A Smart Approach of LPG Monitoring and Detection System Using IoT

Conference Paper · July 2020

DOI: 10.1109/ICCCNT49239.2020.9225293

3 authors, including:

Nagib Mahfuz
Università degli Studi di Trento
8 PUBLICATIONS **79** CITATIONS

SEE PROFILE

A Smart Approach of LPG Monitoring and Detection System Using IoT

Nagib Mahfuz, Shawan Karmokar, Md. Ismail Hossain Rana
Department of Electrical and Electronic Engineering
American International University – Bangladesh (AIUB)
Dhaka, Bangladesh.
mahfuz_aiub@yahoo.com, jotyirmay@yahoo.com, ihrana.raj@gmail.com

***Abstract*—Liquefied petroleum gas (LPG) is most widely used all over the world for heating, cooking, vehicle fuel, and so many other fueling purposes. LPG is a highly flammable gas and leakage of LPG occurs major accidents. This paper approaches a smart technique for monitoring the leakage of LP Gas using IoT. In this research, a smart electronic system is developed for monitoring the presence of LP gas, Natural gas, butane, temperature, humidity, and heat index through a webserver. This system can trigger an alarm if the gas leakage is found or any measured parameters exceed the threshold value and also send an alarming SMS to the concerned authority. It can prevent the exploration occurs due to gas leakage. This system is integrated with sensors array which measures the important index related to gas presence and exploration. NodeMCU is a development board having an ESP8266 Wi-Fi chip that is used as a controller unit. The sensors data are fed into a NodeMCU and it imports these data to a website that is accessible from anywhere by using the internet. A 16*2 LCD is connected with the NodeMCU for displaying the sensor's value onsite. A user can enquire about the gas presence by sending SMS also. It's a NodeMCU based low-cost smart system to overcome accidents and gas leakage.**

Keywords – LPG, Internet of Things (IoT), NodeMCU, LPG, Webserver, GSM.

I. INTRODUCTION

LPG is available almost everywhere to fulfill household needs and industrial demands. It's mainly a mixture of propane and butane which are extremely flammable. A small leak of LPG can occur heavy damage to humans and infrastructures. LPG is heavier than air and cause of suffocation after inhaling. Human safety has always a prior concern. To prevent gas leakage, it's important to continuously monitor of LPG supply. Internet of Things (IoT) technology can handle these tasks sophisticatedly.

This paper approaches a simplified and effective device for detecting and monitoring LPG detection. This device can be used in any place where LPG is used. A NodeMCU development board is used as a controller. MQ5, MQ6 gas sensors are used for LPG detection. Dht11 sensor is used for monitoring the temperature and humidity. All the sensor data are uploaded on a web server. Users can access this data from anywhere if he has internet access or without internet within the NodeMCU wifi range free at cost. This system can send automated SMS to the concerned authority if LPG leakage is detected. The system also triggers a buzzer alarm to aware of the people. The system has an LCD for displaying the sensor's data. A combination of a web server monitoring and SMS alarming subsystems made this low-cost device unique and more effective rather than other existing devices. This simplified device is portable and can be implemented in house and industrial sector for monitoring LPG.

II. RELATED RESEARCH

There are many existing methods of detecting LPG leakage and researcher are continuously working on it to make it more efficient. Sony et al. [1] developed an IoT based gas management system for cooking gas cylinders. This system detects the gas leakage and sends alert SMS to the user and automatic booking SMS when the gas cylinder becomes empty. Tamizharasan et al. [2] developed another IoT based household LPG gas detection system using an MQ6 sensor and automatic booking by the registered gas booking number when the LPG level of the cylinder is critically low. Suma et al. [3] presents a system of detection of LPG leakage and sends booking notification using wifi. Rahul et al. [4] present microcontroller-based LP gas detection and monitoring system in the android platform. This system is integrated with exhaust fan and electrical switches also. This can be monitored and controlled using an android application. Hardware transmits data to android application through a ZigBee based Bluetooth module which can work in short-range only. Ravi et al. [5] developed a low-cost IoT based industrial plant safety gas leakage system using MQ4, MQ6, and MQ135 which detects LPG, Methane, and Benzene Gas. These sensors data are uploaded in cloud storage using ESP - 32 Wi-Fi module. Alan et al. [6] approach an Arduino based LPG monitoring using an MQ4 gas sensor and automatic cylinder booking with an alert system. Shankey et al. [7] developed a new technique for detecting the gas leakage by checking the status of the LPG stove whether it is on or off and the result comes on an Android application. Kumar et al. [8] describe a gas booking system over IoT and a siren (60db) is triggered through RF if any changes in the surrounding environment of a gas container. Banik et al. [9] developed a low-cost device that will send SMS alert for the presence of LP gas in the air. Anindya et al. [10] developed micro-electro-mechanical interdigital sensors for the detection of leakage of domestic cooking gas which is fabricated on oxidized single-crystal silicon surfaces by a maskless photolithography method. Arpit et al. [11] developed an IoT based LP Gas cylinder monitoring system which has a special feature of controlling gas regulator with the angular rotation of servo motor. Metta et al. [12] developed an IoT based LP gas leak detection device by using NodeMCU, MQ2 gas sensor, and flame sensor. The device data are displayed in an android based smartphone. Shruthi et al. [13] developed a microcontroller-based LPG detection and monitoring system

using the MQ6 gas sensor and load cell. All this research shows concern about gas leakages. Most of the research focused on the gas leakage from a household cooking LPG cylinder. This research aims to develop a multilayer alarming method with an appropriate gas sensing mechanism. The proposed electronic device has the facility to monitor real-time gas leakage conditions and SMS inquiry and alarming functionality. In the webserver database, the sensor's data are preserved for further analyzing and assumption research. This proposed device has a simplified mechanism for operation.

III. ARCHITECTURE OF THE SYSTEM

The main objective of this research is to develop a microcontroller-based low-cost LPG monitoring and detection system using the Internet of Things (IoT). To achieve this goal a NodeMCU is used along with few sensors related to LPG detection and exploration. Figure 1 describes the block diagram of the LPG monitoring and detection system using the Internet of Things (IoT).

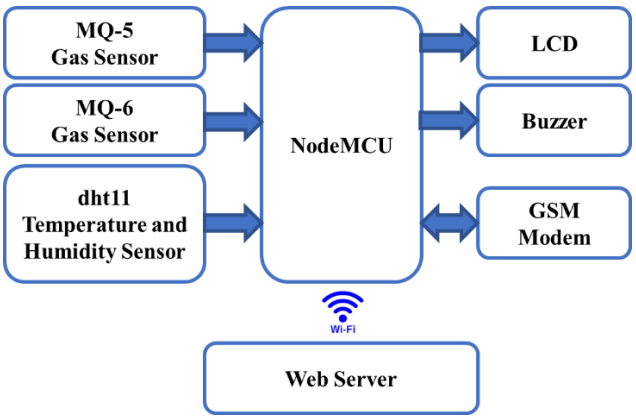

Figure 1: Block Diagram of LPG Monitoring and Detection System using IoT.

Multiple sensors are used to detect the surroundings and LPG leakage condition of LPG sources. NodeMCU determines the leakage status and executes the necessary actions.

A. MQ-5 Gas Sensor

This gas sensor can detect LPG, Natural, Town gas with higher accuracy. This sensor can test the presence of gas between 2000ppm to 10000ppm concentration [14]. This sensor operates at 5V and the output voltage is increased when the concentration of gas increases.

B. MQ-6 Gas Sensor

This is suitable for detecting the presence of LPG. This sensor is an analog resistance-based sensor. The accuracy of this sensor is higher and the first response time for the gas concentration between 200ppm to 10000ppm [15].

C. DHT11 Temperature and Humidity Sensor

DHT11 is a low-cost digital sensor for measuring temperature and humidity in the air. It has a very wide range of capabilities of sense. It measures 0-50^{0}C temperature with ±2°C accuracy and 20 -80% humidity with 5% accuracy [16]. It's a very power-consuming device, operates at 3V to 5V and it consumes a maximum 2.5mA current while requesting data for reading.

D. NodeMCU DEVKIT 1.0

NodeMCU is an opensource Lua based firmware for IoT platform. NodeMCU DEVKIT 1.0 is a microcontroller development board with ESP12E wifi chip. In this research, NodeMCU is used as a controller unit. Though it's an Internet of Things (IoT) based system NodeMCU is a better option at low cost for uploading data to a web server. All the sensor's data are fed into this controller unit. This controller unit takes proper actions after analyzing the sensor's data.

E. Liquid Crystal Display

A 16*2 Liquid Crystal Display (LCD) is connected with NodeMCU through the I2C communication protocol. This LCD is displaying the real-time sensor's data onsite.

F. Buzzer Alarm

A buzzer is also integrated with the system for an alarming purpose. The NodeMCU triggers the alarm if the sensors detect gas presence in the air. It's very effective in short-range for informing people about gas leakage.

G. GSM Modem (SIM800L)

A SIM800L GSM Modem is connected with the NodeMCU that can send and receive SMS. It's a hardware device that accepts a SIM card and operates over a subscription to a mobile operator. It's similar to a mobile phone. The controller unit sends an automatic notification to the concerned authority about the gas leakage when the sensor detects the presence of gas or any abnormal values of sensors. A user can inquire about the status of gas leakage by sending an SMS from a remote distance.

H. Webserver

A webserver is developed for continuous monitoring of the sensor's value. NodeMCU makes an HTTP post request to a PHP script to insert sensors value into a database. A specific domain name and hosting space are required for reaching out to the webserver. A MySQL database is prepared for storing data from the sensors. A PHP script is developed for inserting the data into the MySQL database. The user can monitor the value of the sensor from anywhere by accessing the web address. For further research purpose data that's are stored in MySQL database can be analyzed to predict the leakage of LPG. The overall process of the webserver is given in Figure 2 block diagram.

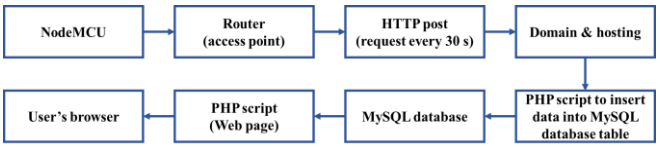

Figure 2: Block diagram of uploading data to the webserver process.

In this system, MQ-5 and MQ-6 gas sensors are used because both sensors can detect LPG and other flammable gas presence and their ratio in air. Temperature and Humidity measurement is important for getting the heat index. From these sensors, NodeMCU can assume the exploration or other

accidental possibilities. On the webpage, the system shows the important index values and results of analyzing the sensor values. This webpage is working like a dashboard. Someone can understand the situation of gas leakage or normal status directly from the result status on the webpage without understanding the sensor's values. If gas leakage occurs the system creates an alarm on-site and also warns the concerned authority by sending SMS alert that can reduce the possibility of exploration. Figure 3 describes the flow chart of the LPG monitoring and detection system using the Internet of Things (IoT).

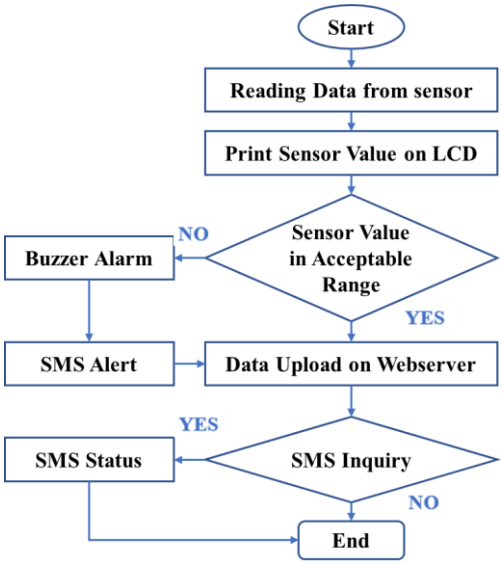

Figure 3: Flowchart of LPG monitoring and detection system using IoT

IV. SIMULATION AND RESULT ANALYSIS

Before implanting the hardware, the system is simulated in Proteus simulation software. Though all required tools are not available on Proteus Software, it's important to simulate the system with available tools to demonstrate the idea.

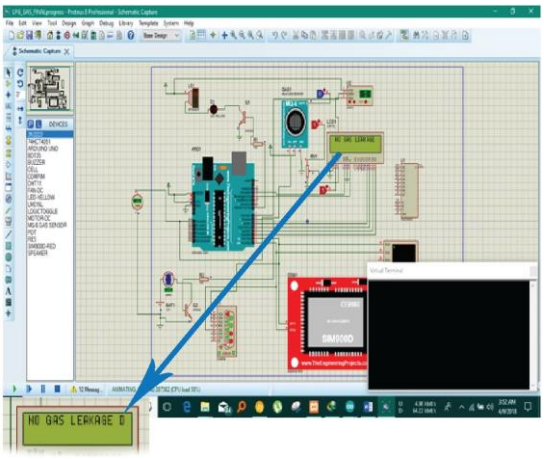

Figure 4: Schematic Diagram on Proteus Simulation Software.

V. HARDWARE IMPLEMENT AND RESULT ANALYSIS

In this section hardware implementation and output results are described. Implemented hardware in figure 5 and the output result in figure 6 is given.

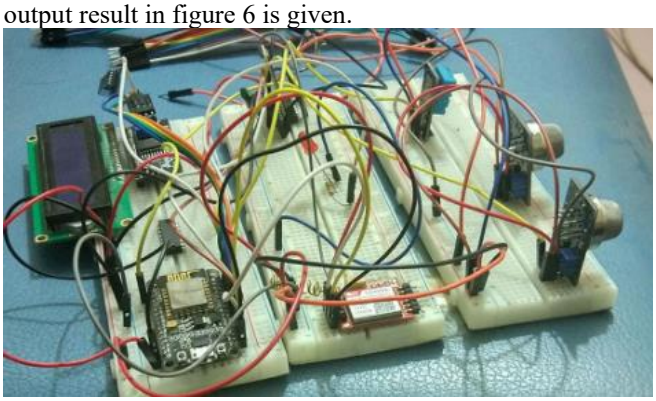

Figure 5: Implemented Hardware Prototype.

Figure 6: Output result on LCD.

In webpage, real-time gas percentage, heat index, humidity, smoke presence, and temperature are visualizing. The snapshot of the webpage with real-time data is given in figure 7.

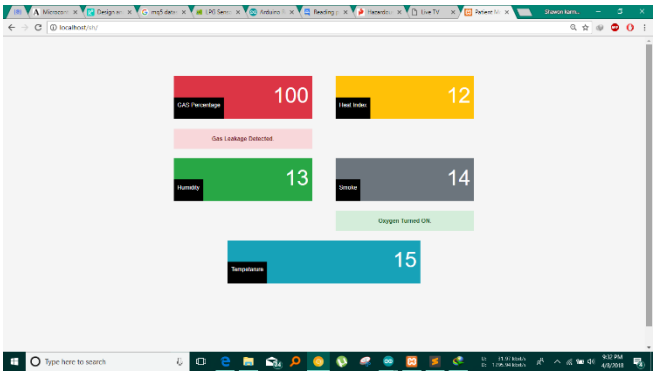

Figure 7: Visualization of the Web server.

For the gas presence or any unacceptable value of any sensors, an alert SMS will be sent to the user and the user also can inquire about the status of all sensor's value.

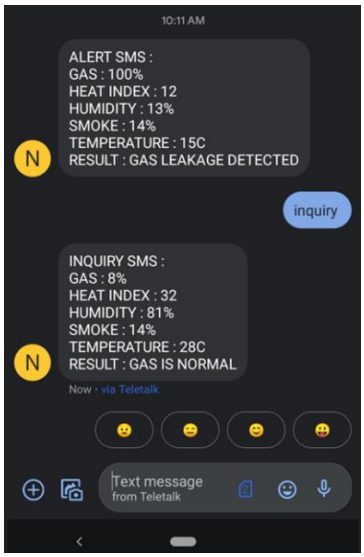

Figure 8: SMS alert, inquiry, and feedback.

VI. CONCLUSION

This paper presents a simplified solution for monitoring and detecting LPG using IoT. IoT has so many applications in daily life and it's very reliable. This research finds a new solution to solving the LPG leakage problem. This smart electronic system notifying people about gas leakage in multiple ways. Besides the onsite buzzer alarm, it sends SMS alert and updating data on a webserver. A combination of multiple observation ways from a remote distance makes this system more unique and effective. Multiple systems can be controlled by using a single web server and mobile phone. Sometimes this system can trigger an alarm for the presence of a small presence of LPG nearside cooking stove during cooking. However, it's a low-cost system but very effective on gas leakage monitoring and able to play a vital role to prevent exploration due to LP Gas leakage.

REFERENCES

[1] S. SHRESTHA, V. P. K. ANNE AND R. CHAITANYA, "IOT BASED SMART GAS MANAGEMENT SYSTEM," 2019 3RD INTERNATIONAL CONFERENCE ON TRENDS IN ELECTRONICS AND INFORMATICS (ICOEI), TIRUNELVELI, INDIA, 2019, PP. 550-555, DOI: 10.1109/ICOEI.2019.8862639.

[2] V. Tamizharasan, T. Ravichandran, M. Sowndariya, R. Sandeep and K. Saravanavel, "Gas Level Detection and Automatic Booking Using IoT," 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS), Coimbatore, India, 2019, pp. 922-925, doi: 10.1109/ICACCS.2019.8728532.

[3] V. Suma, R. R. Shekar and K. A. Akshay, "Gas Leakage Detection Based on IOT," 2019 3rd International conference on Electronics, Communication and Aerospace Technology (ICECA), Coimbatore, India, 2019, pp. 1312-1315, doi: 10.1109/ICECA.2019.8822055.

[4] R. Kurzekar, H. Arora and R. Shrestha, "Embedded Hardware Prototype for Gas Detection and Monitoring System in Android Mobile Platform," 2017 IEEE International Symposium on Nanoelectronic and Information Systems (iNIS), Bhopal, 2017, pp. 6-10, doi: 10.1109/iNIS.2017.11.

[5] R. K. Kodali, R. N. V. Greeshma, K. P. Nimmanapalli and Y. K. Y. Borra, "IOT Based Industrial Plant Safety Gas Leakage Detection System," 2018 4th International Conference on Computing Communication and Automation (ICCCA), Greater Noida, India, 2018, pp. 1-5, doi: 10.1109/CCAA.2018.8777463.

[6] A. Macker, A. K. Shukla, S. Dey and J. Agarwal, "ARDUINO Based LPG Gas Monitoring … Automatic Cylinder Booking with Alert System," 2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, 2018, pp. 1209-1212, doi: 10.1109/ICOEI.2018.8553840.

[7] S. Garg, J. Moy Chatterjee and R. KumarAgrawal, "Design of a Simple Gas Knob: An Application of IoT," 2018 International Conference on Research in Intelligent and Computing in Engineering (RICE), San Salvador, 2018, pp. 1-3, doi: 10.1109/RICE.2018.8509034.

[8] K. Keshamoni and S. Hemanth, "Smart Gas Level Monitoring, Booking & Gas Leakage Detector over IoT," 2017 IEEE 7th International Advance Computing Conference (IACC), Hyderabad, 2017, pp. 330-332, doi: 10.1109/IACC.2017.0078.

[9] A. Banik, B. Aich and S. Ghosh, "Microcontroller based low cost gas leakage detector with SMS alert," 2018 Emerging Trends in Electronic Devices and Computational Techniques (EDCT), Kolkata, 2018, pp. 1-3, doi: 10.1109/EDCT.2018.8405094.

[10] A. Nag, A. I. Zia, X. Li, S. C. Mukhopadhyay and J. Kosel, "Novel Sensing Approach for LPG Leakage Detection: Part I—Operating Mechanism and Preliminary Results," in IEEE Sensors Journal, vol. 16, no. 4, pp. 996-1003, Feb.15, 2016, doi: 10.1109/JSEN.2015.2496400.

[11] A. K. Srivastava, S. Thakur, A. Kumar and A. Raj, "IoT Based LPG Cylinder Monitoring System," 2019 IEEE International Symposium on Smart Electronic Systems (iSES) (Formerly iNiS), Rourkela, India, 2019, pp. 268-271, doi: 10.1109/iSES47678.2019.00066.

[12] M. Santiputri and M. Tio, "IoT-based Gas Leak Detection Device," 2018 International Conference on Applied Engineering (ICAE), Batam, 2018, pp. 1-4, doi: 10.1109/INCAE.2018.8579396.

[13] S. Unnikrishnan, M. Razil, J. Benny, S. Varghese and C. V. Hari, "LPG monitoring and leakage detection system," 2017 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), Chennai, 2017,pp. 1990-1993, doi: 10.1109/WiSPNET.2017.8300109.

[14] B. Zuo, "Grove - Gas Sensor(MQ5) - Seeed Wiki", Wiki.seeedstudio.com, 2020. [Online]. Available: https://wiki.seeedstudio.com/Grove-Gas_Sensor-MQ5/. [Accessed: 28- May- 2020].

[15] L. MQ-6, "LPG Gas Sensor - MQ-6 - SEN-09405 - SparkFun Electronics", Sparkfun.com, 2020. [Online]. Available: https://www.sparkfun.com/products/9405. [Accessed: 28- May- 2020].

[16]]A. Industries, "DHT11 basic temperature-humidity sensor + extras", Adafruit.com, 2020. [Online]. Available: https://www.adafruit.com/product/386. [Accessed: 28- May- 2020].