U Smell:
Smart Safety System For The Detection Of Gas Leakages

Ts. Dr. Sivadev Nadarajah, Muhd. Hadif Syahmi Bin Zamali, Muhammad Faiz Bin Hamidon, Muhammad Daniel Putra Bin Shahrullnizam

(Electrical Engineering Department, Polytechnic Ungku Omar, Malaysia)

ABSTRACT *: Nowadays safety plays a major role and it is necessary that good safety systems are to be implemented in a place of education and work. This work modifies the existing safety model installed in industries and capable of being adapted to be used in homes and business premises. One of the preventive measures to avoid the danger associated with gas leakage is to install a gas leakage detector at vulnerable locations. "Unique SMELL" or "U SMELL" is a project that uses to detect a gas leakage from the gas storage areas (such as cooking cylinder gas storage area) and gas utilizing areas (such as stoves and ovens). It is meant to detect the unattended gas leakages in areas that are left without supervision. In this project utilises the MQ-6 sensor are used to detect the Liquefied Petroleum Gas (LPG) which regularly used for cooking stove. It will send an alert to the responsible stakeholders about unattended gas leakages that are left without supervision and will detect LPG gas leakage and produce localized audio and visual warning through LED and Buzzer. The GSM Module is where the contact number of the stakeholder is set and alert messages are sent by Short Messaging Services (SMS). This project used Arduino (ATMEGA328P) as the main microcontroller where it process the input from the sensor and send the output to GSM module to communicate with the stakeholder and localized alerting systems. The benefit of these projects is to prevent the earlier stage of fire hazard because of leakage gas could cause an explosion. With this project we can decrease the risk of explosion that commonly happens at home, business and industries.*

KEYWORDS – *Audio and Visual Warning, Gas detection, Microcontroller, Safety, SMS.*

I. INTRODUCTION

The development of technology has further enhanced the development in the field of electronics. With this sophisticated facility and equipment like this, it will make it easier and quicken the processes of human work and help and facilitate people in terms of safety, health and environment protection. This project is entitled U SMELL: Smart Safety System for the Detection of Gas Leakages (U SMELL), the main function of this project is to send information via Short Message Service (SMS) to users in the event of leakage of Liquefied Petroleum Gas by using Global System for Mobile (GSM). It also has localized warning system where audio and visual warning is produces to alert anyone nearby in the event of a gas leakage [1], [2] & [3].

The U SMELL project will be complemented by the use of GSM which serves as an information conveyor to the user in the event of gas leakage, which may cause fire. This project uses MQ6 gas sensors to detect gas leaks where sensors detect the presents of gas and the Peripheral Interface Controller in this program will process the signal provided by the sensor. In addition, the LED indicator and a buzzer are added as a localized alert system.

I.I. Existing Safety Methods

The problem that the U SMELL will try to tackle is more to safety, health and environment preservation. Gas leaks frequently occur in homes, businesses and industries and are often unnoticed. Gas such as LPG which is propane or butane are naturally odourless so an additive known as Ethyl Mercaptan is present and has strong and pungent odour added to provide warning, but this is most often unnoticed when unsupervised [4] & [5]. A gas leakage detection device will be a must especially in areas where supervision is little or none.

The chemical compound Ethyl Mercaptan as the following effects and characteristics
- In terms of short term health effects, it can cause temporary incapacitation or residual injury.

- In terms of Flammability, it burns readily with the presents of a fire source. The gas itself will rapidly or completely vaporizes at atmospheric pressure and normal ambient temperature.
- In terms of Instability, the gas is normally stable but can become unstable at elevated temperatures and pressures.
- In terms of the characteristic, it is a clear colourless, low-boiling liquid (at 36ºC) with an overpowering, garlic-like / skunk-like odour. The flash point is at -48°C and is less dense than water and very slightly soluble in water. The vapours are heavier than air and may irritate nose and throat. The liquid form may be toxic if swallowed, by inhalation or by contact. Usually added to natural gas as an odorant and also used as a stabilizer for adhesives.

This additive as saved many lives and prevented many near miss accidents and has proven itself as being the most cost effective way for hazard control. This is all good with the presents of people nearby, but in areas where there is little or no supervision, a better method is needed.

Here is where the U SMELL comes in handy. The U SMELL is developed as a gas leak monitoring system in homes, businesses and industries for early detection and warning. We have designed this system with audio and visual warning to alert people nearby. And in the event there is no one nearby, the U SMELL is developed using a microcontroller that will provide information via GSM to a stakeholder.

The Significance of the U SMELL is as follows;

- It can be easy for users to detect when gas leakages occur in unsupervised areas.
- Save time for users to know the area that is leaking gas easily and quickly
- LED will light up the sections experiencing gas leakage and GSM will send SMS to the stakeholder when it detects leakage on affected parts for user convenience.

II. LITERATURE REVIEW

To work against the dangerous effect of gas leakage, significant efforts was carried out in manipulative and miniaturizing the gas leak sighting technique. The occurrences of gas leak related incident are studied by several researchers and have published statistical data incidents.

The network coordinator is also responsible for alerting a network operator or an emergency service using the Ethernet network or sending a SMS using a GSM/GPRS modem. In fact, upon receiving the alert message from the sensor node, the network coordinator can perform the first counter by deactivating the sources of gas emission via the wireless actuator.

This will provide a review about the previous research and existing about different scenarios with enhanced gas sensor calibration. With a differences concepts and design, there are other creation and innovation of projects done by other people.

The following component was sourced but before that, some research was done to determine the best possible components with the concern of cost and effectiveness in mind.

II.I. Microcontroller

Various microcontrollers exist in the market with various advantages and disadvantages. The AtMega 328P microcontroller with the controller board Arduino Uno was chosen [6]. The Atmel 8-bit AVR RISC-based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz [7].

II.II Gas Sensor

For the purpose to detect the presents of gas, a sensor is required. Various sensors was researched with the focus towards sensing LPG [8]. The MQ6 (LPG Gas Sensor) is a simple-to-use liquefied petroleum gas (LPG) sensor. It can be used in gas leakage detecting equipment in consumer and industry applications, this

sensor is suitable for detecting LPG, iso-butane, propane, LNG. Avoid the noise of alcohol, cooking fumes and cigarette smoke. The sensitivity can be adjusted by the potentiometer [9].

II.III.   Global System for Mobile communications (GSM)

GSM (Global System for Mobile communications) is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile devices such as mobile phones and tablets [10].

II.IV.   Buzzer

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke [11].

II.V.   Fan

A 12V fan is any fan inside, or attached to, can used for active cooling. Fans are used to draw cooler air into the case from the outside, expel warm air from inside, and move air across a heat sink to cool a particular component. Both axial and sometimes centrifugal (blower/squirrel-cage) fans are used in computers. Computer fans commonly come in standard sizes, and are powered and controlled using 3- or 4-pin fan connectors [12].

II.VI.   Light-Emitting Diode

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. This effect is called electroluminescence. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device [13].

III.   METHODOLOGY

The methodology is pictorially simplified by representing in the form of flowchart, block diagram and Gantt chart as follows.

III.I.   Flowchart

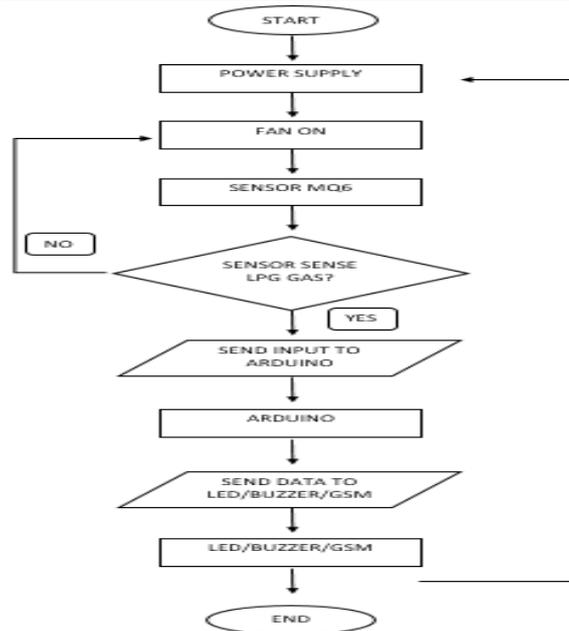The methodology flowchart is as in Fig. 1.

Figure 1: Flowchart of Methodology

The brief description is the Fan will continuously be on and blows air into U SMELL. The air passes through the sensor; hence the air is continuously tested for the presents of LPG vapors. If the present of LPG is detected, the information is sent to the microcontroller. The microcontroller will then check to see if it is above the danger level. Once confirmed that the presents of LPG is above the danger level, the microcontroller will then switch on the audio warning system which is the buzzer and the visual warning system which is the buzzer. At the same time the microcontroller will send a alert message to the stakeholder. SMS is chosen because it is the most effective way to send important information fast and reliably. Information on the SMS will be the location of leakage and level of leakage.

III.II.   Block Diagram of U SMELL

The overall project of U SMELL is represented in Fig. 2.

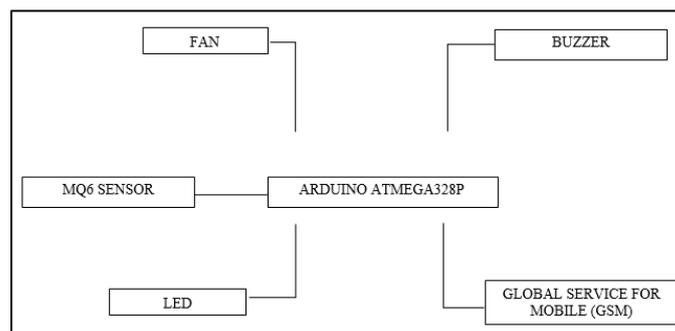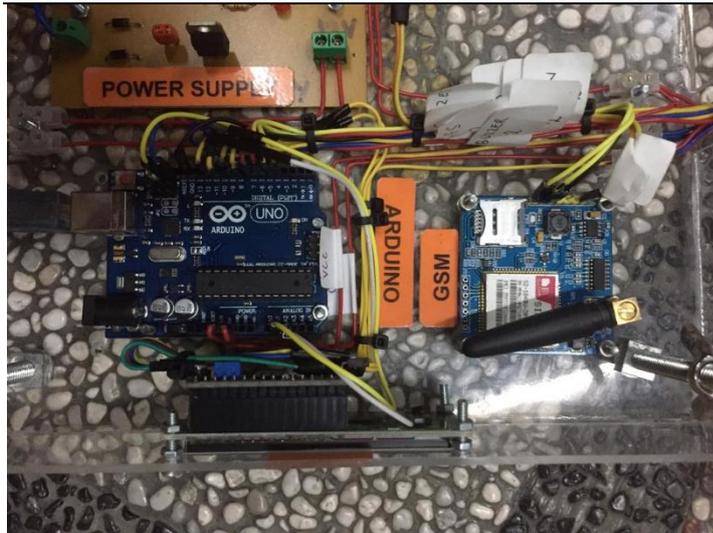**Figure 2: Block Diagram of U SMELL**

Main Control Unit   Sensors

Figure 3: Project Prototype

The main components of U SMELL are kept to simplicity as to reduce the chances of failure and increase reliability. All the components are stored in a convenient package. The input to the microcontroller is the sensor whereas the outputs are LED, Buzzer and GSM. Fig. 3 shown the main control unit and one of the sensors.

IV.   RESULTS AND DISCUSSION

Based on the research, it is determined that the acceptable level for LPG is at 0.4% in open air [11]. Many experiments were done to determine the appropriate setting and placement. Table 1, shows the distance and readings on the simulated leakage. For testing purposes, a simple LPG lighter was used as the usage of actual LPG cylinders pose great danger.

Table 1: Distance and Reading

Distance Between LPG Source and U SMELL (in cm)	Reading (in Percentage)
2	50
4	30
6	10
8	5
10	2
12	1
14	0.5

As shown in Table 1, the distance plays an important role. The simulation was done from a very small LPG source, besides the danger when using actual LPG cylinder, this simulation actually depictures the actual leak which is most often very small.

V.   CONCLUSION

Each project has its own interests and objectives. Similarly with this U SMELL project. Although many weaknesses are identified, the goal of the project is achieved. Based on the results of the circuit analysis in creating and completing this project, it is found that this designed project can benefit many sectors such as homes, food and beverages businesses, and industries not to mention the gas-related LPG industry which can help reduce the problem of fire or LPG gas leak.

With the creation of this project, it can at least help detect the leaked gas leak. Additionally, it saves

time to detect which gas leak is happening quickly. It will also warn people around if leaked gas levels are at a dangerous level through LED lights and buzzer sounds as well. The project will also give a message to the person who is responsible via GSM if the working period is over when no one is working at that time.

Finally, it is hoped that this project can be fully utilized, adopted and widely used in accordance with today's technological developments and the results obtained from this project can meet the needs of all users.

ACKNOWLEDGEMENTS

REFERENCES

[1]   H. S. Wah, "Gas for households: LPG for cooking as first step," *Petroliam Nasional Berhad (Petronas) Training Presentation,* vol. 1, no. 1, pp. 1-16, 2013.

[2]   M. S. Ishak, "Determination of explosion parameters of LPG-air mixtures in the closed vessel," UMP, Pahang, Malaysia, 2008.

[3]   E. a. A. R. a. K.-A. S. Broni-Bediako, "SAFETY KNOWLEDGE OF DOMESTIC LIQUEFIED PETROLEUM GAS (LPG) USERS IN GHANA-A CASE STUDY.," *Petroleum & Coal,* vol. 59, no. 1, pp. 26-32, 2017.

[4]   CAMEO Chemicals, "Chemical Datasheet for ETHYL MERCAPTAN," 1 January 2010. [Online]. Available: https://cameochemicals.noaa.gov/chemical/701. [Accessed 24 July 2019].

[5]   I. D. Campbell, "Odorant Depletion in Portable Cylinders," in *Institute of Gas Technology Odorization Symposium*, Ontario, Canada, 1987.

[6]   M. A. Mohammed, "ResearchGate: What are the advantages and disadvantages of arduino compared to microcontrollers?," 11 November 2017. [Online]. Available: https://www.researchgate.net/post/What_are_the_advantages_and_disadvantages_of_arduino_compared_to_microcontrollers. [Accessed 24 July 2019].

[7]   Farnell, "Arduino Uno," 17 March 2018. [Online]. Available: https://www.farnell.com/datasheets/1682209.pdf. [Accessed 24 July 2019].

[8]   D. P. D. A. M. M. T. G. C. L. Dattatray S. Dhawale, "Room temperature liquefied petroleum gas (LPG) sensor," *Sensors and Actuators,* vol. 147, no. 1, pp. 488-494, 2010.

[9]   HanWei Sensors, "TECHNICAL DATA MQ-6 GAS SENSOR," HanWei Sensors, Shanghai, 2018.

[10]   ArduinoCC, "Getting Started with the Arduino GSM Shield," ArduinoCC, 5 February 2013. [Online].
        Available: https://www.arduino.cc/en/Guide/ArduinoGSMShield. [Accessed 25 July 2019].

[11]   Farnell, "Buzzer," pro-Signal, 11 February 2011. [Online]. Available:
        http://www.farnell.com/datasheets/2171929.pdf. [Accessed 25 July 2019].

[12]   CUI Inc., "CFM-70 DC AXIAL FAN," CUI Inc., 8 August 2010. [Online]. Available:
        https://www.cui.com/product/resource/cfm-70-series.pdf. [Accessed 25 July 2019].

[13]   KiTronik Ltd., "Red 5mm Water Clear LED - 25deg - 1150mCd," KiTronik Ltd., 1 July 2011. [Online].
        Available: https://www.kitronik.co.uk/35104-red-5mm-water-clear-led-25deg-1150mcd.html. [Accessed
        24 July 2019].

[14]   A. Pandey, "What level of lpg leakage (in ppm) is dangerous and alarming?," 18 September 2016.
        [Online]. Available: https://www.quora.com/What-level-of-lpg-leakage-in-ppm-is-dangerous-and-
        alarming. [Accessed 25 July 2019].