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ENHANCING LPG CYLINDER SAFETY THROUGH SMART SYSTEM INTEGRATION

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ABSTRACT: ***The proposed system aims to enhance safety and efficiency in households using LPG gas cylinders through the integration of smart technologies. It includes features such as gas leakage detection mechanisms with advancedsensors, real-time gas level monitoring, and Bluetooth- enabled gas cylinder trolleys for mobility. Voice-controlled regulation minimizes manual intervention, while robust fire detection and suppression capabilities ensure swift response in case of emergencies. The system seamlessly integrates with mobile applications and web servers, providing users with real-time updates on gas levels and safety alerts.Automatic gas booking functionality simplifies the refill process, ensuring uninterrupted gas supply. By addressing key painpoints and introducing innovative features, the proposed system aims to revolutionize LPG cylinder usage, making kitchens safer and more conducive to healthy living. Overall, it represents a significant leap forward in enhancing safety, efficiency, and convenience in households using LPG gas cylinders.***

KEYWORDS: Bluetooth, Trolley, LPG Cylinder,Automation, Safety.

I. INTRODUCTION:

At the heart of the system lies a sophisticated gas leakage detection mechanism equipped with advanced sensors. These sensors are strategically deployed throughout the household environment to continuously monitor for any signs of gas leakage. By promptly detecting even minute traces of gas leakage, the system ensures early intervention and mitigation of potential hazards, thereby enhancing overall safety and instilling confidence in users regarding the security of their kitchen environment.

In addition to gas leakage detection, the system offers real-time gas level monitoring capabilities [1]. Load sensors integrated into the gas cylinders enable usersto track the remaining gas level with precision. This feature not only facilitates proactive gas management but also ensures uninterrupted cooking operations by providing timely alerts when gas levels are low. As a result, users can effectively plan for gas refills and prevent unexpected disruptions in gas supply, thereby enhancing efficiency and convenience in household kitchens [2].

To further enhance mobility and flexibility, the system incorporates Bluetooth-enabled gas cylinder trolleys. This innovative feature allows users to effortlessly maneuver the trolleys using their smartphones, providing greater convenience in organizing and rearranging kitchen layouts. By enabling seamless control and movement of gas cylinders within the household environment, the system promotes user convenience and optimizes kitchen space utilization.

Minimizing manual intervention and ensuring swift response to emergencies are paramount in household safety. The system achieves this through voice-controlled regulation, allowing users to toggle gas regulators with simple voice commands. Moreover, robust firedetection and suppression capabilities are integrated to promptly detect and contain fires, mitigating potential risks and minimizing damage to property and personnel. These features collectively contribute to a safer and more secure kitchen environment [3].

The system seamlessly integrates with mobile applications and web servers, providing users with real-time updates on gas levels, safety alerts, and other system functionalities. Automatic gas booking functionality simplifies the refill process, ensuring uninterruptedgas supply and further enhancing user convenience. By empowering users with remote monitoring and control capabilities, the systemoffers peace of mind and confidence in the reliability of LPG cylinder usage [6].

II. PROBLEM STATEMENT:

LPG cylinders offer a convenient and versatile energy source, but they come with a range of challenges and issues that need to be addressed. Safety concerns are paramount dueto the flammable nature of the gas they contain. Improper handling, storage, or usage can lead to accidents such as leaks, fires, explosions, and even fatalities. Therefore, ensuring proper installation, maintenance, and adherence to safety guidelines is essential to mitigate these risks.

Another common issue with LPG cylinders is leaks and gas loss. Over time, cylinders can develop leaks due to factors such as corrosion, damage, or faulty seals. These leaks not only pose safety hazards but also result in gas wastage, leading to financial losses for consumers and environmental concerns due to the release of greenhouse gases.

Regulatory compliance is also a significant challenge for manufacturers, distributors,and users of LPG cylinders. Regulations related to cylinder design, construction, transportation, storage, and usage vary across regions and jurisdictions, requiring careful adherence to ensure legal compliance and safety.

Transporting and storing LPG cylinders safely can be logistically challenging due totheir bulky size, weight, and flammable contents. Specialized vehicles and handling procedures are required to ensure the safe transportation of cylinders, while proper storage facilities with adequate ventilation and safety measures are needed to prevent accidents and leaks. Illegal refilling and adulteration of LPG cylinders pose significant risks to consumers. Unauthorized filling stations may not adhere to safety standards or quality control measures,leading to potential damage to appliances, health risks, and compromised safety.

Addressing these challenges requires concerted efforts from stakeholders across the LPG value chain. Implementing rigorous safety protocols, regulatory oversight, publicawareness campaigns, and investment in innovation and technology can help mitigate the risks and challenges associated with LPG cylinders, ensuring their continued role as a safe, efficient, and sustainable energy solution.

III. LITERATURE SURVEY:

This Chapter holds a Literature Survey of various Journal papers supports overview of anLPG Cylinder integration with technology.

C-Leakage: Cylinder LPG Gas Leakage Detection for Home Safety [1]:
This paper [1] suggests a good way to control the system using ATMega328 microcontroller, load cell, and MQ-6 gas sensor to monitor the levels of LPG through the loadcell and display the levels continuously and to book a refill automatically when the gas level reaches below the threshold value. The gas sensor detects the gas leakage and alerts the user through a buzzer and turns off the gas supply by turning off the regulator knob.

Gsm Based Gas Leakage Detection System [2]:
This paper [2] uses the MQ-6 gas sensor, AT89C51 microcontroller, stepper motor, LCD display module, and GSM module to build the gas leakage detection system. The gas leakage is detected by the MQ-6 gas sensor and it sends the signal to the microcontroller with the help of ADC, the microcontroller receives the signal and activates the buzzer anddisplays the message on the LCD display and also drives the stepper motor to turn off the regulator knob.

Gas Leakage And Detection Control [3]
This paper [3] uses ARM microcontroller, MQ-6 gas sensor, solenoid valve, weight cell, buzzer, LCD display, and GSM module to build the control system. The gas sensor detectsthe gas leakage and sends a signal to the ARM microcontroller which then turns on the exhaust fan and turns off the regulator valve using a solenoid and then turns off the main power supply. Thissystem also monitors the gas level using weight cell and displays the gaslevel in the LCD display and if the gas level reaches below 2kg i.e. the set threshold value then the system automatically books the refill for the gas from the agency.

Automation of LPG Cylinder Booking and Leakage Monitoring System[6]:

In paper [6] "Automation of LPG Cylinder Booking and Leakage Monitoring system" Abhishek B N used LPC2148 microcontroller, GSM module, exhaust fan and MQ5 sensor here the load cell measures the weight of the cylinder. The output of the same is converted to digital data with the help of A/D converter. This data is then fed to the controller as an input. The controllers perform actions as per the input data. In case if there is an any gas leakage it is detected by MQ5 sensor in addition to if the exhaust fan is also turned on to release the gas out the room. Also the gas leakage alert is provided to the customer if form of SMS with the help of GSM for this is the TTL output is converted to CMOS logic with the help of RS232 module and provided to the GSM.

IoT Based Smart Gas Monitoring System[4]:

In paper [4] "IOT Based Smart Gas Monitoring System" Anandhakrishnan S has implemented a system which consist of ARDUINO UNO controller. It's an advanced processer here the major modules excluding the ARDUINO UNO are MQ2 sensor, wifi module, load cell. This project has introduced a feature of internet in it. The load cell a featureof internet in it. The load cell weights the LPG cylinder. Then the load cell output is given asinput to the ARDUINO UNO. The wifi module is used to facilitate the communication amongst the other module. The LCD display, displays the level of cylinder. The internet provides the information about the gas level reaching below threshold to the gas agency afterthis cylinder is auto booked.

IV. EXISTING WORK:

Extensive research and development efforts in the field of LPG gas cylinder safety and management have yielded significant progress in enhancing safety features, monitoring capabilities, and regulatory compliance. Key areas of focus include gas leakage detection systems utilizing advanced sensors, fire detection and suppression mechanisms, and monitoring systems for gas cylinder weight and gas levels [5]. Additionally, innovations such as Bluetooth-enabled gas cylinder trolleys and voice- controlled regulator features have been explored to improve convenience and user experience. Regulatory standards and public awareness campaigns play pivotal rolesin promoting safe practices and ensuring compliance. Continued collaboration and innovation are essential to further enhance safety, efficiency, and user experience in household kitchens using LPG gas cylinders [4] .

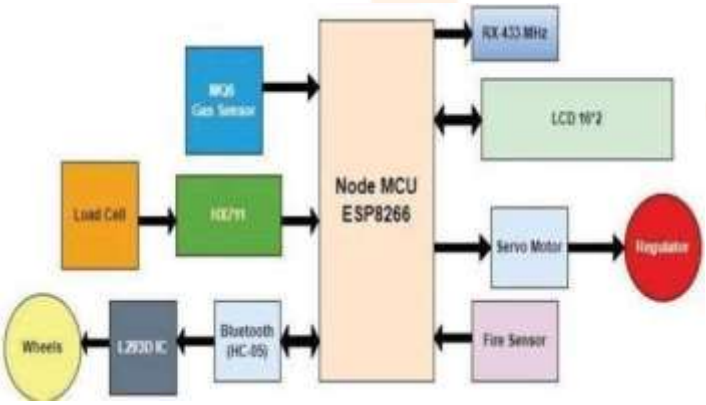

Figure 1: Block Diagram of existing model

V. PROPOSED WORK:

Hardware requirements:

- Arduino uno
- LCD 16*2
- GSM module
- Servo motor
- Fire sensor
- Wi-Fi module
- MQ6 sensor
- HX711
- HC-05 Bluetooth
- L293D IC

5.1 Arduino Uno:

Arduino is an open-source electronics platform featuring a microcontroller board, easy- to-use software, and a supportive community.It simplifies hardware prototyping and interactive project development with its accessible programming language, vast array of compatible components, and expandable capabilities through shields. With Arduino, anyone can bring their ideas to life, from basic LED projects to complex interactiveinstallations.

Figure 2: Arduino Uno

5.2 LCD 16*2:

An LCD consists of a layer of liquid crystalssandwiched between two transparent electrodes. Whenan electric current is applied, the crystals align to control the amount of light passing through them, creating the image you see on the screen. Itis a flat panel display technology, mainly used in TVs andcomputer monitors, nowadays it is used for mobile phones also. These LCDs are completely different from that old CRT displays, it uses liquid crystals instead of cathode ray in its primary form of operation.

Figure 3: LCD

5.3 GSM Module:

The GSM (Global System for Mobile Communications) module is a crucial component in many applications requiring wireless communication capabilities. SIM900 GSM/GPRS shield is a GSM modem specifically designed for the ESP 32, which can be integrated into a great number of Embedded projects. This shield can be used to accomplish almost anything a normal cell phone can; SMS text messages, make or receive phone calls, connecting to the internet through GPRS, TCP/IP, and more.

Figure 4: GSM Module

5.4 Servo Motor:

A servo motor is a rotary actuator that allows for precise control of the angular position. It consists of a motor coupled to a sensor for position feedback. It also requires a servo drive which uses the feedback sensor to precisely control the rotary position of the motor. This is called a closed-loop operation which provide a high-performance alternative to stepper. The lock can be locked andunlocked by the servo motor.

Figure 5: Servo Motor

5.5 Fire Sensor:

The flame detection response can depend on its fitting. Itincludes an alarm system, a natural gas line, propane &a fire suppression system. This sensor is usedin industrial boilers. The main function of this is to give authentication whether the boiler is properly working or not. The response of these sensors is faster as well as more accurate compare with a heat/smoke detector because of its mechanism while detecting the flame.

Figure 6: IR Sensor

5.6 WiFi Module:

The ESP8266 wifi module is low-cost standalone wireless transceiver that can be used for end-point IoT developments. ESP8266wifi module enables internet connectivity to embedded applications. It uses TCP/UDP communication protocol to connect with the server/client. To communicate with the ESP8266 wifi module, microcontroller needs to use set of AT commands.

Figure 7: WiFi Module

5.7 MQ-6 Sensor:

This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to dois power the heater coil with 5V, add a load resistance, and connect the output to an ADC. Sensitive material of MQ-6 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, The sensor's conductivity is more higher along with the gas concentration rising.

Figure 8: MQ-6 Sensor

5.8 HX711:

Electronic board based on the HX711 chip, a 24-bit analog-to-digital converter, specifically designed to interface the load cell to a microcontroller such as Arduino, Fishino or compatible. The input multiplexer selects either Channel A or Bdifferential input to the low-noise programmable gain amplifier. In Load cells and weight sensors the output range of a strain gauge is very small and thus thesignal needs to be amplified before processing to prevent introduction of errors.

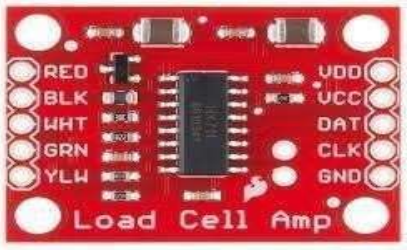

Figure 9: HX711

5.9 HC-05:

HC-05 is a Bluetooth device used for wireless communication with Bluetooth enabled devices (like smartphone). It communicates with microcontrollers using serial communication (USART). Default settings of HC-05 Bluetooth module can be changed usingcertain AT commands. As HC-05 Bluetooth module has 3.3 V levelfor RX/TX and microcontroller can detect 3.3 V level, so, thereis no need to shift TX voltage level of HC-05 module. But we need to shift the transmit voltage levelfrom microcontroller to RX of HC-05 module.

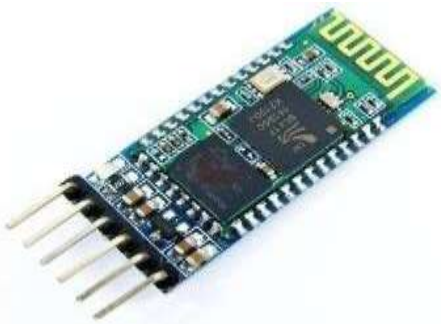

Figure 10: HC-05 Bluetooth

5.10 L293D :

The L293D Motor driver shield is one of the best ways for controlling DC motor, Servo motor, and Stepper motors ina single board.It can control the rotation direction and speed of four DC motors, two Servo motor, and two Stepper motors. It is easy to connect withan Arduino UNO or MEGA. This shield especially using Arduino projects like robotics and CNC. This module consists of two L293d dual-channel H-Bridge motor driver IC and a 74HC595 shift register IC The L293D is a 16-pinIntegrated circuit, with eight pins, on each side, dedicatedto the controlling of a motor. There are 2 input pins, 2 output pins and 1 enable pin for each motor.

Figure 11: L293D driver

The implementation of the proposed project representsa significant leap forward in the realm of LPG cylinder usage. By combining cutting-edge technologies with user-centric design principles, the implementation enhances safety, efficiency, and convenience in household kitchens.

Figure 12: Block Diagram of Proposed Work

VI. METHODOLOGY :

STEP 1: Power on the Arduino Board through the power supply which represents that the project kit is turn ON

STEP 2: The regulator will turn ON and OFF through voice control commands using Bluetooth app.

STEP 3: With Bluetooth technology, we can move the cylinder forward and backward using voice and terminal commands which gives easier to handle the cylinder

STEP 4: Load cell measures the weight of the cylinder continuously and gives the update of weight on the LCD display and also sends message to the userregarding gas booking

STEP 5: Mq-6 sensor measures the atmospheric levels of gas and if the threshold value crosses then the buzzer will get into active state and a message will deliver to the respective mobile user

STEP 6: Fire sensor detects if any fire occurs, then automatically water sprinkler will get turned on and reduces the damage by sprinkling the water.

VII. RESULTS & DISCUSSION:

Figure 13: Project Kit

7.1 Regulator On & Off:

Figure 14: Regulator On & Off

Voice commands activate the regulator, displaying weight, gas levels, and frequency on the LCD display for user convenience and real-time monitoring.

Voice commands deactivate the regulator, discontinuing the display of weight, gas levels, and frequency on the LCD display, ensuring user control and energy efficiency.

7.2 Bluetooth Trolley:

Figure 15: Bluetooth Controlled Trolley

Moving forward, this integrated system offers seamless operation and real-time data visualization, enhancing user experience and ensuring efficient monitoring of essential parameters.

Voice commands activate the regulator, displaying weight, gas levels, and frequency on the LCD display for user convenience and real-time monitoring. Movement can be stopped accordingly.

7.3 Analytics of Data:

The status of the Regulator will be updated every secondin the ThingSpeak View app, along with the data (including month, year, and date) and time.

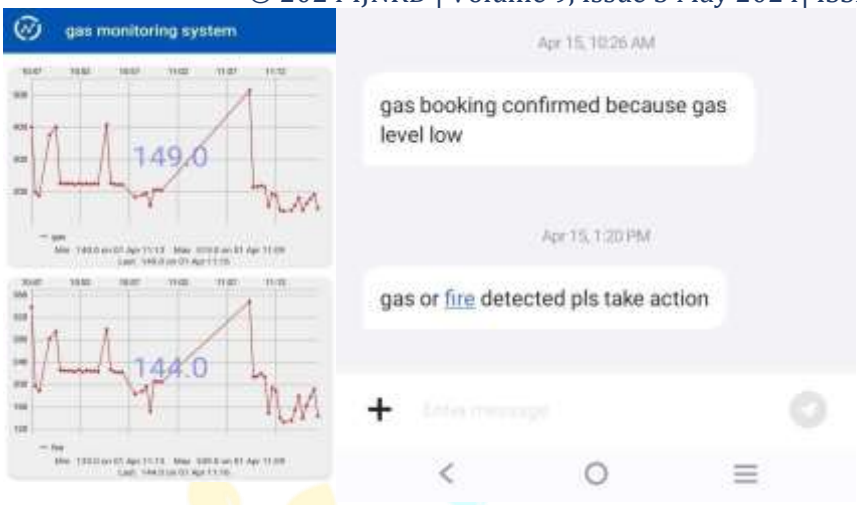

Figure 15: User Alerts

Table 1: Comparison with Reference Papers

Ref	**Gas Level Monitoring**	**IoT Platform**	**Water Sprinkler**	**User Alert**	**Trolley Movement**
[1]	Present	Present	Not Present	Not Present	Present
[2]	Present	Not Present	Not Present	Present	Not Present
[3]	Present	Not Present	Not Present	Present	Present
[4]	Present	Not Present	Not Present	Not Present	Not Present
Present Work	Present	Present	Present	Present	Present

VIII. CONCLUSION:

In conclusion, the proposed comprehensive solution represents significant advancement in addressing the safety and efficiency concerns associated with LPG gas cylinder usage in households.By integrating smart technologies such as gas leakage detection, real-time monitoring, Bluetooth- enabled trolleys, voice-controlled regulation, and robust fire detection and suppression capabilities, the system aims to revolutionize the way households interact with LPG gas cylinders. With its focus on enhancing safety, convenience, and user experience, the system has the potential to significantly mitigate risks, streamline operational processes, and empower users with greater control and peace of mind in their kitchen environments. Overall, the implementation of this innovative solution holds promise for making kitchens safer and more conducive to healthy living, marking a significant leap forward in LPG cylinder usage.

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