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GSM Based LPG Gas Cylinder Level Indication and Leakage Detection Alert System

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ABSTRACT

The GSM-Based LPG Gas Cylinder Level Indicator and Leakage Detection Alert System is a safety-enhancing and user-friendly solution designed for domestic and industrial applications. This system employs a load cell sensor, gas leakage sensor (MQ-2), GSM module (SIM900), and microcontroller to enable real-time gas monitoring and alert mechanisms. The load cell sensor continuously measures the LPG gas cylinder level, and when it drops below a predefined threshold, the GSM module sends an SMS and call notification to the designated user, prompting timely cylinder refilling. Simultaneously, the gas sensor detects LPG leakage, immediately triggering a buzzer alarm and transmitting an alert message to prevent hazardous incidents. The system is designed for autonomous operation, reducing manual monitoring efforts and minimizing risks associated with gas leaks, fire hazards, and explosions. This cost-effective, efficient, and scalable technology ensures continuous gas level tracking, rapid leakage detection, and enhanced safety measures. Its user-friendly interface, low power consumption, and easy installation make it an ideal safety solution for homes, restaurants, commercial kitchens, and industrial gas storage facilities. By providing instant alerts and proactive safety management, this system significantly improves LPG usage efficiency and accident prevention strategies.

Keywords: GSM-Based LPG Monitoring, Gas Leakage Detection , Real-Time Alert System, Automatic Cylinder Level Indicator

1. Introduction

The GSM-based Gas Cylinder Level Indicator and Leakage Detection Alert System offers an innovative and reliable solution to improve safety and convenience when using LPG gas in various settings, including homes, businesses, and industrial environments. This system integrates two critical functions—monitoring gas cylinder levels and detecting potential gas leaks—using Global System for Mobile Communications (GSM)[6] technology to keep users informed through real-time alerts and it was developed by Jain et al., in 2012[7].

The system employs sensors such as weight sensors or pressure transducers to measure the amount of gas remaining in the cylinder. This data is constantly monitored by a microcontroller, which processes the information and sends SMS notifications to the user's mobile phone when the gas level reaches a critical point. This early warning system allows users to take timely action by either refilling or replacing the gas cylinder before running out, reducing downtime and potential disruptions.

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In addition to level monitoring, the system also features a gas leakage detection mechanism. The sensors continuously monitor the gas cylinder and its fittings for any leaks. If a leak is detected, the system activates an alert to the user's mobile device and may trigger an alarm or even shut off the gas supply automatically. This ensures safety by preventing potential accidents, such as fires or explosions, caused by undetected gas leaks. Wireless sensors network were used for detection of leakage in gas tanker[3].

By integrating GSM technology, the system offers remote monitoring, allowing users to receive alerts even when they are away from the premises. [1,2] This real-time notification system provides peace of mind by ensuring users are always aware of the status of their gas cylinders, reducing the risk of hazardous situations.

2. Components for GSM Based LPG Gas Cylinder Level Indication and Leakage Detection Alert System:

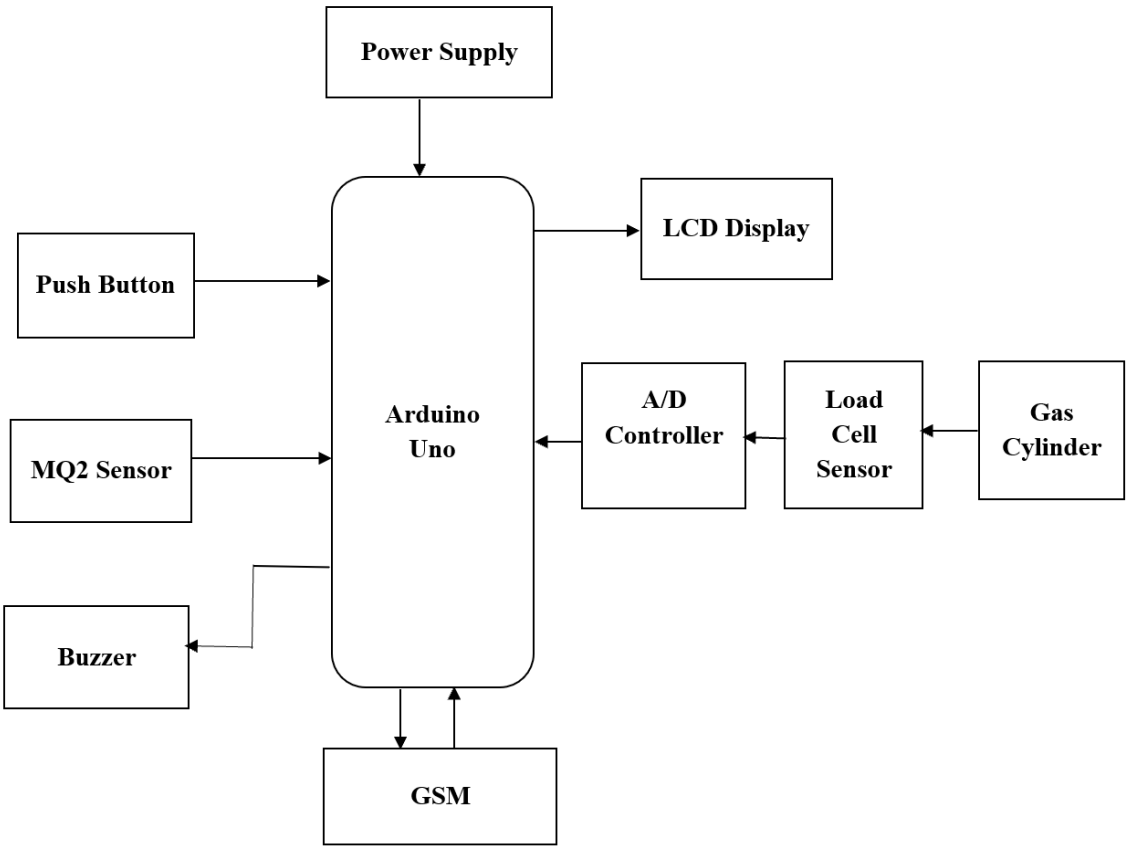

Figure 1: Block diagram for GSM Based LPG Gas Cylinder Level Indication and Leakage Detection Alert System.

Components for GSM Based LPG Gas Cylinder Level Indication and Leakage Detection Alert System uses Arduino Uno , LCD 16x2 With I2C Module, 50kg half bridge load cell sensor , MQ2 Sensor , hx711 dual-channel 24bit precision A/D , Weight Pressure Sensor , Buzzer , GSM 900 With Module , Push Button.

2.1 Arduino Uno: The Arduino Uno serves as the central microcontroller in the system, responsible for processing data from various sensors and facilitating communication with the GSM module[15]. It receives input from sensors like the gas level sensor (weight sensor) and the gas leakage sensor. The weight sensor continuously tracks the gas level in the cylinder, while the gas sensor monitors for any leakage.
When the gas level drops below a set threshold or a leak is detected, the Arduino Uno processes the collected data and triggers an alert. The system sends an SMS or call notification to the user's mobile phone via the GSM module (SIM900), providing real-time updates about the gas level or leakage status.

2.2 LCD 16x2 With I2C Module: The 16x2 LCD (Liquid Crystal Display) is essential for providing real-time visual feedback to users regarding the gas cylinder's status. It displays the current gas level, enabling users to monitor the cylinder directly, reducing their reliance on SMS alerts from the GSM system. This allows for easy and immediate assessment of the gas level.
The LCD also serves as a user interface, displaying status messages such as "Gas Level Low" or "Gas Leak Detected," helping users understand the system's status. For instance, when the gas level approaches a critical threshold, the LCD shows a warning, prompting users to take action and refill or replace the cylinder. If a gas leak is detected, the LCD provides a visible warning, working in conjunction with the SMS notifications sent through the GSM module to keep users informed and ensure timely intervention.

2.3 50kg half bridge load cell sensor: The system uses a load cell sensor to accurately measure the weight of the LPG gas cylinder, allowing the determination of the remaining gas level. This sensor converts the cylinder's weight into an electrical signal, which is then processed by the system. The half-bridge configuration of the load cell ensures precise weight measurements, even when external forces or slight pressure changes are applied, resulting in reliable readings. Integrated with a microcontroller, the load cell continuously monitors the sensor's output. When the gas level in the cylinder falls below a predefined threshold, the sensor detects the weight change and sends the data to the microcontroller. The microcontroller then activates an alert, sending an SMS or call notification to the user via the GSM module. This ensures that the user is notified in time for refilling or replacing the cylinder, preventing it from running out unexpectedly.

2.4 MQ2 Sensor: The MQ-2 sensor[16] is a highly sensitive device designed to detect various gases, including LPG, methane, carbon monoxide, and smoke[12,13]. In this system, it is specifically employed to monitor LPG gas leaks around the gas cylinder and its connections. When the sensor detects a gas concentration that exceeds a set threshold, it sends a signal to the system's microcontroller, which processes the information. This triggers an alert, such as

activating an alarm or sending an SMS notification through the GSM module to the user's mobile phone. The alert enables users to respond quickly by shutting off the gas supply or taking other necessary precautions. This timely response is critical in reducing the risk of fire hazards or explosions caused by unnoticed gas leaks.

2.5 hx711 dual-channel 24bit precision A/D: The system utilizes load cells or weight sensors to accurately measure the gas cylinder's weight, which is essential for providing timely notifications to users about the remaining gas. The HX711 module is used to process the low-voltage signals generated by these sensors, converting them into precise digital readings that the microcontroller can understand. It delivers high-resolution data with 24-bit precision, enabling the detection of even the smallest changes in weight, resulting in more accurate gas level monitoring.

2.6 Weight Pressure Sensor: The Weight Pressure Sensor is a vital component in the GSM-Based LPG Gas Cylinder Level Indication and Leakage Detection Alert System, responsible for continuously monitoring the remaining gas in the cylinder. It detects changes in the weight of the cylinder as the gas is consumed, converting this data into digital signals. These signals are then sent to the microcontroller, which processes the information to determine the gas level. If the gas level falls below a set threshold, the system triggers an alert by sending an SMS notification to the user, prompting them to replace or refill the cylinder. By utilizing a weight sensor, the system ensures precise and reliable monitoring of the gas quantity, preventing the risk of running out of gas unexpectedly. This method offers a more automated and accurate approach compared to traditional manual checks. The sensor also contributes to efficient gas usage, allowing users to manage their gas supply effectively.

2.7 Buzzer: The buzzer is triggered when the gas level reaches a critical point or if a gas leak is detected. When the gas level falls below a preset threshold, the buzzer alerts users that the cylinder needs to be refilled or replaced, helping avoid any unexpected gas shortages. Similarly, if a gas leak is detected, the buzzer emits a sound to warn individuals of the potential danger, prompting them to take quick action, such as turning off the gas supply or evacuating the area.
The buzzer works in tandem with the SMS and call alerts from the GSM module, making the system a comprehensive solution for gas safety management in residential, commercial, and industrial settings.

2.8 GSM 900 Module: Its main function is to send SMS notifications to the user's mobile device, informing them of important events like low gas levels or gas leaks. When the system detects that the gas level has dropped below a preset threshold, the GSM module sends an SMS to notify the user that the cylinder needs to be either refilled or replaced. Likewise, if a gas leakage sensor identifies a potential leak, the GSM[17,18] module promptly sends an SMS alert to the user, helping to avoid dangerous situations like fires or explosions. Additionally, the GSM module allows users to remotely monitor the status of the gas cylinder, ensuring they can receive alerts even when they are away from the location.

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2.9 Push Button: It allows users to acknowledge alerts or reset the system when necessary, especially after a gas leakage has been detected.

3. Methodology :

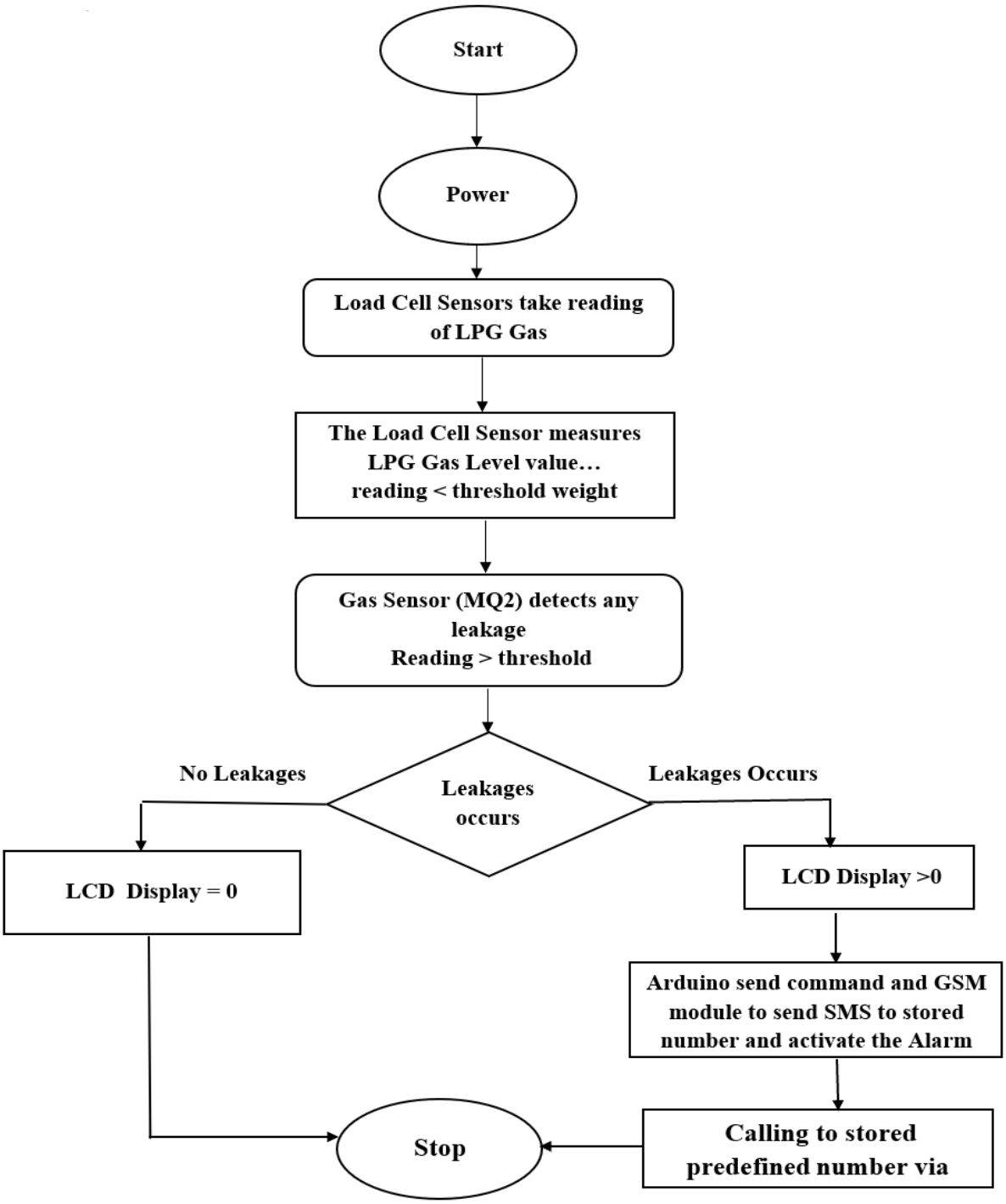

Figure 2: Flow Chart for GSM Based LPG Gas Cylinder Level Indication and Leakage Detection Alert System.

Step 1 : The system is powered on to begin the LPG gas monitoring process. The sensor takes a reading of the gas level in the cylinder.
Step 2 : If the gas level is below the set threshold, further monitoring continues. The MQ2 sensor checks for any gas leakage in the surrounding area.
Step 3 : If no leakage is detected, the LCD display remains at 0. If leakage is detected (reading exceeds threshold), necessary actions are triggered.
Step 4 : The LCD display updates to show a non-zero value. The Arduino sends a command to the GSM module.
Step 5 : The GSM module sends an SMS alert to a stored number. An alarm is activated.
Step 6 : The system makes a call to a predefined number to alert concerned individuals.

4. Syntax for LPG Gas Cylinder Level Indication and Leakage Detection Alert System

```
// Include required libraries
#include "HX711.h"
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <SoftwareSerial.h>
#include <EEPROM.h>

// Define constants and pins
const int buz = 13;
const int button = 12;
const int LOADCELL_DOUT_PIN = 4;
const int LOADCELL_SCK_PIN = 5;
const int MQ2_PIN = A0;
const int SMS_THRESHOLD_WEIGHT = 20;
const int LPG_CALL_THRESHOLD = 25;

// Initialize objects
HX711 scale;
LiquidCrystal_I2C lcd(0x27, 16, 2);
SoftwareSerial sim900(8, 9);

// Declare variables
float calibration_factor = 24600;
String phoneNumber;
const int PHONE_NUMBER_ADDRESS = 0;
const int PHONE_NUMBER_LENGTH = 15;

// Setup function
void setup() {
  // Initialize serial, GSM, scale, LCD, buzzer, and button
  // Retrieve phone number from EEPROM
```

```
  // GSM initialization loop
  // Scale calibration setup
}

// Main loop function
void loop() {
  // Check for serial input (calibration or phone number update)
// Measure weight using HX711
  // Read LPG level from MQ2 sensor
  // Display weight and gas level on LCD
  // Check thresholds for SMS or call alerts
  // Print values to Serial Monitor
  // Delay for stability
}

// GSM initialization function
bool initialize GSM() {
  // Send AT commands to GSM and check network registration
}

// Function to send SMS
void send SMS(String message) {
  // AT commands to send SMS using SIM900
}

// Function to initiate a call
void initiate Call() {
  // AT command to call stored phone number
}

void write Phone Number To EEPROM(String number) {
}

String read Phone Number From EEPROM() {
  // Read phone number from EEPROM
}
```

5. Results :

The GSM-Based LPG Gas Cylinder Level Indication and Leakage Detection Alert System is a smart safety solution designed to monitor gas levels and detect leaks, enhancing safety in homes and industries. This system integrates key components such as a gas sensor (MQ-2), load cell, microcontroller (Arduino or PIC), and GSM module (SIM900) to provide real-time alerts. The main goal is to notify users via SMS when gas levels are low or if a leak is detected,

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ensuring timely action to prevent accidents.For gas level monitoring, a load cell measures the weight of the LPG cylinder, helping determine the remaining gas level. When the gas level drops below a preset threshold (less than or equal to 25kgs) , an SMS notification is sent to the user's mobile device, enabling them to replace the cylinder before it runs out. Additionally, a display unit (LCD) can be included to show the gas level visually, providing instant feedback. To detect gas leaks, an MQ2 gas sensor continuously monitors the air for any leaked LPG. If the gas concentration exceeds a safe limit, the system activates an alarm (buzzer or LED indicator) and instantly sends an SMS alert to the user, warning them of the potential danger. This rapid alert mechanism helps prevent fires, explosions, and health risks due to gas inhalation.

The GSM module plays a critical role in enabling remote monitoring. It allows users to receive alerts even when they are away, making it ideal for residential areas, restaurants, and industrial sites. Unlike conventional gas detectors, this system provides real-time updates, reducing response time and increasing safety.

Figure 3 : Leakage Detection for GSM Based LPG Gas Cylinder Level Indication and Leakage Detection Alert System.

6. Conclusion:

The GSM-based LPG Gas Cylinder Level Indication and Leakage Detection Alert System is a valuable innovation designed to enhance safety and convenience in residential, commercial, and industrial environments. By incorporating GSM technology, sensors, and microcontrollers, this system ensures continuous monitoring of gas levels and leakage detection. It sends real-time SMS alerts to users, allowing them to stay informed about their gas supply and any potential hazards, even when they are not physically present. This proactive approach helps prevent gas shortages and minimizes risks such as fires, explosions, and health issues caused by gas leaks. The use of GSM technology significantly improves remote monitoring capabilities. Unlike traditional alarm systems that require users to be present to hear alerts, GSM-based notifications ensure that users receive warnings regardless of their location. This feature is particularly useful for individuals managing multiple gas cylinders in different locations, such as restaurant owners and industrial operators..It is a highly effective and affordable solution for improving safety and reliability in gas usage**.**

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