

Design and Construction of a Domestic Microcontroller based Dangerous Gas Detector

Adeosun Olajide Olusegun¹, Olajide Blessing Olajide²

¹Doctor, Dept. of Computer Science and Engineering, Engineering Faculty, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

² Lecturer, Dept. of Computer Science Education, Science Faculty, Osun State College of Education, Ila-Orangun, Nigeria.

Abstract –

Fire hazards are becoming rampant in recent years and takes toll on lives and properties. This fatal inferno has been trailed to the leakages of gas in industries and household especially. LPG is highly inflammable and can burn even at some distance from the source of leakage. Various accidents resulting could be as a result of a poor-quality rubber tube or when the regulator is not turned off and careless handling of the LPG cylinders. The supply of gas from the regulator to the burner is on even after the regulator is switched off. By accident, if the knob is turned on it results in gas leaks. The adverse effect and bad experiences of victim of gas leakages inform the pursuit of this research work. This paper describes a microcontroller-based system that is designed with cheap electronic component to detect and alert the domestic environment when LPG leakage is detected. The system is easy to deploy and void of complex configurations and installation. This work curtails injuries and losses caused by explosions due to gas leakages and improve safety of life and property while using domestic cooking gas.

Key Words: *LPG, Regulators, Burner, Microcontroller-based, Leakage, explosion.*

1. Introduction

The Liquefied Petroleum Gas LPG gaining more and more welcome by people most especially the domestic users in particular. LPG and natural gas are environmental friendly they are easily detected. They are normally stored in pressurized steel cylinders in liquid form and vaporize at normal temperatures. LPG is a mixture of commercial butane and commercial propane having both saturated and unsaturated hydrocarbons. LPG is a gaseous fuel and known to be dangerous if exposed carelessly to fire.

The characteristics of this dangerous gas include:

- (a) Flammability: LPG has an explosive range of 1.8% to 9.5% volume of gas in air. This is considerably narrower than other common gaseous fuels;
- (b) Combustion: The combustion reaction of LPG increases the volume of products in addition to the generation of heat. LPG requires up to 50 times its own volume of air for complete combustion;

- (c) Odour: LPG has only a very faint smell, and consequently, it is necessary to add some odorant so that any escaping gas can vapor phase, but can, however, suffocate when in large concentrations due to the fact that it displaces oxygen.;
- (d) Toxicity: LPG even though slightly toxic, is not poisonous in can pose a serious effect if they leak. Impacts: LPG may leak as a gas or a liquid. If the liquid leaks it will quickly evaporate and form a relatively large cloud of gas which will drop to the ground, as it is heavier than air. LPG vapors can run for long distances along the ground and can collect in drains or basements Cylinders can explode if involved in a fire.
- (e) The health impact: This dangerous gas can cause cold burns to the skin and it can act as asphyxiate at high concentrations. Leak cause a negative effect to the health such that the hydrocarbons and other chemicals of the LPG causes very long sleep. It also causes irritated respiratory tract, nose and eyes (Soundarya, Anchitaalagammai, Deepa and Karthick, 2014).

In developing societies, electronics has come to stay as the most important branch of engineering. These electronics are in forms of devices that supplement the human ability to sense, monitor, calculate, observe, and control. Hence this project decides to employ the benefits of electronic technology to sense and alert the people around the vicinity of where the gas alert system is installed. The main focus of this research is to design an easy to construct and cheaper device that can be installed in residential homes especially now that LPG is enjoying enormous embrace from home users in Nigeria. The need for an economical and commercially-visible device to help protect life and property from fire hazard initiate this project.

1.1 Literature Review

A number of research have been carried out on gas leakage security system in which gas sensors are used to detect gas leakage and a response circuit is caused to initiate an alert. Some of these researches are examined to guide in the development of this project.

A wireless LPG leakage monitoring system is proposed for home safety. This system detects LPG leak and alerts the consumer about the leak by SMS and as an emergency measure the system will turn off the power supply, while activating the alarm. The device ensures safety and prevents suffocation and explosion due to gas leakage. This project is implemented using ARM 7 processor and simulated using keil software (PadmaPriya, Surekha and Preethi, 2014). This approach does not make provision for kitchen gas that uses gas cylinders not supplied by power utility supply which is common in developing countries like Nigeria who have not developed such infrastructure.

In yet another approach, leak detection module consists of MQ-6 gas sensor to detect amount of combustible gas present in the surrounding. When leakage is detects the ARM 7 controller sends the message to LCD which displays “Gas Leakage Detected”. The ARM 7 controller checks the concentration of gas is within safe level if it beyond safe level (safety level is programmable) then ARM 7 activates buzzer and switch on the exhaust fan so that the gases are sent out (Shinde et al ,2012).

2. Aim of The Project

The aim of this project was to design and construct a low-cost gas detecting system with audible alarm system.

3. Methodology

The aim was accomplished through the following approach:

- (a) Design a microcontroller-based gas alarm system that would:
 - (i) Automatically detect the event of gas
 - (ii) Digitally generate warning tones to alert occupants of the building
- (b) Construct an electronic system that would feature the above- listed designs.
- (c) Test the constructed electronic system to ensure stability of the project

3.1 Circuit Design

The schematic diagram in Figure 1.1 diagrammatically depicts the gas detection system (i.e. from the power stage, detection and alarm stage). The amount of supplied power into the circuit is dependent on the combined power usage on each component in the circuit. Each component (i.e. active or passive) has its power rating; consideration will also be given to the arrangement of the components (i.e. series or parallel arrangement). From the right-most part of Figure 3.4; is written (12V, 300mA) this is the calculated average power that was sufficient to power the whole circuit. And this power was generated from a purchased AC-DC adapter. The adapter does the function of stabilization, step down and rectification of the supply to the constructed circuit.

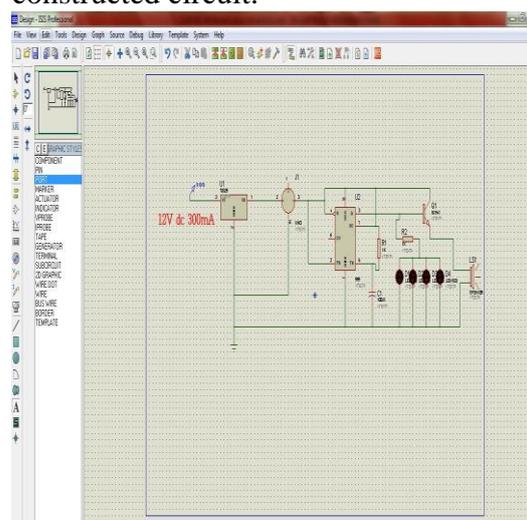


Figure-1.1: Close Circuit Diagram for the Gas Detector with Alarm System with ISIS Professional

The adapter gets connected to the circuit board via a polarized adapter jack port which is

not fixed on the board but screwed to the casing that houses the whole circuit. From the supplied (12V, 300mA), is connected to the (U1, 78L05) a three (3) pin voltage regulator which be supplied with any DC < 35V and will always give the DC output of 5V.

This DC output of 5V is where other components tap from. First, is the gas sensor (MQ-9), then ATMEGA328P microcontroller, and most importantly, the alarm systems (the four (4) red led and sounder) and other components as the resistors and capacitors. The gas detector with audible alarm system is designed with the intention to ensure that the event of gas is intelligently detected, promptly notified and interactively managed than what is obtainable with conventional ring-ring fire alarm systems. For detecting the event of Liquefied Petroleum Gas LPG, MQ-9 sensor was used because from datasheet they are used in gas detecting equipment. Also it is known for its low cost and long life span. The MQ-9 have 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current. The sensor works with voltages between 5V and 12V AC or DC. A 5V supply voltage was used for this design. Once powered, the output of the sensor is normally HIGH but goes LOW when gas is sensed. The diagram of the MQ-9 is as depicted in figure 1.2.



Figure-1.2: MQ-9 Sensor

The Low signal is then fan into the microcontroller chip ATMEGA328P from the MQ-9. This microcontroller is used because it is an 8-bit microcontroller that has 32K of flash memory, 1K of EEPROM (electrically erasable programmable read-only memory), and 2K of internal SRAM (static random access memory). The microcontroller has 28 pins in total, it has 14 digital I/O pins, of which 6 can be used as PWM (pulse width modulation) outputs and 6 analog input pins, these I/O pins account for 20 of the

pins. The microcontroller and its pinout is shown in figure 1.3

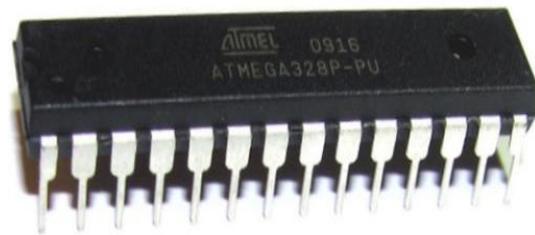


Figure -1.3: The ATMEGA328P microcontroller (source: Krithikal and Lavanya, 2017)

The 20 pins that function as I/O ports are set by programming the chip. 14 of the pins are digital pins, of which 6 can function to give PWM output. 6 of the pins are for analog input/output. 2 of the pins are for the crystal oscillator. This is to provide a clock pulse for the Atmega chip. A clock pulse is needed for synchronization so that communication can occur in synchrony between the Atmega chip and the devices that are connected to it. The chip is powered by two of the pins, Vcc and GND, Atmega328 is a low-power chip, so it only needs between 1.8-5.5V of power to operate. Atmega328 chip has an analog-to-digital converter (ADC) inside of it. This must be or else the Atmega328 wouldn't be capable of interpreting analog signals. Because there is an ADC, the chip can interpret analog input, which is why the chip has 6 pins for analog input. The ADC has 3 pins set aside for it to function-AVCC, AREF, and GND. AVCC is the power supply, positive voltage, that for the ADC. The ADC needs its own power supply in order to work. GND is the power supply ground. AREF is the reference voltage that the ADC uses to convert an analog signal to its corresponding digital value. Analog voltages higher than the reference voltage will be assigned to a digital value of 1, while analog voltages below the reference voltage will be assigned the digital value of 0. Since the ADC for the Atmega328 is a 10-bit ADC, meaning it produces a 10-bit digital value, it converts an analog signal to its digital value, with the AREF value being a reference for which digital values are high or low. Thus, a portrait of an analog signal is shown by this digital value; thus, it is its digital correspondent value. The last pin is the RESET pin, this allows a program to be rerun and start over and this sums up the pinout of an Atmega328 chip (Krithikal and Lavanya, 2017).

The microcontroller is thereafter connected through some resistors and capacitor to the alarm system. The design is implemented on a solder-less experiment board (bread board) as

shown in figure 1.4. After the polarity of all the electronic component had been ascertained, the design was then implemented on a Vero-board. Individual component were soldered carefully on the Vero-board. The entire project was then later assembled into a plastic case as shown in figure 1.5a and 1.5b

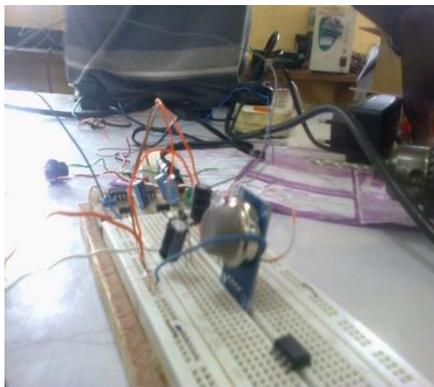


Figure-1.4: Solder-less Experimentation of the Gas Detector



Figure-1.5a: Component layout on Vero-board

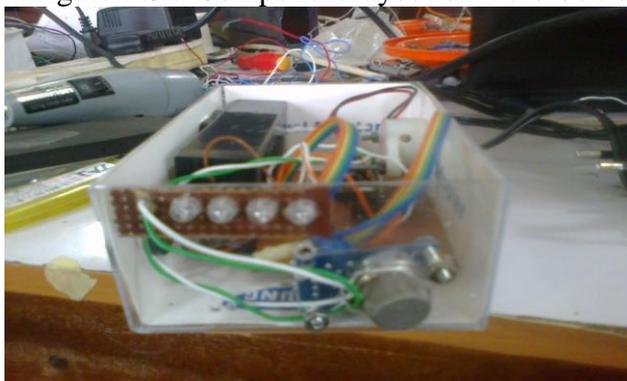


Figure-1.5b: Summary view of the Circuit

4. Result and Notables on the Operation of the Gas Detector

The physical realization of the project was accomplished by constructing and testing the device in the Software Computer Science and Engineering department laboratory of Ladok Akintola University of Technology, Ogbomosho. The device was tested by exposing it to the outlet from a 12kg LPG cylinder places some meters

away from it. The gas detector performed very well in sounding alarm in response to the opened gas cylinder. This is where the fantasy of the whole idea meets reality. The following are the notables on the constructed detector:

- (i) Set of pore holes for proper ventilation and proper communication between the circuit and the external environment.
- (ii) When the circuit is ON, a green led comes ON, and red when gas is sensed.
- (iii) A protruded sensor for proper contact in detecting gas.
- (iv) The packaged container fit the size of the circuit.

5. Conclusion and Recommendation

The construction of the microcontroller-based domestic gas detector was designed considering some factors such as economic application, design economy, availability of components and research materials, efficiency, compatibility and portability and also durability as applicable. The performance of the project after test met design specifications. However, the general operation of the project and performance is dependent on the user who is prone to human error such as entering wrong timing.

Also the operation is dependent on how well the soldering is done, and the positioning of the components on the printed circuit board. If poor soldering lead is used the circuit might form dry joint early and in that case the project might fail. Also if logic elements are soldered near components that radiate heat, overheating might occur and affect the performance of the entire system. Other factors that might affect performance include transportation, packaging, ventilation, quality of components, handling and usage.

The construction was done in such a way that it makes maintenance and repairs an easy task and affordable for the user.

References

- [1] Soundarya T., Anchitalagammai J. V., Deepa P. G., Karthick K. S. (2014) : "C-Leakage: Cylinder LPG Gas Leakage Detection for Home Safety", in IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) e-ISSN: 2278-2834, p- ISSN: 2278-8735. Volume 9, Issue 1, Ver. VI (Feb. 2014), PP 53-58 www.iosrjournals.org.

- [2] PadmaPriya K., Surekha M. and Preethi R. (2014): “Automatic Refill Booking Using Embedded System”, in International Journal of Key Scientific Research for Industrial Engineering & Technology. Vol.1, Issue 1, pp. 01-05
- [3] Shinde S., Patil S.B. and Patil A. J. (2012): “Development of Movable Gas Tanker Leakage Detection Using Wireless Sensor Network Based on Embedded System”, in International Journal of Engineering Research and Applications (IJERA) ISSN: 2248- 9622 Vol. 2, Issue 6, pp.1180-1183. Accessible at www.ijera.com.
- [4] Krithikal V. and Lavanya M. (2017): “Smart Fire Prevention System”, in International Conference on Emerging Trends in Engineering, Science and Sustainable Technology(ICETSST-2017), UG Scholar, Department of ECE, KPR Institute of Engineering and Technology, Arasur, Coimbatore, pp55-56.