Portable Model for Gas Leakage Detection using Node MCU

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ABSTRACT

Liquefied Petroleum Gas (LPG) is a main source of fuel in urban areas. Most of the fire-break outs in houses and industries are due to leakage of gas. This cause damages to human life, environment, and equipments and too many more things. Such accidents can be avoided using modern technology. In the present work, Node-MCU based gas leakage detection and alerting system is developed to monitor the concentration of LPG gas. System is built using Node-MCU ESP 32. MQ6 gas sensor is used for detection of LPG. Node-MCU takes the decision based on information provided by gas sensor. Firmware has been developed and deployed into Node MCU using arduino IDE. Presence of gas is displayed on OLED display module in terms of ppm. It also alerts the person by generating alarm. The designed system helps to achieve portability, light weight and cost effective solution to commercially available system.

Keywords: Liquefied Petroleum Gas, Node-MCU ESP 32, MQ6 gas sensor, OLED display

I. INTRODUCTION

Safety plays major role in human life and it is important to incorporate safety device in working place. Monitoring of air quality in an indoor environment is a necessary step for person with health related issues like respiratory disorders. Inhaling of such a air causes suffocation and may lead to loss or harm of life. Liquefied petroleum gas (LPG) made by combination of propane, butane, propylene, butylenes, isobutane and hydrocarbon gases is the main source of fuel present in indoor environment [1]. Due to the smelliness nature of these chemicals, the odour is applied to keep the gas odourless [2]. It is highly explosive and non renewable source of energy. Now-a-days, LPG is used as main source of fuel for household and industrial purpose. Due to its effectiveness and affordability, it becomes more popular as a fuel [3]. The primary feature of the LPG is that it is heavier

than the air present in our surrounding so it doesn't dissipate successfully. The dissipated gas gets lighted by any source of light; it can cause blast resulting in damage to life and people [4]. Normally LPG gas is available in cylinder and mainly used for cooking purpose. It is highly inflammable and can burn even at some distance from the source of leakage. Gas leakage causes serious problem in household and other areas where it is used [5]. It leads to various accidents resulting in both material loss and human injuries [6]. Most fire accidents occur due to substandard cylinders, old valves, poor quality rubber tubes, worn out regulators or it is not turned off when not in use and lack of awareness in handling gas cylinders. Home fires have been taking place frequently and the threat to human lives and properties is growing in recent years. Therefore, developing the gas leakage alert system is very essential [7]. A gas leakage detection system can be made smart by addition of sensor and communication interface [8]. It makes data accession and alerting to user through internet.

Exhaustive literature survey has been carried out on gas leakage detection system. H. Ruqsar et al. [9] developed a system for monitoring and detection of gas leakage. They used Xively IoT platform for monitoring of real time sensor data over the internet. A. Shrivastava et al. [10] designed GSM based gas leakage detection system. In this system, gas leakage is detected and it alerts the user by sending SMS using GSM module. It also turns off main power and gas supplies. A. Varma et al. [11] developed an IoT based gas leakage detector. They proposed smart alerting in their work like calling, sending SMS and email to concerned people. Data analytics has been done by sending sensor reading to cloud. A. Raj et al. [12] constructed LPG monitoring system that detect gas leakage and alert the concerned people. It also monitors the level of LPG and automatically booking of cylinder done by sending SMS using GSM module. Several designs of LPG detection and

alert system have been proposed in the literature. Apeh et al. [13] designed kitchen gas leakage detection and automatic gas shut off system. T. Soundarya et al. [14] presented the LPG gas leakage detection system in household application . V. Yadav et al. [15] proposed an idea of microcontroller based LPG gas leakage detector system. It consists of a background into the area of 8051 microcontroller, interfacing of sensor, mobile communication and setting of AT commands in communication. L. Dewi et al. [16] designed wireless sensor network for LPG gas leakage detection using arduino. In this work, when gas leakage is detected then system turn on the alarm automatically. It releases gas regulator, and neutralizes the air with the exhaust fan. V. Sharma et al. [17] developed an IoT Based Gas Leakage detection System using GPS. They designed system using arduino microcontroller. The system comes with a GPS module and a smoke detector for real-time position tracking and fire detection. The smoke detector detects smoke and sounds an alert, while the GPS module monitors the system's location. A. Manhas et al. [18] constructed gas leakage detection system from different source like air conditioner, refrigerator using IoT. It continuously monitors surrounding and alerts authority to avoid any accident.

In the present work, a low-cost Node-MCU based portable model for gas leakage detection and alerting is designed. MQ6 sensor module is used for detection of gas leakage. The necessary signal conditioning circuits have been designed in the laboratory using off the shelf components. Presence of gas in terms of parts per million (ppm) is displayed on OLED module.

II. METHODS AND MATERIAL

Proposed system has been constructed using MQ6 gas sensor module, Node-MCU ESP32, OLED display module to inform the user with text and buzzer used

to indicate excess amount of release of gases. Figure 1 shows the block diagram of developed system.
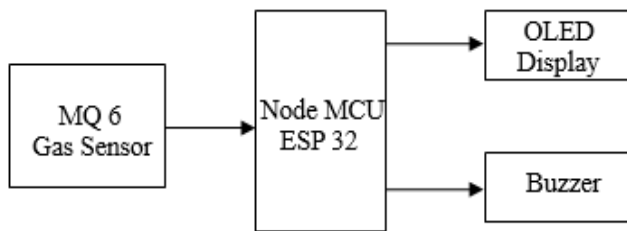

Figure 1: Block Diagram of System

Figure 2 shows the sample images of component used for construction of gas leakage detection and alert system.

Figure 2: Hardware Component of the System

ESP32 Node MCU is powerful system on chip microcontroller unit with integrated Wi-Fi and Bluetooth module. It is developed by the Espressif Systems Company, which currently offers several ESP32 versions of the system on chip (SoC) in the form of ESP32 Developer Kit. It has dual core processor with 520 KB of on-chip SRAM. Some version of ESP 32 module such as ESP32-Wrover has 4 MB of external SPI flash and an additional 8 MB of SPI PSRAM. It runs 32 bit programs and it has 30 GPIO pins. It is open source microcontroller and easily programmed using arduino IDE to built numerous applications around it. It also provides features such as SPI, I2S, I2C, CAN, and UART. These features help us to design various applications. It includes variety of peripherals such as Hall Effect sensor, temperature sensor and touch sensor. The MQ-6 Gas sensor is useful to detect or measure gases like LPG, methane and butane. It can be used as digital or analog sensor. This sensor module provides four pins (V$_{CC}$, Ground, analog output and digital

output). It gives analog output voltage ranging from 0V to 5V and digital output in terms of TTL logic depending on the concentration of gas detected by the module. The digital output pin of this module makes the sensor as handy device to detect one particular gas. When it comes to measuring the gas in ppm the analog pin has to be used, the analog pin also TTL driven and works on 5V and hence can be used with most common microcontrollers.

Organic light emitting diode (OLED) display used in this work is SSD 1306 model. It is monocolor having size of 0.96 inch with 128X64 pixels. This display can be visualized without any backlight resulting in nice contrast in dark environment. It is available in four pins that can interface with any microcontroller having I2C communication capabilities. Alarm indicator used in this work is piezobuzzer that generates beeps when the concentration of detected gas is above desired level. It is light weight, low cost and provides two pins for connection with external device.

The system is designed using Node-MCU ESP-32. MQ6 gas sensor has 4 pins (V$_{CC}$, Ground, Do and Ao) for connection to enable das detection. V$_{CC}$ pin is connected to the 3.3V supply. Ao output pin of the sensor is connected to the GPIO 12 pin of the Node-MCU. OLED display module provides four pin and also has I^{2}C communication capabilities, so it is connected to GPIO 22(SCL) and GPIO 21(SDA) pin of Node MCU. A buzzer is connected between GPIO 2 and ground pin of the Node MCU. Figure 3 shows circuit diagram for gas leakage detection system using MQ6 sensor module.
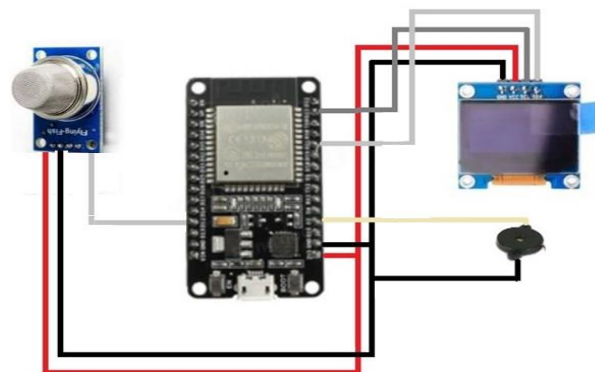
Figure 3 : Diagram for Implementation of Gas Leakage Detection System

After implementation of gas leakage detection system, necessary code is developed in arduino IDE. This code include processing of sensor data, display gas concentration level in terms of ppm on OLED display module and activate an alarm if gas concentration is above 2000 ppm. It is useful in household application when gas concentration goes beyond predefined value and inform user to take necessary action.

III. RESULTS AND DISCUSSION

Figure 4 shows the developed prototype. This device is equipped with Node-MCU ESP 32 for processing sensor data, MQ6 gas sensor to detect gas concentration from 200 to 10,000 ppm, OLED display module to display the presence of gas and buzzer as an alarm indicator in the event of gas leak. The overall software and hardware parts of the system has been designed successfully and verified for its performance in indoor and outdoor environment.

Figure 4: Developed Prototype

An indoor environment test has been done by slightly opening the valve of regulator. It has been found that; device detects the presence of gas with level of 1568 ppm at a distance about 1 meter successfully. In outdoor testing, sensor is unable to detect the presence of leaky gas levels due to presence of sensitive material SnO_2 in MQ6 module that possesses low conductivity in clean air.

IV. CONCLUSION

The LPG gas level detection system is an important tool in household application and various workplaces. Leakage of a LPG gas can cause dangerous situation leading to destroy of human life and significant damage to property within a short period of time. The proposed system is a reliable and cost effective solution for detection of LPG and generates an alarm to avoid catastrophic outcomes.

The experimental results of the developed prototype show its capacity to precisely detect gas leakage and generate an alarm to control damage caused by gas leakage. Consequently, the proposed model can improve house safety and industrial safety. It also prevents accidents and minimizes damage caused by gas leakage. Consequently, it is a significant and important venture for anybody utilizing LPG gas as a fuel source.

In future, this system can be make smart using recent technologies where it can be notify the emergency service in case of any accident take place. A mobile app and web based app can be developed to monitor wastage of gas and uses of gas by adding some subsystem.

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