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IOT Based LPG Leakage Detection System With Prevention Compensation

Mohammad Abas Malik, Magray Abrar Hassan and Adnan Shafi

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Mohammad Abas Malik[1] **Magray Abrar Hassan**[2] **Adnan Shafi**[3]
[1]Assistant Professor, Department of Electronics and Communication Engineering
BGSB University, Rajouri, J&K, India
[2,3]Department of Electronics and Communication Engineering
BGSB University, Rajouri, J&K, India
[1]abasmalik@bgsbu.ac.in

***Abstract*—To provide safety apparatus for the use of LPG gas connections in common households and industries against hazardous conditions such as Gas Leak, Fire and Explosion of compressed gas Cylinders. Our aim of this research is to give security to all the people around the world from LP gas leakage by equipping them with an economical and effective alarming system which not only can detect this menace threat but also can automatically control it by its safety line of action. The module consists of a gas sensor MQ6 which has a high sensitivity to gases such as propane and butane which in combination constitute the LPG. The aim behind our research is to implement a mechanism by automatically disabling the gas supply from the source instantly once the leakage of gas is detected, followed by rapid closure of Regulator valve along with triggering an sounding alarm and alerted Wi-Fi display that too without any manual dependence.**

Keywords—liquid petroleum gas, gas sensor, wi-fi module, servo motor.

I. INTRODUCTION

Liquefied Petroleum Gas is seeking its sole importance for use in industrial, agricultural, horticultural, manufacturing and commercial applications. There is a drastic increase in the demand of LP Gas due to its ecofriendly nature as energy surfed from it is free of pollution and is being extracted from the fossil fuels. It has an ease in its installation process that is the reason for its wide market demand. It even powers cogeneration plants but at the same time it is one of the common reasons for fire breakouts and causing terrible accidents particularly in closed buildings by its leakage in the vicinity. The content energy source in LPG include 60% of butane (C4H10) and 40% of propane (C3H8), which is highly flammable and an odorless gas. In case of the leakage of such gas takes place, then it mingles with the air and replaces oxygen instantly causing suffocation and ignition, resulting to the terrible fire eruption and explosions due to the rupturing of the gas cylinders.

The LPG gas cylinder is designed to withstand a pressure of upto 25kg per square cm. That is like a 25kg weight put on an area of your fingernail. That is a massive pressure to control. Usually inside the cylinder, the gas stays at a pressure of about 5–7kg per square cm (almost 1/3rd of the maximum pressure). But occasionally, people indulge in unsafe practices of heating the cylinder or throwing the cylinder which damage the welding and/or body of the cylinder. This damage can lead to leakage of gas which can catch fire and this cylinder then starts getting heated up in the fire caused. The fire raises the temperature and leads to massive increase of pressure inside. Once it goes beyond the maximum limit, the metal of the cylinder fractures and explodes

The tendency of LP Gas ignition is when it forms almost 2%and 10% of a vapour/air mixture. Also as a colorless liquid, LP Gas constitute around 0.4% of its vapour volume, but still is about half of the density of water and can easily float on water before vaporizing. Uncontrolled fire eruption of LP Gas may lead to devastating fires along with explosions. An already flame of fire available at some distance from the source of LP Gas leak can rapidly direct towards it resulting in the overheating and bursting of cylinder exhibiting gaseous volume violently.

Figure 1: Shows an exploded cooking gas cylinder at a house of Shyamala Buchamma, 60, at Veerannagutta Hyderabad India, where she was staying along with her son Raju, daughter-in-law 'Rani' and their two children.[1]

Apart from being colorless LP gas is odorless and to compose it to an odorant gas, we manually add Ethyl Mercaptan so as to be smelled and sensed. Being heavier than air, these gases do not disperse easily and tend to settle the down surfaces. It may lead to suffocation when inhaled but in case there is the absence of any human resources at the spot to perceive the smelling signals, then it is unaffordable to depend on this inbuilt precautionary mechanism. Also some people have a weakened sensation of smelling and thus are too feeble to detect any surrounding odor.

So to avoid this problem there is a need for developing a system which will detect the leakage of LPG in domestic and commercial premises in its early stages and would also facilitate the safety measures to eliminate the accidental possibility. Our research has successfully fulfilled these demands and is efficient enough to operate in any surrounding circumstances.

Some of the recent hazardous accidents due to domestic LPG cylinder blasts are mentioned below:

1. **At Banihal (Jammu and Kashmir):**

On Friday*30 November 2019*, a woman, resident of Ballot, identified as Darshana Devi along withsix other, including three of her daughters got killed after the explosion of *LPG gas cylinder* at her house in district Ramban of Jammu and Kashmir. [2]

2. **Duo of Mother and son got killed. Also 32 injured after LPG cylinder blast (Giaspora, India):**

On *April 27 2018* at 7am in the house of Sunita and her son, the leaking LPG cylinder bursted to flames after the electricity supply to the area was restored. Sunita and her son Raj Yadav succumbed to their injuries at CMC Hospital Ludhinia in the evening. [3]

3. **Five got killed by the LPG cylinder blast at Dibrugarh/Assam.**

On Saturday *October 19 2019*, four from a family andfive otherslost their lives after LPG cylinder blast at their residance caught fire followed by numerous more explosions.The victims include *Krishna Sunar(husband), Maya Sunar(wife), Vishal Sunar(younger son), Sankar Sunar(grandson)*and *50* year old*Nunu(house keeper). [4]*

4. **AT INDIAN LABORTORY, A RESEARCHER GOT KILLED DUE TO LP GAS EXPLOSION.**

On Wednesday December 5*Dec 7, 2018*, one researcher "Manoj Kumar" 32 years old was flung 20 feet above ground and died instantly after explosion of LP gas at the Laboratory of the Indian Institute of Science known as *Hypersonic and Shock Wave Research lab*, in Bangalore/India. [5]

Following mentioned are the details of total number of accidents across India reported by India Stat [6] due to LPG and deaths reported.

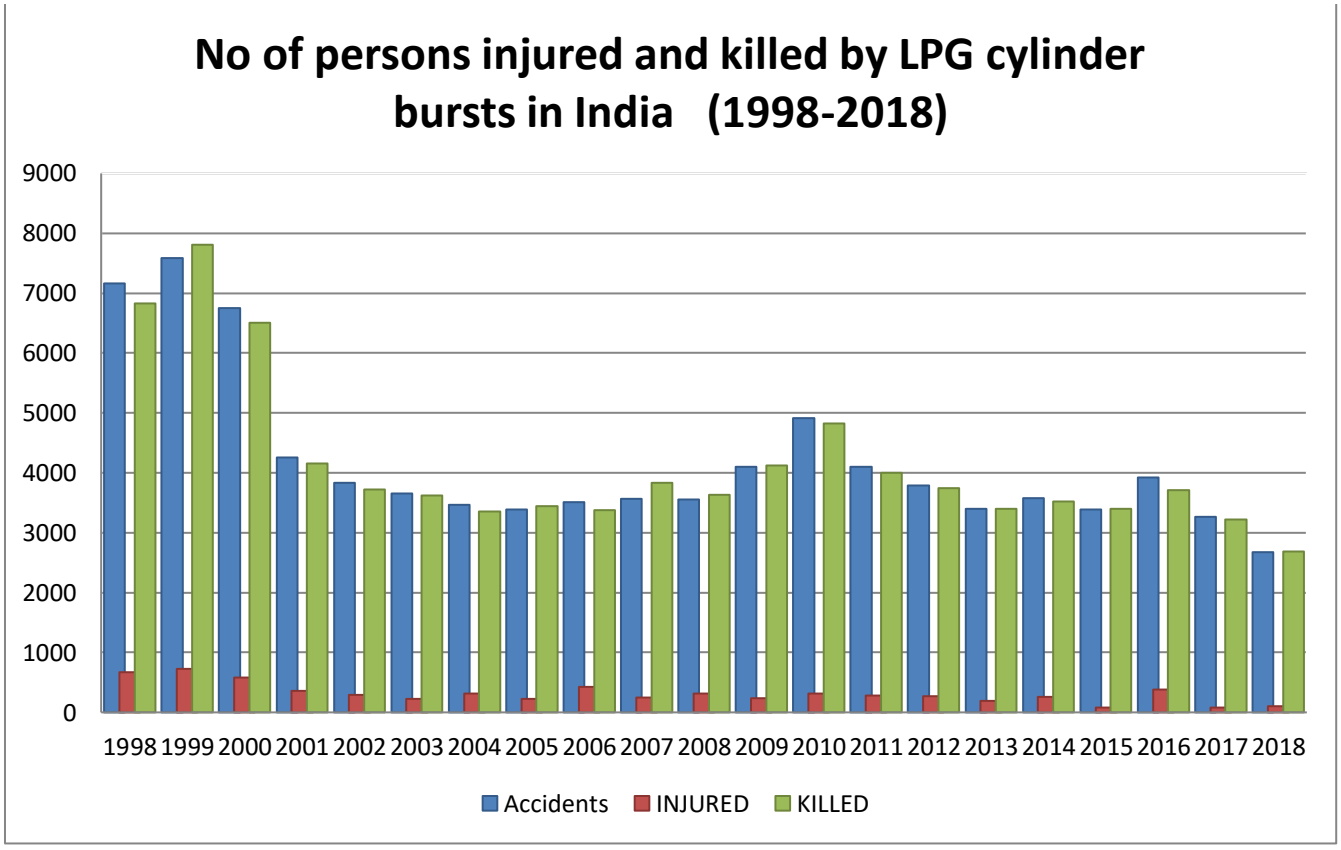

Figure 2: No of persons injured and killed by LPG cylinder burst in India(1998-2018)

Since now continuous efforts are being made to overcome the issue of LPG leakage. Many systems of LPG detection and alert system have been proposed in the literature to identify potentially hazardous gas leaks by means of various sensors.

Our project entitled "IOT based LPG Leakage Detection System with Prevention Compensation", will impart its role to surf for safety of people and imparts prevention from any danger to be caused by the leakage of LPG.

We use a gas sensor MQ6,which has a rapid response time to examine the LPG leakage when it exceeds the threshold value. Apart from informing the authorized person via a display connected to the wifi module and activating a sounding buzzer, the system owns the capability to trigger the valve using servo motor to turn off the gas flow from the source and to avoid any mishap in advanced form.

II. SYSTEM DESIGNING

A. Electronic part of the system

The designing of our proposed LPG gas leakage detection system with prevention compensation consists of a microcontroller board (ATmega328P) called as Arduino Uno, a MQ-6 gas sensor which continuously senses the surrounding atmosphere and owns a threshold value of 200 ppm, a Piezo buzzer is being used, ESP8266 wifi-module and LEDs as accessory circuitry for sensitivity adjustment.
It is battery operated and hence portable. The information about the leakage has to be informed to the user. For this purpose, a Piezo buzzer generates a steep sound with Red LED blinking simultaneously and Esp8266 WIFI module displays a warning status on to the display.
The required simulation for the system designing is full-filled by an open-source Arduino Software (IDE),which manufactures an easy code for uploading to the panel.

B. Mechanical part of the system

The kit exhibits the integration of a 'Servo Motor' tied with the knob of the gas tank 'Regulator'. Since Servo motor in itself is an electronic part but exhibits mechanical action, it is encoded by Arduino software (IDE) to rotate on precise angle or in the direction opposite to ON rotation cycle at the instant of gas leakage which is being detected by MQ-6 gas sensor. The rotation is from 90 degree to 0 degree so as to turn the knob and consequently the gas regulator to the OFF state. Thus ensuring the automatic closure of the gas source.

The Servo Motor which is programmed to rotate at precise angle after the gas leakage detection being perceived can be directly connected to the knob of the Regulator as there are no threats in the production of electrical sparks. So the adjustment of the project is done in such a way that electronic parts are kept at a distance for prevention purposes and Servo motor is tied directly with the Gas regulator.

III. FUNCTIONAL BLOCK DIAGRAM OF THE DEVELOPED SYSTEM

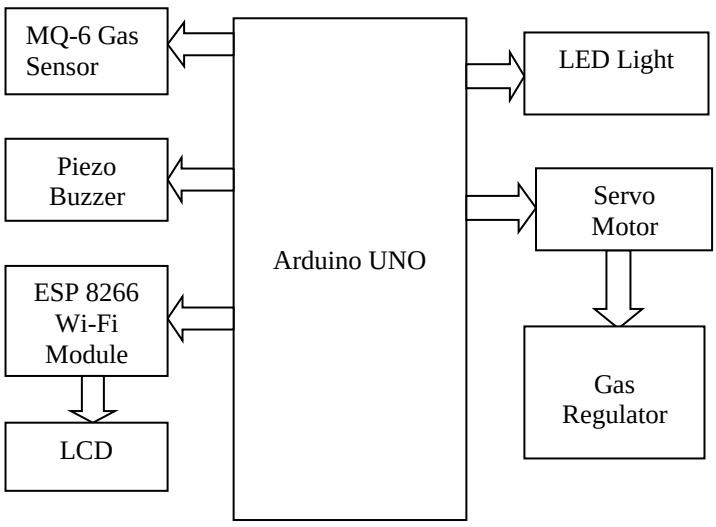

Figure 3: Block Diagram of LPG Leakage detection system with Prevention Compensation

Block Diagram Description

The LPG gas sensor is directly connected with the Arduino uno and is being programmed by the software Arduino IDE.

The Buzzer is also integrated with Arduino and its operational function is being programmed as well.

The wifi module is connected with any of the electronic gadget that may be either the computer or the mobile phone or a tablet to enable the displaying medium for the representation of the schematic working of the project. Also for its working there is no need of internet connection.It can view the 'Ensuring message' as well as a 'warning message', so as to satisfy the user on behalf of the working procedure of system

The Servo motor that is connected with the arduino by means of jumper wires is in turn directly tied with the Knob of Gas Regulator by a tensile thread so as to control the rotating valve positions of this regulator and acquire control over the supply of LP gas from proceeding further.

IV. SYSTEM OPERATION

After Feeding this IOT based system with Dc power source of 9v, it is preferred to place the Mq6 Gas sensor to the ground level from the gas Platform as the vapour of LP Gas is denser and heavier than air and tends to settle at low areas such as cellars, drains and other depressions.[7]

The detection power of gases by the gas sensor, depends on the chemiresistor acting as integrated nosal part of Mq6 Gas sensor to promote current. Tin Dioxide (SnO2) is the most commonly used chemiresistor which is n-type semiconductor thus having free electrons. Since the atmosphere in normal conditions contain more oxygen than that of combustible gases. The free electrons are attracted by oxygen particles available in SnO2 that pushes them towards the surface of the SnO2. As soon as the sensor is keptin the combustible or toxic gaseous environment, itleads to the reaction with the adsorbed particles of oxygen and ultimately breaks the chemical bond between oxygen and free electrons which results in the conduction of current, and consequently this conduction will always be proportional to the amount of free electrons available in SnO2.

In normal situations when LPG is proceeding through proper encased pipelines, the status of the display which is connected to the wifi module follows statement "Gas Connection Normal". Also the green LED glows to provide visual satisfaction to the user.

But in the conditions of LPG leakage, the gas sensor induces an emergency situation in IOT system exactly as per programmed, by enabling the buzzer sound 'ON', Blinking of Red LED and the Servo motor turns the knob of the Gas regulator to 'OFF'state to terminate the LPG supply and avoid any disastrous condition. The display which is connected to the wifi module follows statement as "Leakage at Plug Detected".

V. SCHEMATIC CONNECTIONS IN THE SYSTEM

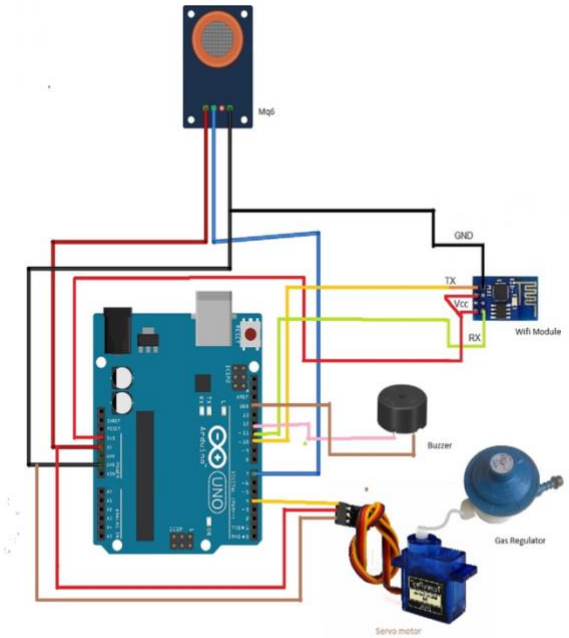

Figure 4: Circuit connections for LPG Leakage detection and prevention system

We Use a Dc battery and connect it with Arduino board with the help of a jack to turn the system ON. The green led of arduino blinks, confirming the connection status is established. The components to be used in this project are integrated with the Arduino board and the program is being compiled using Arduino IDE software.
On the interface of Arduino we connect Mq6 Gas sensor first with 5v pin and other with gnd terminal of Arduino board, its output as per program is being taken at digital Pin 3 of Arduino board..
Then we take ESP8266 Wi-Fi module and integrate it with Arduino board. It is connected with 3.3v pin and gnd pin. The TX of wifi module as per program is connected with Pin 10 and Rx with Pin 11.
The connection of Buzzer and Red Led is same, that is Anode with Pin 12 and other terminal is grounded.
The green Led is connected with Pin 13of Arduino Board.
Then we take servo motor and connect with 5v pin and gnd pin, its output is derived from digital Pin 4.
The rotation of the servo motor is precise and tested well. It triggers the knob of the gas regulator by means of a tensile thread so that it rotates automatically to turn the knob off and demands deliberate manual effort to turn the knob back to On position

VI. THE ARDUINO IDE SKETCH

Once the circuit has been established, weupload the program also known as a sketch which is a set of instructions that directing the board of what particular functions it needs to execute.
The Code that we have used for establishing the functional working procedure of this project after controlling the input/output ports of the Arduino board follows in sequence as:

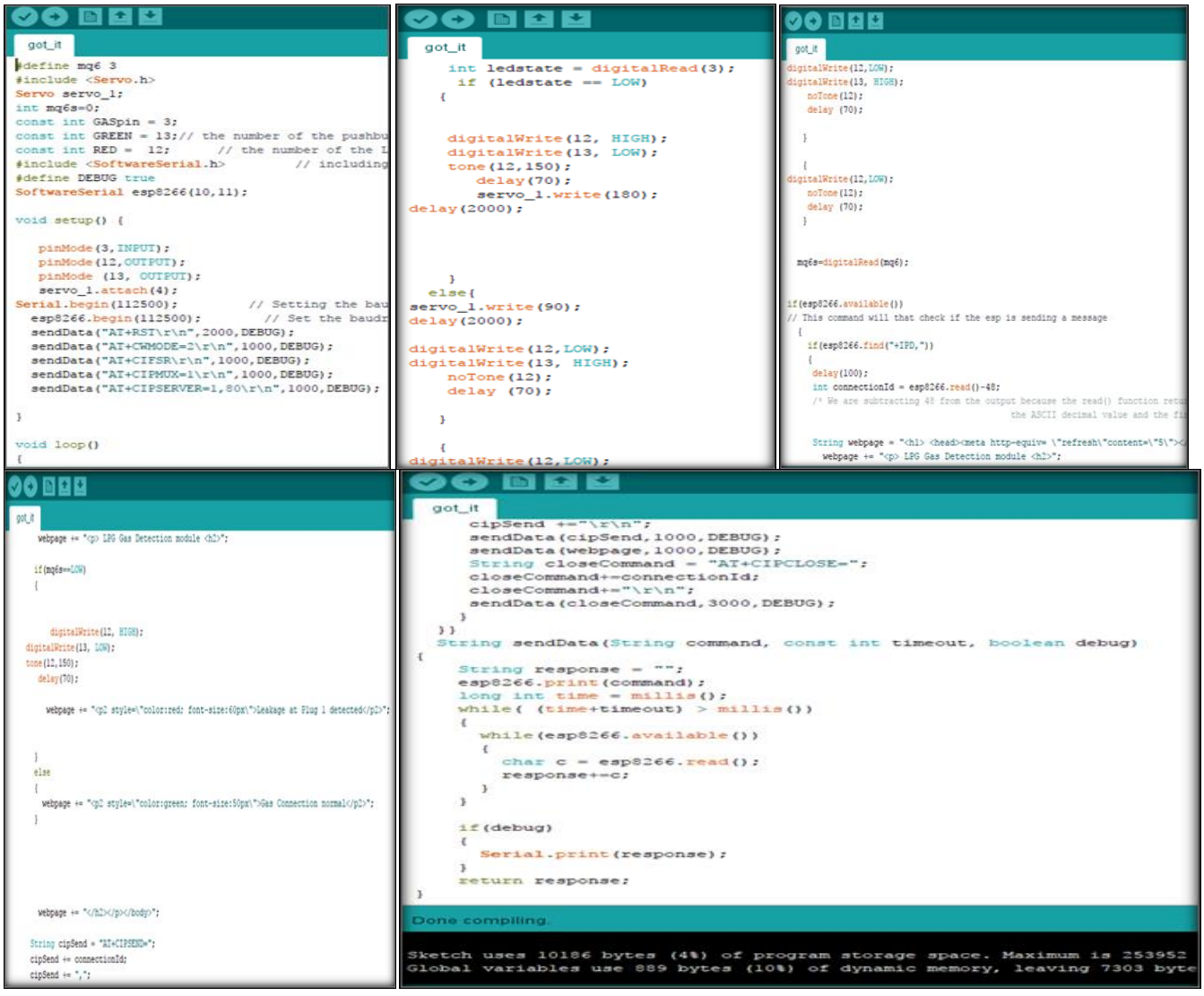

Figure5: The compiled Arduino code for LPG leakage detection and prevention method

VII. DATA FLOW DIAGRAM OF THE PROPOSED SYSTEM

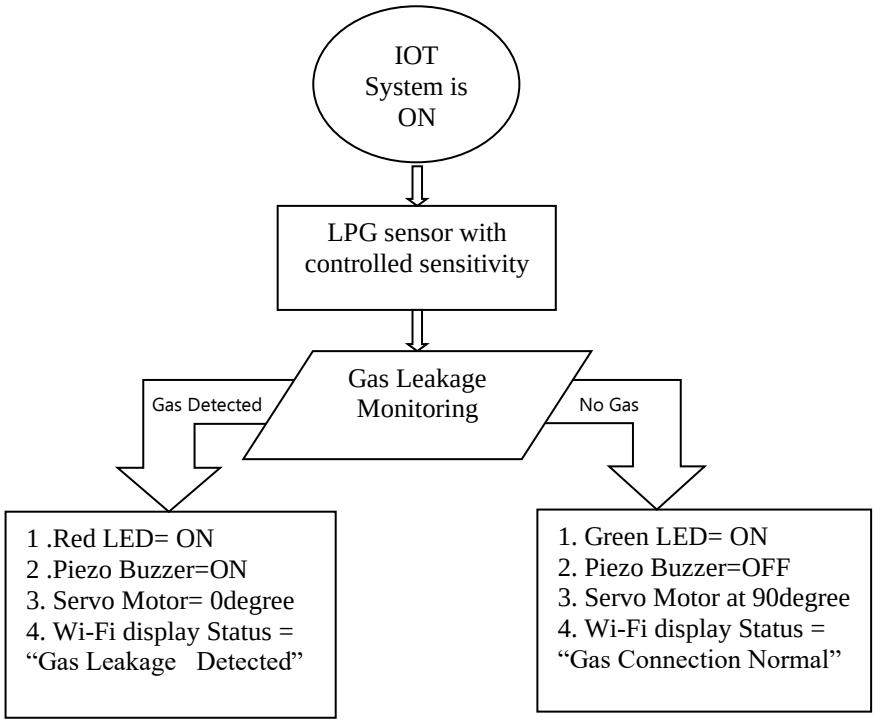

Figure 6: Flow Chart of LPG Leakage detection and prevention system

VIII. TESTS AND THE RESULTS.

We use a'lighter' as a replicate of a LPG gas source in order to check the system function. Initially we imitate low level concentration from the lighter and was then gradually brought it closer to the gas sensor so as toexpel high concentration of LP gas, we found the detector provides satisfactory results. Excellent performance was shown by the system when we repeated the test several times. The sensor has an immediate response to the fuming gases once the leakage is perceived. As soon as the gas concentration reduced below 25% of the monetary value, then the buzzer goes off automatically.

Figure 7 shows the system state when no gas is detected and follows up the statement as shown in Figure 9. State of servo motor is 90 degree and green LED is ON.

Figure 8 shows the system state when LP gas is detected and it follows the statement as shown in Figure 10. State of servo motor is shifted to 0 degree and RED LED is ON

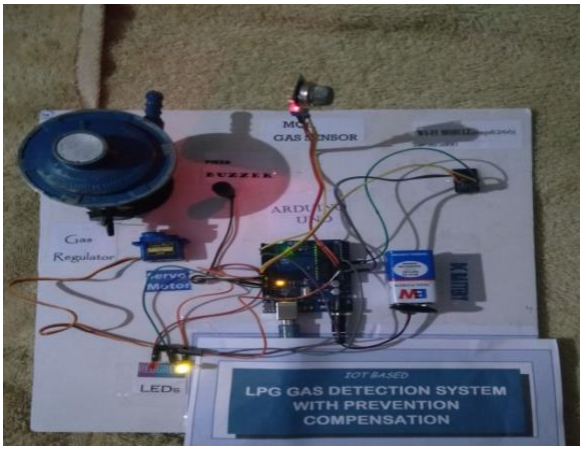

Figure 7: Test at Normal Gas Connection

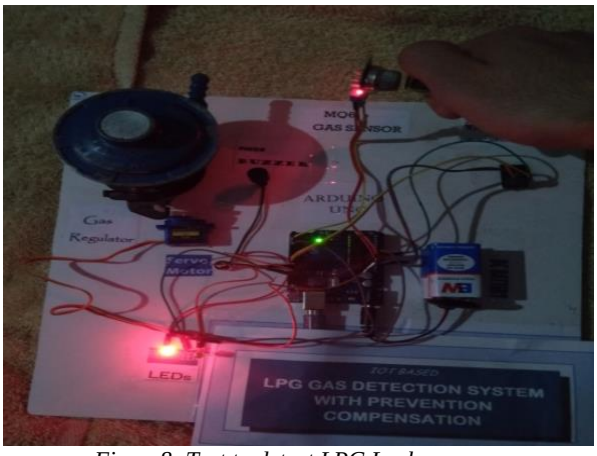

Figure8: Test to detect LPG Leakage

S. no.	Test condition	LED	Buzzer	Servo Motor	Wi-Fi Status
1	No Leakage detected	OFF	OFF	OFF	Connections Normal
2	Leakage Detected	ON	ON	90 – 0	Leakage at Plug 1 Detected

Table 1: Test condition and results

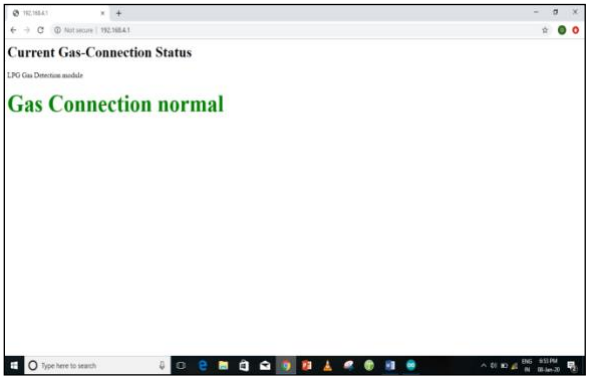

Figure 9: Display Showing Normal Gas Connection

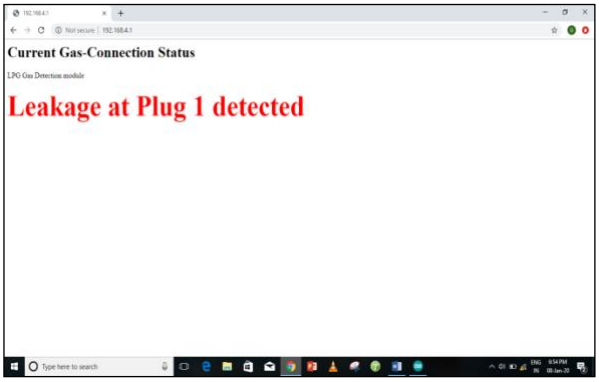

Figure 10: Display Showing Leakage Status

IX. FUTURE SCOPE OF THE PROJECT

1. The overall cost of the system is Rs.350- which is very less and affordable.
2. Notices Butane leak also LPG leak and any such combustable gaseous material.
3. Produces Sound Alarm when gas fume is perceived.
4. Can also be updated to transmit the SMS Alert to the owner.
5. Displaying the gas flow status which signifies whether the gas is in normal stage or not.
6. Automatic and abrupt closure of the gas from itssource by using Servo motors.
7. Can also be updated to monitor the level of LPG gas left in the tank.
8. The easy availability of this handy system can spread out and reach in every household who seek use of LPG for cooking purposes etc.
9. Figure 11 shows the Ujjwala scheme, run by the Ministry of Petroleum and Natural Gas of the central government of India launched on 1 May 2016 in Ballia, Uttar Pradesh [8]. In India LPG consumption has grown rapidly in recent years as shown in figure 12, and it is expected demand would further reach to a new level. Mishaps due to LPG can conclude it as threat and in order to secure it & make it reliable, here we offer the solution through this simplified and candid project.

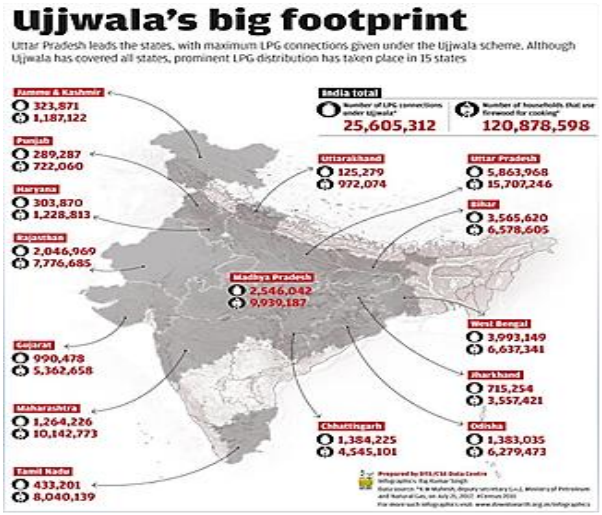

Figure 11: Ujjwala Scheme as per Census 2011 [9]

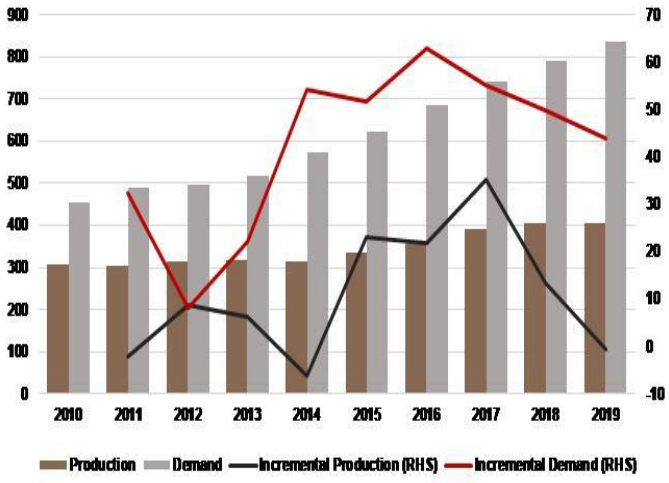

Figure 12: Demand & Production of LPG across India [10]

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