

LPG Transport Tracking and Leakage Detection with Accident Prevention System using ML

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Abstract - Transportation of LPG cylinders involves significant safety risks due to possible gas leakage, vehicle accidents, and improper handling during transit. This project presents a smart LPG transport safety system designed to improve monitoring and emergency response. The system is developed using an Arduino microcontroller that gathers data continuously from different sensors.

The system uses multiple sensors to monitor the safety of LPG transportation. It is designed to improve the safety of LPG transportation through continuous monitoring and early hazard detection. A gas sensor constantly checks the surroundings for any indication of LPG leakage. A load cell measures the weight of the LPG cylinder, making it possible to identify unexpected weight loss. A GPS module continuously tracks the vehicle's location, allowing its position to be monitored in real time.

Whenever the system detects a gas leak, an accident, or any other abnormal situation, a GSM module immediately sends alert messages to authorized users. For local notification, a buzzer produces an audible warning so that nearby personnel can quickly respond to potential dangers. An LCD display provides instant feedback by showing current sensor readings and the operational status.

A Python-based application that employs the Random Forest machine learning algorithm. This algorithm evaluates the sensor readings and classifies the system's condition into categories such as normal operation, gas leakage, or accident occurrence. By incorporating machine learning techniques, the system improves the accuracy of event detection and minimizes false alarms.

A regulated 12 V power supply provides stable operation of all hardware components. Overall, the system offers a reliable solution for LPG transportation safety by enabling continuous monitoring, timely hazard detection, and rapid alert generation.

Key Words: Arduino UNO, MEMS sensor, Load Cell, MQ135 gas sensor, LCD Display.

1. INTRODUCTION

LPG is used for domestic and industrial purposes because of its efficiency and convenience. However, transporting LPG cylinders is associated with several safety risks due to the combustible nature of the gas. Leakage during transportation, careless handling, or vehicle related accidents may lead to fire hazards, explosions, and serious damage to life and property.

Because of these risks, there is a growing need for a reliable system that can continuously monitor the condition of LPG cylinders during transit and provide immediate warnings whenever unsafe situations occur.

This project is about developing a smart safety monitoring system for LPG transportation. The system uses an Arduino microcontroller to collect data from sensors and monitor the condition of the LPG cylinder during transport. The collected data is used to identify possible safety issues such as gas leakage or other abnormal conditions. Machine learning techniques are used to improve the accuracy of detection. The main aim of this project is to increase safety and reduce risks during LPG transportation. Different sensors are used in the prototype to monitor safety during LPG transportation. A gas sensor is used to detect LPG leakage. A load cell is used to measure the weight of the cylinder and identify any unusual loss of gas. A MEMS sensor is used to detect sudden movements, tilting, vibrations, or accidents during transportation. To improve the monitoring system, GPS and GSM modules are also used in the prototype. The GPS module helps to track the current location of the vehicle, while the GSM module sends alert messages to users when any abnormal condition is detected. An LCD display shows the sensor readings, and a buzzer gives an immediate warning alert. The sensor data is also analyzed using Python with the Random Forest machine learning algorithm to improve the detection of unsafe conditions. The algorithm classifies system conditions into categories such as normal operation, gas leakage, and accident situations. By combining hardware-based sensing with intelligent data analysis, the proposed system demonstrates an effective and economical approach for improving safety and monitoring during LPG transportation.

2. LITERATURE REVIEW

Puja Chavan cholke[1] introduced the concept of LPG Transport tracking using IoT (Internet of Things) sensor technology and machine learning method. The system collects environmental data continuously, which is obtained from connected sensors, through which the data levels of gases is collected, and the data obtained is analyzed using the Random Forest algorithm, which helps to assess the state of the gases and make decisions that are automated. The accuracy of the model was tested in an experiment (around 96.6%) and was found to be superior to some other algorithms. Overall, the study showcases the potential of leveraging IoT and machine learning for real-time monitoring.

Sincy Elezebeth Kuruvilla[2] has created Real Time Detection and Alerting System for LPG Gas Leakage with Weight-Based Consumption Tracking, AIML approaches to enhance the detection operations. The proposed system consists of a network of sensors that collect real-time environmental data such as weight level, gas concentration and a cloud platform for monitoring and analysis. Plus, the system can be accessed remotely via mobile apps, which means users can check on the farm from anywhere. The study serves as a testament to the potential of combining the IoT and machine learning to improve the health of poultry, boost productivity, and drastically cut down on manual management efforts.

Mr.Selvakumar[3] researched automatic monitoring and LPG leakage detection and alerting user by notification on machine learning approaches of live weight of broilers. The system of data collection used in their research was that many of the parameters were continuously recorded. The approach transforms the traditional manual measure practices, so that less labor is needed and it yields accurate and timely predictions

3.METHODOLOGY

The proposed leakage detection system is designed to monitor parameters continuously and automatically monitors. The system integrates an Arduino Uno microcontroller, sensing modules, Power supply, GSM, GPS modules.

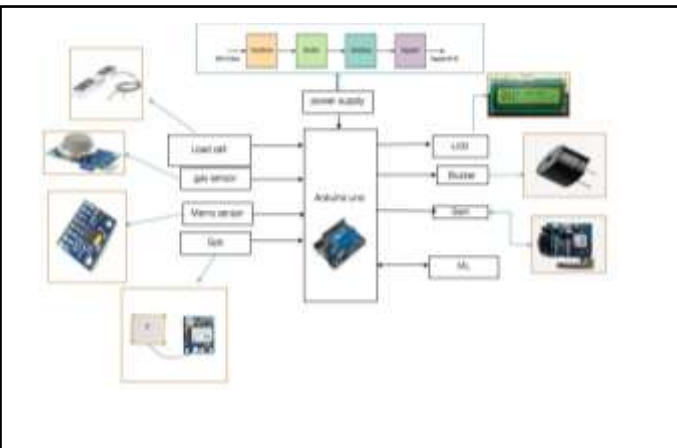


Fig 1: Block diagram

3.1 System Architecture

Various sensors installed in the vehicle continuously monitor important parameters such as LPG leakage, cylinder weight, vehicle movement, and geographical location

The measured values are received by the Arduino Uno, which processes the information and displays the current system status on the LCD screen. The machine learning model examines the incoming data and determines whether the system is operating normally or if conditions such as gas leakage, accident occurrence, or a low gas level are present. Once the analysis is completed, the prediction outcome is transmitted back to the Arduino controller. If the system identifies any unsafe or unusual condition, the controller

immediately triggers warning mechanisms, including audible buzzer alerts and visual indications

3.2 Working Procedure

The operation of the proposed system is carried out in the following sequence:

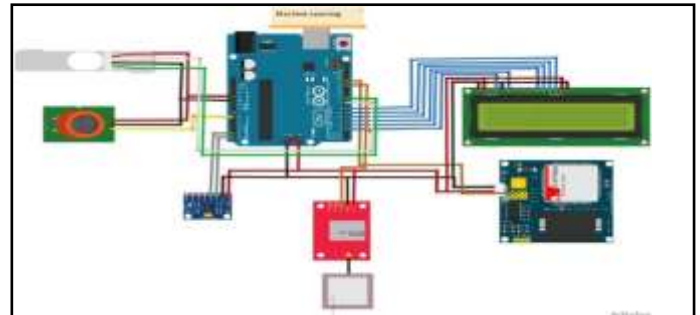


Fig 2: Circuit diagram

Step 1: The power supply energizes the Arduino Uno and all connected modules. The Arduino initializes the load cell, gas sensor, MEMS sensor, GPS, LCD, buzzer, GSM module, and ML module before starting the monitoring process.

Step 2: The Arduino continuously reads data from the load cell, gas sensor, MEMS sensor, and GPS module. These sensors monitor weight, gas concentration, movement, and location in real time.

Step 3: The collected sensor data is processed by the Arduino and sent to the Machine Learning (ML) module. The ML model analyses the readings to determine whether the system is operating under normal or abnormal conditions.

Step 4: If any abnormal condition such as gas leakage, excessive weight, or unusual movement is detected, the Arduino activates the buzzer and displays the warning message on the LCD.

Step 5: The GPS module provides the current location coordinates. The GSM module then sends an alert message containing the detected hazard and GPS location to predefined emergency contacts.

Step 6: After sending the alert, the Arduino continues monitoring all sensor values. The system remains active and repeats the process continuously to ensure real-time detection and safety.

3.3 Control Algorithm

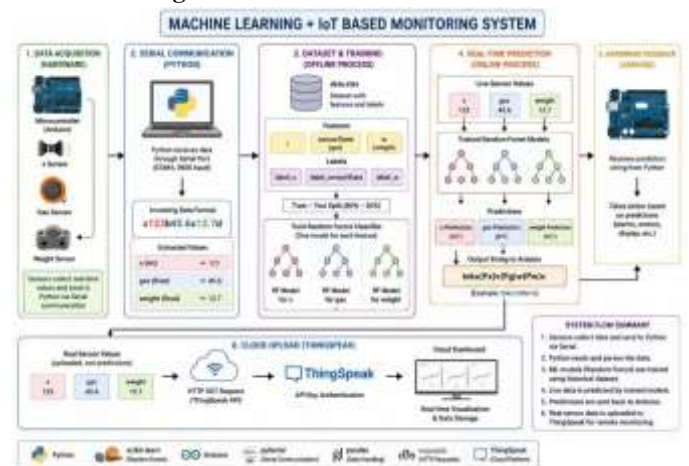


Fig 3: Working flow of algorithm

The proposed control algorithm operates according to the following logic:

1. The Arduino Uno continuously collects real-time data from the gas sensor, weight (load cell) sensor, and other connected sensors.
2. The collected sensor data is transmitted to a Python program through serial communication for pre-processing and feature extraction.
3. The pre-processed data is compared with the trained Machine Learning (Random Forest) model to classify the system condition as normal or abnormal.
4. The prediction result is sent back to the Arduino, which takes the appropriate action based on the identified condition.
5. If an abnormal condition is detected, the Arduino activates the buzzer, displays the warning message on the LCD, and initiates the necessary safety measures.
6. Simultaneously, the sensor readings and prediction results are uploaded to the Thing Speak cloud platform for real-time monitoring, visualization, and data storage.
7. The entire process is repeated continuously, enabling real-time monitoring, intelligent decision-making, and immediate response to hazardous conditions.
8. Repeat the monitoring and control cycle continuously until the system is switched off.

The proposed methodology provides an intelligent, low-cost, and IoT-enabled solution for automatic gas leakage. By combining continuous parameter monitoring, cloud-based remote supervision, the system improves reliability, enhances safety, minimizes manual intervention, and ensures efficient utilization of available electrical resources.

4. Results and Discussion

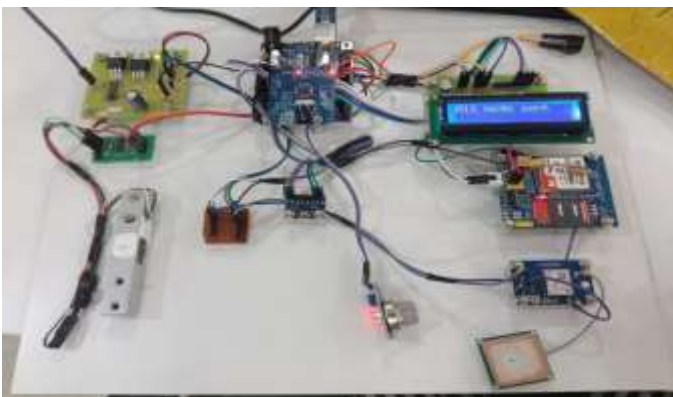


Fig 4: Project Model

The system integrates a **load cell** to measure weight, a **gas sensor** to detect hazardous gases, a **MEMS sensor** to monitor movement or vibration, a **GPS module** to determine the current location, and a **GSM module** to transmit alert messages. Sensor data is processed using a **Random Forest machine learning model**, which classifies the system condition as normal or abnormal. When an abnormal condition is detected, the Arduino activates the **buzzer**, displays the warning message on the **LCD**, and sends an SMS containing the alert and GPS location to predefined contacts. The sensor

readings and prediction results can also be uploaded to the cloud for real-time monitoring and analysis.



Fig 5: Implementation

Figure 4 and Figure 5 show the developed hardware prototype and its implementation.

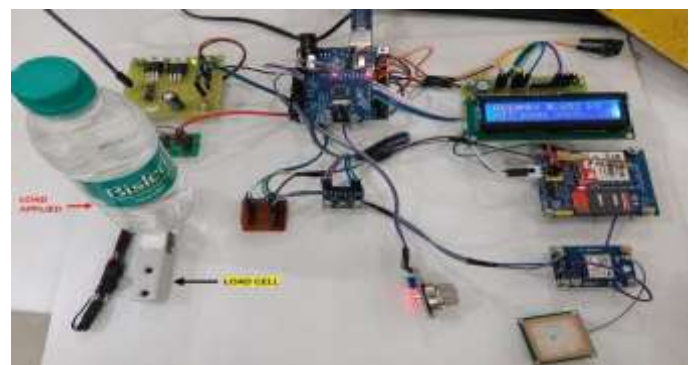


Fig 6: Load is applied to the load cell

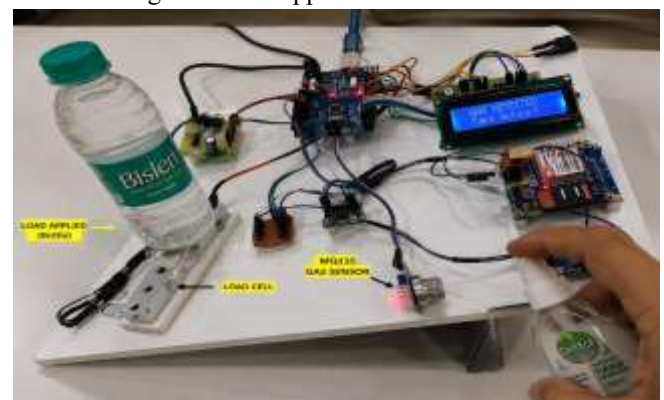


Fig 7: Gas is detected by sensor

Figure 6 and Figure 7 demonstrate the real-time monitoring of load applied and supply voltage through the LCD display. The measured supply voltage was approximately **5V**, indicating accurate sensing and stable system performance.



Fig 8: remote monitoring

Figure 8 This interface features two main graphical fields: 1.(Air Quality - MQ135): You can see the graph spike sharply to orange, coinciding with the "GAS DETECTED"

event from the sanitizer spray.

2. (Weight - Load Cell): This graph shows a steady plateau, representing the constant weight of the water bottle (approximated at 250g).

5. Conclusion and Future Scope

Ensuring the safe movement of LPG cylinders is essential, as any unexpected incident during transportation can lead to serious safety concerns. The developed system addresses this requirement by bringing together monitoring, tracking, and communication technologies. The proposed framework continuously observes important contents as gas concentration, cylinder weight, vehicle movement, and geographical location. By analysing these inputs in real time, the system can recognize unusual conditions and take appropriate action before the situation becomes critical. The integration of machine learning techniques enhances the system's ability to interpret sensor information accurately and identify potential hazards more effectively.

A key strength of the project is its capability to deliver timely notifications whenever unsafe conditions are detected. Location information is found GPS, combined with GSM-based communication, enables responsible personnel to receive alerts quickly and respond without unnecessary delays. This feature can play a significant role in reducing losses and improving emergency handling.

Its compact design, affordability, and ease of deployment make it suitable for practical use in LPG distribution and other applications involving hazardous materials.

In summary, the project presents a dependable approach for enhancing transportation safety through continuous monitoring, intelligent analysis, and instant communication. The combination of embedded technology and data-driven decision-making helps create a safer operating environment and supports more secure handling of LPG during transit.

The future scope of an **LPG Transport Tracking and Leakage Detection with Accident Prevention System using the Random Forest algorithm** includes improving prediction accuracy through larger real-world datasets and advanced IoT sensors for real-time monitoring of gas leakage, pressure, temperature, and vehicle conditions. The system can be enhanced with cloud-based monitoring, mobile applications, predictive maintenance, and automatic emergency alerts to improve response time. Future integration with edge computing, smart traffic systems, and advanced machine learning models can further increase safety, reduce accidents, minimize LPG leakage, and improve the overall efficiency of LPG transportation.

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