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Smart Solutions for Safe and Convenient Home Gas Management: A Comprehensive Approach to LPG Cylinder Monitoring and Booking

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Abstract - In today's fast-paced world, people often struggle to manage daily tasks, including household chores such as scheduling LPG cylinder deliveries and addressing emergencies like gas leaks or fires. Recognizing this challenge, there's a growing need to develop technological solutions. The Proposed work focuses on designing a system to detect gas leaks from cylinders. It utilizes a gas sensor that triggers a servo motor to shut off the gas regulator upon detecting any presence of gas leakage, while also sending a notification to the user via a GSM modem. Additionally, the system addresses the issue of irregular LPG cylinder supply by automatically placing an order when the cylinder's net weight drops to 16.5kg, ensuring a reserve of 2kg of gas until the new cylinder arrives. Other features include flame intensity control through precise timing of the burner using Arduino, as well as an automatic gas supply shutoff if inactive for an extended period. Implementing this system in households guarantees enhanced safety and convenience in various ways.

Key Words: Arduino Mega, Gas sensor MQ5, GSM Module, Load cell, Gas regulator, Servomotor.

1.INTRODUCTION

The leakage of LPG gas is one of the hazardous accidents that occur in the kitchen [6]. This leads to suffocation and may lead to explosions. Thus, there are still some shortcomings on real time monitoring and on data transmission and accurate location of leakage point when accident happens. These problems can be solved with help of developing embedded system using wireless sensor network. It can give real time detection of potential risk area, collect the data of leak accident and locate leakage point. The system also supports to provide real-time monitoring of concentration of the gases present in air. As this method is automatic the information can be given in real time such that the threat to human lives can be avoided. It also provides a feature to measure the weight of LPG cylinder with its value displayed on LCD display. If the gas level in the cylinder is below the threshold value it is informed to the user and dealer by sending message using GSM module. Thereby informing dealer to book new LPG cylinder automatically and give conformation message to the user about the booking [5].

2. Related Work

Digambar Surse, Swati Talekar, Tejal Suryawanshi, Prof. M. R. Gaikar[1] presented paper on security alert system using GSM for gas leakage, which uses the MQ5 sensor to detect gas leakage and GSM to provide the SMS to the user. It consisted of Arduino controller, gas sensor (MQ5), Load cell (L6D).GSM module (SIM900), and 16*2 LCD display. B.D. Jodhe, P.A. Potdukhe and N.S Gawai [2] describe a microcontroller based system where a gas sensor, MQ6 is used to detect dangerous gas leaks. If leakage is detected, message to the authorized person member using cellular network called GSM is sent automatically. It consisted of microcontroller (ATmega16A), gas sensor (MQ6), Load cell (L6D).GSM module (SIMCOM 300), and 16*2 LCD display.
S. Rajitha and T.Swapna [3] presented paper on security alert system using GSM for gas leakage, which uses the MQ5 sensor to detect gas leakage and GSM to provide the SMS to the user. It consisted of LPC2148 based on 32 bit ARM7TDMI-S cup. Hrushikesh Keluskar, Pooja chavan, Sonali Kudale, G.D. salunke and Satish pawar [4] describes GSM based home safety. They also used the MQ6 sensor as gas sensor, but they have used LPC2138 microcontroller. In addition to the above papers they have added XBEE.XBEE is used form a control room in building; with the help of XBEE we can transmit the data from sensor to computer.

3.SYSTEM DESCRIPTION

The Block diagram of smart kitchen comprises of gas sensor, weight sensor and Co2 sensor. Gas sensor is a high sensitivity sensor which detects the gas leakage. It is a semiconductor type sensor with very low conductivity, fast response time and stable long life. However, it is not only has sensitivity to LPG, but also to slightly sensitive to polluted fluid like cigarette smoke. Gas cylinder

should be placed on weight sensor. Weight sensor can provide weight of gas cylinder. The power supply unit was designed to supply voltages of 5V and 12V.
This was achieved by rectification. It is used to power the device. The alert unit is the GSM that sends SMS alerts. All the sensors are set with threshold values. If a reading from the sensors goes below the threshold values, then it will send SMS alert to the user. The mobile receives signals from the GSM device.

A. Hardware components used

The operation performed by the hardware components used in the above system is shown in Table 1.

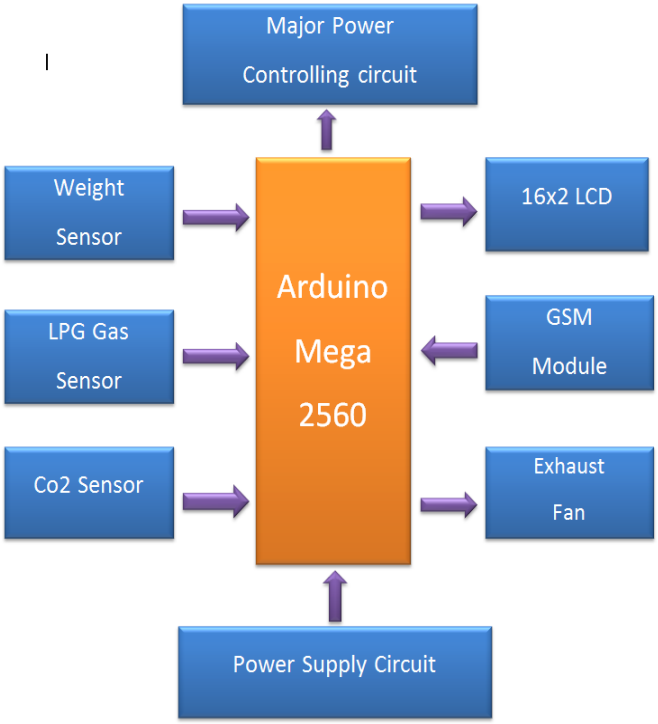

Fig-1.Block diagram of Smart kitchen

TABLE 1: Operations of Hardware Components

Components	Input	Output
GSM modem	Voice or SMS	Alert Message to user
Arduino mega	Receive signal from sensors	Control the Servomotor, Mains supply and Exhaust fan
Load cell	Load	Required voltage
MQ-05	LPG,Co2	Produces voltage more than 2.5v

B. Softwares used

The various softwares used in developing the above system are listed in the Table 2.

TABLE 2: Softwares Used

Softwares	Uses
Arduino 1.8.2	Program microcontroller
Fritzing.0.9.2b.64.pc	PCB Design
Ubidots	Create Database to store user data

C. Flow chart

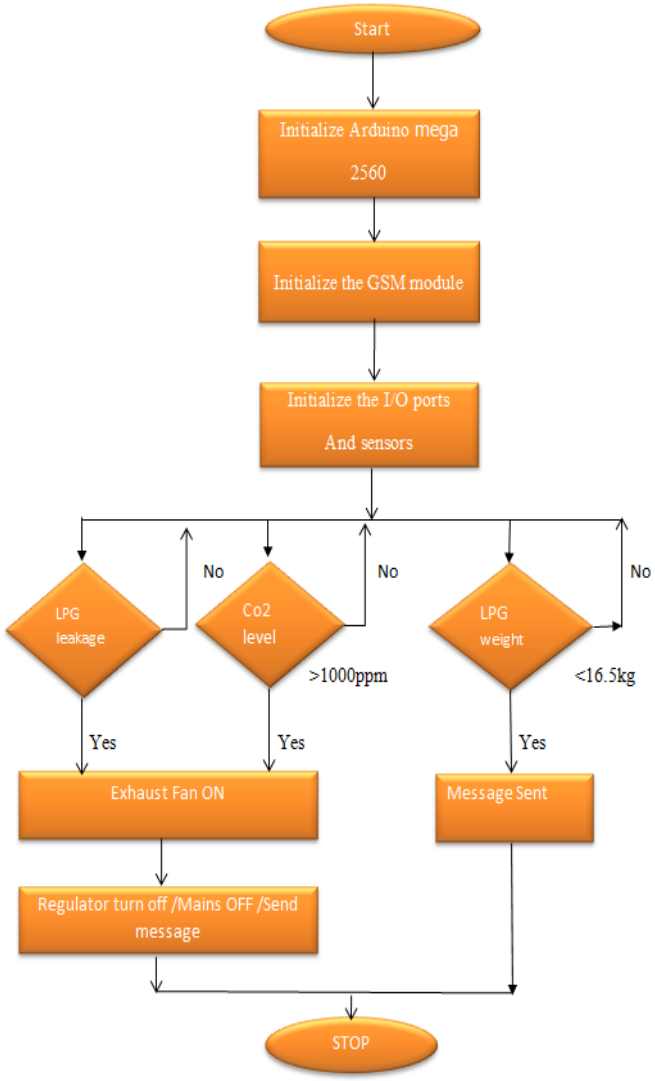

Fig-2.Flow chart for Smart Kitchen

The flow chart for smart kitchen initially initializes the arduino, GSM module, I/O devices & sensors. If the LPG leakage found in the kitchen or Co2 caused by the fire the MQ-05 sensor drives the arduino, arduino turns on the exhaust fan, turns off the gas regulator & mains supply, and sends alert message to the user.

If the weight of the LPG level less than the specified value it sends alert message to the use and distributor.

D. Block diagram

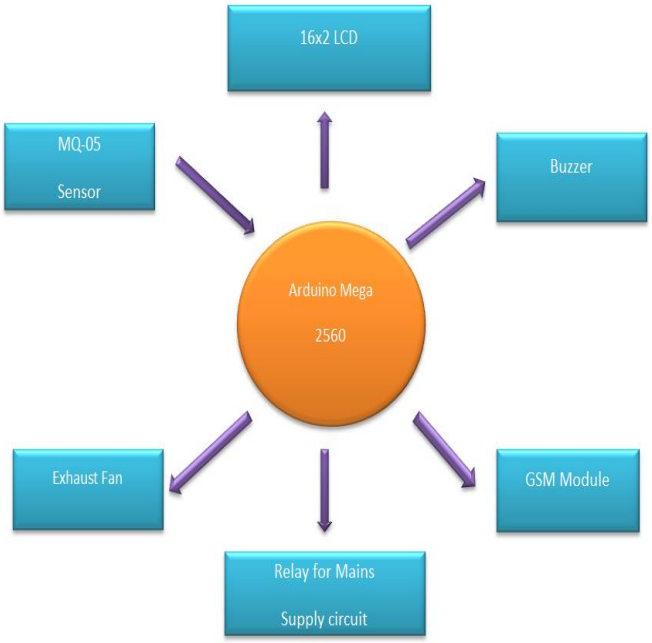

Fig- 3.Block diagram of LPG detection

The design of LPG detection is shown in figure 3. As the data from various gas accidents indicate that most of the accidents are caused due to leakage of gas from the burner and not from the cylinder, so based on the data study the system during the case of leakage released the Nob pin which press the valve of the cylinder thus cutting of the supply of the gas. This mechanism is obtained by a combination of a servo motor of high torque value and Arduino. During leakage Arduino commands the servo motor to release the nob of the regulator.

The system also has many basic functions like.

a) Alarm generation.
b) Text message using GSM
c) Automatic exhaust of the gas
d) Electric supply cut off (AC) and DC illumination for guiding the user.

E. Flow chart

When the AC power is available then the module is running over AC power and if by chance AC power is cut off then the module is having its own DC power. So the risk of module failure is reduced. In the module we are using the MQ-05 sensor, which is a gas detector. When no gas is detected then there is approx. 0.8v which is equivalent to ground, and when sensor detects any leakage of LPG gas then it generates 4.5v which is equivalent to +vcc When sensor detects some LPG in environment then output will be 5v and when it is fed to the Arduino it act as a trigger to the Arduino and according to the software Arduino works and switch ON buzzer, exhaust fan and turns off the gas then send message to the user and mean while switch off the power supply.

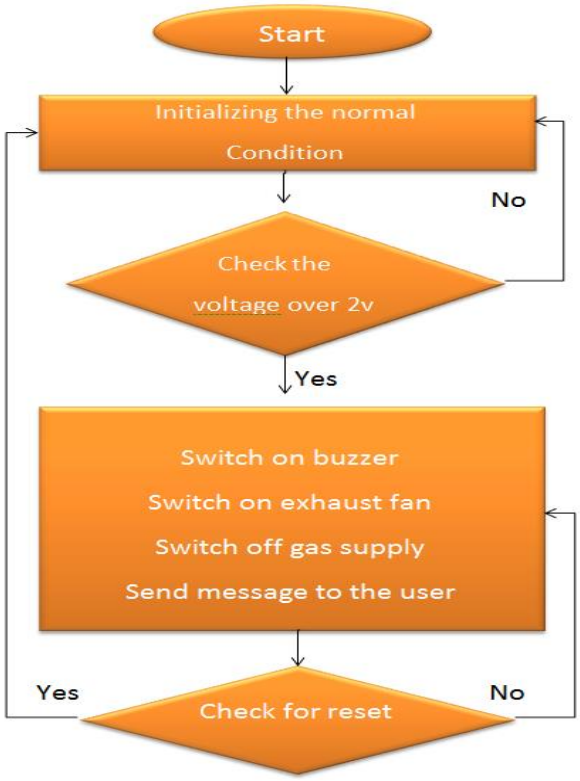

Fig- 4. Flow chart for LPG detection

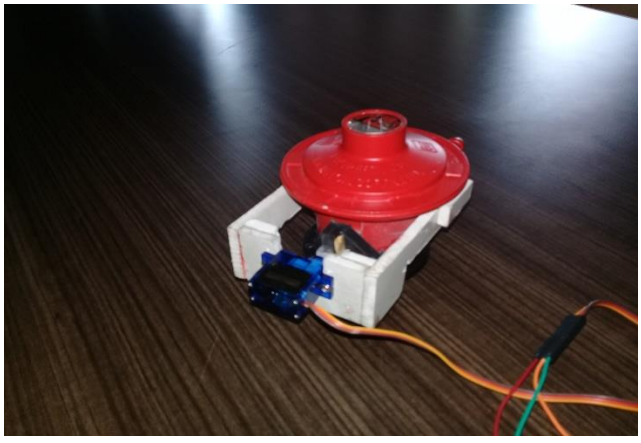

Fig- 5.Servo regulator

Advantages

a) It automatically opens and closes the gas supply.
b) Loss of life and property is reduced.
c) It can also be used for CNG leakage detection.
d) It also detects smoke.

e) The sensor has excellent sensitivity.
f) Dual power input.

Disadvantages

a) Since electronic components are used regular check-up of the system is required.
b) Error can occur in case of higher concentration of Co2, Co.

F. Servomotor

Servo motor is a special type of motor which can automatically operate up to certain limit for a given command with help of error-sensing feedback to correct the performance. A servo motor is basically a DC motor (in some special cases it is AC motor) along with some other special purpose components that make a DC motor a servo. In a servo unit, there will be a small DC motor, a potentiometer, gear arrangement and intelligent circuitry. The intelligent circuitry along with the potentiometer makes the servo rotate according to our wishes.

G. Load cell

As per dictionary, a load cell is described as a "weight measurement device necessary for electronic scales that display weights in digits." However, load cell is not restricted to weight measurement in electronic scales. Load cell is a passive transducer or sensor which converts applied force into electrical signals. They are also referred to as "Load transducers". Load cells come in various ranges like 5kg, 10kg and 100kg and more, here we have used Load cell, which can weight upto 40kg.

H. Arduino Mega

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

I. MQ-05 Gas sensor

MQ-05 gas sensor has high sensitivity to LPG, also response to Natural gas. The sensor could be used to detect different combustible gas, especially Methane; it is with low cost and suitable for different application.

Features:

a) High sensitivity to LPG.
b) Small sensitivity to alcohol, smoke.
c) Fast response.
d) Stable and long life.
e) Simple drive circuit.

Application:

a) Domestic gas leakage detector.
b) Industrial Combustible gas detector.
c) Portable gas detector.

J. GSM Module

The GSM/GPRS Modem-RS232, built with the Dual Band GSM/GPRS engine SIM900A, operates on 900/1800 MHz frequencies and features an RS232 interface for easy connection to PCs and microcontrollers via the MAX232 chip. Its baud rate is adjustable from 9600 to 115200 using AT commands, and it includes an internal TCP/IP stack for internet connectivity through GPRS. This modem supports SMS, voice, and data transfer applications in M2M interfaces, and its on-board regulated power supply allows for connection to various unregulated power sources. It enables functionalities like making audio calls, sending and reading SMS, attending incoming calls, and accessing the internet through simple AT commands, making it versatile for applications like remote monitoring, automated meter reading, vehicle tracking, and home automation.

K. Design of smart stove

Smart Stove technology automatically turns off gas stove regulator after the particular time. This system controls the flame intensity level (low, high, and medium).

Fig- 6.Smart stove

Fig- 7.Smart stove regulator control switches

Smart Stove technology automatically turns off gas stove regulator after the particular time. This system controls the flame intensity level (low, high, and medium).

4.RESULTS

In Arduino based LPG gas Monitoring & Automatic Cylinder booking with alert system MQ-05 gas sensor,40 kg load cell as input devices and Piezoelectric buzzer,16x2 LCD display and GSM module used as output devices.

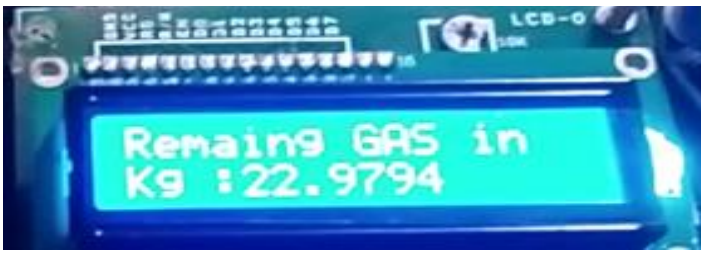

Fig-8.LCD showing output of LPG cylinder weigh

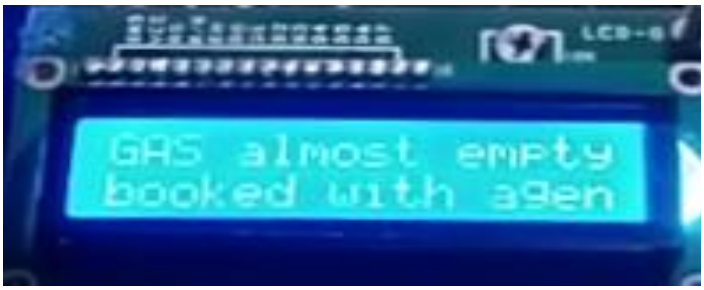

Fig-9.Output showing Status of LPG cylinder

Fig-10.Output showing Status of flame intensity

Fig- 11. Output showing timer value for flame

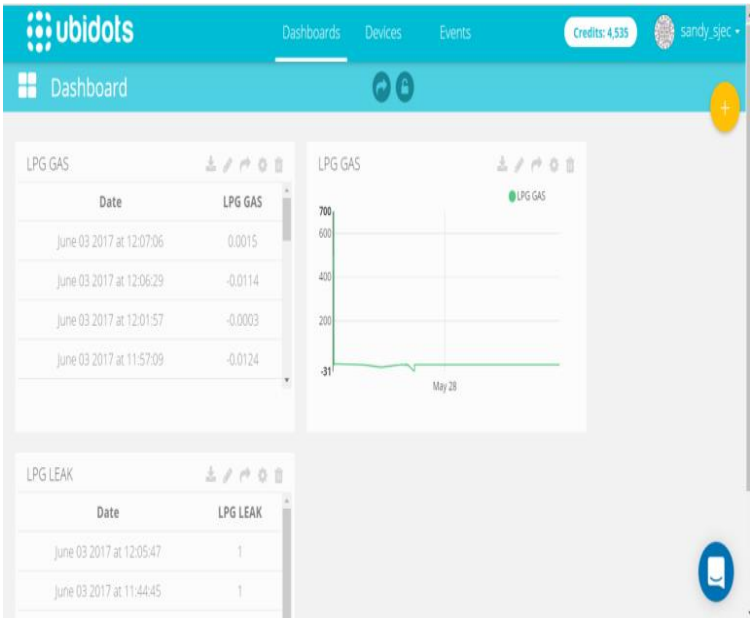

Fig-12. Display of LPG leakage and LPG level

Fig-13.Implementation of main circuit

The system has arduino as the control unit which is interfaced with the sensors, relay and GSM. The sensor values are displayed on the LCD. If there is a leakage, the servomotor will turn off the regulator and through GSM modem a message is sent to the user. As per current government regulations, intense demand but shortage in production of LPG cylinder, once a new cylinder is booked, we need to wait for some days to get it delivered. Therefore, the implemented system continuously monitors the level of the LPG present in the cylinder that is achieved with the help of load cell. If the gas level reaches below the threshold limit of gas around 16.5 kg it automatically books the cylinder using a GSM module so that the old empty cylinder is replaced by a new one on time. Moreover, another smart stove facility is also introduced. The purpose of Smart Stove is to prevent the wastage of gas energy. Smart Stove technology uses a timer, which will automatically turns off gas stove regulator after the particular time that is set in the timer. This system controls the flame intensity level (low, high, and medium).

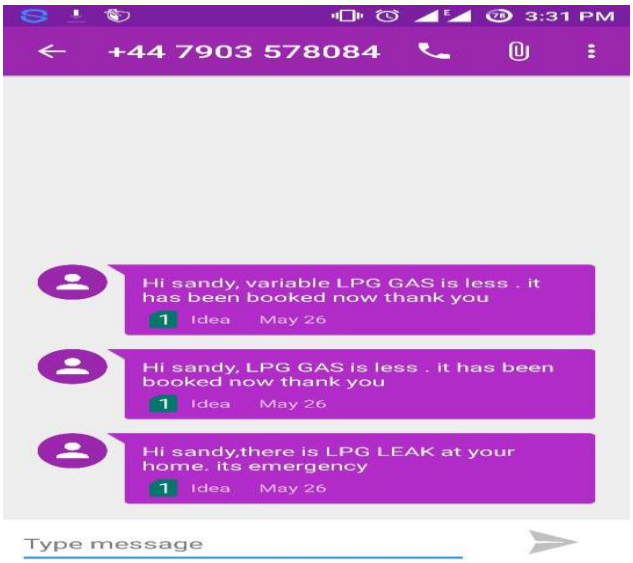

Fig-14.SMS's sent to the user mobile

5. CONCLUSIONS

The smart kitchen system is a fully automatic solution that activates immediately upon detecting a gas leak, unlike other systems that require human intervention. It addresses the shortcomings of existing systems to offer a more precise and reliable performance. The smart kitchen utilizes sensors, a power supply, and a mains control circuit to enhance safety. Gas leakage prevention is achieved by automatically turning off the gas regulator using a servomotor. To further prevent fire accidents, the system is designed to cut off the mains power. It continuously monitors gas levels, and automatically books a refill when necessary. Additionally, the smart gas stove incorporates an igniter and a timer, which automatically turns off the gas stove regulator based on the pre-set time, ensuring safe and efficient cooking.

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