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Advanced Gas Detection System with Auto Shut off Regulator and SMS/Call Alerts

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ABSTRACT: Gas leakage, particularly of LPG (liquefied petroleum gas), poses significant safety risks, including fire hazards and health threats. Early detection and prompt action are crucial to mitigate these risks. This report details the design and implementation of a gas leakage detection system using Arduino. The system employs an MQ-135 sensor to detect LPG gas, a solenoid valve to stop the leakage, a GSM module to send alerts, exhaust fan also connected for gas disperse and an LCD for process display. The integration of these components aims to provide a reliable, automated, and cost-effective solution for gas leakage detection and prevention.

KEYWORDS: Lineman protection, Electrical safety, GSM module, minimizing accident occurrence probability.

I. INTRODUCTION

Gas leakage is a critical issue in both residential and industrial settings, often leading to catastrophic events if not promptly addressed. Traditional methods of detecting gas leaks can be insufficient, leading to delayed responses. In recent years, technological advancements have enabled the development of automated systems that enhance safety by providing early detection and immediate responses. This project leverages the Arduino platform to create a comprehensive gas leakage detection system that addresses these challenges.

This project aims to develop an advanced gas detection system that can automatically shut off the gas supply in the event of a leak and send alerts to users via SMS. This system is designed to enhance safety and prevent accidents caused by gas leaks.

This project has the potential to significantly improve safety in homes, businesses, and industrial settings where gas leaks are a concern. By combining advanced gas sensing technology with automated shut-off and alert systems, this project can contribute to a safer environment for everyone.

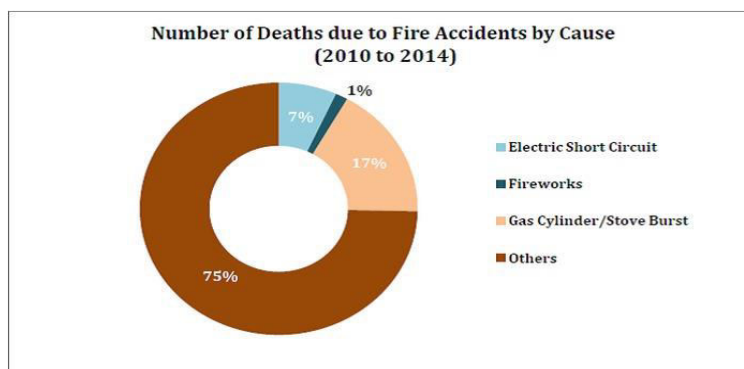


Fig.1 Graph of Deaths due to fire accidents(in%)for each work specialty

II. MOTIVATION

The motivation behind this project stems from the need to enhance safety measures in environments where LPG gas is used. Incidents of gas leakage can lead to severe consequences, including explosions, fires, and poisoning. An automated detection and response system can significantly reduce the risk of such incidents, providing peace of mind to users and safeguarding lives and property. Additionally, the project aims to leverage affordable and readily available technology to create a solution accessible to a broad audience.

III. OBJECTIVES

- The primary objectives of this project are:
- Detection: Develop a system that can accurately detect the presence of LPG gas using an MQ-135 sensor.
- Response: Integrate a solenoid valve that automatically stops the gas flow upon detection of a leak.
- 3Communication: Implement a GSM module to send alert messages to predefined contacts, ensuring timely notification.
- Display: Utilize an LCD to display the system status, including gas levels and alerts, providing users with real-time information.
- Reliability: Ensure the system operates reliably under various conditions and can be easily maintained.

IV. LITERATURE REVIEW

In the year 2011, A. MAHALINGAM, R. T. NAAYAGI, N. E. MASTORAKIS, "Design and Implementation of an Economic Gas Leakage Detector", This project developed system to detect the gas leakage and providing immediate alarm or intimation to the user. Later in 2013, few people developed the design proposed for home safety. This system detects the leakage of the LPG and alerts the consumer about the leak by buzzer. This project was developed using microcontroller ARM version 7 processor and simulated using Keil software.

In the year 2014, Hitendra Rawat, Ashish Kushwah, Khyati Asthana, Akanksha Shivhare, designed a system, They provided security issues against thieves, leakage and fire accidents. In those cases their system sends SMS to the emergency number provided to it. In the proposed system we have designed "LPG gas monitoring and automatic cylinder booking with alert system". These report focus on detection of economic fuels like petroleum, liquid petroleum gas, alcohol..etc., and alert the surrounding people about the leakage through SMS. It also sense surrounding temperature, so that no fire accidents occurs. The one more important feature is automatic cylinder booking by noticing the current expenditure of LPG gas in our daily life. These projects alert the user by sending message to mobile through SMS in three conditions.

They are

- └ When LPG gas weight reaches to maximum threshold value.
- └ When the LPG gas exceed its peak value.
- └ When the temperature exceed more than room temperature.

These project gives alert message by buzzing the buzzer and trough SMS to the house holders. We also provide automatic doors and windows opening, so that the compressed gas can spread in to air freely. Hence a fire accident does not occurs.

GSM based gas leakage detection system in year 2014. International Journal of Technical Research and Applications by- Ashish Shrivastava, Ratnesh Prabhaker, Rajeev Kumar and Rahul Verma. The paper focus on Real time gas monitoring system, LPG Gas detection and prevention of leakage gas in year 2014. International Journal for Research in Applied Science & Engineering Technology.

LPG Gas Weight and Leakage Detection System device will help to book the new cylinder by using GSM module. We came to know that it has use GSM & leakage detection. LPG gas weight and leakage detection system using GSM has applicable in home, restaurants, hotels as well as industries. This project is used to continuously monitor the weight of the LPG gas cylinder. Many times we observes that in our home whenever LPG gas cylinder is empty, then we give request for new cylinder at the office of LPG gas provider. Many times it happens that because of shortage of LPG gas cylinder, there is delay in providing gas cylinder. Main reason behind this is delay in booking /informing to the gas

provider. The use of the LPG gas is in the home or restaurant for the cooking purpose and it also useful in industries for the cutting or welding purpose. In these place if the LPG gas in the gas cutters are empty at that time request for new gas cylinder are sent to the storage departments and if there is shortage of gas cylinders in the storage department then there is delay in providing LPG gas cylinder. To avoid all such situations, we are implementing a project which is "LPG Gas Weight and Leakage Detection System Using GSM". When our 20% gas is remaining then a lower priority MSG is send to the owner of the gas cylinder and when the 5% gas is remaining then the higher priority MSG is send to the owner of the gas cylinder.

IVRS was introduced due to the users complaints regarding to the landline phones of the distributor's . Because they are not giving response to the users call or the call line is busy and also in the IVRS user required to follow the instructions according to their format which is very confusing process.

ONLINE BOOKING are the little time consuming process And it required some knowledge about the messaging and internet. These entire tasks are difficult to the uneducated peoples and time consuming for busy schedule peoples. Mostly users are not able to guess the level of LPG gas in cylinder. So booking was not done within time and user required to wait for a new cylinder which creates a difficulties to the user.

For SMS required STD code and distributor mobile no. SMS < IOC > to the same mobile number where booking is made .So IVRS, ONLINE BOOKING, SMS are time consuming processes for gas booking

V. PROPOSED MODEL

The proposed method consists of gas leakage detection system, weight measurement module, microcontroller, GSM module and alert system. The main basic Node MCU micro controller requires the power supply ranging from 7-12 volts which can be build by using different components like step down transformer, rectifier, filter and regulator which are readily available as adapters these days. Supply can be either from an ac to dc adapter or battery. The board can operate on at 7-12 volts. If voltage<7V then board becomes unstable. If voltage>12V then board get damaged. The Main platform we are using to build the project is Node MCU which provides us the flexibility to write the code effectively in convenient way and also it will provides us features like Inexpensive, Cross platform, Simpler and clear programming environment, Open source and extensible software, Easy for beginners, The Node MCU is a microcontroller board based on the ATmega328 (datasheet).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. With the above features it force us to use in our project design. The other main component we are using in our project is use of Load cell.

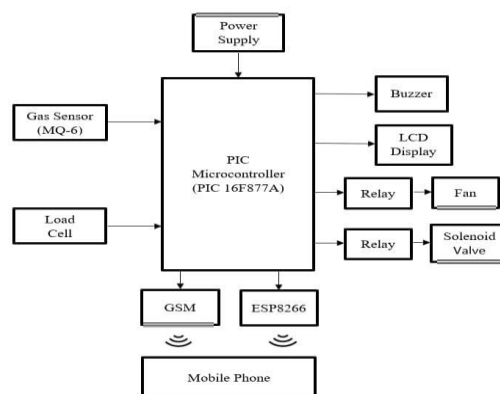


Fig:5.1(work flow of the proposed model)

Gas level detection and automatic booking is designed with various features which is implemented using Arduino and this device will be a single system with multiple applications for LPG consumers. The device monitors the load level of the LPG using the load cell, if the gas level goes below threshold value then it will be displayed in the LCD. It also detects the gas leakage by gas sensor. This includes an additional feature of booking a new LPG cylinder when the gas

level becomes critically low. Then it sends an alert to the registered mobile number by a SMS with the help of WIFI/GSM module.

The system architecture is divided into two modules:

1. Hardware module.
2. Software module.

The working components of the models are as follows.

1. AURDINO

Overview The Arduino Uno is a microcontroller board based on the ATmega328(datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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.



Fig:5.2(Arduino Uno)

2. Power Supply

The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 6V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So, in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage.

Regulated Power supply



Fig:5.3(Block diagram of power supply)

5.2.1 Transformer

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors without changing its frequency. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core, and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction. If a load is connected to the secondary, an electric current will flow in the secondary winding and electrical energy will be transferred from the primary circuit through the transformer to the load. This field is made up from lines of force and has the same shape as a bar magnet. If the current is increased, the lines of force move outwards from the coil. If the current is reduced, the lines of force move inwards. If another coil is placed adjacent to the first coil then, as the field moves out or in, the moving lines of force will "cut" the turns of the second coil. As it does this, a voltage is

induced in the second coil. With the 50 Hz AC mains supply, this will happen 50 times a second. This is called MUTUAL INDUCTION and forms the basis of the transformer.

5.2.2 Rectifier

A rectifier is an electrical device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid-state diodes, vacuum tube diodes, mercury arc valves, and other components. A device that it can perform the opposite function (converting DC to AC) is known as an inverter.

5.2.3 Filter

The process of converting a pulsating direct current to a pure direct current using filters is called as filtration. Electronic filters are electronic circuits, which perform signal-processing functions, specifically to remove unwanted frequency components from the signal, to enhance wanted ones.

5.2.4 Regulator

A voltage regulator (also called a ‘regulator’) with only three terminals appears to be a simple device, but it is in fact a very complex integrated circuit. It converts a varying input voltage into a constant ‘regulated’ output voltage. Voltage Regulators are available in a variety of outputs like 5V, 6V, 9V, 12V and 15V. The LM78XX series of voltage regulators are designed for positive input. For applications requiring negative input, the LM79XX series is used. Using a pair of ‘voltage-divider’ resistors can increase the output voltage of a regulator circuit. It is not possible to obtain a voltage lower than the stated rating. You cannot use a 12V regulator to make a 5V power supply. Voltage regulators are very robust. These can withstand over-current draw due to short circuits and also over-heating. In both cases, the regulator will cut off before any damage occurs. The only way to destroy a regulator is to apply reverse voltage to its input. Reverse polarity destroys the regulator almost instantly.

5.2.5 Jumper wires

A **jump wire** (also known as jumper, jumper wire, jumper cable, DuPont wire, or DuPont cable) is an electrical wire or group of them in a cable with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

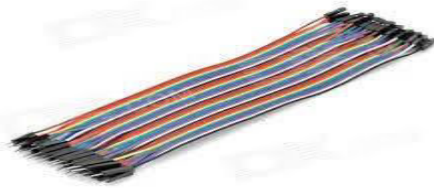


Fig 5.4 Jumper wires

5.2.6 LCD DISPLAY

A 16*2 LCD demonstrate contains two lines likewise, there are 16 characters for each line. Each character is appeared by 5x7 pixel lattice. This LCD includes two registers, specifically, Order and Data. The charge select extras the charge bearings that are given to the LCD. A charge is a rule given to LCD to do a predefined errand like presenting it, clears its screen, sets the cursor position, controls show et cetera. The data enroll saves the data to be appeared on the LCD [2].

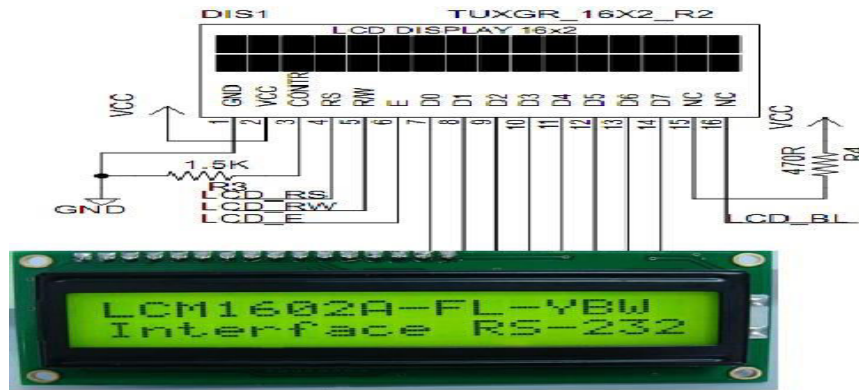


Fig 5.5 LCD Display

5.3 Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC- to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center- positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5Vpin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

5.4 Relay

A relay is an electrically operated switch. Relay is special switch designed to allow a small circuit to control a large circuit. These devices use a solenoid to control a heavy-duty switch. The wiring for the solenoid may require only 0.5amp to activate, while the switch it controls carries 10 to 30 amps. This device allows the high-current devices to keep localized in one place; this is good for added fire safety and keeping dangerous voltage current as far away from people as possible. Many relay use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relay are used where it is necessary to control a circuit by a low-power.

5.5 GSM

GSM(Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band. It supports voice calls and data transfer speeds of up to 9.6 k bit/s, together with the transmission of SMS (Short Message Service).

VI. RESULTS & DISCUSSION

The gas leakage detection system was tested in a controlled environment to simulate LPG gas leaks. The system successfully detected gas leaks, activated the solenoid valve to stop the gas flow, sent SMS alerts to predefined contacts, and displayed real-time information on the LCD. The system demonstrated reliable performance and timely response, meeting the project objectives.

The project successfully implemented an automated gas leakage detection and response system using Arduino. The integration of the MQ-135 sensor, solenoid valve, SIM800A GSM module, and LCD provided a comprehensive solution for gas leakage detection and prevention. The system's cost-effectiveness and ease of installation make it suitable for widespread adoption in residential and industrial settings. Future improvements could include enhancing the system's sensitivity, integrating additional sensors for other types of gases, and developing a mobile application for remote monitoring.

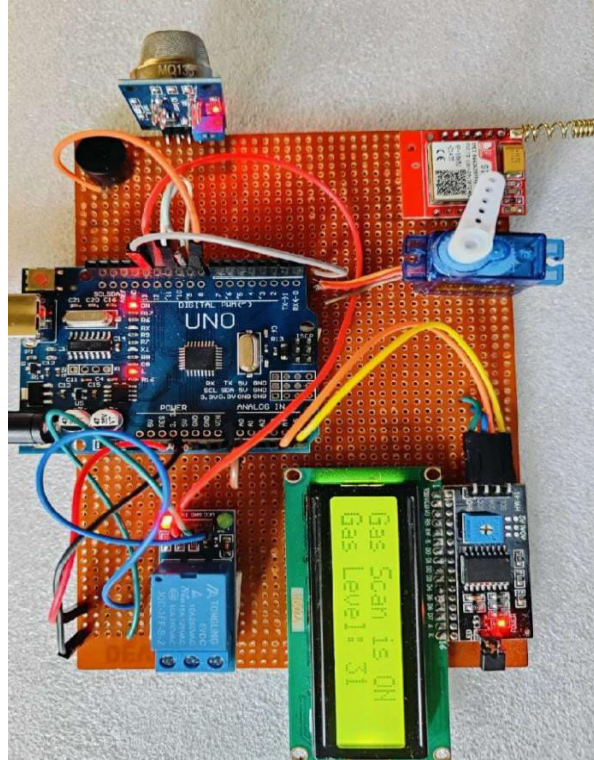


Fig:6.1(Proposed working model)

VII. CONCLUSION

This project aimed to provide an efficient, automated solution for gas leakage detection using Arduino. By integrating an MQ-135 sensor, solenoid valve, SIM800A GSM module, and LCD, the system ensures early detection, immediate response, and timely notification, enhancing safety in environments where LPG gas is used. The project achieved its objectives, demonstrating the system's reliability and effectiveness in detecting and responding to gas leaks.

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