Available online at www.worldscientificnews.com

World Scientific News

An International Scientific Journal

WSN 198 (2024) 29-55 EISSN 2392-2192

Design and Implementation of an Arduino based Gas Leakage and Temperature Monitoring System with SMS Alert

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ABSTRACT

Everyone needs security guarantee in their homes and when they work in a building hence, making security an integral aspect in human life. Various kinds of developments in the field of technology are designed to provide security at all times to protect lives, assets and privacy. The application of monitoring and safety systems to buildings especially in homes, market shops and ICT centres, can reduce or even eradicate the menace of fire disaster and equipment damages. The Gas sensor will sense the premises for gas leakage within its radar range; also, the temperature sensor will sense the temperature of the premises within its radar range. The output values from the Gas and temperature sensor will be sent as inputs to the microcontroller. The microcontroller will activate the buzzer alarm, send a text message upon gas leakage and a temperature value that is not equal to the room temperature and give out a display output; the alarm will sound upon detection.

***Keywords**:* Arduino UNO, Gas Sensor, Temperature Sensor, GSM Module, Buzzer.

(Received 5 September 2024; Accepted 1 October 2024; Date of Publication 14 October 2024)

1. INTRODUCTION

Liquefied petroleum gas is being used for the past decades as industrial fuel and for domestic purposes and could be referred to as LPG, LP gas and Auto gas. The gas comprises of saturated and unsaturated hydrocarbons. Liquefied Petroleum Gas has two major constituents which are Propane (C3H8) and Butane (C4H10) and their proportion depends on the application. It has characteristic of smokeless burning in air, highly flammable chemical, molecularly heavier than other gases present in the air. The leakage of LPG has become one of the fundamental issues in recent times. There are fire disasters that were heard of in the past which could have been avoided if gas leakage was detected. Everyone needs security guarantee in their homes and when they work in a building; hence, making security is an integral aspect in human life. Various kinds of developments in the field of technology are designed to provide security at all times to protect lives, assets, and privacy. The application of monitoring and safety systems to buildings, especially in homes, market shops and ICT centres, can reduce or even eradicate the menace of fire disaster and equipment damages. Going by the increasing level of patronage of LPG for cooking and heating applications, coming up with safety measures and methods of checkmating the impact of fire outbreak that may result from its leakage has attracted the attention of many researchers. Before the development of house hold electronics gas detectors in the early 90s, chemically infused paper that changes its colour in response to exposure of the gas leakages and was used to detect the presence of LPG. Since the introduction of electronic gas detectors, quite a number of devices have been developed. The issue of Gas leakage is a very sensitive one, which if not handled properly, could result to explosion, which leads to loss of lives and properties. To handle this problem, this work is geared towards designing and constructing of a gas detection and temperature monitoring system, which will reduce the risk attached to the use of LPG. The demand for the liquefied petroleum gas as a source of energy for plants, equipment, and household appliance is at the increase, as the careless use of it has led to accidents and hence loss of lives and properties.

Muhammad Ahmad Baballe *et.al* [1] designed a system that aims to detect, alarm, and control gas leakage using an exhaust fan to suck away the gas from the premises where there is leakage. The system detects the nature of gas using LEDs (red and green). The alarm gives a sound when gas leakage is detected, the exhaust fan sucks the gas away, and the Liquid Crystal Display (LCD) indicates the system performance at any distortion condition. The Arduino UNO is used as the main controller of the system, and the buzzer is used as the means of notification.

Ronnell, S.Paulina *et.al* [2] published a paper about LPG leakage detector using arduino with SMS Alert and sound alarm. Apart from the sound alarm, an SMS alert will inform the authorized person, and the solenoid valve will be triggered to shut down the gas supply to prevent any harmful effects due to gas leakage.

Nivedita Babanagare *et.al* [3] published a paper on a Gas leakage detector using Arduino with SMS alert that will continuously monitor the level of gas present in the air. While monitoring, if the value of gas in the air is within the set limit, then the result will be displayed on LCD simultaneously, an alert message is provided to the user by sending an SMS on mobile number.

Manasi Choche *et.al* [4] published a paper on a gas detection system based on Arduino UNO, used to detect the site from where the gas is leaking and accordingly disseminate messages to the coupled customers or its analogous users. The IOT system uses MQ6 gas sensor used to measure or detect the presence of gases like LPG and butane.

Kuo-Pao Yang *et.al* [5] published a paper on a gas leak detection device with the utilization of Internet of Things. The gas leak detection device focuses on detection of liquefied petroleum gas. Upon detection of a leak, the device can communicate over the internet using cellular networks, thus helping to alleviate Wi-Fi and Ethernet failure issues such as loss of power in a natural disaster.

Hazarathaiah *et.al* [6] in this project they told us about Gas leakage detection and rectification using GSM. The project was aimed at monitoring of liquefied petroleum gas leakage to avoid fire accidents, providing house safety feature where security has been an important issue. The system detects the leakage of LPG using gas sensor. It closes the regulator using electromagnetic valve and switch ON the exhaust fan. The wireless communication is used between the exhaust fan and LPG gas module.

Raphael E. Ochagwuba *et.al* [7] in this work, a prototype gas leakage detector, based on dedicated Peripheral Interface Controller (PIC), sensitive MQ-6 gas sensor, GSM/GPRS SIM900 and discrete components, is developed and tested. Both indoor and laboratory tests were conducted where the results indicate gas concentration levels of 372 ppm to 255 ppm were measured to display a message on Liquid Crystal Display (LCD) and trigger audio alarm at instances of 2.42 seconds and 8.35 seconds in locations of 5cm and 30cm away from gas source, respectively. Finally, the viability test proved satisfactory as it indicates that whenever a particular network fails, the second network was available to receive the SMS message adequately.

Yekini N. Asafe *et.al* [8] in this paper a device was proposed to detect gas leakage and alert, the device is based on a microcontroller that employs a gas sensor as well as a GSM module, an LCD display, and a buzzer. The system was designed for gas leakage monitoring and alerts with SMS via an Arduino microcontroller and with a buzzer and an MQ2 gas sensor. When the sensor detects gas leakage, it transmits the information to the microcontroller while the microcontroller makes a decision and then forwards a warning message to the user as SMS to a mobile phone for decision to be taken accordingly.

R. K. Parate *et.al* [9] developed Node-MCU based gas leakage detection and alerting system to monitor the concentration of LPG gas. The system is built using Node-MCU ESP32. MQ6 gas sensor is used for detection of LPG. Node-MCU takes the decision based on information provided by gas sensor. Firmware has been developed and deployed into Node-MCU using Arduino IDE.

Presence of gas is displayed on OLED display module in terms of ppm. It also alerts the person by generating alarm. The designed system helps to achieve portability, light weight and cost effective solution to commercially available system.

Sayeda Islam Nahid *et.al* [10] developed a detector that includes a MQ-6 LPG gas sensor, a PIC16F690 microcontroller, an LCD, a buzzer, and a number of LEDs to learn about the gas leak's condition. When a voltage signal is present from the MQ-6 sensor exceeds a specific threshold, the microcontroller detects the presence of a gas and sends an audio-visual alert. All peripherals are linked to the microcontroller through its pins, which are coded in the PIC assembly language. When the system was turned on, the microcontroller turned on a green LED to indicate that there was no gas leakage. A digital multimeter is used to monitor the sensor voltage signal when LPG gas is discharged.

Whenever the voltage is less than 2.0V, the green light remains illuminated; when the voltage is more than 2.0V, the microcontroller blinks a red LED and sounds an alarm to indicate the presence of a gas. The alert can be recognized by pressing a button on the sensor. When the system was turned on, the microcontroller turned on a green LED to indicate that there was no gas leakage. A digital multimeter is used to monitor the sensor voltage signal when LPG gas is discharged. Whenever the voltage is less than 2.0V, the green light remains illuminated; when the voltage is more than 2.0V, the microcontroller blinks a red LED and sounds an alarm to indicate the presence of a gas.

Alexander Tommy [11] designed a detector that can detect gas leaks with the MQ-6 sensor and solenoid valve to close the gas line. The research was conducted by testing the voltage from the sensor using a predetermined program. The maximum reading distance from the gas sensor is 18 cm with a time of 45.26 seconds based on tests carried out by narrowing the gas exit path to provide a faster rate effect so that the sensor can detect gas.

Anjali T. Pawar *et.al* [12] developed a system that utilizes a gas sensor with high sensitivity to propane (C3H8) and butane (C4H10) gases and incorporates a GSM module for sending warning SMS messages.

Pratiksha W *et.al* [13] this paper aims to present the design approach for both the software and hardware components of the system to ensure timely detection and prevention of gas leakage accidents.

The main objective of the project is to build a Gas leakage detector using LGP gas sensor this device will continuously monitor the level of LPG gas present in the air and also connect it to with IoT using ESP module for safety and security. This system can be installed in homes, hotels, LPG gas storage areas. Arduino is used as the main controller.

Abhijeet B. Shingate *et.al* [14] this work aims to minimize such incidents by making an IoT-based gas leakage detecting device that will send a notification with the threshold value to stop further leakage for safety and maintenance. Gas sensor is connected to the Wi-Fi module, where it checks the gas sensor value sent from the bolt device to the Cloud for every 10 sec and if gas concentration crosses threshold, then it switches on the BUZZER and during that time it sends an alert to your phone number.

J. S. Vimali *et.al* [15] the objective of this article is to detect gas leakage and control the airflow of the exhaust automatically to vent out the gas. An alert would also be sent to the concerned person, and an emergency request will be placed directly to the fire service along with the appropriate location. The project is carried out using the Internet of Things (IoT). This system has been proposed to minimize the accidents caused by gas leakage and exhaust the gas by automatically controlling the airflow. The proposed system also comes with the ability to automatically book a new gas if the current one extinguishes.

We have made use of Google's Firebase cloud services to constantly update the data obtained from the various sensors used in the system.

Adoyi Boniface [16] designed a gas monitoring system to detect liquefied natural gas (LPG) using MQ 6 sensor and generate an alarm signal when the detected gas reaches its hazardous level (300ppm). The project was built around a microcontroller ATMEGA 328. This project alarmed when the LPG gas reaches its hazardous level based on threshold. The drawback of this project was the MQ 6 senses not only LPG only but also all other gases and smoke, hence avoiding accurate measurement concerning the progress and status of the system.

Zarith Sofia Suraya Bt Hj Bakeri [17] designed a gas monitoring system to detect carbon monoxide and liquefied natural gas (LPG) using TGS 2442 gas sensor and generate an alarm signal when the detected gas reaches its hazardous level (300ppm). The project was built around a microcontroller PIC18F2550. This project alarmed when the carbon monoxide and LPG gas reaches its hazardous level based on threshold. The drawback of this project was the absence of a liquid crystal display to indicate visually the status of the system, hence avoiding imaginative assumptions concerning the progress and status of the system.

Raju *et.al* [18] they introduce an Android-based automatic gas detection and indication robot. They proposed prototype depicts a mini mobile robot that is capable to detect gas leakage in hazardous places.

Whenever there is an occurrence of gas leakage in a particular place the robot immediately read and sends the data to Android mobile through wireless communication like Bluetooth. We develop an Android application for Android-based smart phones that can receive data from robot directly through Bluetooth.

The application warns with an indication whenever there is an occurrence of gas leakage and we can control the robot movements via Bluetooth by using text commands as well as voice commands.

Fal Ohun *et.al* [19] in this paper they proposed the detection of dangerous gas using an integrated circuit and MQ-9. They used an embedded design that includes typical input and output devices include switches, relays, solenoids, LEDs, small or custom LCD displays, radio frequency devices, and sensors for data such as, humidity, light level etc. Embedded systems usually have no keyboard, screen, disks, printers, or other recognizable I/O devices of a personal computer, and may lack human interaction device. The amount and type of detectors and the type of fire alarm system that one chooses for property protection will depend on the owner's property protection goals, the value of the property, and the requirements of the owner's insurance company. Generally, heat detection will be used in all areas that are not considered high value.

Amsaveni [20], the aim of this project is to present such a design that can automatically detect, alert and control gas leakage. In this project, after the leakage of gas is detected, the valve is automatically closed thereby stopping the leakage. Then the electric power supply is also shut down to prevent fire accidents. In particular, gas sensor has been used which has high sensitivity to gases like propane and butane.

Gas leakage system consists of GSM module, which alerts the user by sending SMS. In the existing method, different gas sensing technology is used. The semiconductor sensor detects the LPG gas leakage.

In this paper a systematic solution to this particular problem is developing a system that analyses the value of LPG in the atmosphere, temperature of the surroundings, compares it with the set threshold value, and communicate with the third party. To accomplish this, a system capable of monitoring liquefied petroleum gas through a gas sensor and temperature of the surrounding through a temperature sensor, then sending messages to the specified number without any time delay if there is gas leakage or rapid rise in temperature in the surroundings.

2. MATERIALS AND METHOD

The analysis stage is the front- end phase of the development process of any Microcontroller based system. This phase constitutes an important stage of the development process and one of the critical issues that determines the quality of the final project. The analysis stage sets the stage for the whole project. The necessary groundwork for understanding what the project is all about is completed in this phase. The total design of any microcontroller-based system typically involves three stages which are Hardware design and development, Software design and development, Prototype implementation and testing.

The method used in the execution of this project comprises the combination of serial communication protocols, signal processing, programming logics with embedded system.

In other to establish the aim of the project these methods were combined from the design stage to the construction and performance results of the system, using carefully selected materials and software implementation to drive the complete system as seen in the final construction. This chapter entails the design procedure of the system, detailing the theoretical analysis, choice of components and values and 11 construction and packaging materials, indicating calculations, schematics and drawings. The figure below shows how the microcontroller is connected to the alarm system, gas sensor, temperature sensor, GSM module, display system (LCD) and the power supply.

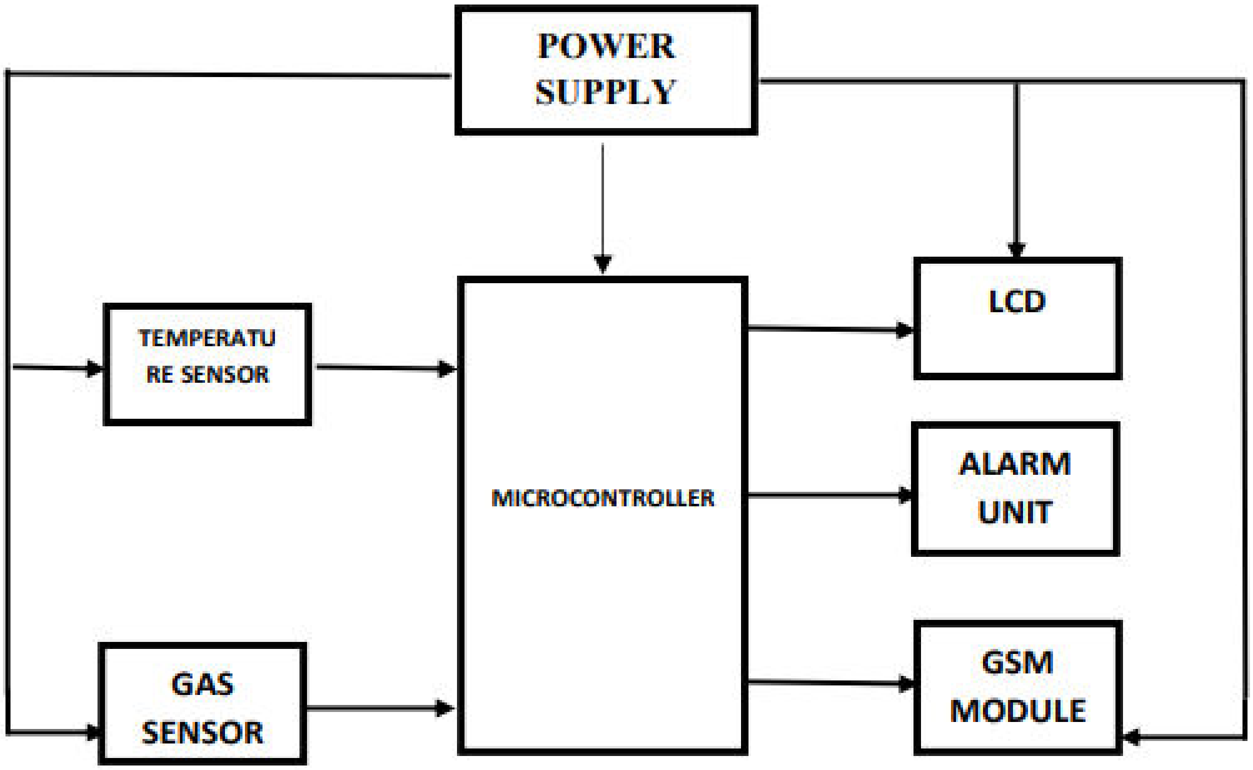


Figure 1. Block Diagram of the system.

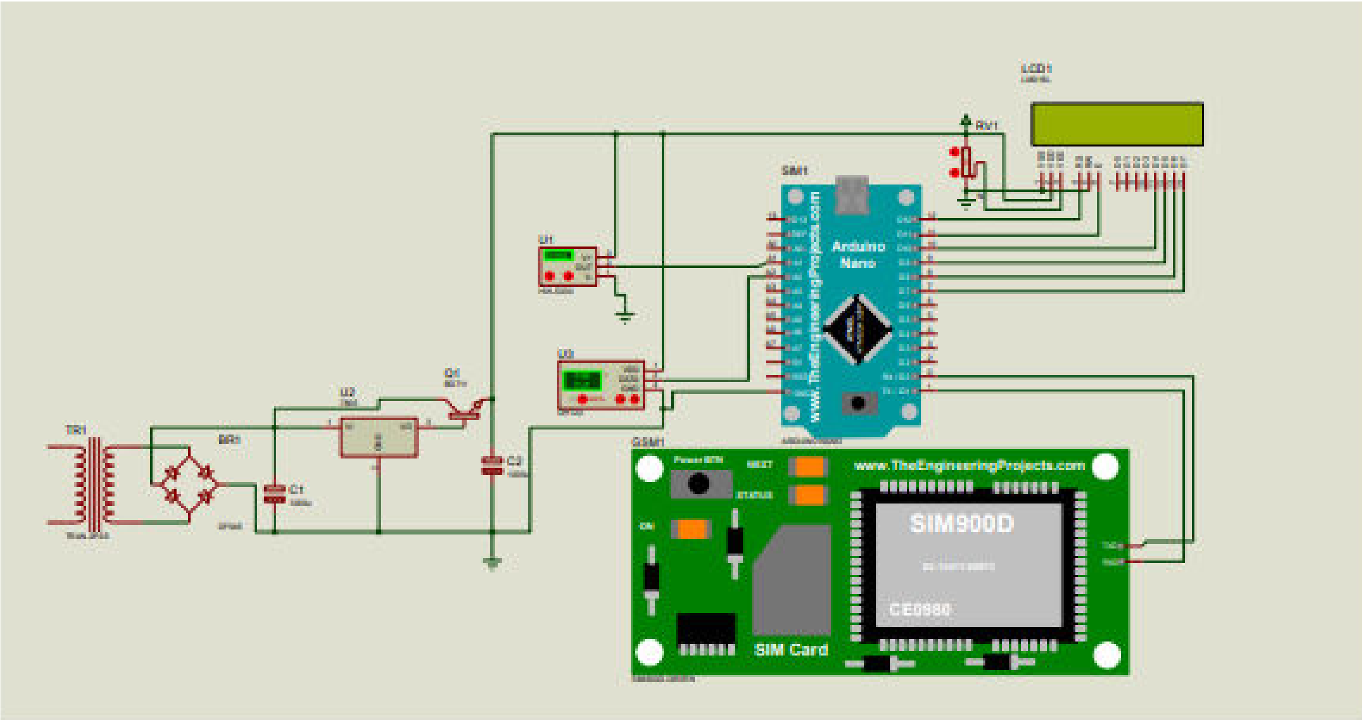


Figure 2. Circuit Diagram of the System.

2.1. Hardware Design and Development

This section describes the methods used in designing each component part of the system. Analysing the choice of components used in the circuit. The project work was critically achieved in four main units. They are power supply unit, the Microcontroller unit, input units, and output units.

The Power Supply Unit is the unit that gives power to the circuit. The power supply unit consist of four sections, these are: The transformer, Rectification, filtration, and the voltage regulating sections. The power supply unit was achieved by the integration of different components such as the transformer, Rectifier, Capacitor and Voltage regulator.

The Step down Transformer of 220/12VAC shown in figure.3 has the following parameters:

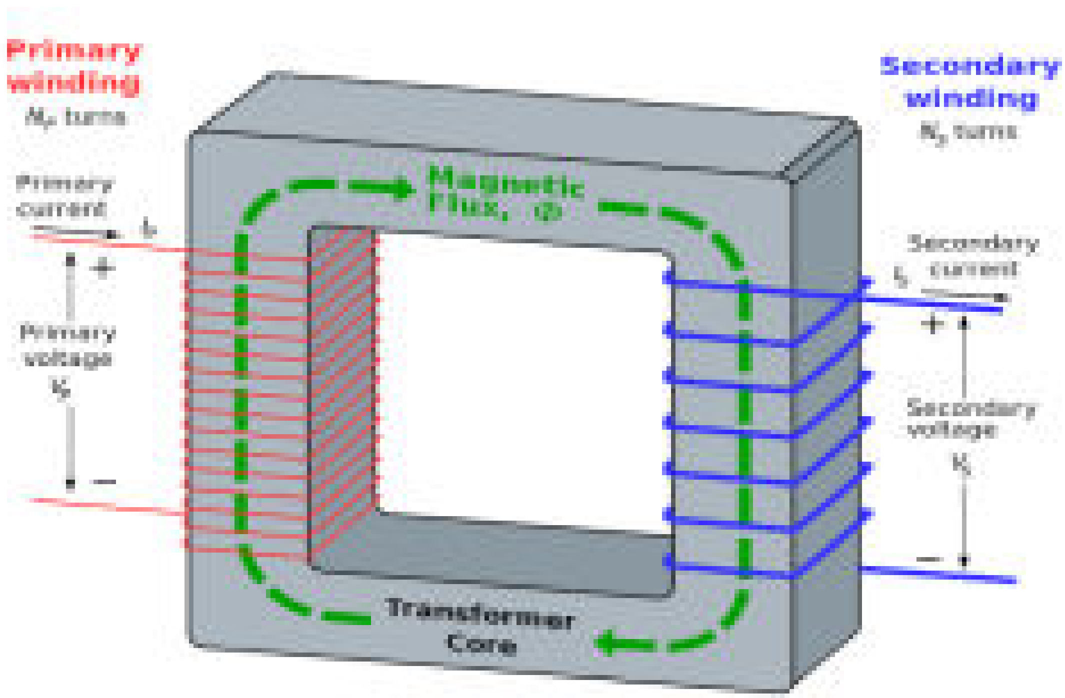


Figure 3. The Transformer unit.

Input voltage = 220V (RMS)

Output voltage =12V ((RMS)

Current rating = 500mA

Hence, let the secondary current, Is = 1A

This transformer core has 64 laminations, each of $0.5m^2$ thickness. The width of the core is therefore $32m^2$

Hence, cross sectional area, A of the core is:

A = 32 x 0.5 x 64 = $1024mm^2$

Since the input voltage is sinusoidal (AC), the R.M.S value of the input voltage is:

$$E_{rms} = \frac{2xFNAB}{\sqrt{2}} = 4.44FNAB$$

Primary voltage is 220v and the number of turns for primary winding transformer is:

N1 =220 x 3.66 = 806 turns

Secondary voltage is 12v and the number of turns for secondary winding of transformer is:

N2 = 12 x 3.66 = 44 turns.

Since secondary current = 1A, the transformer power rating in volt ampere = 1 x 12 = 12VA

The transformer ratio is

$$\frac{Vp}{Vs} = \frac{Is}{Ip} = \frac{Np}{Ns} = k$$

Where K is the transformer ratio.

Thus

$$I_2 \frac{V_2 \times I_1}{V_1} = \frac{12 \times 1}{220} = 0.05A$$

Current density of copper wire is 3A/mm^2

The 220/12VAC step down transformer (already made) was gotten from the market as it met the required output voltage for the project hence, no need for the designing it.

2.2. Rectification Unit

Full wave rectification was used here, by using a bridge rectifier. This rectifier consists of four pieces of 1N4007 diodes (D1, D2, D3 and D4) connecting each other. As shown below.

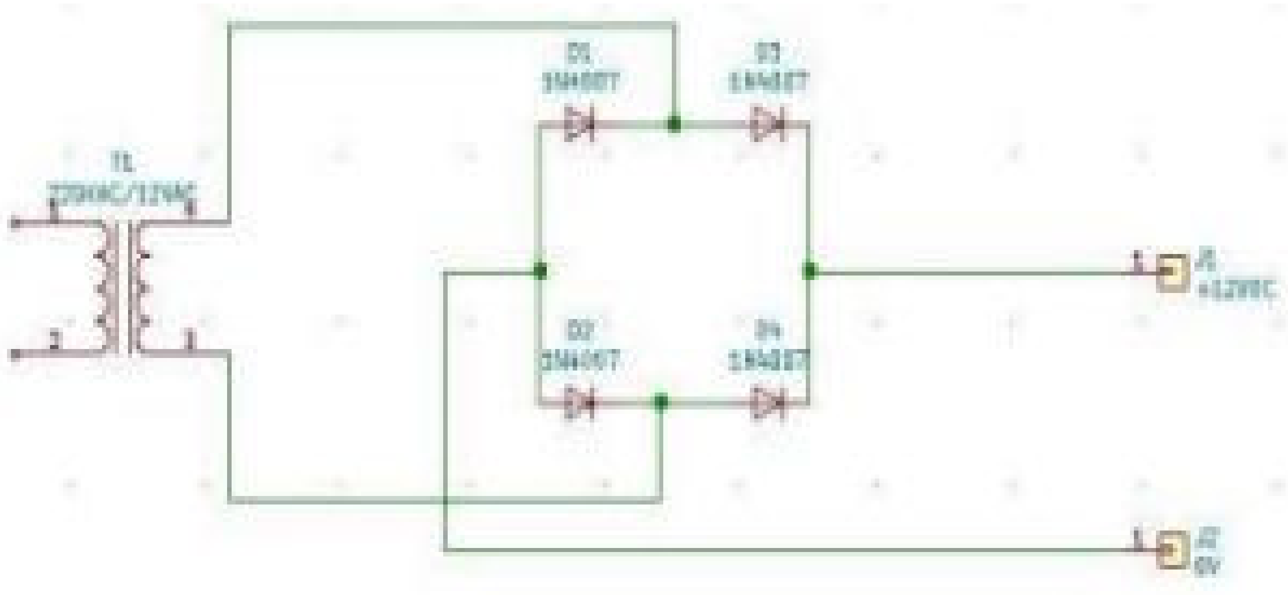


Figure 4. Line Diagram of a Bridge Rectifier.

When the positive half cycle of AC waveform reaches the upper terminal of the bridge rectifier, this terminal becomes +12V and the lower terminal becomes -12V with respect to the upper terminal. Then Diodes D1 and D2 become forward biased and conduct in series, while D3 and D4 become reverse biased. The current flows from this path (D1 to D2). This positive half cycle is observed at the output of bridge rectifier.

Now, when negative half cycle reaches the upper terminal of bridge rectifier the lower terminal becomes positive with respect to upper terminal, and diodes D3 and D4 conducts and current flows through this path (D3 to D4) while diodes D1 and D2 are switched off. This negative half cycle is converted to positive half cycle at the output, thereby giving a pulsating DC output; the output waveform is shown in fig.3.3. The advantage of bridge rectifier over two diode rectifier is that, peak inverse voltage of bridge rectifier is very low as compared to the two-diode rectifier, power dissipation of bridge rectifier is low, and the output of bridge rectifier is very efficient than two diode rectifier.

Due to these advantages, bridge rectifier was used in the circuit. The principle of bridge rectifier is based on wheat stone bridge.

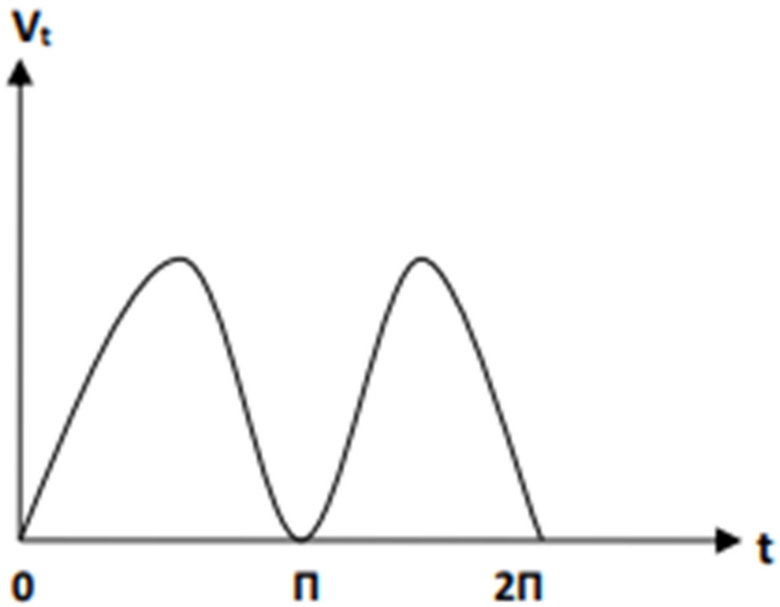


Figure 5. Rectifier output waveform.

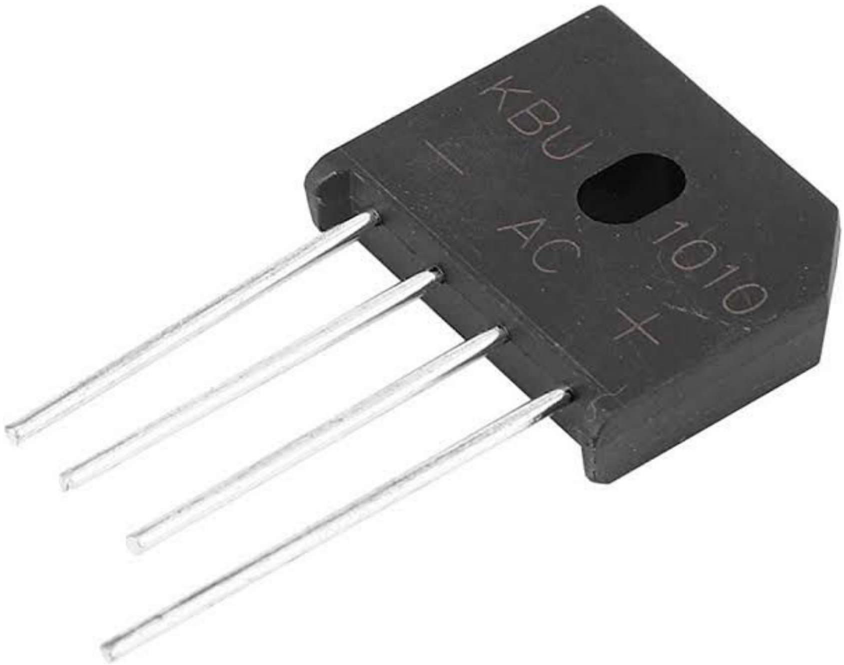


Figure 6. Bridge Rectifier.

2.3. Voltage Regulation Unit

The LM78xx series (Linear Monolithic, '78'stands for the input voltage range of 1V to 78V dc), made by National Semiconductor. These digits indicate the output voltage the particular device is designed to provide. E.g. we have the 7805, 7806, 7808, 7809, 7812, 7815, representing 5V, 6V, 8V, 9V, 12V and 15V respectively in the positive voltage range. Because of the 5Vdc requirement of the circuit components used for this project, it is best to use a fixed positive voltage integrated circuit regulator. Thus, the LM7805 (+5V) regulator was chosen.

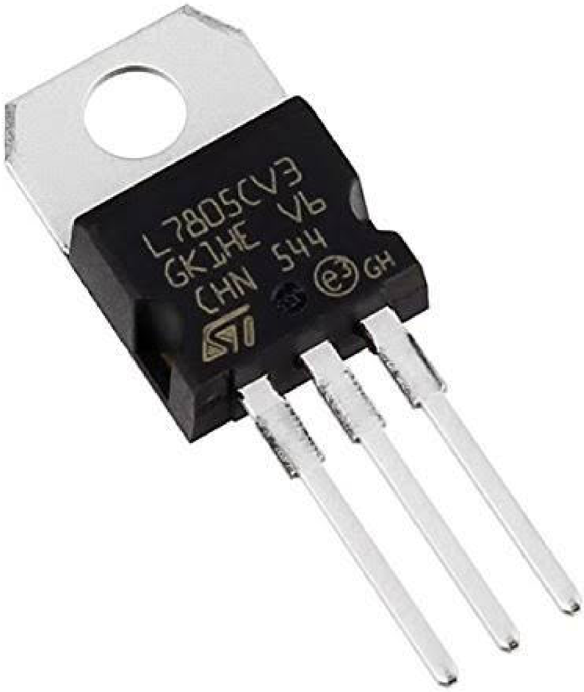


Figure 7. 5V LM7805 Voltage Regulator.

2.4. Microcontroller Unit

The microcontroller used in this unit is the high-performance Atmel 8-bit ATmega328 microcontroller shown in figure 3.7, which is a low-power, high performance based microcontroller combines 32KB ISP flash memory with readwhile-write capabilities, 1KB EEPROM (1kilobyte Electrically Erasable Programmable Read Only Memory), 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, a single 16-bit Timer/Counter with independent pre-scale, compare and capture modes with 28 pins.

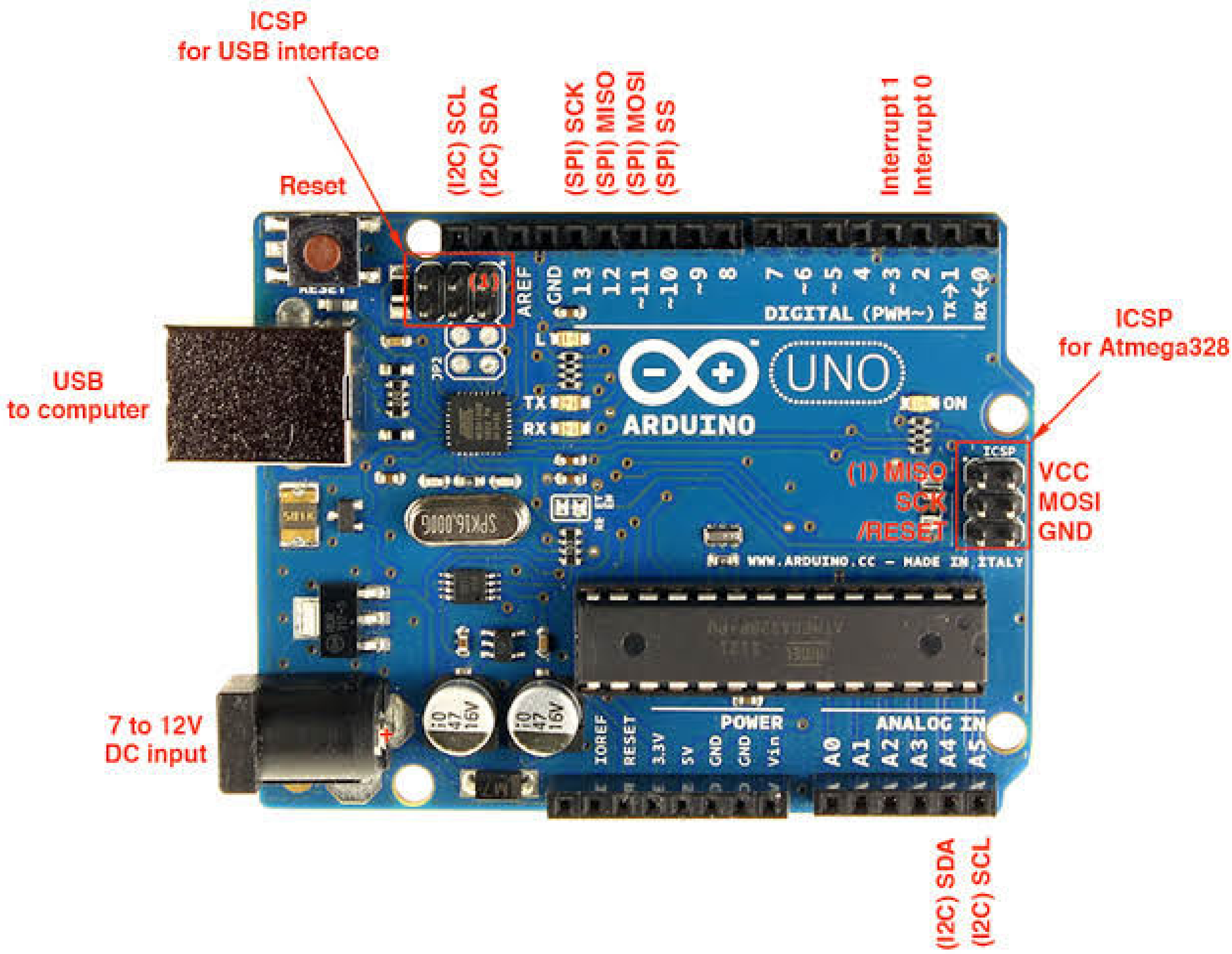


Figure 8. Aduino Uno.

2.5. The input unit

In this project, two sensors were used and the sensors serve as input devices. They sense signals from the environment and feed such signals to the microcontroller to take a decision. The two main sensors used in this project are: Gas sensor and the LM 35 Temperature sensor.

2.6. Gas sensor

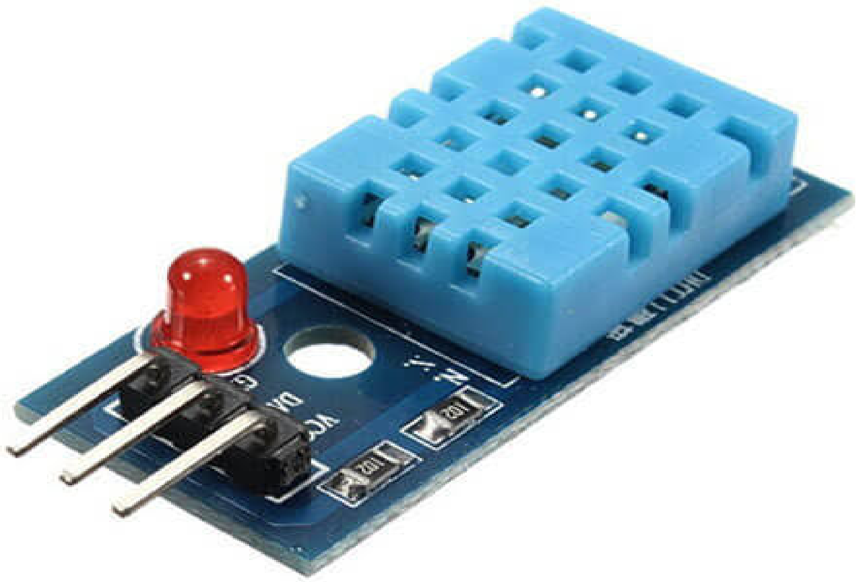
The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. They are sensitive for a range of gasses and are used indoors at room temperature. The output is an analog signal and can be read with an analog input of a atmega328 microcontroller. The MQ-6 Gas Sensor module is useful for gas leakage detecting in home and industry. MQ2 Gas sensor works on 5V DC and draws around 28 800mW. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane, and Carbon Monoxide concentrations anywhere from 200 to 10000ppm.

The specifications are operating voltage 5V, load resistance 20 KΩ , heater resistance 33Ω ± 5%, heating consumption <800mw, sensing Resistance 10 KΩ – 60 KΩ, concentration Scope 200 – 10000ppm and preheat Time Over 24 hours.

Figure 9. MQ2 Gas Sensor.

2.7. LM 35 temperature sensor

The LM 35 is a Precision Centigrade Temperature Sensor, with an output voltage linearly proportional to the Centigrade temperature. It has an advantage over linear temperature sensors calibrated in Kelvin, as there is no need required to subtract a large constant voltage from the output to obtain convenient Centigrade. The temperature-sensing element is then buffered by an amplifier and provided to the VOUT pin. The amplifier has a simple class A output stage with typical 0.5-Ω output impedance. Therefore the LM35 can only source current, and its sinking capability is limited to 1µA.



Sensor Figure 10. DTH11 Temperature.

2.8. Output Unit

This unit consist of the LCD display, GSM module, and the alarm.

2.9. LCD display unit

LCD is a flat panel display, either electronic visual display or video display that uses the light modulating parameters of liquid crystals. LCD's do not emit light directly; they are available to display arbitrary images (as in a general purpose computer display). A "16×2" LCD is employed in this design, as shown in fig.3.13. It has input ports D0……….D7, a cathode "K", anode "A", enable "E", reset "R/S", read and write "R/W" pins, respectively, as well as VDD supply pin, a variable resistor pin which is used to set the contrast of the LCD, and ground Vss. The LCD is used to display the temperature value. The LCD has the following functions: Pin 1 and pin 2, are Vss and Vdd, respectively (power supply), Pin 3 is Vo (Contrast adjustment), Pin 4 is R/S, Pin 5 is R/W and Pin 6 is E (control line) select either instruction or character, Pin D0……………….D7 (Data line) Transfer data or instruction, and Pin 15 is A and Pin 16 is K (Back light) LED.

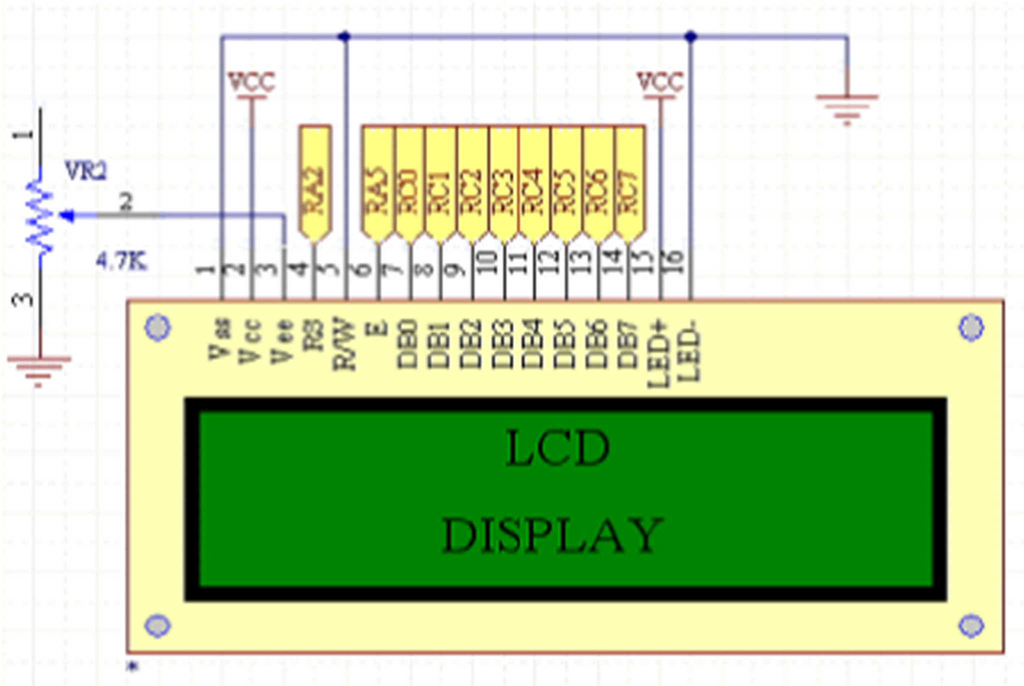


Figure 11. LCD Display datasheet.

2.10. GSM module (SIM800L)

This is a quad-band GSM/GPRS module that works on frequencies GSM850MHz, EGSM900MHz, DSC1800MHz and PSC1900MHz. With a tiny configuration, SIM800L can meet almost all the space requirement in user application such as smart phone, PDA and other mobile device. SIM800L has 88pin pads of LGA packaging and provides all hardware interfaces between the module and users board. It has the following feature: Programmable general purpose input and output, A SIM card interface, Support FM, Support PWM and Power supply range of 3.4V-4.4V.

Figure 12. Sim800L GSM Module.

2.11. Alarm system

This is a loud device called a buzzer which is triggered when there are abnormalities in any market shops or ICT office detected by the sensor based on threshold calibration. The siren shall be driven by receiving command from the microcontroller when unnatural condition occurs.

Figure 13. Buzzer.

2.12. Software Development and Design

The construction of the project work consists of two major parts, which are the "Hardware" that is made up of the microcontroller, voltage regulator, LDR circuitry, LCD display unit, etc. and the "Software" which is a computer program that runs on the ATmega 328 microcontroller which controls the entire project. The software is a computer program called "Source code" In compiling, source code is a collection of computer instructions written in human readable language, usually text. The source code cannot be executed by the microcontroller or any other machine unless it is compiled into a low level machine language called "Object code". For the sake of this project, the "Source code" usually called "Sketch" is written in C++ under the Microcontroller IDE platform. The sketch is compiled by this platform and uploaded into the ATmega328 microcontroller via a USB (Universal Serial Bus) cord.

2.13. Implementation

This involves the steps and works carried out so as to realise the project work.

2.14. Tools used

The tools used for the design and construction are soldering iron, lead, digital multi-meter, rubber gum, jumper wires, etc.

2.15. Simulation on Proteus

Before the construction of the system, the circuit was first designed and simulated using the Proteus 8 circuit design and simulation software, this was done to see the behavior of the system in real time situations when fully completed.

2.16. Construction on a breadboard

This is always the stage of work done in implementing a project work. It is always the arrangement where all the components to be used in the project are tested temporarily on the bread board for experimental purpose. By so doing, we ascertained the workability of the individual components before heading to the next stage.

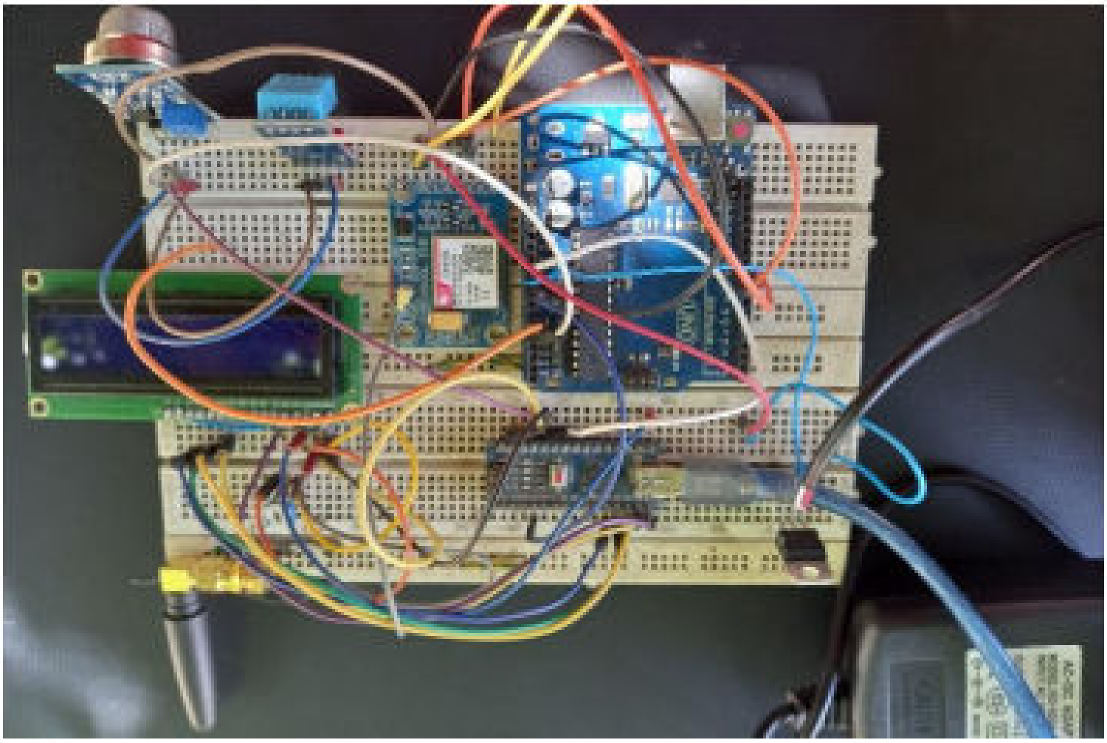


Figure 14. Construction on a breadboard.

2.17. Construction on a Vero board

This is usually the second stage after ascertaining that the components are working and that the circuitry is correct as shown in Figure 2. PCB (Printed Circuit Board) is used to mechanically support and electrically connect electronic components using conductive pathways, tracks, or signal traces etched from copper sheets laminated onto a non-conductive board. Components are connected through the conductive material below a non-conductive board, the common conductive material used in packaged PCBs are usually copper, since copper is cheap and common. Connections and wiring of the various circuits was carried out by a careful soldering of the component terminals on the PCB. Where a short circuit is likely to occur, insulated copper wires (jumpers) were used to connect the terminals before soldering. Also, components that are likely to be affected by heat during soldering were mounted on sockets. After the components are soldered to the PCB, a digital multi-meter was used to carry out short circuit and continuity test on the components to ensure proper connections.

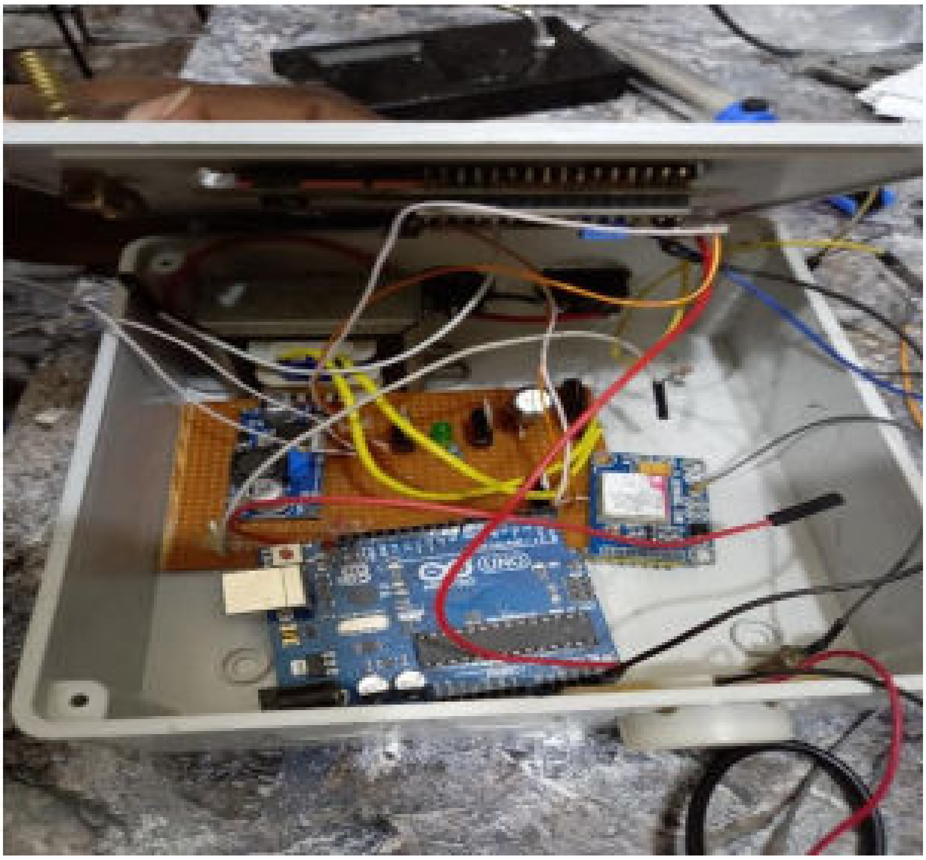


Figure 15. Construction on a Vero board.

3. RESULTS AND DISCUSSION

This chapter presents the description of test performed on the various sections of the overall system and their corresponding results as well as the result of the overall system. In order to verify the functionality of the system, each component had to be tested individually. The functionality of the implemented project and results obtained and recorded from the exercise is presented, which discussions were made based on these observations.

3.1. Test

The components used for the implementation of this project were tested on breadboard for better performance, and were later transferred to the Vero board and soldered. The heat applied during soldering was just moderate to avoid damage of the Vero and the components since most of the components have low heat resistance. The test equipment includes; Breadboard: to assemble and test individual components, Digital multi meter: to measure voltage, current, resistance and check for continuity and Light emitting diodes.

3.2. Power Supply Tests and Results

The results obtained for the power supply unit as compared with the no-load and full load conditions are given in the tables below.

Table 1. Power Supply Test on no Load.

Transformer	Theoretical Values (V)	Measured Values(V)	%Error
Input voltage	220Vac	219Vac	0.4%
Output voltage	12Vac	11.89Vac	0.9%
Rectifier			
Input voltage	12Vac	11.89Vac	0.9%
Output voltage	10.80Vdc	10.79Vdc	0.1%
Filter			
Output voltage	10.80Vdc	10.79Vdc	0.1%
LM7805			
Input voltage	10.80Vdc	10.79Vdc	0.1%
Output voltage	5Vdc	4.99Vdc	0.2%

Table 2. Power Supply Test on Full Load.

Transformer	Theoretical Values (V)	Measured Values(V)	%Error
Input voltage	220Vac	219Vac	0.4%
Output voltage	12Vac	11.89Vac	1.2%
Rectifier			
Input voltage	12Vac	11.89Vac	0.9%
Output voltage	10.80Vdc	10.79Vdc	1.3%
Filter			
Output voltage	10.80Vdc	10.79Vdc	1.3%
LM7805			
Input voltage	10.80Vdc	10.79Vdc	1.3%
Output voltage	5Vdc	4.99Vdc	0.6%

As seen from tables 1 and 2 of the no-load and full-load voltage values, there are slight changes in the readings obtained when the power supply was on no load and on full load. Thus, for the no-load: the theoretical values differ slightly from the measured values which could be due to the fluctuation in the power supply and the components' tolerance or manufacturer's defects. For the full-load, there were voltage drops due to the load on the system, which were not much, as it did not go down below the minimum input voltage of the LM7805 voltage regulator which is 7Vdc for an output of 5Vdc. The voltage regulator essentially acts like a big variable resistor; it adjusts its resistance as needed to maintain ideally a consistent regulated 5V. The efficiency of the voltage regulator on load will be calculated using the formula:

$$Efficiency = \frac{Output\ Voltage}{Input\ Voltage} \times 100\% = \frac{4.97}{5} \times 100\% = 99.4\%$$

The performance of the voltage regulator is thus satisfactory as it has the efficiency of 99.4%.

3.3. Testing of the MQ-2 Gas Sensor

The sensor was tested by calibrating it with LPG gas. Since the digital output of the sensor was used, the digital pins of the sensor were used to obtain the output of the sensor. A digital voltage was obtained at the digital pin. When gas is sensed, the voltage at the digital pin read 0.15V and when smoke is absent, the voltage swings 40 back to 5V. The potentiometer behind the sensor is used to adjust the sensitivity of the sensor to respond digitally in regards to 300PPM concentration.

Table 3. Analysis on Testing of MQ-2 Gas Sensor.

Input	**Expected output**	**Actual output**	**Remark**
0<=ppm<=139	Normal	Normal	Pass
140<=ppm<=150	Gas detected	Gas detected	Pass
151<=ppm<=200	Gas detected	Gas detected	Pass
300<=ppm	Gas detected(high concentration)	Gas detected(high concentration)	Pass

TESTING OF THE TEMPERATURE SENSOR The temperature sensor gives an equivalence of the sensed temperature to voltage. A verification test was made to confirm the status of the temperature sensor as it relates to the data sheet specification. The data sheet specified that for every degree rise in temperature, the sensor should output a voltage of 10mV. As shown in the table below.

Table 4. Analysis on Testing of DHT11 Temperature Sensor.

S/N	**VOLTAGE OUTPUT (VOLT)**	**LCD PROGRAMME DISPLAY TEMPERATURE**
1	0.22	30
2	0.69	82
3	0.56	71
4	0.52	57
5	0.38	50

From the test result obtained for the various power supplies, clearly show that result obtained are approximate to earlier theoretical design. For instance, the central power supply had a voltage regulation of 1.63%, the 5V power supply had a voltage regulation of 2% and the 12V power supply had a voltage regulation of 2.58%. These results correlated to the initial theoretical design for power supply were a 1% percentage ripple voltage was chosen, although there were cases of small overshoot. The graphical result from the oscilloscope was as expected. A straight line with no ripples showed that perfect rectification was achieved for all voltage levels. The temperature sensor result deviated from what the data sheet prescribed as earlier aforementioned with a ±3oC. Lastly, the gas sensor during calibration produced result as expected. Output of the gas sensor was taken from its digital pin. When gas is sensed, the digital voltage swings to 0.15V and when gas is not detected, it swings to 5V. By virtue of these tests and the result obtained, the implemented construction can be easily trouble shot if any abnormality arises.

4. CONCLUSIONS

With the increasing rate of fire disaster in tropical countries like Nigeria, this maniacal menace could be handled by having this project implementation in market shops or ICT centres for safety reasons. In United State of America, the United States Consumer Product Safety Commission has emphasized the need for gas detectors for building security and recommends at least one for each layer of building. This proves the need for gas detection alarm systems to be 100% reliable. The project fulfils all the goals proposed for the system which is to develop an Arduino based GSM enabled monitoring, detection and control system for market shops, ICT Centres with precise accuracy. Such a system possesses the advantage of flexibility in method of programming, durability, and simple set of instruction. Testing of the implementation components before use is the only method to test their workability instead of relying fully in the component specification sheet, as attested in the test carried out with the temperature sensor. Such test will guarantee expected result. This project can be used in industries, as security system in coal mines or wood cutting or cotton industry, market places, ICT centres and soon. In conclusion, at the end of the project, the system has managed to achieve its objectives.

A backup power supply is recommended to be included in the system design to augment for power failure condition. In addition, calibration of the gas sensor can be done to sense not only LPG but also numerous gases.

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