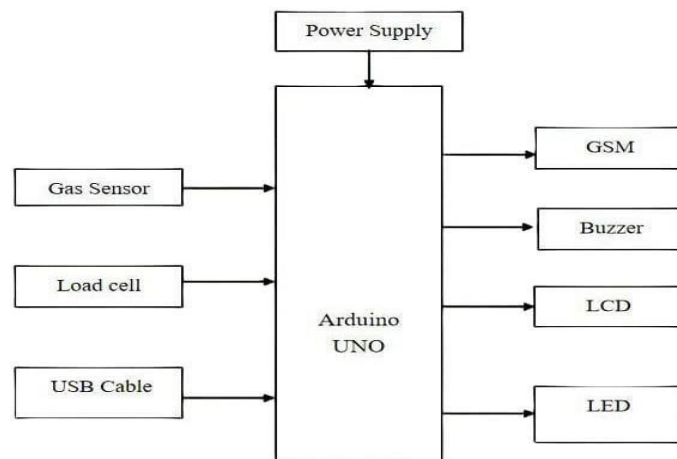
Methodology:

Fig 1- Block Diagram

The Integrated LPG Level Monitoring and Alert System using IoT and Machine Learning continuously monitors the LPG gas level in cylinders using an IoT-enabled gas sensor. The sensor data is transmitted to a cloud platform for real-time analysis. Machine learning algorithms analyze consumption patterns to predict low levels or potential leaks. When critical thresholds are detected, the system sends automated alerts via SMS or email to users and service providers, ensuring timely refills and enhanced safety. The model send the collected sensor values to the IoT cloud platform ThingSpeak which is useful for remote monitoring of the environmental values with the use of internet. The machine learning model takes the input data from this ThingSpeak.

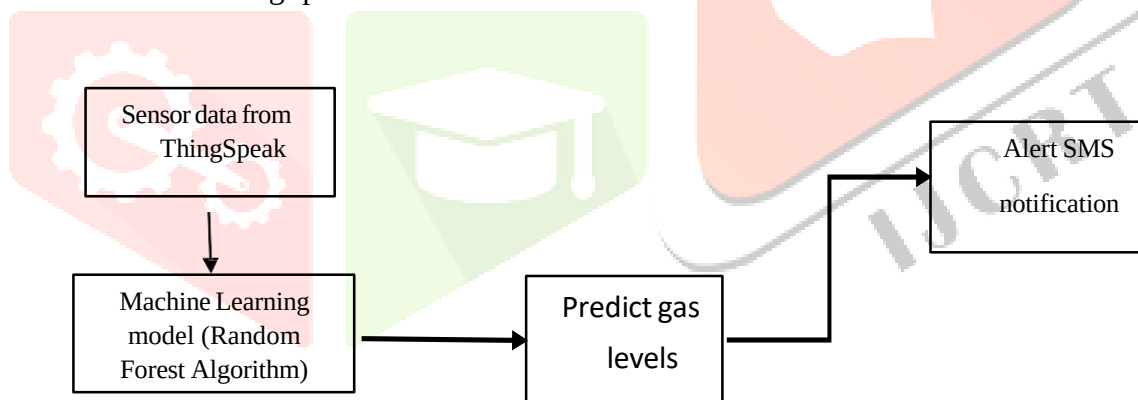


Fig 2- ML module block diagram

The microcontroller collects the data from the sensors and sends to the thingspeak cloud. The machine learning uses random forest algorithm which takes the data from the thingspeak cloud through API keys to analyse the data. This model makes some predictions based on that dataset. This machine learning model uses some formulas of random forest algorithm to process the data to learn and it understand the patterns, relationships in the dataset. After the model is trained, it makes the predictions by taking the sensor inputs from the thingspeak.

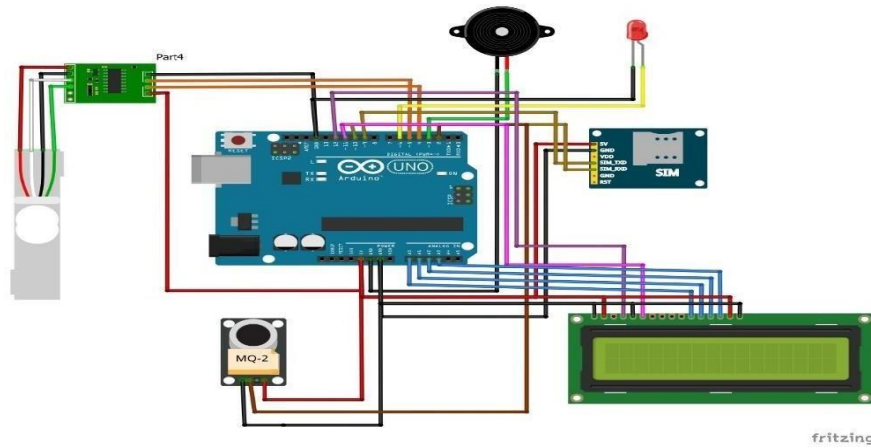
Circuit Diagram:

Fig 3- Circuit Diagram

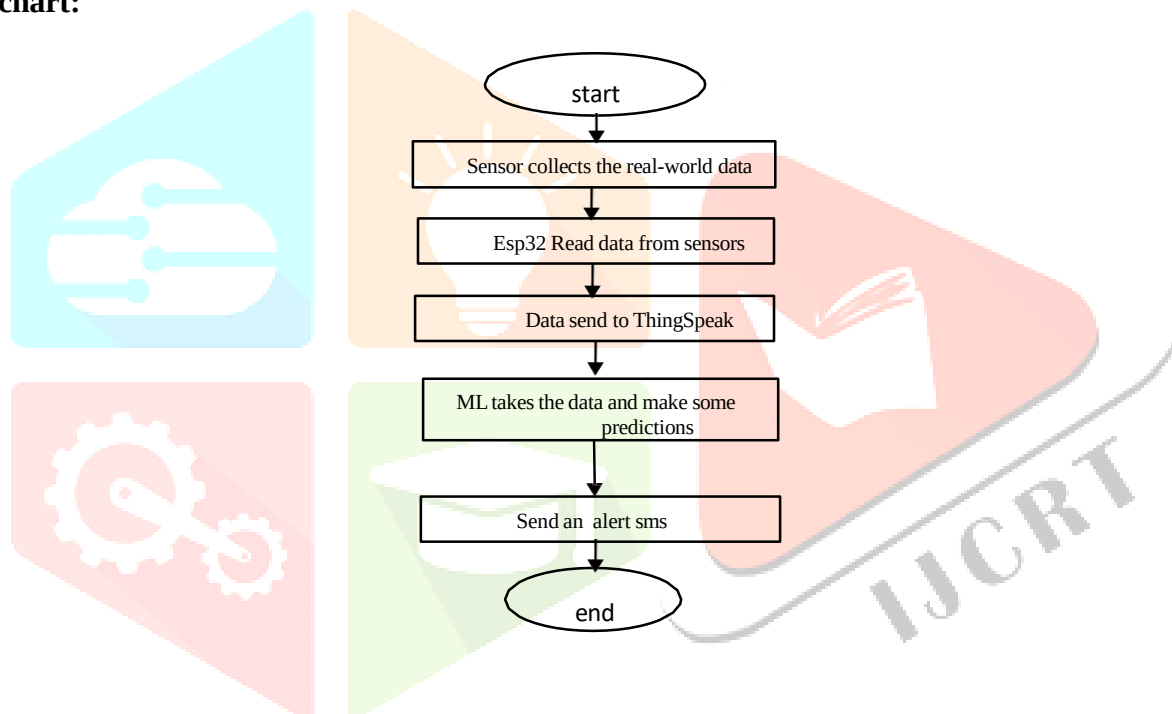
Flowchart:

Fig 4-Flowchart

Advantages:

- 1.Enhanced Safety: Automatically detects and alerts users about LPG leaks, preventing potential hazards.
2. Real-Time Monitoring: Provides continuous LPG level tracking through IoT, ensuring timely refilling.
- 3.User Convenience: Sends smart alerts via mobile device, allowing remote monitoring and Management.

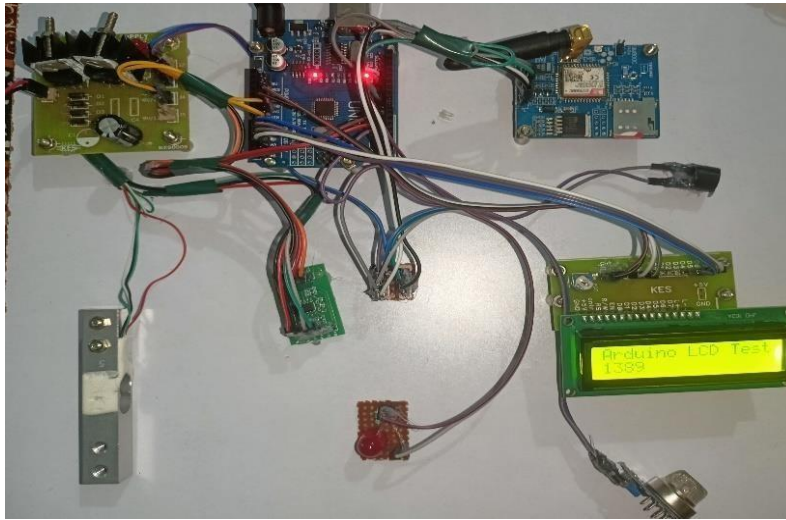
Result:

Fig 5- Project Setup

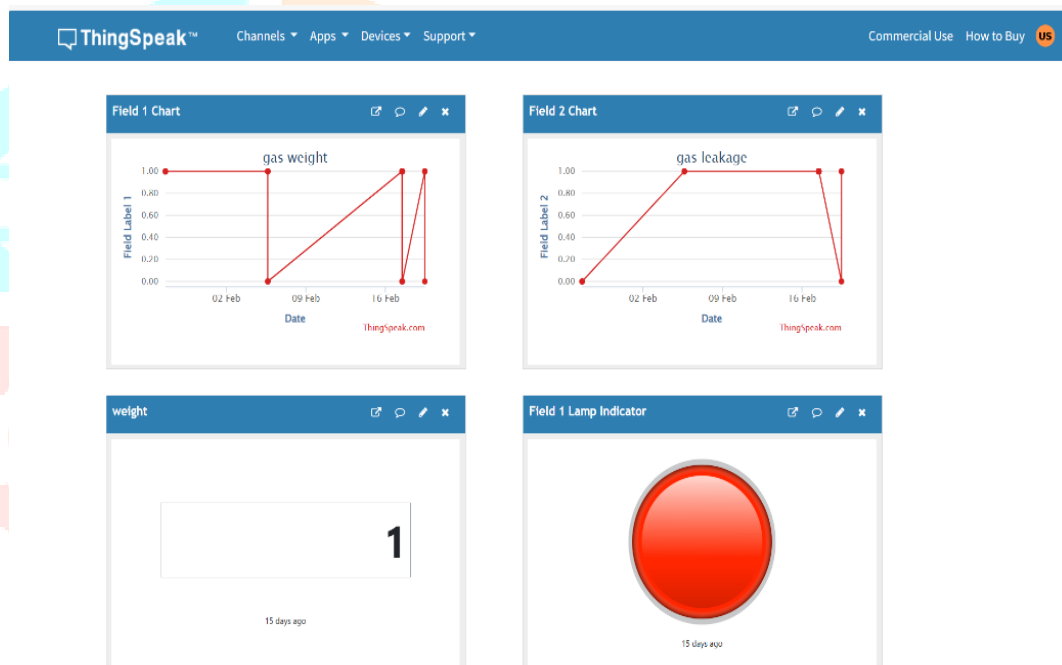


Fig.6- Sensor values in the ThingSpeak

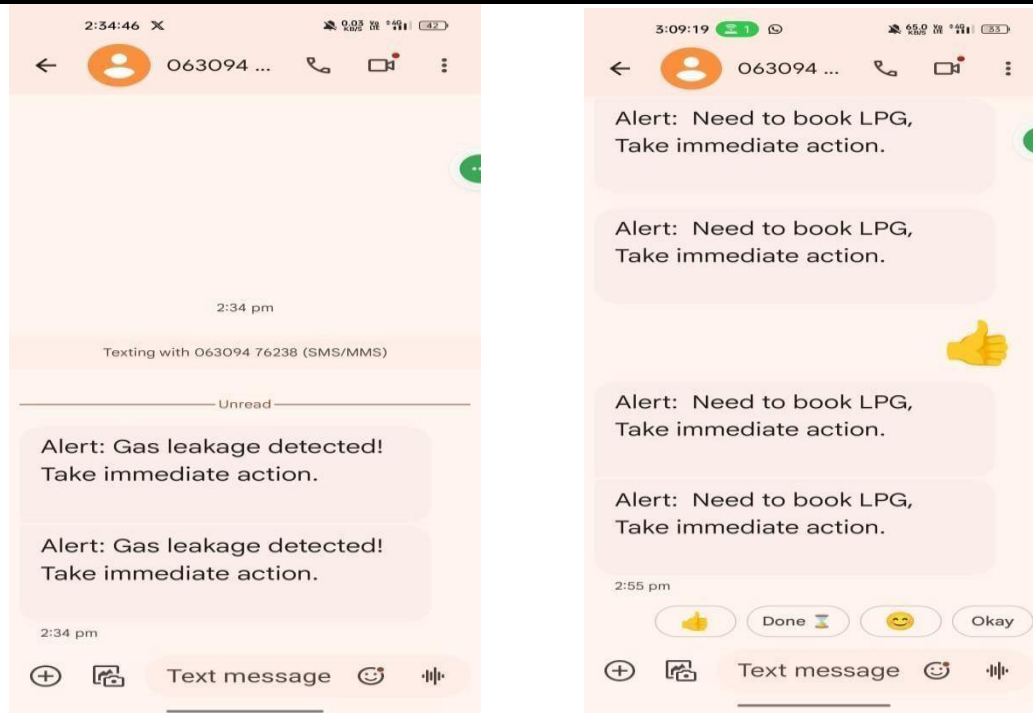


Fig.7- Alert SMS send to the user

Conclusion:

In conclusion, the "Integrated LPG Level Monitoring and Alert System Using IoT and Machine Learning" project represents a significant advancement in the safe management of LPG gas cylinders. By effectively combining IoT technology, machine learning, and real-time monitoring capabilities, the system not only detects gas leaks and low levels but also enhances user awareness through immediate SMS alerts. The use of advanced data analytics, particularly the Random Forest algorithm, allows for accurate classification and prediction of LPG levels, thereby empowering users to take proactive measures. This innovative approach not only improves safety but also promotes efficient usage of LPG, making it a valuable solution for households and businesses alike. As we continue to explore the integration of technology in everyday life, systems like this pave the way for smarter, safer living environment.

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