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The Development of A System for Measuring the Level of LP Gas in the Home

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***Abstract**: This research aimed at developing a system which can measure the level of a Liquefied Petroleum (LP) gas in a home. The system studies how the gas is used over a period of a week so that the remaining gas can be displayed (on an LCD) in months, weeks and days, which is more convenient for the user. There is also an option of displaying the remaining gas in KGs. The system also detects the leakage of the gas and emits an audible warning sound when the gas concentration exceeds 400ppm. These measurements can also be relayed to the user via SMS, using System for Mobile communication module. The software tool used is the version of C++ used by Arduino under the Integrated Development Environment.*

***Keywords:** gas, leakage, level, measurement, SMS.*

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I. Introduction

The LP gas consists of butane and propane both of which are flammable and have high hydrocarbons. It is commonly stored under pressure, as a liquid in a gas bottle. It turns back to gas by "boiling" into gas vapor at -40^{0}C. This gas has a wide variety of domestic uses which includes cooking and heating. In some remote villages and towns, the level of the gas not monitored, leading to inconvenience of the user when the gas suddenly finishes without warning. For this research, a system for measuring the level of the gas has been developed. The system displays the level of the gas on an LCD and can also give a warning if a gas leak is detected.

Traditional ways of monitoring the level of the domestic gas is just noting the number of months which the previous gas took to finish and use that as a rough guide. Another method is the use of temperature difference at the boundary of the gas. In this method, hot water is slowly pouring down on the side of the gas bottle/cylinder. A line of condensation may appear, indicating the level of gas in the bottle. If the condensation does not appear, a hand is run down the same side where the water was poured. A change of temperature would be felt at the level of gas. If no difference, the gas might be empty. Fig. 1 demonstrates this simple concept.

Figure 1: Checking the level of LP gas by the hand

Another attempt to measure remaining level of gas is to use gas pressure. This method is not effective as the pressure within the cylinder remains constant until all the liquid gas has vaporized. At this point, the gas will gas will effectively be finished, [5]. Also, the use color change of a litmus paper against the cylinder containing gas is not very effective.

II. Proposed System

The proposed system is basically a cumulative weighting of the cylinder and its gas contents. The system is initialized when new bottled gas is connected. The system ‘studies’ the usage of the gas over time (e.g., a week). Then it averages out to get the amount of gas used per day. Then the system can now display the remaining gas in terms of months, weeks and days, to the convenience of the user. The systems can also measure the gas concentration in the air to detect if there is any gas leakage. All this information can also be relayed to the user via SMS using GSM.

The cylinder would be mounted on the load cell which would give out an electrical signal which would be fed to the amplifier to amplify the signal. The amplified signal would be fed to the input of the Arduino mega 2560 R3. The output of the microcontroller was connected to the Liquid Crystal Display to continuously display the weight of the gas in the cylinder, hence showing the amount of LPG gas left in the cylinder. Coupled with this was a gas leakage sensor that would sense the leaking gas from the cylinder and a buzzer that would alert people for gas leakage. The leakage of the gas would be shut off by the normally closed solenoid and a fan would be used to fan off the gas from the house.

Fig. 2 shows the block diagram of the proposed system.

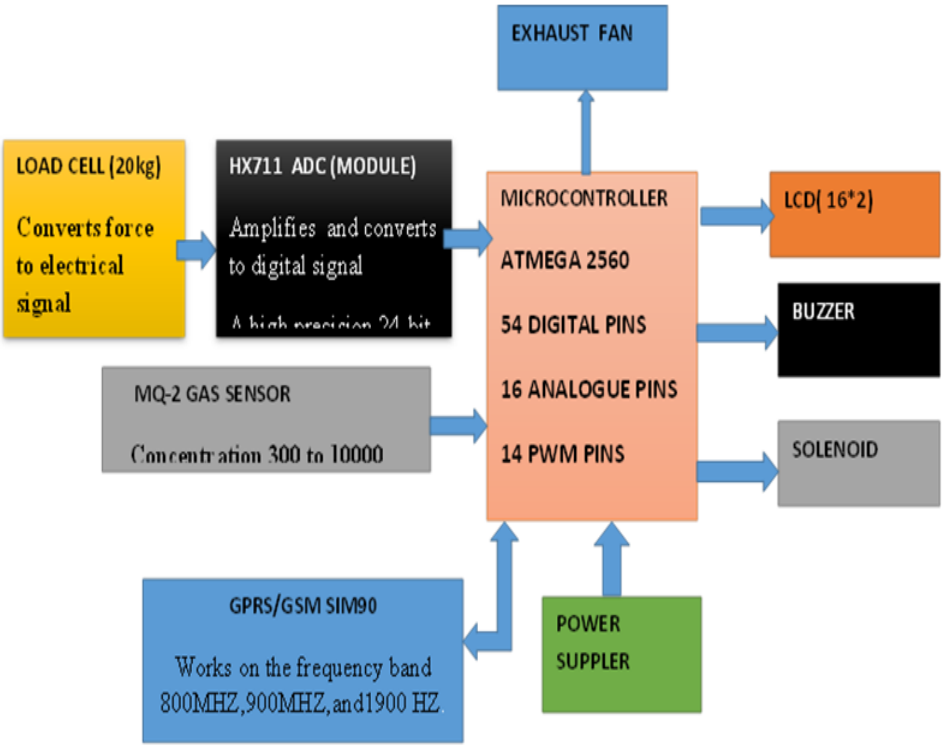

Figure 2: Block Diagram of the Proposed System

III. Description of Components Used

3.1. The Arduino Microcontroller

The Arduino mega 2560 is an open source microcontroller which could easily be programmed, erased and be reprogrammed any time [4]. This microcontroller is user friendly, simple to interface many circuits. Many projects had been carried out using the Arduino microcontroller. From alarm systems, video games and others. The versatility of the platform encompassing both hardware and software, combined with its inherent openness, had captured the imagination of tens of thousands of developers [1]. The programming of the Arduino mega 2560 development board was developed using Arduino IDE platform which supports simplified C programming language version and can be used to simulate designs.

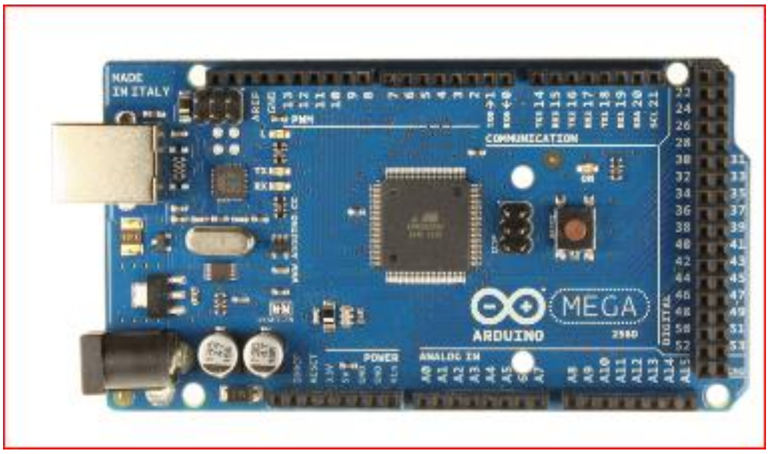

Figure 3: Arduino mega 2560

Fig. 3 shows the Arduino module. It is a prototyping platform featuring an ATmega2560 R3 processor. It has 54 digital I/O pins. They operate at 5v and each pin can provide or receive a maximum of 40mA and has an interrupt pull up resistor of 20-50 KiloOhms. It has 16 analogue input pins each of which provide ten bits resolution and they measure from ground to 5v. Other pins can be used as PWM output. The Arduino mega 2560 is the main processor and the output signal from the analogue-to- digital module is fed into the digital input of the arduino where the processing of the information occurs. The results are displayed on the LCD as the weight of the cylinder which will actually represent the level of gas remaining in the cylinder. The leakage of gas detected by the gas sensor analogue signal is fed to the arduino which in turn processes the information and displays the warning message on the LCD.

3.2. The LP gas Detector MQ-2

The Liquefied Petroleum gas Detector MQ-2 (fig. 4), detects the leakage of gas from the cylinder. This sensor detects the presence of combustible gas and smoke at concentrations from 400 to 10 000ppm. The sensor consumes less than 150mA at 5V and can operate at temperatures from -20 to 50 °C. The MQ2 sensor used in this project consists of an SnO_2 (Tin Oxide), a sensitive material which has a lower conductivity in clean air and higher conductivity when the target gas is detected and heating element inside. The sensor output an analogue voltage signal which corresponds with the level of the LP gas, hence the output is proportional to the concentration of the gas. When the gas is detected, the resistance of MQ2 sensor decreases. The external load resistance provides resistance variation which in turn provides variation in voltage, hence the higher the concentration, the higher the output and vice versa. This is an SnO_2 based gas sensor which can sense gases like methane, propane, butane, alcohol, smoke and hydrogen, [7]. Liquefied Petroleum Gas contains mostly propane and butane hence MQ-2 sensor can be used for sensing LPG.

MQ2 sensor senses the flammable gases by the increase in temperature when they are oxidized by the heating element. If there is any flammable gas present in the sample, the oxidization of the same gas results in increased temperature and the resistance of the sensor resistor will drop. That means more current will flow through the load resistor and so the voltage across it will shoot up.

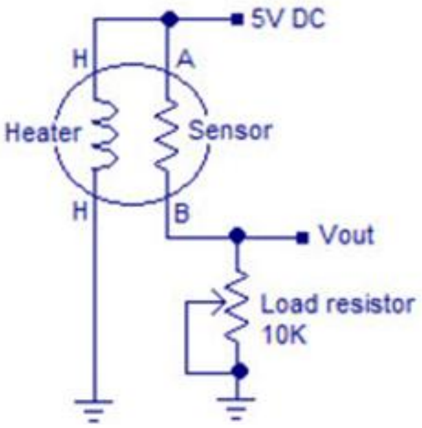

Figure 4a): The MQ-2 gas sensor diagram. **b)** The MQ-2 gas sensor

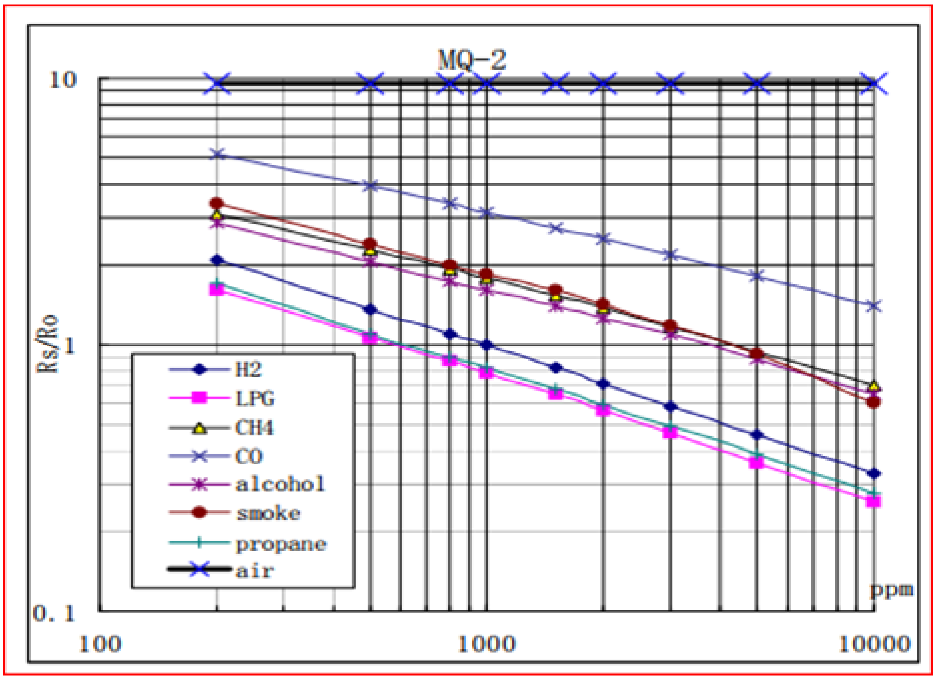

Figure 5: Sensitivity characteristics of MQ-2 Gas Sensor

Fig. 5 shows typical sensitivity characteristics of MQ-2 for several gases under the following conditions:

- Temperature at 20 degrees Celsius
- Humidity at 65 %
- Oxygen concentration at 21 %
- Load Resistance (RL) at 5kilo Ohms
- Sensor resistance (Ro) at 1000ppm of H_2 in clean air
- Sensor resistance (Rs) at various concentrations of gases

3.3. The Load Cell

The load cell is a sensor/passive transducer which will measure the weight of the cylinder and converts force into an electrical signal (in the range of microVolts). This device is designed for weigh scale and industrial control applications to interface directly with a load cell. A load cell is a device which experiences a change in resistance when it is stretched or strained [2]. One of the most common types of load cell is the Strain Gauge. This is the type that is stiff, has good resonance values and tends to have long life cycles in applications. The strain gauge works in the principle of a bridge circuit. There are two critical effects in signal conditioning being the small, fractional changes in resistance that require carefully designed resistance measurement circuits and the other is the need to provide some compensation for temperature effects to eliminate masking changes[1].

The Strain gauge load cell works on the principle that a strain which is a planar resistor, does reform, stretches and contracts when the material of the load cell deforms appropriately. The values from the cell are very small and relational to the stress and strain that the material load cell is undergoing at the time. The change in the resistance of the strain gauge provides an electrical values change that is calibrated to the load placed on the cell. The load cell works on Wheatstone bridge theory (fig. 6a). R1 & R2 form the first voltage divider, whilst R3 & R4 form the second one. Output is found in the middle of the nodes. Wheatstone bridge is an electrical circuit having two parallel voltage dividers circuits to measure the unidentified resistance.

Fig. 6b shows an ideal typical mounting arrangement for a single-ended beam. The fixed end is fixed to a rigid foundation while the free end cantilevered to allow for down ward deflection as load F is applied. The mounting surface should be flat, horizontal and perfectly rigid. The load F should be introduced vertically with minimal extraneous forces applied and the load cell would be totally insensitive to all forces other than precisely vertical ones. The industrial load cell is shown in fig. 6c.

Realistically, the load cell mounting and loading conditions are far from ideal hence incorrect loading is the most prevalent problem. In the project of the measurement of the level of LP gas remaining in the cylinder, a cylinder is placed vertically on top of the load cell and the force exerted by the cylinder is converted to an electrical signal which is in millivolts. This signal is fed to the converter and amplifier before fed to the processor for further processing.

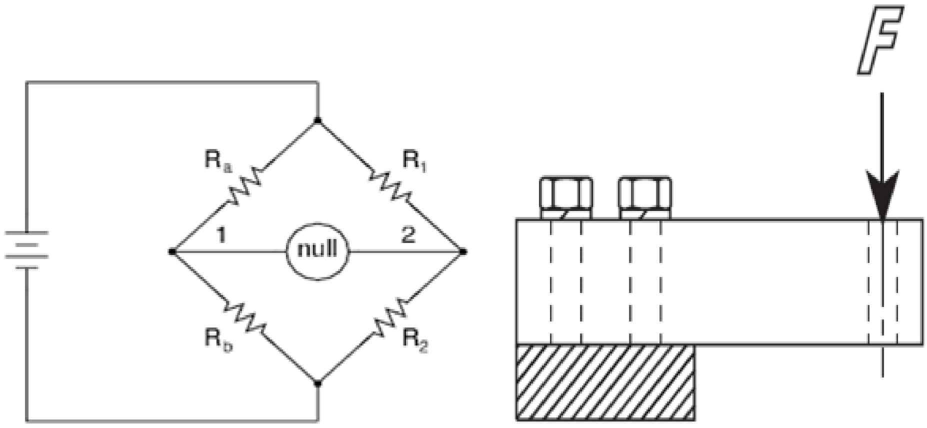

Figure 6a): Wheatstone Bridge.   **b)** Load cell mounting arrangement

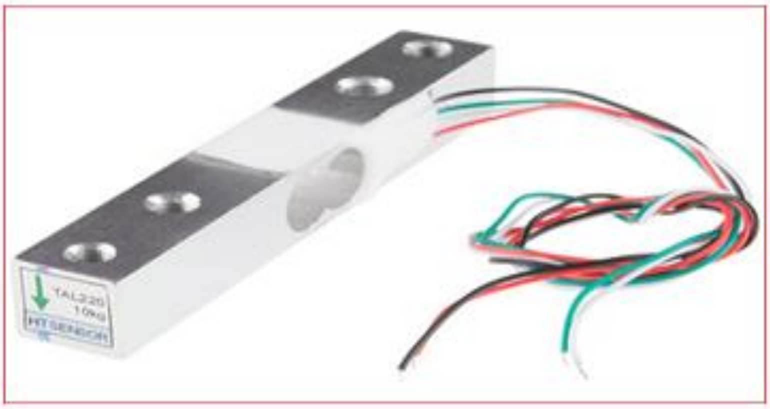

Figure 6c). The Load Cell used in the project.

3.4 The Analog to Digital Converter Module

The HX711module (Fig. 7), contains an amplifier and a 24-bit precision Analogue to digital converter. It will amplify the analog signal from the load cell and converts it to a digital signal for processing by the micro-controller.

HX711 is an Integrated Circuit that enables one to integrate with a load cell. This consists of an amplifier and a precision 24-bit analogue-to-digital converter designed for weighing scales. This device uses a two wire interface (Clock and Data) for communication. Compared to other chips, it has added advantages such as high intergration, fast response, immunity and other features improving the total performance and reliability.

Figure 7: HX711 Weighing Scale Module

3.5 The piezoelectric buzzer and LCD

The piezoelectric buzzer (fig. 8a) will give out a sound (at 1KHz) when the gas is leaking. Its construction is very simple and it is very light in weight. It is not expensive and this makes it to be widely used in many applications such as a car and truck reversing indicator. It is used in call bells and computers. A Liquid Crystal Display (LCD) screen will be used to display the messages of both the level of gas remaining in the cylinder and the alert message of the leakage of gas from the cylinder. For this project, the LCD 16*2 has been used (fig. 8b). The 16*2 means that it can display sixteen characters per line and there are two rows for each line. The command instructions are stored by the command register issued to the LCD. The screen can either be initialized, cleared, set the cursor position for controlling the display and many more displays. The actual data is the ASCII value of the character to be displayed on the LCD.

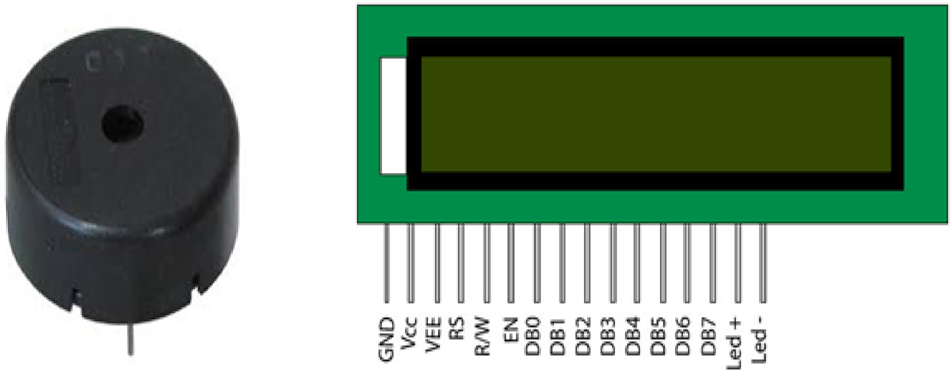

Figure 8a): Piezo buzzer. **b)**. The Liquid Crystal Display (LCD 16*2)

3.6. The GSM/GPRS Module

The SIM900 GSM/GPRS module (fig. 9), is a quad-band GSM/GPRS solution which delivers GSM/GPRS 850/900/1800/1900MHz performance for voice and SMS. It integrates TCP/Protocol and extended TCP/IP AT commands which are very useful for data transfer applications, especially text messages. SIM900 is designed with power saving technique so that the current consumption is as low as 1.0mA in sleep mode. There are several status lights that are found in the SIM 900 module. Upon power on of the nodule, the status light will light. There is also a Netlight that will also illuminate or blink each 800 milliseconds and this means that the module is not yet registered to the network. When the Netlight blinks every 3 seconds, it means that the Global System for Mobile Communication (GSM) is now registered to the network [10]. This will enable the system to receive commands and it checks that the data is available on the receive (RX) terminal of the GSM, hence it will send text messages to the user.

Figure 9: SIM900 GSM/GPRS Module

IV. Methodology

Fig 10 shows the complete system. Note the various components discussed in the previous section. Fig. 11. shows the flow chart used to develop the C++ code which was then used to program the ATmega2560 R3 microcontroller. The options indicate different levels of gas and concentrations. Fig. 12 shows the algorithm used to send SMSs to the user.

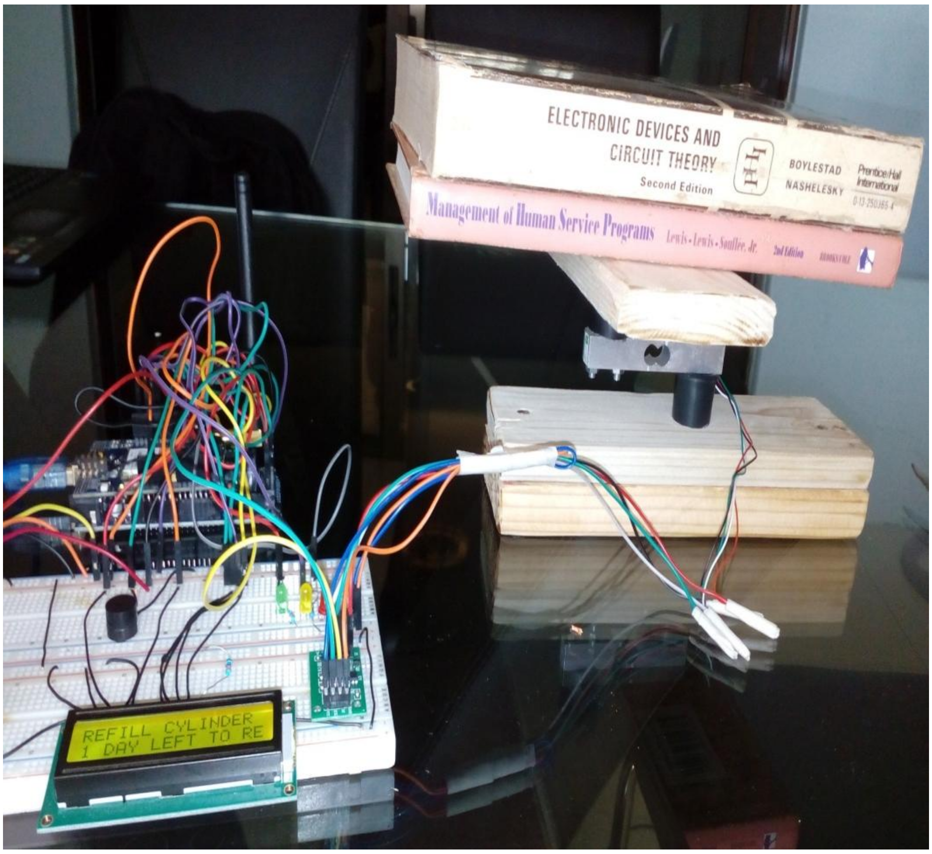

Figure 10: The Complete System.

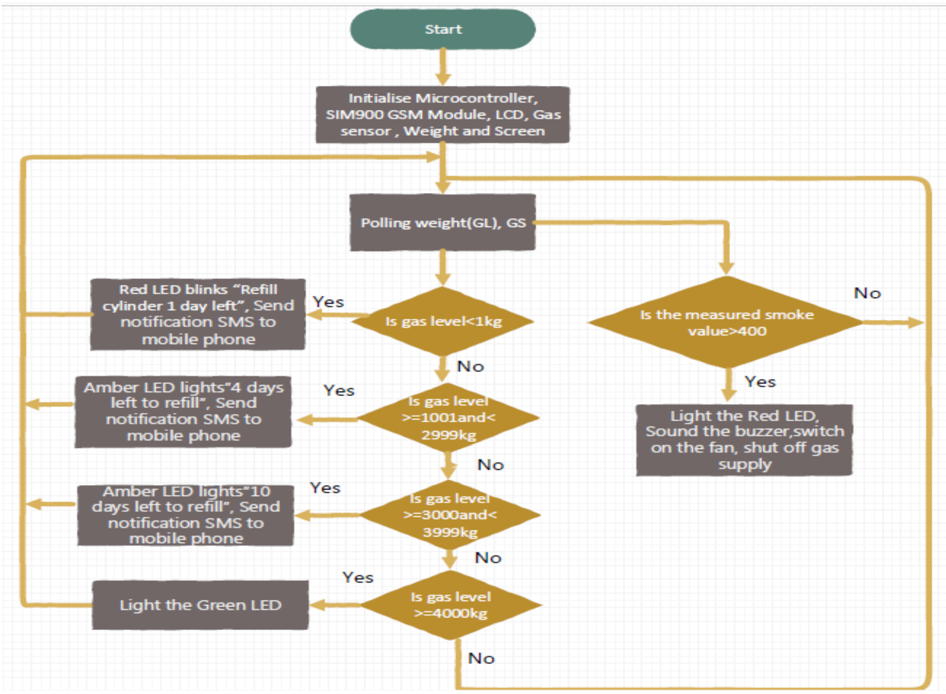

Figure 11: The Flow Chart the measurement of the level of LP Gas in the home

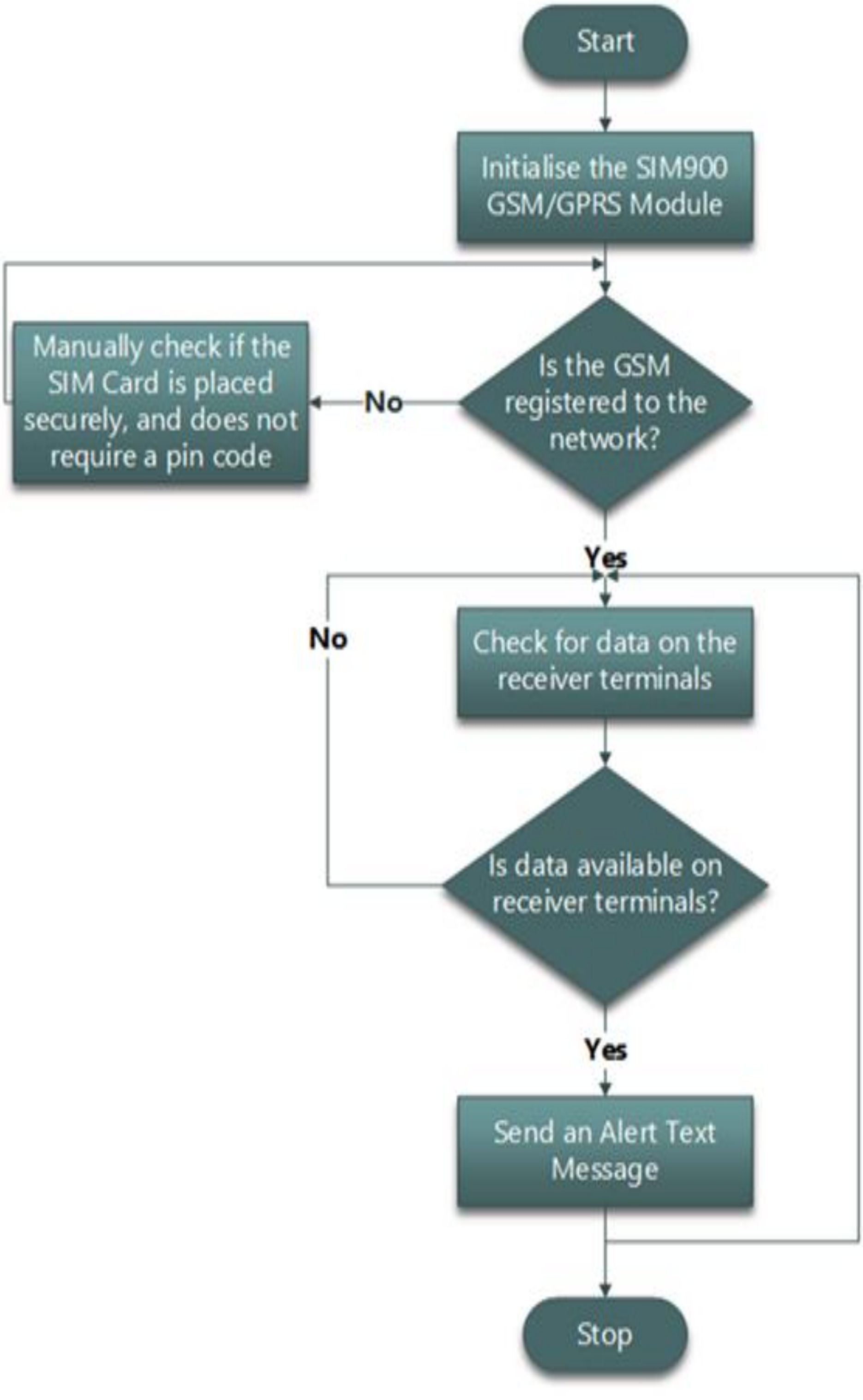

Figure 12: Flow chart for sending a text message

V. Results Analysis

Fig. 13 shows the system response when the gas concentration exceeds the set threshold of 400ppm. Notice the alert message generated. Fig. 14 shows the amount of gas which is equivalent to 20 days. Fig. 15a shows the amount of gas as displayed on the Arduino. Fig. 15b shows the corresponding message send using an SMS to the user.

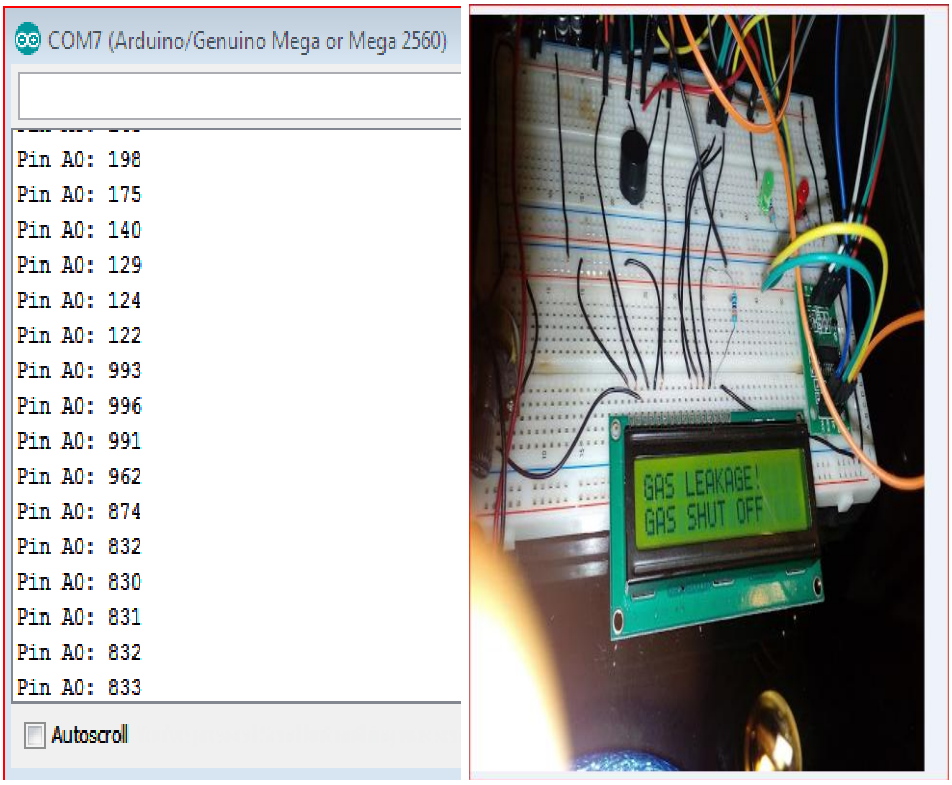

Figure 13: System response when gas concentration exceeds the set limit of 400ppm.

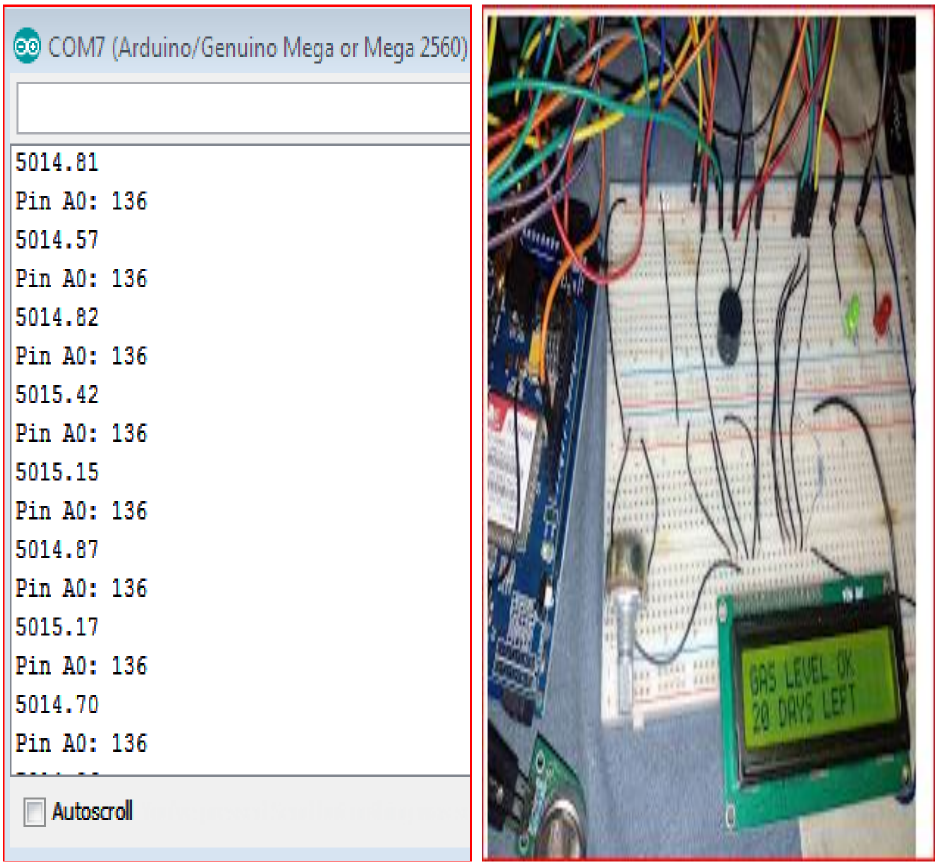

Figure 14a): Weight of gas is (5014g)= 5kg (Full LPG. b) : Message on LCD

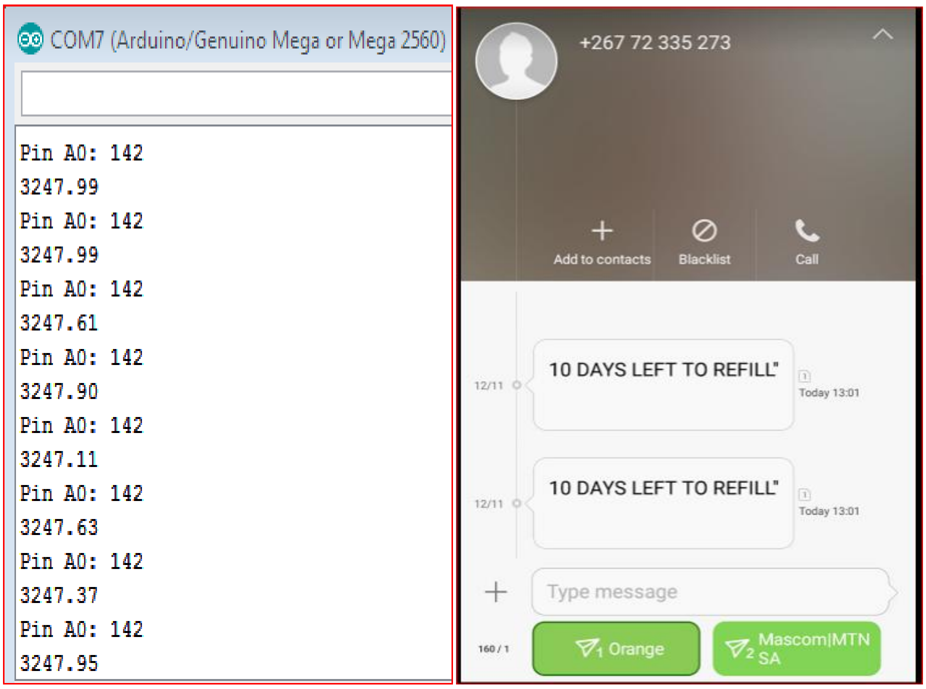

Figure 15a): Weight of gas (3.247 kg) b): Alert text message to User

VI. Conclusion

The system has performed as expected. It was able to convert weight to equivalent of days. When the gas level reached a critical point, the displayed text turned to flashing. At the same time, the same display messages were sent by SMS to the user. The buzzer sounded accompanied by a flashing LED when there was a gas leak. The fan operated to clear the leaked gas.

References

[1]. Curtis D. Johnson, Process Control Instrumentation Technology, Prentice-Hall, 1977.
[2]. Alan.S.Morris, Principles of Measurement and Instrumentation, Prentice- Hall, 1993.
[3]. G. Sen Gupta, Embedded Microcontroller Interfacing, Springer-Verlag Berlin Heidelberg, 2010.
[4]. Leo Louis "international Journal of Control, Automation, Communication and Systems# (IJCACS), Vol.1, No.2, (2016): 21.
[5]. Nikita Mahajan and Mamta Khatape "International Journal of Advanced Scientific and Technical Research" Issue 4 volume 4, (2014):172-175.
[6]. Chen Li and Lijia Xu "Journal of Engineering Science and Technology Review" 9 (1) (2016) 95-101.
[7]. http://sandboxelectronics.com/?p=165.
[8]. S. Monk, "Programming Arduino Getting Started With Sketches," 1st Ed. New York: McGraw, 2011.
[9]. http://www.journal.au.edu/au_techno/2008/jan08/journal113_howto.pdf..
[10]. http://www.academia.edu/9692166/GSM_remote_home_appliance_control_system..

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