Telemetry Based Gas Leakage Monitoring System With External Digital Display And Sound Alert,
A Solution To Gas Explosions In Nigeria

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Abstract—**A lot of cases have been reported of burns, death and damages to lives and properties due to unnoticed gas leakages especially at the urban regions of Nigeria. Some researchers have opined that LPG leakage is becoming one of the most concern issues these days. Some reports show that some gas explosion occurrences could have been prevented in the past if gas leakages were monitored. Some cases of gas explosion were identified in various areas ranging from homes, industries, laboratories, pipelines and gas stations in Nigeria. In this work, a solution is proffered in a form of Telemetry based gas leakage monitoring system with external digital display and sound alert. This unit is equipped with the gas sensor which collects the gas leakage concentration then the microcontroller compares it with a predefined threshold concentration level and makes its decisions. The decisions are communicated via the on-spot LCD, buzzer and to a specified location using the GSM module.**

Keywords— LPG, GSM module, Gas Explosion

I.   INTRODUCTION

Accordingly, [1] noted that world energy consumption is mainly based on fossil fuels. Owing to the cost effectiveness of Liquefied Petroleum Gas and its ease of using it to cook, there has occurred a sudden decline in the use of other fossil fuel for cooking. In support to this [2] observed that in Africa, the use of kerosene stove and/or electric cooker is rapidly replaced by the gas cooker which is abundant and more cost effective for domestic use. [3] and [4] observed that Liquefied Petroleum Gas (LPG) is the main source of fuel, especially in urban areas because it is clean compared to firewood and charcoal. It is equally used by vehicles that run by gas. [5] defined LPG (Liquefied Petroleum Gas) as a hydrocarbon gas production from refineries and gas refinery with the major components of propane gas (C_3H_8) and butane (C_4H_{10}). At atmospheric pressure, LPG remains gaseous and,

it's converted to liquid state by applying pressure during distribution.

Liquid petroleum gas (LPG) is highly inflammable and can burn even at some distance from the source of leakage. Gas leakage reduces the quality of air in the environment and poses more risk of setting inferno if not monitored. Due to these, the users and owners of gas refilling stations across the nation continue to nurse fear in Liquefied Petroleum Gas (LPG) usage and disposal especially when not properly monitored as it could be source of major accidents to lives and properties. According to [6], home security has been a major issue because of increasing gas leakage and same is observed among the retailer, residential and vehicles that run by gas. According to [7], gas explosion occurs as a result of gas typically from gas leakage, mixing with air in the presence of an ignition source.

Among the various cases of gas explosions, [8] reported that in last year, there have not been fewer than six cases of gas explosions in Lagos state. In April 2020, a gas explosion occurred at a gas dispensing shop in Agboju area of Lagos state. In October 2020, at Baruwa area of Lagos State, there was a gas explosion, In August 2020 there was a gas explosion at Orile-Aganmu Lagos, July 2020, and there was another incident at Ajao Estate. All these accidents according to the above authority were attributed to gas leakage.

Therefore, the gas leakage should be detected and communicated on time to the user for control as to protect people from danger.

The process of detecting gases in the environment started as early as the coal mining era. According to [9], the coalmine was identified as an area housing many combustible and toxic gases which caused dangerous explosions, fire and even death in the mines. This then created the need for developing how to detect the harmful gas that was responsible for the explosion and fire in the coal mines, and hence, the advent of gas detectors

LPG is a colorless and odorless gas. For the purpose of detecting and monitoring gas leakage in the environment, an odorant such as ethane thiol can be added to LPG, so that leaks can be detected easily by most people. This approach has been the first and most common way of detecting gas leakage. But this approach is not optimal.

In this paper a low-cost sensor-based gas leakage monitoring system with GSM module is proposed and discussed. Extending the system with telemetry capability using GSM module allows the user to have a real time update on the status of (LPG) facilities in the environment from a remote location. GSM is a cellular network, with five varieties of cell sizes. It describes a second generation (2G) protocol and operates at different carrier frequency ranges between 800MHz to 900 MHz. The GSM module is used to form the telemetry system for this work. Telemetry simply implies a long distance communication for environmental information.

II.   RELATED LITERATURES

Some works have been done in gas detection while others are on sensors that detect gas. To start with, [10], proposed a gas leakage alert system to detect the gas leakage and to alarm the people onboard.

Okonkwo, et al (2021), design and fabricated a cooking gas (LPG) leakage detector by incorporating an MQ6 sensor, with a beeping buzzer, LED light, LCD display unit together with an Arduino controlled SIM800L Module for SMS alert.

[11] in their research, developed a system device monitoring and early detection of gas leaks by utilizing gas sensors MQ4 and AVR microcontroller family as control devices. The system is also equipped with XBee PRO S2B nirkable devices as the interface to the wireless networking system that is used to transmit sensor data from the detection point to the monitoring center equipped with a PC and software integrated Visual Basic. Then gas leak alert is sent with the message formats through social networking Gtalk.

[12] developed an intelligent Arduino-based gas detector. The system is equipped with MQ-2, SIM800L and buzzer gas sensors. The principle behind the system is that the system can convert input data received from the sensor MQ-2 sensor that can detect propane and butane gas, then the system will send the actual data in the form of short messages (SMS) to the mobile number that has been registered into the system. Besides being able to send SMS the system also emits a sound that is generated from the buzzer

III.   HARDWARE IMPLEMENTATION

The device measure the concentration in part per million (PPM) or part per thousand (PPT) of LPG in the air. To achieve this, MQ2 gas sensor is deployed. This sensor has a metalized surface for sensing the gas. It does this by varying its internal resistance with respect to the concentration of LPG gas available in the air.

The output of this sensor is connected to a PIC16F877A microcontroller. This microcontroller has an ADC (analog to digital converter) which it uses to convert the analog voltage from the sensor to a digital quantity. The microcontroller processes the digital quantities and makes its decision. If the concentration of the gas is below the threshold, the microcontroller initiates a process to send an SMS to the gas facility owner and equally display "gas not leaking". But if it is above the threshold, the system sends SMS, activates the buzzer and displays "gas is leaking".

Figure 3.1: Device under Testing

The SMS is sent by means of a GSM module. The GSM module is connected to the microcontroller using the serial PORT and

communicates using the AT command. It has a SIM card through which it accesses the GSM network.

The device displays its status at any point in time and equally shows the level of gas concentration at all time when pressed button. The button is connected to the microcontroller to enables the user to display information on the LCD and to start the system. The LCD is connected to the microcontroller. The LCD has 16 pins on its body. It's a 4line 20 character LCD. The pins configurations are extracted from the datasheet are shown below.

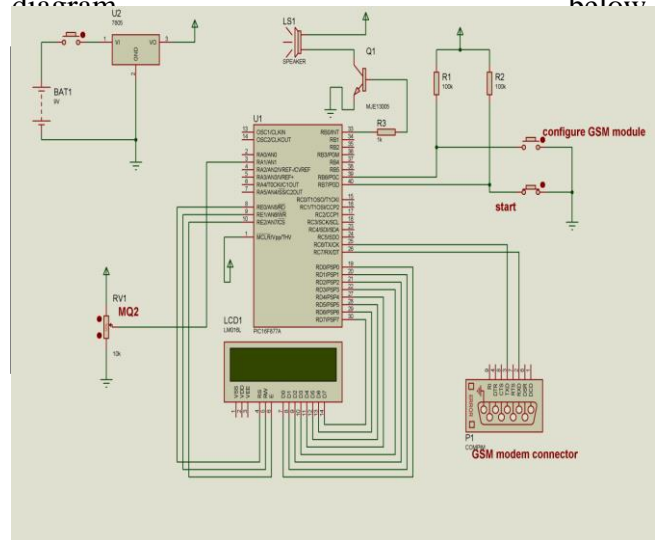**Figure 3.1- Diagram of LCD Pin Configuration**

Figure 3.2: Device after Construction

The entire system is summarized in the circuit diagram below.

IV. SOFTWARE IMPLEMENTATION

The system software component of the device is written in C++ programming language. Its main functions are to check the output from the gas sensor, to put information on the LCD, to send SMS using the GSM module, sound the buzzer and to detect when a button is pressed and respond accordingly. Below is system flowchart.
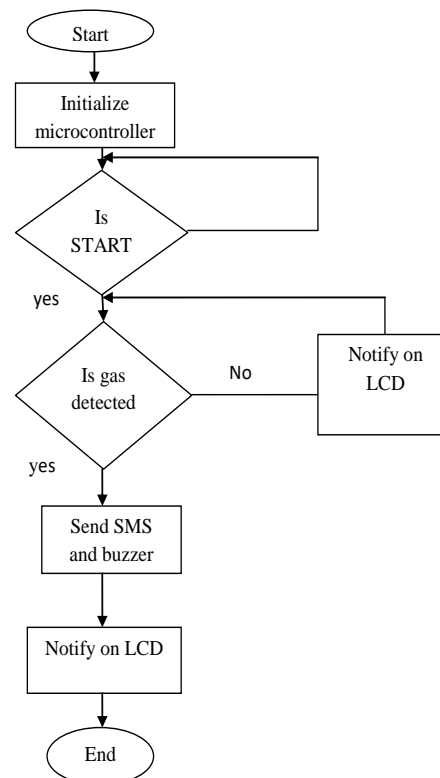

Figure 4.0-Flowchart of the System Software

V. CONCLUSION

The design of Telemetry based gas leakage monitoring system with external digital display and sound alert is designed to assist the citizens of Nigerian in monitoring and taking control of gas leakage in their environment. After testing the device for different levels of concentrations, the device proved reliable. The buzzer is way that the system can alert the user if such user is close to the facility and this type of alert is limited by distance hence the extension of the work with SMS alert. With this telemetry system, the owner of gas facility will be notified on real time about the impending danger ahead and early precaution can be taken.

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