DESIGN AND FABRICATION OF A MICROCONTROLLER BASED LIQUEFIED PETROLEUM GAS LEAKAGE DETECTION WITH GSM ALERT MONITORING SYSTEM

BY

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CERTIFICATION

This project with the title

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DEDICATION

I dedicate this report to God, the Almighty; the all-knowing, the all sufficient, the giver of wisdom, knowledge and understanding.

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ABSTRACT

Liquefied Petroleum Gas (LPG) is a group of flammable hydrocarbon gases that are liquefied through pressurization and commonly used as fuel. This project aims to design and implement a micro-controller based Liquefied Petroleum Gas (LPG) gas monitoring & leakage detection system with GSM alert system. Design and implementation of gas detection system as well as SMS alert systems were done to achieve the project aim.

Gas leaks can cause major incidents resulting in both human injuries and financial losses. To avoid such situations, a considerable amount of effort has been devoted to the development of reliable techniques for detecting gas leakage. Various literatures were reviewed and compared, and conclusions were drawn chapter two gives the detailed accounting of the literatures as well as the review of fundamental theories about the project.

Chapter three shows the design steps taken to actualize the project. The system is built around three sensors; gas sensor, load cell and temperature sensor. These sensors are interfaced together to an embedded system. Software simulation of the design was done using Proteus professional software and the design was actualized on a printed circuit board.

The design was tested by deliberately exposing it to gas leakage, the alarm system of the design goes off and it sends a SMS text to the user to notify about a potential threat.
The goal of this project was achieved by fabricating and design a device that detect Gas leakages effectively using a gas sensor and alert people and also the designed system is capable of notifying the user about the level of the gas in the cylinder through the weight sensor.

Improvements can be made on the system to make it a more efficient detector system by using Internet of Things (IOT) instead of SMS alert notification for the proper monitoring and control of the system. To ensure uninterruptible power supply, solar power can be incorporated into the design. Another improvement can be made to ensure it can also be powered using a battery as ac power cannot be stored.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

LIQUEFIED PETROLEUM GAS (LPG) is a group of flammable hydrocarbon gases that are liquefied through pressurization and commonly used as fuel which include propane, butane and mixtures of these gases. LPG comes from drilling oil and gas wells; it is a fossil fuel that does not occur in isolation used as fuel in heating appliance, cooking equipment and vehicles. They are also referred as simply propane or butane which are increasingly used as an aerosol propellant and a refrigerant, replacing chlorofluorocarbon in an effort to reduce damage to the ozone layer. (Elgas Handbook on LPG gas, 2017)

LPG first produced in 1910 by Dr. Walter Snelling is a mixture of Commercial Propane and Commercial Butane having saturated as well as unsaturated hydrocarbons. Because of the versatile nature of LPG it is used for many needs such as domestic fuel, industrial fuel, automobile fuel, heating, illumination etc. and the demand for LPG is on an exponential raise day by day. The liquefied petroleum gas is finding wide usage in homes, industries and in automobiles as fuel because of its desirable properties which include high calorific value, produces less soot, produces very less smoke and does not cause much harm to the environment. Natural gas is another widely used fuel in homes. Both burn to produce clean energy, however there is a serious threat about their leakage (Priya).

The increase in the development of technology and the human race, we failed to take care about the surroundings in which we live in. Then we pollute the environment and thereby reducing the quality of the place we live. Even though there are several aspects of pollution such as soil, air and water pollution, out of these air pollution acts as the serious aspects others can be detected visually and by taste, but the polluted air cannot be detected as it can be odorless, tasteless and colorless. The gas is generally stored in metallic cylinders as its boiling point is lower than ambient temperature. LPG is molecularly heavy than other gases present in the air, The gases being heavier than air do not disperse easily and may lead to suffocation when inhaled; also the leaked gases when ignited may lead to explosion which leads to loss of lives and properties (NGOCHI, 2016). The number of deaths due to the explosion of gas cylinders has been increasing in recent years.

Hence, there is a growing demand for LPG gas both for domestic usage and industrial use, for this reason the need for safe environment is the utmost importance, the LPG gas leakage monitoring and controlling system which send SMS alert the consumer about gas leakage finds it wide application here, This project propose a design of micro controller based LPG gas control and leakage detection system, the system which detects gas leak, the level of gas and also send information about the gas status to the consumer through SMS alert and signals (LED, Buzzer).

1.2 AIM AND OBJECTIVES

The aim of this project is to design and implement of micro-controller based LPG gas monitoring & leakage detection system with GSM alert system

The specific objectives of this project are to:

1. Design a Microcontroller based LPG gas monitoring and leakage detection system which monitors and detects gas leakage in a cylinder;

2. Design a Microcontroller based LPG gas monitoring and leakage detection system which notify the consumer Using SMS alert notification system about gas level;

3. Design system notify the consumer about the state of the environment using SMS alert notification system (Temperature and humidity); and

4. Evaluate the performance of the developed system.

1.3 STATEMENT OF PROBLEM

Natural gases such as Liquefied Petroleum Gas (LPG) are widely used in the whole world. LPG is used for cooking in home or hotel. It is also used in certain gas based industry. As for now, the use of natural gases instead of petroleum as the alternative for fuel for mobile cars also has been increased. Due to this, there is increase in demand for LPG gas which also increases the rate of fire occurrence (home accident).

Human cannot detect the presence of natural gases as fast as the sensor do. Thus, the use of gas sensing system is hugely needed to give real-time monitoring of the gas system. In certain cases, gas leakage can cause fire that destroys human property; the large scale of fire also could contribute to serious injury or death.

Also the problem of gas finishing without sending any signal to the consumer, the system is design to pre-inform the consumer about the current state or level of the gas.

Therefore, this project shall be able to resolve the problem stated. This is because this project is able to sense the presence of natural gases (LPG) as well as fire. Besides that, it is also capable of sending out an SMS alert automatically to the consumer.

1.4 SCOPE OF THE PROJECT

This project is capable of detecting gas leakage and sending alert via SMS to the consumer, it also helps to monitor the gas level, and this project is limited to domestic usage only. The maximum weight of cylinder the load cell can take is 20kg which can be improve with time.

1.5 SIGNIFICANCE OF STUDY

The use of SMS alert notification for the design and implementation of a Gas leakage detector system using temperature sensors will be beneficial to its users in many ways, some of which are:

1. Quick Awareness of the gas status: The system to be designed will send a SMS alert notification the user about the status of the gas, which will be gotten by the temperature and Gas sensors of the designed system.

2. Overall Control and Mobility: The proposed system will be fully operational from the user's cellular phone.

3. Better Monitoring and Communication: The system to be designed will have the ability of a two way communication between the user and device at any time.

4. The Sensor used in this Project has excellent sensitivity combined with a quick fast response time, the system is highly reliable, tamper-proof and secure. In the long run the maintenance cost is very less when compared to the present systems, It is possible to get instantaneous results and with high accuracy

CHAPTER TWO

2.0 Literature Review

Gas leaks can cause major incidents resulting in both human injuries and financial losses. To avoid such situations, a considerable amount of effort has been devoted to the development of reliable techniques for detecting gas leakage. As knowing about the existence of a leak is not always enough to launch a corrective action, some of the leak detection techniques were designed to allow the possibility of location the leak. The main purpose of this paper is to identify the state-of-the-art in leak detection and localization methods.

To work against the dangerous effects of gas leakage, significant efforts was carried out in manipulative and miniaturizing the gas leak sighting technique. The occurrences of gas leak-related incidents are studied by several researchers and have published statistical data incidents. In 2012, *Somov et al* reported "Energy-Aware Gas Sensing Using Wireless Sensor Networks" focusing on a sensor node, a relay node, a wireless actuator and a network coordinator. The network coordinator is the main unit of the WSN. It supports the network operation by wireless communication based on the IEEE 802.15.4 standard and the ZigBee specifications. 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 modem. In fact, upon receiving the alert message from the sensor node, the network coordinator can perform the first counter action by deactivating the source of gas emission via the actuator.

In (Ya, 2012) their work focused on the intelligent residential burglar alarm, emergency alarm, fire alarm, toxic gas leakage remote automatic sound alarm and remote control system, which is based on single chip computer. The system can perform an automatic alarm, which calls the police hotline number automatically. It can also be a voice alarm and shows alarm occurred address. This intelligent security system can be used to control the electrical power remotely through telephone.

Peijiang and Xuehhua,2014 developed a system namely "Design and Implementation of Remote Monitoring System Based on GSM", which has focused on the wireless monitoring system; a remote monitoring system based on SMS through GSM. The hardware and software architectures of the system are designed. In this system, the remote signal is transmitted through GSM network. The system includes mainly two parts; the monitoring center and the remote monitoring station. The monitoring Centre consists of a computer and a TC35 communication module for GSM. The computer and the TC35 are interfaced by RS232. The remote monitoring station consists of a TC35 communication module for GSM, a MSP430F149 MCU, a display unit, sensors and a data gathering and processing unit. The software for the monitoring center and the remote monitoring station were designed using Visual Basic. A low cost automotive localization system using GPS and GSM-SMS services was proposed by *Lita et al.* It is concerning "A New Approach of Automatic Localization System Using GPS and GSM/GPRS Transmission", which provides the position of the vehicle on the driver's or owner's mobile phone as a short message (SMS).The system can be interconnected with the car alarm 9

In 2011, *Bhattacharjee et al,* designed a system entitled "Design and Development of a Flexible Reliable Smart Gas Detection System". The system composed of three modules; the base station, wireless sensor array and an intelligent wireless alarm unit, which offers high reliability, flexibility and uninterrupted sensing. These are achieved by incorporating various intelligent protocols like auto sensor calibration, sensor handover, wireless threshold fixation and intelligent alarm mechanism. The sensor node consists of three gas sensors, one temperature sensor and one pyro-electric infrared sensor which enhances the sensing intelligence. The sensed data are digitized and processed by the peripheral interface controller (PIC) 16f877A based centralized embedded 8 platform and wireless communication is achieved with a pair of 433 and

315 MHz amplitude shift keying (ASK) wireless module. The encoding and decoding of sensed data offer a high secured gas detection system. System that alerts the owner, on his mobile phone, about the events that occurs with his car when it is parked. The system is composed by a GPS receiver, a microcontroller and a GSM phone. In addition, the system can be settled for acquiring and transmitting the information, whenever requested about automobiles status and alerts the user about the vehicle's started engine. The system can be used as a low cost solution for automobiles position localizing as well as in car tracking system applications. Investigation on vehicle cabin air quality monitoring system with metal oxide semiconductor gas sensor was the breakthrough in this field by *Galatsis et al.* Herein, commercially available gas sensors are compared with the fabricated M0O3 based sensors. The sensor has a response of 74% or higher relative to the host commercial sensor tested. The same authors have also contributed to the added vehicle safety through a vehicle cabin air quality monitor using carbon monoxide (CO) and oxygen (02) gas sensors system designed, developed and on-road tested. The continuous monitoring of oxygen and carbon monoxide provides added vehicle safety as alarm could be set off when dangerous gas concentrations are reached, preventing driver fatigue, and drowsiness and exhaust gas suicides. CO concentrations of 30 ppm and oxygen levels lower than 19.5% were experienced whilst driving. (Fraiwan, Lweesy, Bani-Salma, & Mani, 2011)

(Srivastava, 2011) provides a cost effective and highly accurate system, which not only detects the gas leakage but also alert and turn off the mains power and gas supplies and sends a SMS (Priya). The alerting of gas leakage is through buzzer and SMS. A"WSN based Smart System for Detection of LPG and Combustible Gases" has been proposed by *Hema et al*, which identifies potentially hazardous gas leak within an area by means of various sensors based electronic systems. These systems also employ an audible alarm to alert the people whenever a dangerous gas is detected. These gas 10 detection systems are of immense use because they can be used to detect a wide range of combustible, flammable and toxic gases which have hazardous effects on human health.

"Design Implementation of an Economic Gas Leakage Detector" (A. Mahalingam, 2016) provided a cost effective audio-visual solution for LPG leakage detection in homes and commercial premises and audibly alert the users in case of a hazardous situation and provide warning signals (beeps).

2.1 The Liquefied Petroleum Gas (LPG)

The Liquefied petroleum gas (LPG) has no colour and no smell. The LPG gas liquefies under moderate pressure and vapourize upon discharge of pressure. Therefore, the LPG is stored in liquid form (concentrated). In general, LPG obtained from sanitized crude oil, in this way, it is under pressure form and also from natural gas or crude oil streams. The LPG can be odorized by adding an appropriate odour for the prevention of explosive attacks. The most important property of LPG is that, it is heavier than air. As concentration of LPG increases, it creates hazards to human health. The LPG can be used as a fuel for many sectors, viz. domestic, industrial, cooking processes etc. LPG is also used as a fuel for vehicles. (Elgas Handbook on LPG gas, 2017)

Due to the flammable behavior of LPG gas, out of harm's way handlings of LPG must be useful in the domestic and industrial situations. Its liquid form is very harmful for the skin. Therefore, to avoid the hazards from this, monitoring and controlling of LPG leakage is carried out through this thesis.

2.2 The Fundamentals of Sensors

A sensor is a device which converts physical quantity into electrical quantity. The human body which can't sense any quantity can be done easily by commercial sensors like temperature, humidity, intensity etc. Any input signals given to electronic instruments, detection of it and convert them into appropriate output signal, the sensor does it entirely. Nowadays, sensor becomes omnipresent in our regular routines (Berna, 2010). The properties of sensors are:

i. Convert the non-electrical quantity into electrical quantity

ii. Take action speedily

iii. Function incessantly

iv. Portable.

The most significant uniqueness of a sensor is:

i. The sensitivity

ii. The stability associated with it.

iii. How repeatability it has?

2.3 The importance of gas sensors

In the existing scenario, the gas sensors are leading the way from home monitoring to industry monitoring. The gas sensors are indispensable for various applications such as monitoring of various environmental parameters, detection of toxic gases etc. There are different semiconductor gas sensors available in the market having got outstanding position, seeing that they are speedy, consistent, cost-effective and bare minimum maintenance. Hitherto, ceramic gas sensors were used for detection of gases. The gas sensors are mainly oxidizing and reducing in nature. Whereas oxidizing sensors results in the creation of acceptor states and the reducing sensor results in donor states. The resistive, potentiometric sensors are most sensitive sensors.

2.4 The Necessity for Gas Sensors

The olfactory system of humans is outstanding for the recognition of odors which can be observed merely at towering concentrations or can't detect at all. For the protection of human life, to take preventive measure against the explosive concentration of gases and for poisonous gas applications, a gas sensor is essential for the detection of gas in low concentration range. To prevent the gas leakage that happens at homes, industries etc, detection of various gases at low concentration is possible only due to gas sensors. Hence, gas sensor becomes the part and parcel of today's life. (Gospel, 2010)

2.5 WIRELESS SENSOR NETWORKS (WSN)

Wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions (i.e. temperature, sound, vibration, pressure, humidity, etc.) and to cooperatively pass their data through the network to a main location. The more modern network is bi-directional, also control of sensor activity, enabling.

The WSN is built of few to several hundreds or even thousands of sensors of nodes, where each node is connected to one (or sometimes several) sensors. Each sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source (i.e. battery or an embedded form of energy harvesting). The topology of the WSNs, from a simple star network to an advanced multi-hop wireless mesh network can vary. (W, A, & R, 2006)

The propagation technique between the hops of the network can be routing or flooding. A wireless sensor network is made up of three components: Sensors Nodes, Task Manager Node (User) and Interconnect Backbone, as shown in Figure below

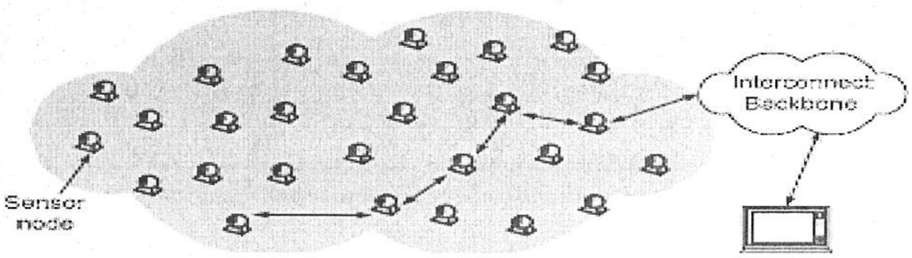

Figure2.1: Showing a Wireless Sensor Network (WSN)

Each Sensor Node can contain various sensors and actuators that are used to collect the data and control physical processes. The collected data is transferred to the User through the network that can include Internet segments. Besides collecting the data and controlling actuators, a node may need to perform some computation on the measured data. Direct communication between individual nodes can also be required. The Task Manager Node (User) performs tasks in data storage, analysis and display (Song ., 2005).

2.5.1 WSN Requirements and Challenges

It must support the following requirements in deployment: scalability, reliability, responsiveness, mobility, and power efficiency. The description of these:

i. Reliability- The ability of the network for reliable data transmission in a state of continuous change of network structure.

ii. Scalability- It is the ability of the network to grow without excessive overhead

iii. Responsiveness - The ability of the network to quickly adapt itself to changes in topology.

iv. Mobility- It is the ability of the network to handle mobile nodes and changeable data paths.

2.5.2 Characteristics of WSNs

The important characteristics of WSNs are:

i. Less power consumption

ii. Ability to cope with node failures

iii. Mobility of nodes

iv. Communication failures

v. Heterogeneity of nodes

vi. Usability in large scale

vii. Withstand in unfavorable environmental conditions

viii. Ease of use

2.5.3 Network Management

Network management is the process of managing, monitoring, and controlling the behavior of a network. Different approaches for network management are given below:

In this section we classify existing sensor network management systems in terms of the functionality they provide. Systems for sensor networks that are based on traditional network management systems include BOSS (Song *et al.*, 2005) and MANNA (Ruiz L.B., 2004) BOSS serves as a mediator between Up nP networks and sensor nodes. MANNA provides a general framework for policy-based management of sensor networks. SNMP (Deb *et al.,* 2005) provides network topology extraction algorithms for retrieving network state.

Other researchers have designed novel routing Protocols for network management. For example, Top Disc (Deb *et al.*, 2001) and STREAM (Deb *et al.,* 2004) are used in SNMP for extracting network topology, RRP ` uses a zone-flooding protocol, SNMS (Tolle G., 2005) introduces the Drip protocol, and Win MS (Louis *et al.*, 2006) is based on the Flexi MAC protocol. Fault detection is an important focus of the systems TP , Sympathy (Ramanathan *et al.,* 2005), MANNA (Ruiz *et al.,* 2004), and Win MS (Louis *et al.,* 2006). In these systems the central server analyses data collected from the network. The main disadvantage of such passive monitoring schemes is that they are not adaptive to current network conditions, and provides no self-configuration in the event of faults. The end user must manually manage the network and interpret the graphical representation of collected data.

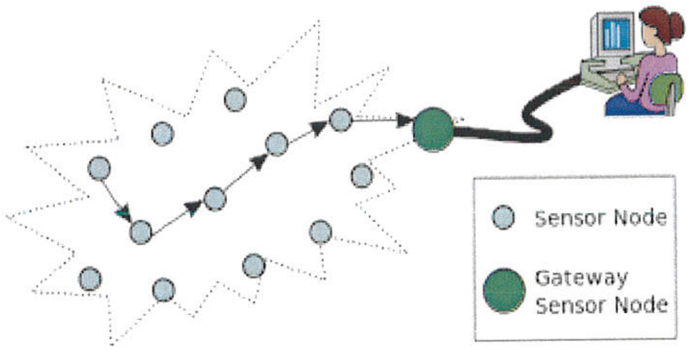

Figure 2.2: Showing sensor and gateway sensor node

2.2 Applications of Wireless Sensor Networks (WSNs)

1. Area monitoring

In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. In military, it is the used for detects enemy intrusion; a civilian example is the geo-fencing of gas or oil pipelines.

2. Environmental/Earth monitoring

The term Environmental Sensor Networks has evolved to cover many applications of WSNs to earth science research including sensing volcanoes, oceans, glaciers, forests etc. Some examples of major areas listed below.

a. Air quality monitoring: In dangerous surroundings, real time monitoring of harmful gases is a concerning process. Wireless sensor networks have been launched to produce specific solutions for people.

b. Interior monitoring: Wireless internal monitoring solutions provide tabs for large areas as well as ensure the precise gas concentration degree.

c. Exterior monitoring: External aerial quality monitoring needs the use of precise wireless sensors, rain & wind resistant solutions as well as energy reaping methods to assure extensive liberty to machine that will likely have tough access.

d. Air pollution monitoring: Wireless sensor networks have been deployed in several cities to monitor the concentration of dangerous gases for citizens. There are various architectures that can be used for such applications as well as different kinds of data analysis and data mining that can be conducted.

e. Forest fire detection: A network of Sensor Nodes can be installed in a forest to detect when a fire has started. The early detection is crucial for a successful action of the firefighters.

f. Landslide detection: It is used for wireless sensor network to detect the slight movements of soil and changes in various parameters that may occur before or during a land slide.

g. Water quality monitoring: The distribution of wireless sensors enables the creation of a more accurate map of the water status, and allows the permanent deployment of monitoring stations in locations of difficult access, without the need of manual data retrieval.

h. Natural disaster prevention: It is used to prevent the consequences of natural disasters, like floods.

3. Industrial monitoring

a) Machine health monitoring: WSNs have been used for machinery condition-based maintenance (CBM) as they offer significant cost savings and enable new functionality.

b) Industrial and control applications: The new aspects are considered as an enabler for future applications in industrial and related wireless sense and control applications, and partially replacing or enhancing conventional wire-based networks by WSN techniques.

c) Water/Waste water monitoring: The area of water quality monitoring utilizes wireless sensor networks and many manufacturers have launched fresh and advanced applications for the purpose.

d) Water distribution network management: Water distribution network sensors are used by manufacturers to concentrate on observing the water management structures such as valve and pipes and also making remote access to water meter readings.

4. Greenhouses

The temperature and humidity levels in greenhouses are controlled by WSNs.

5. Passive localization and tracking

The application of WSN to the passive localization and tracking of non-cooperative targets (i.e., people not wearing any tag) has been proposed by exploiting the pervasive and low-cost nature of such technology.

6. Smart home monitoring

Smart home activities are detected using wireless sensors embedded within everyday objects forming a WSN.

2.5.5 Relationship between Existing Remote Monitoring and Control Systems

The relationships that exist between some of the existing remote monitoring and control systems are highlighted in table 1.1

Table 2.1: Existing Remote Monitoring and Control Systems

Technology	**Monitoring System**	**Module Interfaced**	**Processor used**	**Sensor Interfaced**
Zigbee, internet	Laptop	-	89C52	Moisture sensor
Zigbee, GPRS	Mobile	JN5121	ARM9	Soil moisture/temperature
RF	LCD	CC1110	8051	
Zigbee, internet	Laptop, PDA	CC2420	MSP430	Temperature/humidity/illumination
GSM, RFID	-	-	-	Camera nodes, cattle sensor network, soil moisture.
RF, internet	Laptop, PDA	C43271	C43271 Psoc	Touch, temperature, moisture, light
Single sensor node	-	-	89C52	Temperature/humidity/PH
Zigbee	PC	nRF905	89C51	Temperature/humidity
Zigbee	TFT-LCD	nRF905	MCF52235	Temperature/humidity
Zigbee, internet	PC	Zigbee module 3160	SPCE061A	Temperature/humidity/soil temperature/ soil moisture/co2/ illumination

Zigbee, internet	Laptop, PDA	MSENS SoC	MSENS SoC	Air Temperature/humidity/ soil temperature/soilmoisture /anemometer /radiometer /raingauge/ CMOSimage
Zigbee, internet	PDA	Zigbee transceiver	8-bit MCU	Light/ temperature / humidity
Zigbee, internet	PDA	JN5121 with on chip 32 bit core	JN5121 with on chip 32 bit core	Light/ temperature / humidity/ wind speed

2.6 GAS SENSORS

Gas sensor is a device that can change the concentration of an analyte gas into an electronic or electrical signal. A gas sensor is a chemical sensor that is operated in the gas phase. It is an important component of devices commonly known as electric nose

A gas sensor must possess at least two functions: (i) to recognize a particular gas and (ii) convert the output into measurable sensing signals. The gas recognition is carried out through the surface chemical processes due to gas-solid interactions. These interactions may be in the form of adsorption, or chemical reactions. Most of the gas sensors give an electrical output, measuring the change of current or resistance or capacitance.

The given signal can be related to the chemical environment it is exposed to. The Response of a gas sensor to a single gas can be described as:

$$X = f_{gas}\,(c_{gas})$$

Where $fgas$ is a function (usually non-linear) and $cgas$, the concentration of the gas.

The response is in most cases defined as the difference or ratio between the steady-state sensor response when exposed to the sample gas and the sensor response when exposed to a reference atmosphere (not sample gas). The concentration-response relationship for most gas sensors approximately exhibits either saturated linear behavior, i.e. linear for low concentrations and saturated for higher concentrations, or logarithmic behavior. Three important parameters when describing the response of a sensor are sensitivity; selectivity and stability. The sensitivity of the sensor towards a specific gas is, thus, defined as

$$\gamma = \frac{\partial x}{\partial cgas} \ldots\ldots 2.1$$

The selectivity (E) of a single sensor is usually defined as the ratio of the sensitivity related to the gas concentration to be monitored in the linear region and the maximal sensitivity to all other interfering components. It is given by

$$E = \frac{\gamma}{Max(\gamma)allgases} \ldots\ldots 2.2$$

The stability of the sensor response is defined as the reproducibility of the sensitivity and selectivity as a function of time.

Most of the drawbacks of the commonly used gas sensing technologies come from their lack of stability. There are other demands to be met when producing gas sensors, such as short response time, good reversibility, low cost, small size and low power consumptions. When a sensing material is exposed to gas, then it interacts with the gas, this interaction may be by adsorption or desorption, chemical reactions on the surface or the bulk of the material. The interaction changes some physical properties of the sensing material, such as the electrical conductivity or the mass.

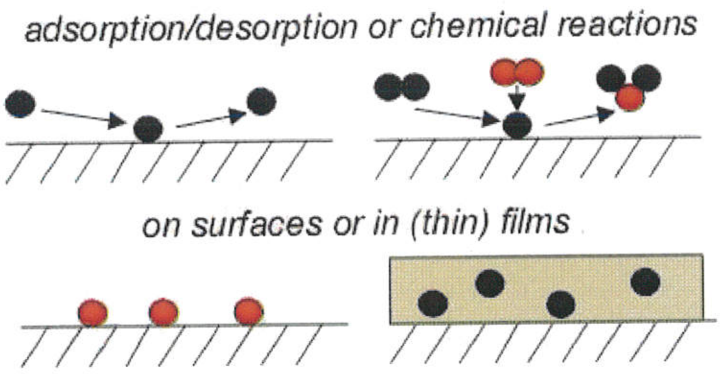

Figure 2.3: Principle of Solid-State Gas sensor

The change in conductivity is detected by the voltage drop over a series resistor or a change in mass is detected by the shift in frequency of a resonator. A schematic description of the working principles of Solid-state gas sensors is depicted in Figure below

2.6.1 Need for Gas Sensors

A numerous luxury items have been brought by today's society but with them series of problems like air pollution and emission of toxic gases have also been introduced to our society. The necessity to constantly monitor and control the gases emitted, sprouted the need for gas sensors. The various uses of gas sensors vary across a wide range from industrial to domestic applications; for example monitoring air pollution, chemical processes and exhaust from combustion engines. In recent years, several types of gases have been used in different areas of industries as raw materials. It becomes really important to control and monitor these gases, as there is a huge risk of damage to property and human lives if a leak occurs. Certain gases are corrosive, explosive or can be toxic for human beings.

Currently, there are three categories in which gas monitoring is needed:

i. For oxygen (O_2), in connection with the monitoring of breathable atmospheres and for the control of combustion.

ii. For flammable gases in air, in order to protect against the unwanted occurrences of fire or explosive limit, which is up to a few percent for most gases.

iii. For toxic gases in air, where the need is to monitor concentrations around the exposure limits which range from less than 1 ppm to several hundreds of ppm.

Therefore, we require gas sensors that can detect these gases continuously and effectively to avoid most of the problems. The increasing demand is for better gas sensors with higher sensitivity and greater selectivity. Intense efforts are being made to find more suitable materials with the required surface and bulk properties for the use as gas sensors. Among the gaseous species to be observed are carbon monoxide (CO), carbon dioxide (CO_2), nitric oxide (NO), nitrogen dioxide (NO_2), hydrogen sulfide (H_2S), sulfur dioxide (SO_2), ozone (O_3), ammonia (NH_3), and organic gases such as methane (CH_4), propane (C_3H_8), liquid petroleum gas (LPG), and many others. (Kousuke & Joseph, 2017)

2.6.2 Sensing Materials

A large number of different materials have their physical properties modified after interaction with a chemical environment such as ionic compounds (metal oxides), metals, polymers and supramolecular structures. Properties of the sensing materials, such as molecular size, polarity, polarizability, and affinity, along with the matching characteristics of the sensing material, govern the interaction.

Two main types of interaction between the presence of gas and the sensing Material are:

i. Lock-and-key-type interaction, which usually consists of organic materials. They can be arranged either as a monolayer of the recognition molecules or as specific recognition sites in a polymeric matrix (Gospel, 2010). Typical materials employed are cagelike molecules such as calixarenes .

ii. Chemical sensing with inorganic materials. Reactions at the surface and/or in the sensing material may lead to chemisorptions or catalytic reactions between the molecules present.

Thus, the charge distribution, the carrier concentration or mobility in the sensing material might change. Hydrocarbon gases are being used as fuel for domestic and industrial purposes. Domestic liquefied petroleum gas (LPG) and CO are combustible gases. They are potentially hazardous; increasing usage of liquefied petroleum gas (LPG) has increased the frequency of accidental explosions due to leakage. The toxic hazardous gases combine with hemoglobin very quickly and results in human death. People have been trying to detect them in its early stages to give alarm and perform effective suppression. Thus the requirements for reliable and sensitive gas detecting instruments have increased for safety at home and industry. Most of previous researches were focused on propane or butane gas sensor but little work has been done on LPG sensor. From the literature, it is inferred that presently available sensors have two major shortcomings, one, low sensitivity and two, its operation at a high temperature. One has to compromise with either the sensitivity or the operating temperature. A highly sensitive sensor mostly works at a very high operating temperature thus increasing the power consumption. On the other hand, other sensors which operate at low temperature are not sensitive enough for trace level detection of LPG . To improve this problem, some researchers paid attention to the study of signal analysis. Many reports showed that it was possible to Discriminate gases by evaluating the sensor response features.

2.6.3 Liquefied Petroleum Gas (LPG)

LPG is the abbreviation of Liquefied Petroleum Gas. Like all fossil fuels, it is a non-renewable source of energy. The main components of LPG are Propane (C3H8) and Butane (C4H10), which can be stored separately or as a mixture. LPG may contain components other than hydrocarbons depending upon the source of LPG and its method of production. It may contain components other than hydrocarbons. LPG is a gas at atmospheric pressure and normal ambient temperatures, but it can be liquefied when moderate pressure is applied or when temperature is sufficiently reduced. Due to these properties (Elgas Handbook on LPG gas, 2017), LPG can be easily condensed, packaged, stored and utilized, which makes it an ideal energy source for a wide range of applications.

There are two main sources of LPG, namely:

(i) Wet natural gas

(ii) Refinery operations

LPG prepared from wet natural gas consists entirely of saturated hydrocarbons, i.e. propane and butane. LPG produced by both cracking and reforming processes will have, in addition to saturated hydrocarbons, some quantities of unsaturated hydrocarbons also (i.e. propylene and butylene). LPG produced will have impurities like moisture and Sulphur compounds like hydrogen sulphied and mercaptans. Moisture may lead to clogging of regulators; valves etc. and Sulphur compounds cause corrosion. Moisture and Sulphur compounds are, therefore removed by suitable treatment at the refinery.

LPG is widely used in the food industry for domestic (cooking) purpose. It can be used in glass and ceramic industry as fuel like LPG can enhances the product quality thereby reducing the technical problems in manufacturing. LPG is used in metal industries basically for cutting, heating and melting processes also in agro industries for horticultural, agricultural, heating and drying processes. LPG can be used as an automotive fuel or as a propellant for aerosols, in addition to other specialist applications.

Over the past few decades, the solid state gas sensor based on stannic oxide (also known as tin dioxide or tin IV oxide) has become the predominant solid state device for gas alarms used on domestic, commercial and industrial premises. This is because it is perceived loas a long lived, low cost sensor which requires only minimal and therefore, reliable electronics, so that little or no maintenance is involved.

However, the principle behind its operation are by no means simple and basic understanding of them can lead to much enhanced methods of utilization. The present book has, therefore, been designed to offer a comprehensive account of these principles, but largely qualitative terms, along with details of various methods of fabrication, and both have been related to observe characteristic. (Kousuke & Joseph, 2017)

This section reviews some types of gas sensor based on the principle they work on

2.6.4 Electrochemical Gas sensor

Electrochemical gas detector work by allowing gases to diffuse through a porous membrane to an electrode where it is either chemically oxidized or reduced. The amount of current produced is determined by how much gas is oxidized at the electrode, indicating the concentration of gas.

2.6.5 Catalytic Bead sensor (pellistor)

Catalytic bead sensor are commonly used to measure combustible gases that present an explosion hazard when concentration are between the lower explosion limit (LEL) and upper explosion limits (UEL).

2.6.6 Photoionization

Photoionization detector (PIDs) use a high photon-energy UV lamp to ionize chemical in the sampled gas. If the compound has an ionization energy below that of lamp photos, an electron will be ejected and resulting current is proportional to the concentration of the compound.

2.6.7 Infrared point

Infrared (IR) point sensors use radiation passing through a volume of gas; energy from sensor beam is absorbed at certain wavelengths, depending on the properties of the specific gas. For example, carbon monoxide absorbs wavelength of about 4.2-4.5 um.

2.6.8 Semiconductor

Semiconductor sensor detects gases by a chemical reaction that takes place when the gas come in direct contact with the sensor. Tin dioxide is the most common material used in semiconductor sensor and the electrical resistance in the sensor is decreased when it come in contact with the monitored gas. The most common used gas sensor domestically included MQ2, MQ3, MQ4, MQ5, MQ135, MQ138 etc.

2.7 GSM TECHNOLOGY

GSM (Global System for Mobile communications) is a digital cellular technology used for transmitting mobile voice and data services which is developed by Group special mobile (founded 1982) which was an initiative of CEPT (conference of European post and telecommunication). GSM provide data transfer speeds around 9.6 Kbit/s, allowing the transmission of basic data services such as SMS (Short Message Service). Another major advantage is its international roaming capability, allowing the users to access the same services even when travelling abroad.

This gives consumers to have the same number connectivity in more than 210 countries. GSM satellite roaming has also widened its service access to areas where terrestrial coverage is not available. GSM-1800 is used to send information from the Mobile Station to the Base Transceiver Station (uplink) and 1805 - 1880 MHz for the other direction (downlink), providing 374 channels (channel numbers 512 to 885) and duplex spacing is 95 MHz. GSM gives worldwide connectivity, transmission quality, high reliability, uninterrupted phone call. It uses encryption and TMSI instead of IMSI. SIM is provided with 4-8 digits PIN to validate the ownership of SIM. (W, A, & R, 2006)

2.7.1 GSM Applications in Various Fields

1. City Area Monitoring System

The city area monitoring system allows a home owner or the particular area monitor to tenuously monitor the various significant home sensor conditions as well as those are tied to flooding, fire, and gas leaks to detecting burglars in their starting stages and alert the people about the sudden events.

Home owners or the particular area monitors can monitor their homes or the particular location via their mobile phone or by using the Internet. This system can also be used in alerting the people about the security firms, defense organizations and municipalities to constantly monitoring and locating the little spots in suburban neighborhoods and compounds using web based free GIS Maps application. This system can play a vital role in monitoring the house through detectors, detecting any abnormal event, alerting home owner through SMS when the event occurs, notifying security service providers or the Civil Defense Department/Security firm with the emergency and its type so they can take immediate action.

2. **GSM Based Health Monitoring System** The movement of physically handicapped or aged

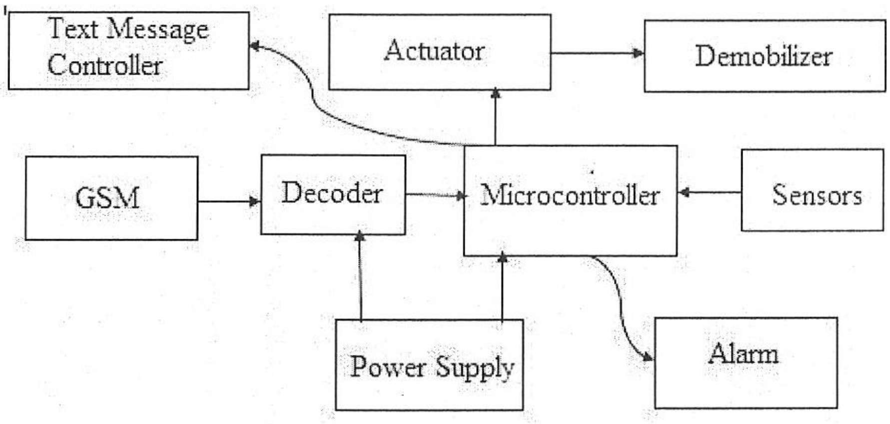

Figure 2.4: Showing Block Diagram of a GSM Based Health Monitoring System

people and the people suffering from some severe diseases are usually restricted to their homes, because of their health conditions. They are kept into helpless situation when they need to go out even for small work (Lai et al., 2009). Here there is another example for monitoring patients remotely using GSM network & Very large Scale integration (VLSI) technique. The System continuously monitor the health conditions and send the information regularly to the hospital as shown in Figure 2.2 below (Lai *et al.,* 2009). The abnormal deviation in the set values of any of these parameters will be immediately sensed and local help is sought from the nearby people. It is a bi directional communication system in which the Doctor/care taker, at any time, can send SMS to know the present parameter status of the person or patient. It enables the doctors to monitor patient's parameters (heartbeat, ECG, body temperature) in real time through an SMS.

3. Antitheft Security System Using GSM

This system utilizes an embedded system design with Dual Tone Multi Frequency (DTMF) and a GSM to monitor and safeguard a car. In a situation where there is high level of theft, there is serious requirement of better security system which does not put human life to risk (Manjula *et al.*, 2009). This tends to utilize the availability of GSM technology to accomplish this purpose. By simply dialing the number of the mobile phone attached to the circuit and sending a code after the phone has automatically been answered, puts the system to either "active or " state. In case of any theft attempt, the system is automatically switched off and an alert message is send to the owner. Hence the car will always remain protected. The absence of security personnel in a packed car is a great discomfort to car owners. Thus in order to enhance an improved and life risk free security system we use this technology , here the purpose is to aid a better security system of cars with the use of GSM. Hence this system monitors one's car against theft, and sends the text message to the car owner, indicating him that his car is being tampered. The system will also stop the car (that is stopping the car from moving) and set up an alarm for the people around to notice what is happening.

2.8 RELATED WORKS

In the process of developing an automated wirelessly monitored detection system, several methods were followed.

2.8.1 Remote Monitoring using GSM

The subscriber or user sends activation command to the system via SMS. The system (Deepak *et al.*, 2015) will check the moisture level and if it is less than the prescribed level, the system will start the motor. While the motor is running, the system will monitor the soil moisture and water level constantly.

If the Gas level reaches the sufficient level, the motor will be turned off. The corresponding event of the operation of motor is notified to the user using SMS. This motor is controlled by a starter which is indirectly activated by a relay circuit. Using GSM technique, an automated remote monitored detection system is provided. The system sets the time period depending on the temperature and humidity of the environment. The humidity and temperature level of kitchens varies.

2.8.2 Monitoring using fuzzy controller

The system (Liai *et al.,* 2013) consists of two units, WSN and a monitoring center. Nodes in the monitoring area collect information of the kitchen environment using solar power. Wireless Sensor Network (WSN) contains many sensor nodes and controller nodes. The data sensed from the WSN is given as inputs to the monitoring center which in turn gives the information about the irrigation, demand of the water level and control over the opening or closing of the valves. ZigBee network in a mesh network topology is used to meet the network coverage and reduce the energy consumption and the cost. Some of the nodes are assigned as routers and coordinators. Sensor nodes sense the temperature and humidity whereas the routing nodes route the communication information and forwarding the data to the relevant nodes and the coordinator node receives data from the routing nodes and sent it to host computer monitoring center through RS232 serial bus.

2.8.3 Monitoring using humidity sensors

For measuring the humidity value of a region, SY-HS-220 humidity sensor (Nilesh *et al.,* 2013) is used. It works on the operating temperature range of 0 – 60°C. Temperature value is sensed by the sensor LM35IC in which the output voltage is linearly proportional to the Celsius temperature. TinyOS (Alagupandi *et al.,* 2014) is an open source component based low power operating system which is designed only for embedded system application. TinyOS based IRIS motes is used to measure the moisture level of paddy field and MD100CB sensor motes are used to reduce the number of motes used. Also in irrigation system using a micro controller, A low cost soil moisture sensor is used to control water supply in water deficient areas. The sensor communicates the information via XBEE wireless communication module to a centralized server.

2.8.4. Weather Monitoring System using Microcontroller

The measurement of temperature and humidity remotely by using the sensor is not only important in environment monitoring but also crucial for many other applications such as industrial processes. A device for real time weather monitoring is presented in this paper to monitor the temperature and relative humidity of the atmosphere via GSM network, using analog and digital component. The sensor output will be given to the ADC. The microcontroller will read the ADC output and display the parameter value on the LCD. An LCD display is also connected to the microcontroller to display the measurement. For analysis and achieving purposes,. (Karishma Patil1 *et al.,* 2016)

2.8.5. Design and Implementation of Automated gas detection system using ZIGBEE and GSM

Automated gas detection system using ZIGBEE and GSM for domestics use. In these system use the Wireless Technology. The system has represented the wireless sensor network of temperature and humidity sensor of the environment. In traditional approach to measure these factors in a domestic environment meant individuals manually taking measurements and checking them at various times. This paper includes the monitoring of the system using ZigBee and GSM

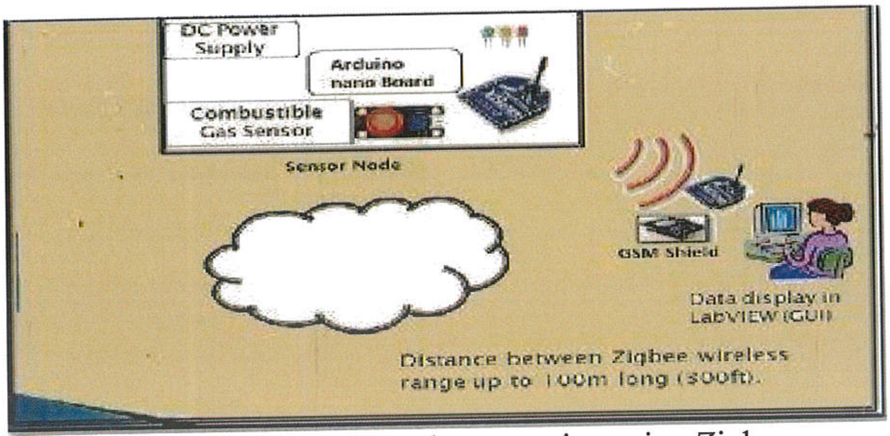

Figure 2.5: Network connection using Zigbee

2.8.6 Design of Remote Monitoring and Control System with Automatic Gas detection System using GSM-Bluetooth

Design of an economical and generic automatic gas detection system based on wireless sensors with GSM-Bluetooth for detection system controller and remote monitoring system. This system has simpler features designed with the objective of low cost and effective with less power consumption using sensors for remote monitoring and controlling devices which are controlled via SMS using a GSM module. A Bluetooth module is also interfaced with the main microcontroller chip. This Bluetooth module eliminates the usage charges by communicating with the appliances via Bluetooth when the application is in a limited range of few meters. The system informs user about any abnormal conditions like gas leakage and temperature rise, even concentration of CO_2 via SMS from the GSM module or by Bluetooth module to the consumer's mobile and actions are taken accordingly by the farmer. In future, the consumer will be able to monitor and control the parameter by GSM and Bluetooth technologies. (S.R.N. Redd 2012)

Table 2.2: Summary of Related Work and Limitations

Name &Year	Topic	Limitation
Ankit Sood, Babalu Sonkar, Atul Ranjan, MR.Ameer Faisal (2015)	Microcontroller Based LPG gas leakage Detector using GSM Module.	1. Reduces the creation of employment. 2. Can only be monitored using wireless technology
Muhammad Yahya Hamdzani (2013)	Gas leakage and fire alert warning system via GSM	Ones these factors reaches its critical level, the device alerts the user but the actuator can be on only manually
Karishma Patil, Mansi Mhatre, Rashmi Govilkar,Shraddha Rokade, Prof.Gaurav Gawas (2016)	Weather Monitoring System using Microcontroller	1. If we want continuous monitoring of required parameter then we have to keep pc on at receiver that will increase the power consumption. 2. Less Secured. 3. Limited Communication range 4. Low data rate.
S.R.N. Redd 2012	Design of Remote Monitoring and Control System with Automatic System using GSM-Bluetooth	The consumer cant request for the status of the consumer, Only gets info via SMS or Bluetooth when an

		abnormal situations like high temperature.
Lutful et al., 2013	Remote Monitoring Using Sensors	Does not include the use of GSM module, and might lead to fire outbreak
Nilesh R. Patel, Rahul B. Lanjewar, Swarup S. Mathrukar, Ashwin A. Bhandekar (2013).	Monitoring using humidity sensors	
Deepak Dharrao, Laxman Kolape, Sanjeet Pawar and Aniket Patange (2015)	Remote Monitoring using GSM	1. The status of the kitchen can only been known when the user requests for it. 2. The critical level can only been know when a request for the status is made
Mrs Pushpalatha O, Mr. Sampath. K.Airani, Mr. Darshan(2015)	Smart gas LPG monitoring system	

CHAPTER THREE

3.0 DESIGN METHODOLOGY

3.1 AN OVERVIEW OF THE PROPOSED SYSTEM

The System is built around three sensor modules, and will be programmed to read in data from a monitoring device that will be attached to the sensors. The figure 3.1 shows the block diagram of the proposed system. The system will use hardware components, as well as software, thereby making it an embedded system. The hardware components are Gas sensor (MQ-5) module, Temperature Sensor, Load cells, LCD (Liquid display crystal) LED (light emitting diode), an actuator, a Microcontroller, monitoring device. In addition we will use a GSM Module to send SMS alert notification to the user.

The Gas sensor module (MQ-5) will be used to detected gas leakage while DHT11 sensor will be used to determine the temperature and the humidity of the environment at that particular time , the load cells are used to measure constantly the weight of the cylinder, buzzer, LED, the LCD displays necessary information about the system, the buzzer and LED are signal or alarm components, the actuator is used to shut off the gas pipe when there is leakage, the Microcontroller will serve as the master control for the entire system, and the monitoring device will record the status of the system from gas sensor and temperature sensor. The present status of the environment is known through the monitoring device will be sent through the GSM Module to the consumer mobile phone.

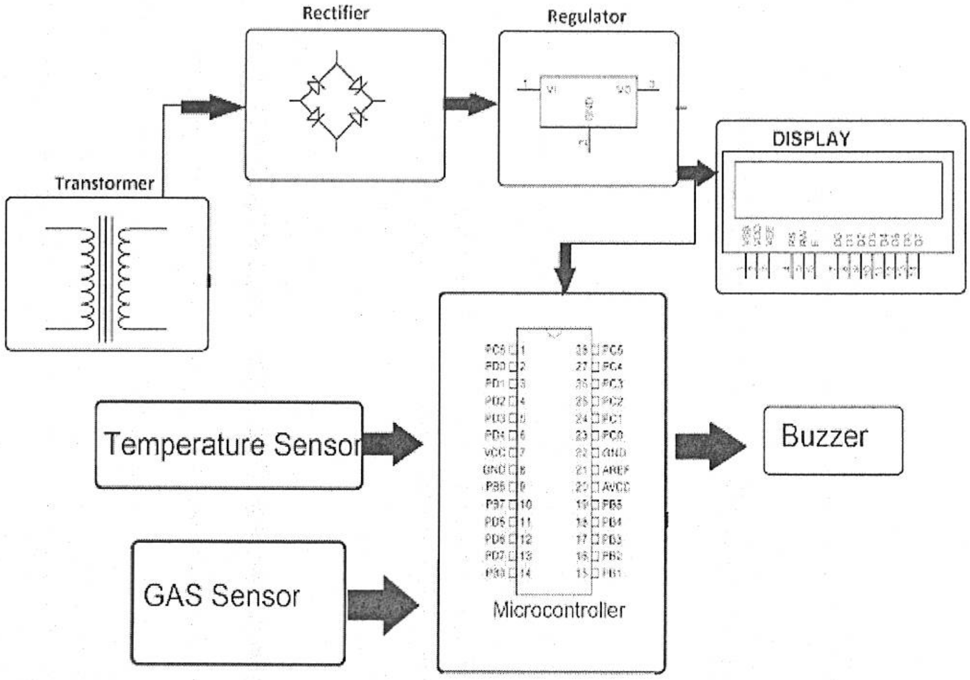

Figure 3.1 Showing Block diagram for the proposed automatic gas detection

3.2 COMPLETE SYSTEM DESIGN

Proteus simulation application is used for the circuit design (see Figure 3.2), the success or failure of the SMS to the mobile phone will be indicated by the DC motor; The GSM module will have two of its pins connected to the pin 2 and 3, the gas sensor has three pins with one of its connected to pin 17 and the other two connected to the temperature and humidity sensor, the weight sensor (load cell) has four pins with two connected to pin 15 and 16 of the ATmega 328 microcontroller, the temperature sensor has three pins two are connected to the gas and weight sensor while one of it is connected to pin 23; the function of the LCD is to display the status of the notification system. In addition to the major components of the notification system (buzzer and LED), other components such as resistors, capacitors, oscillator, transistor, etc. have been added to the circuit diagram to make the system function effectively. The LCD is connected to microcontroller which is configured as an output port. Port C configured as an output port sends signals to the GSM module. When the microcontroller receive the analog signal from the gas sensor, (measured in volts) it processes the signal and converts it to a digital signal using its ADC so that the status of the gas leakage can be shown in ppm. Based on the program of the microcontroller the GSM module and the LCD are activated. The program was written in embedded C programming language and burnt into the microcontroller

In this system the maximum load the load cell (weight sensor) can take is 20kg, the system is designed in such a way that you have to calibrate the system after powered with a known weight body or object, then you set the min weight and max weight with the max temperature, if the temperature or weight exceed the threshold pre-set value the alarming system goes on and the system send an alert SMS to the consumer phone then the solenoid valve off the gas pipe.

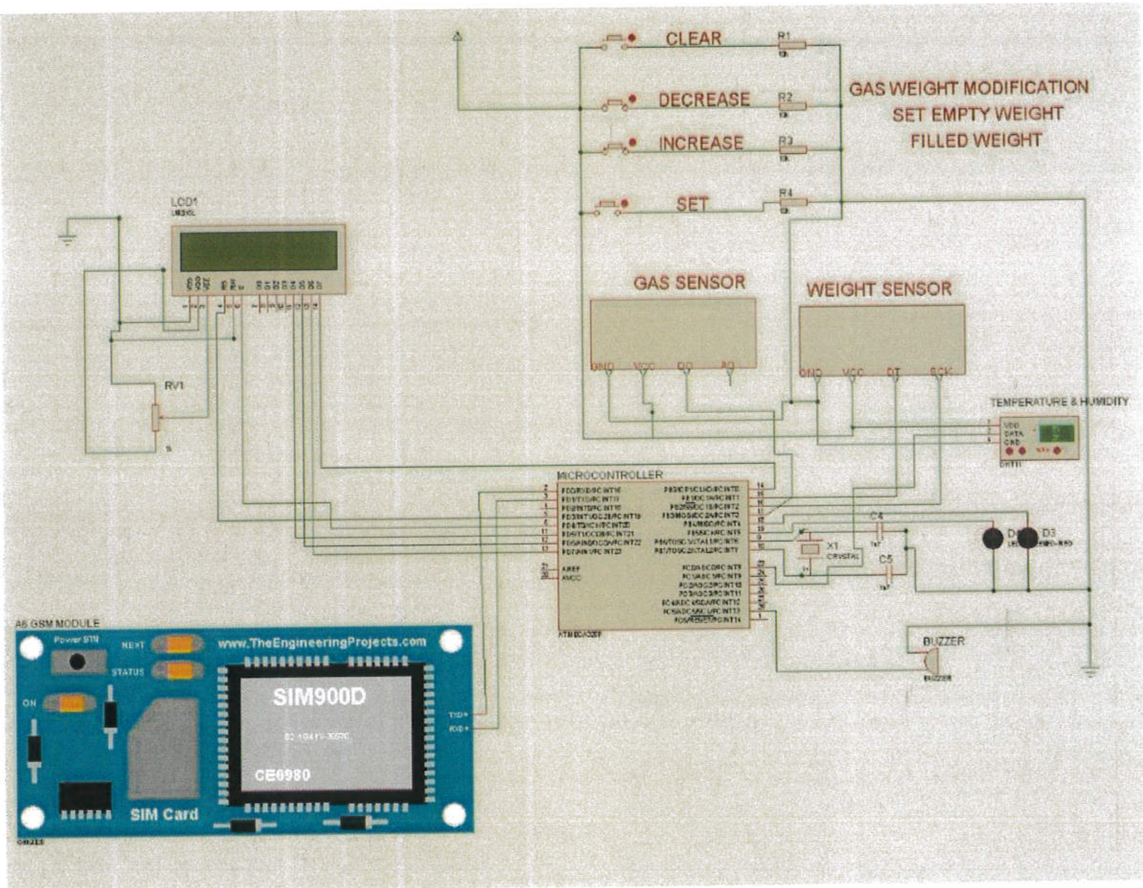

Figure 3.2: Showing the Proposed circuit diagram of the system

3.3 SENSORS

Sensors are used to obtain the required information about the environment (kitchen) like increase in temperature, leakage of gas and when the gas is finished. For this project, the sensors discussed below will be used.

3.3.1 MQ-5 GAS SENSOR

MQ-5 gas sensor (Fig 3.3) module is useful for gas leakage detection (in home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol. Due to its high sensitivity and fast response time measurements can be taken as soon as possible. The sensitivity of the sensor can be adjusted by using the potentiometer. Sensitive material SnO2, which with lower conductivity in clean air. When the target combustible gas exist, the sensor conductivity is more higher along with the gas concentration rising.

MQ-5 gas sensor has high sensitivity to methane, propane and butane and could be used to detect both methane and propane. The sensor could be used to detect different combustible gas especially Methane. It with low cost and suitable application.

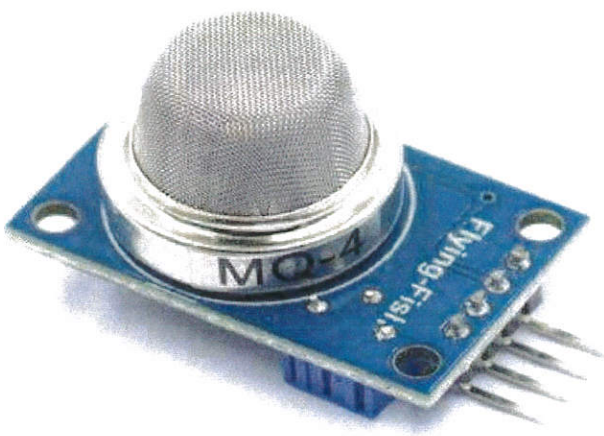

Figure 3.3: MQ-5 Gas sensor

3.3.2 WEIGHT SENSOR (LOAD CELLS)

A load cell is transducer that is used to create an electrical directly proportional to the force being measured. Most load cells use a strain gauge to detect measurements, load cells are highly accurate transducers which provides the user with information they are design to sense force or weight under a wide range of adverse condition. The load cell constantly measures the weight of the gas cylinder.

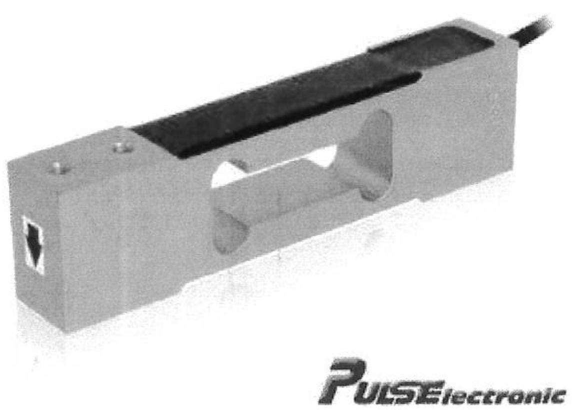

Figure 3.4: Weight sensor (Load cell)

3.3.3 DHT11 SENSOR MODULE

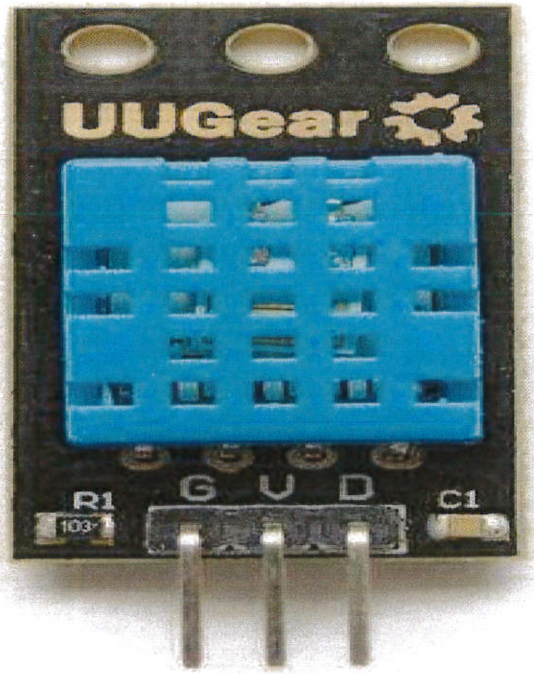

Figure 3.5: Showing a DHT 11 sensor module

The DHT11 sensor module is a humidity and temperature sensor module. This module integrates DHT11 sensor and other required components on a small PCB. The DHT11 sensor includes a resistive-type humidity measurement component, an NTC temperature measurement component and a high-performance 8-bit microcontroller inside, and provides calibrated digital signal output. It has high reliability and excellent long-term stability, thanks to the exclusive digital signal acquisition and temperature and humidity sensing technology. This sensor uses a 3.3V - 5.5V DC supply, measures humidity between the range 20% – 90% humidity, and measures temperature between 0 – 50°C .

3.3.4 SOLENOID VALVE

A solenoid valve is an electromechanical device in which the solenoid uses an electric current to generate magnetic field and thereby operate a mechanism which regulate the opening of the gas in a valve. When there is leakage of gas the gas detector detects that and sends

Figure 3.6: Solenoid valve

information to the microcontroller which send instruction to the solenoid valve to close the gas pipe to avoid more gas leakage.

3.4 POWER SUPPLY

A power source is a device which delivers an exact voltage to another device as per its needs. Power sources, which are sometimes called power adapters, are available in various voltages, and they have varying current capacities, which is the maximum capacity of a power supply to deliver current to a load. For this project, a 5V power source will be required, as the sensors require a 5V DC to work *(Instructables, 2018)*. This power source will convert a 110/240V AC into 5V DC. The power unit is developed following this stages;

3.4.1 STEP DOWN STAGE

Alternate Current Input Coming from the wall, the AC alternates from a minimum to a

Maximum voltage at a frequency of 50Hz between the ranges of 220 – 240 volts (in

Nigeria and other 60Hz countries) is step down through the use of step down transformer To about 22 -24 volts.

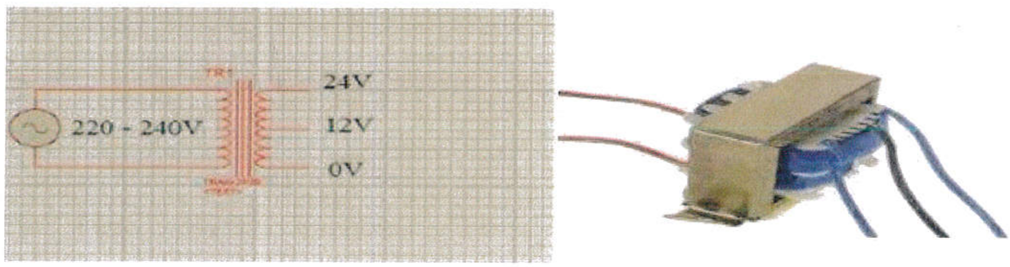

Figure 3.7: Showing Step down transformer

3.4.2 RECTIFICATION

Rectification is the conversion of alternating current (AC) to direct current (DC). This involves a device that only allows one-way flow of electrons. As we have seen, this is exactly what a semiconductor diode does. The simplest kind of rectifier circuit is the half wave rectifier. It only allows one half of an AC waveform to pass through to the load. For most power applications, half-wave rectification is insufficient for the task. The harmonic content of the rectifier's output waveform is very large and consequently difficult to filter. Furthermore, the AC power source only supplies power to the load one half every full cycle, meaning that half of its capacity is unused. There is a need to rectify AC power to obtain the full use of both half-cycles of the sine wave, a different rectifier circuit configuration is used which is a circuit is called a full-wave rectifier this is shown in figure

3.4.3 SMOOTHING

Now we have at least consistently positive voltage levels, but they still dip down to zero 120 times per second. A large capacitor, which can be thought of like a battery over very short time periods, is installed across the circuit to even out these rapid fluctuations in power. The capacitor charges when the voltage is high and discharges as the voltage is low.

3.4.4 REGULATION

In this stage the smoothed voltage is then controlled to maintain a constant range. For this project I utilize two voltage regulator LM7805 and LM7812 which are to regulate the voltage to 5V and 12V respectively.

i. 5V to power the micro controller, light emitting diodes (LED), Liquid crystal display (LCD).
ii. 12V to power the relay

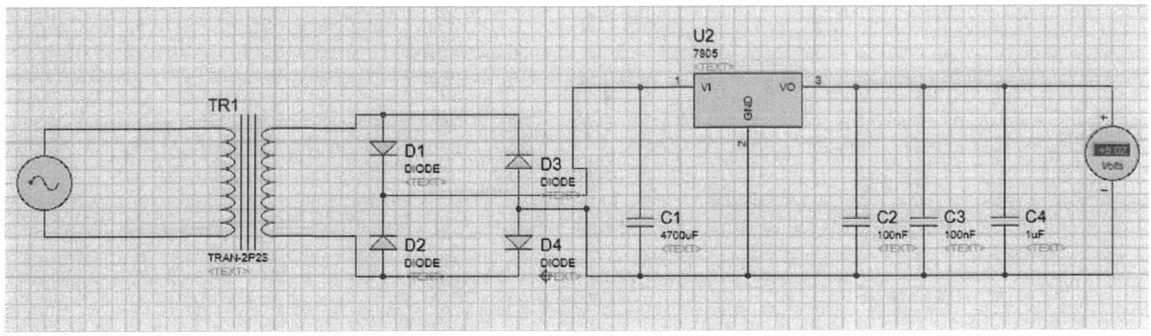

Figure 3.8: Showing The schematic diagram of a 5V power source

3.5 MICROCONTROLLER

For this project, the ATmega 328 microprocessor chip was used. ATmega 328 microprocessor is a high-performance single-chip microchip created by the Atmel in the mega AVR family. The Atmel 8-bit AVR RISC-based microcontroller combines 32kB ISP flash memory with read-while-write capabilities, 1kB EEPROM, 2kB 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, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5V. The device achieves throughout approaching 1 MIPS per MHz. The ATmega 328 is commonly used in many projects and autonomous systems where a simple low-powered, low- cost microcontroller is needed (Microchip, 2018).

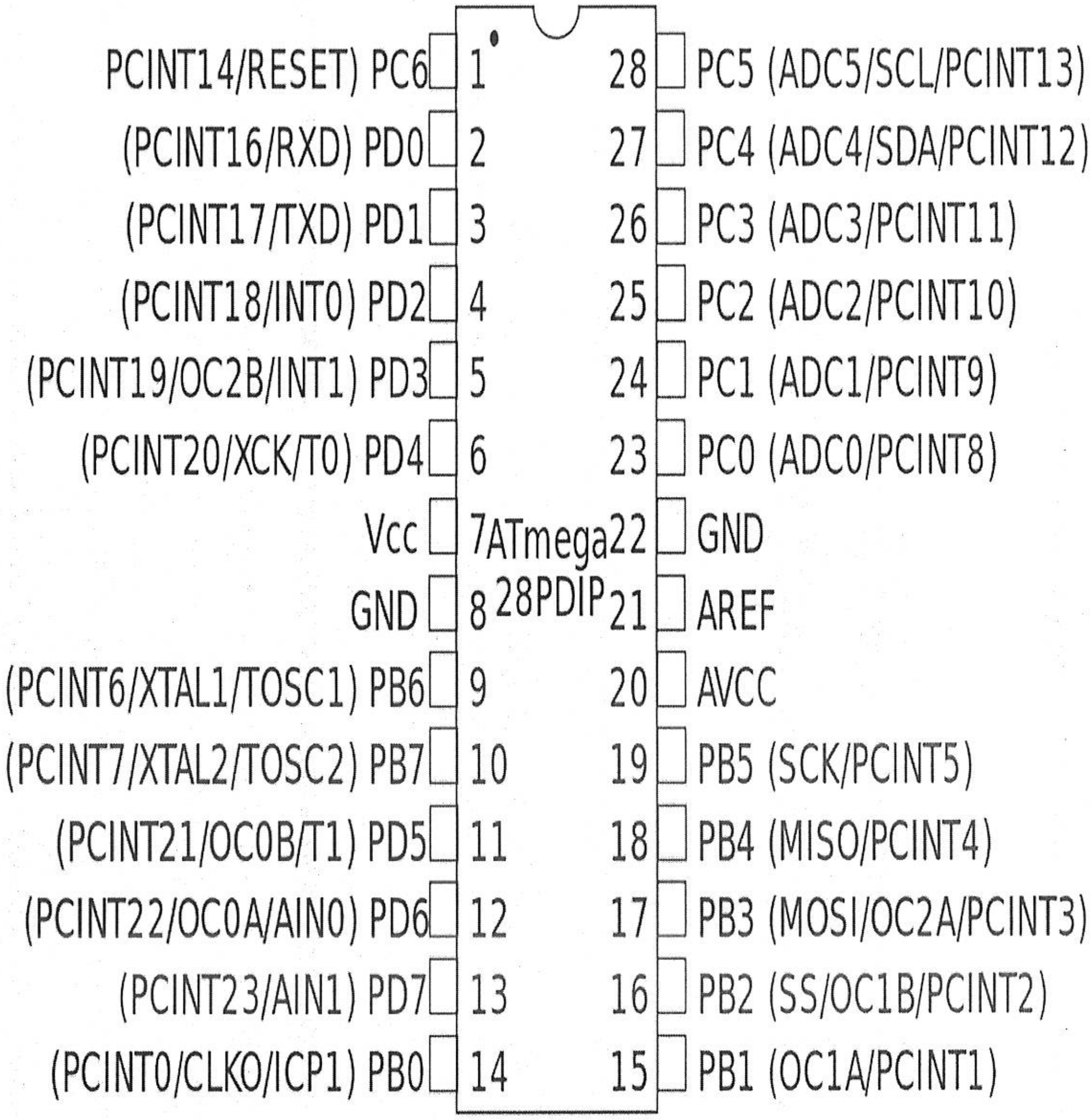

Figure 3.9: ATmega 328 Microprocessor Schematic Diagram.

3.6 GSM MODULE

The GSM module shall be connected to the microcontroller to read and output the data obtained and to wirelessly transmit this data via the GSM to the display paired with it.

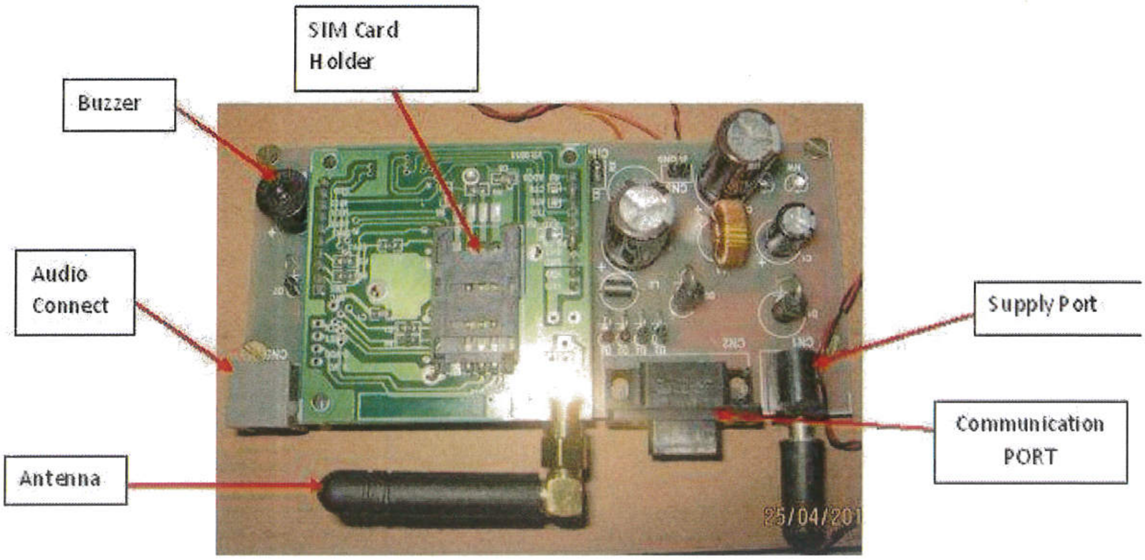

Figure 3.10: GSM Module

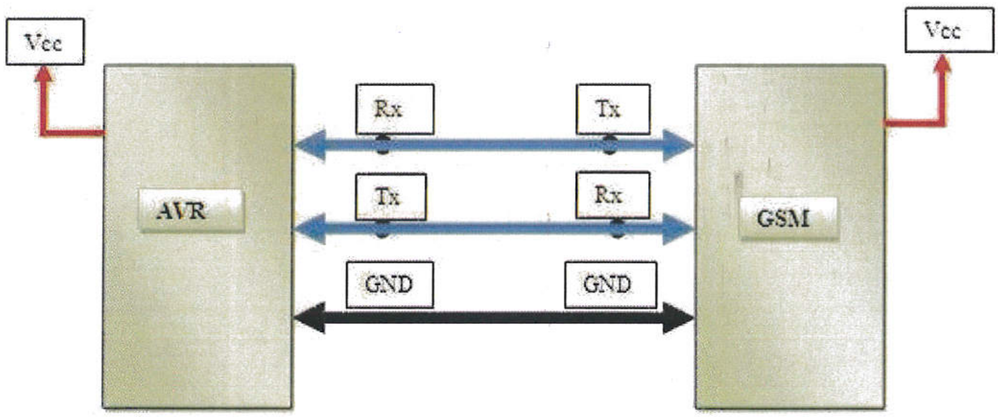

Figure 3.11: Connection between Microcontroller and GSM Module

The data sheet provides a graph for LPG concentration in ppm versus R_s/R_o. The ppm curve R_s/R_o curve was fitted for the values provided, which gives:

R_s/R_o=18..446 X(LPG pmm)$^{-0.421}$ Then:

$$LPG\ ppm = \left(\frac{\frac{RS}{RO}}{18.446}\right) \qquad (3)$$

Substituting for RS in the equation and assuming temperature and relative humidity to be constant equation 3 will become:

$$LPG\ ppm = \left[\frac{\frac{100000-20000}{Ro}}{18.446}\right]^{1/(-0.421)}$$

$$LPG\ ppm = \left[\frac{\frac{100000-20000}{Ro}}{18.446}\right]^{-2.3753}$$

$$LPG\ ppm = \left[\frac{\frac{1}{(100000-20000Vo)}}{18.446XRoXVo}\right]^{2.3753}$$

Where Ro=40kΩ

$$LPG\ ppm = \left[\frac{\frac{1}{(100000-20000Vo)}}{18.446X40000XVo}\right]^{2.3753}$$

Therefore the LPG concentration is given as

$$LPG\ ppm = \left[\frac{\frac{1}{(100000-20000Vo)}}{18.446X40000XVo}\right]^{2.3753} \qquad (4)$$

Where Vo = the output voltage measured from the sensor

Connection between Microcontroller and GSM Module:

DESIGN ALGORITHM

Step 1: Start.

Step2: Initialize the system

Step3: Select the threshold value for temperature and gas cylinder weight

Step4: Display the present state of the environment

Step5: Check if threshold value is equal to the weight of the cylinder

Step5.1: Else go to step4

Step6: Check if there is a gas Leak, increase temperature or gas below threshold value for environment status

Step6.1: Else go back to step4.

Step7: Check if there is a request to turn ON Actuator

Step7.1: Else go to step4.

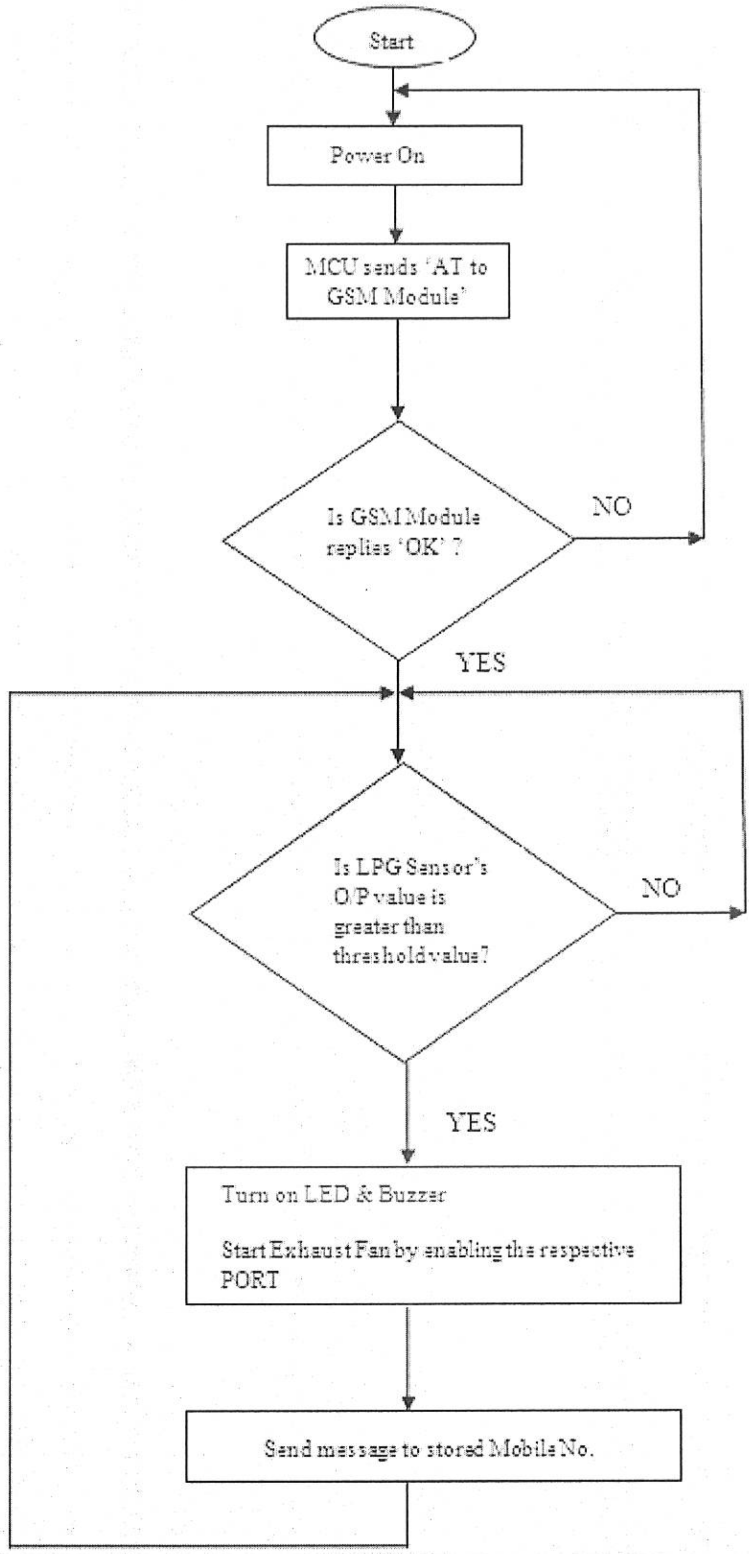

Figure 3.12: Showing the flow chart for the proposed project

3.7 **Design Calculation of the Sensing Unit.**

The efficiency of the gas leakage detector depends on the sensitivity of the sensor. For this reason MQ 5 gas was chosen. To calibrate the gas sensor for high sensitivity and to give its output in ppm instead of in volts, the following derivations were made.

Deriving LPG concentration from the sensor reading

The output of the sensor is measured in volt Vo

RS= sensor resistance

RL = load resistor value in ohms (10 k- 60k) from the MQ5 data sheet

To calibrate the sensor in clean air, Ro must be determined. So we measured the values of the output voltage in clean air. Four reading were taken and the average was determined. 0.664mV 0.670mV 0.662mV and 0.657mV

0.664+0.670+0.662+0.6574=0.663mV

The sensor operated with current of 0.17mA

V=IR...(1)

$$R = \frac{0.663mV}{0.17mA} = 3.9$$

From the data sheet R ranges from 10k to 60k. Therefore at minimum value (clean air) $R0$= $3.9\times 10k \cong 40k\Omega$ Ro= 40kΩ

Also from the MQ 5 data sheet: R_s= V_C−V_O ×R_L/V_O ....(2)

Rs= 5−Vo ×20000/V_O Rs= (100000−20000V_O)$_O$

The data sheet provides a graph for LPG concentration in ppm versus R_s/R_o. The ppm curve R_s/R_o curve was fitted for the values provided, which gives:

R_s/R_o=18..446 X(LPG pmm)$^{-0.421}$ Then:

$$LPG\ ppm = \left(\frac{\frac{RS}{RO}}{18.446}\right) \text{.......................................(3)}$$

Substituting for RS in the equation and assuming temperature and relative humidity to be constant equation 3 will become:

$$LPG\ ppm = \left[\frac{\frac{100000-20000}{Ro}}{18.446}\right]^{1/(-0.421)}$$

$$LPG\ ppm = \left[\frac{\frac{100000-20000}{Ro}}{18.446}\right]^{-2.3753}$$

$$LPG\ ppm = \left[\frac{1}{\frac{(100000-20000Vo)}{18.446XRoXVo}}\right]^{2.3753}$$

Where Ro=40kΩ

$$LPG\ ppm = \left[\frac{1}{\frac{(100000-20000Vo)}{18.446X40000XVo}}\right]^{2.3753}$$

Therefore the LPG concentration is given as

$$LPG\ ppm = \left[\frac{1}{\frac{(100000-20000Vo)}{18.446X40000XVo}}\right]^{2.3753} \text{.......................................(4)}$$

Where Vo = the output voltage measured from the sensor

To make the system very sensitive a set point of 250ppm was chosen to detect the presence of LPG in the environment. This is highly sensitive because at 1000ppm concentration the gas is considered dangerous.

The solenoid valve drive unit controls the opening and closing of the solenoid valve which controls the flow of gas from the supply to the point where the gas is being used. The solenoid valve drive receives signal from the control unit and the carries out the appropriate action.

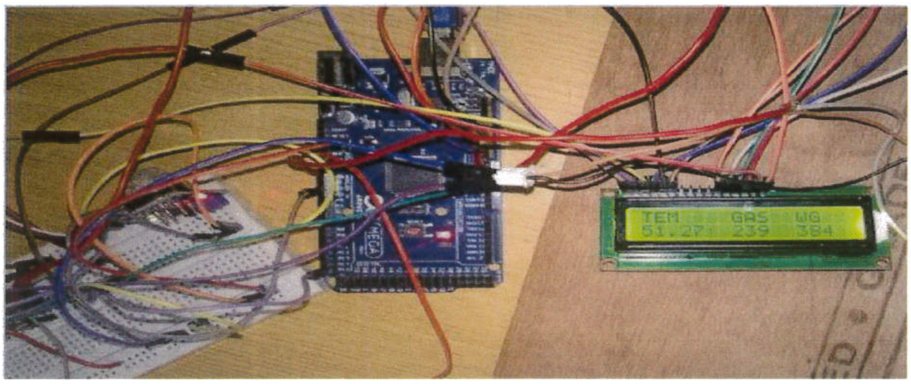

Figure 3.13: The connection of the system

3.8 Software Implementation

Proteus 8 was used; it is one of the best simulation software for various circuit designs of microcontroller. It has almost all microcontrollers and electronic components readily available in it and hence it is widely used simulator. It can be used to test programs and embedded designs for electronics before actual hardware testing. The simulation of programming of microcontroller can also be done in Proteus. Simulation avoids the risk of damaging hardware due to wrong design.

3.9 EVALUATION

In order to ensure that all the necessary specifications and requirements are met, the performance of the system will be evaluated in real life situations. The three major metrics to be used are Hardware testing, functional requirements and user evaluation.

3.9.1 Hardware Testing

Under this section, system hardware will be tested independently to ensure that every component is in good working condition. For example, the voltage of the power source must be 5V, as any voltage that is less than or greater than 5V will have an effect on the system. Also, the AC current to be used to power the power source must be within the range of 110-230V; any voltage greater than 230V will damage the power source.

3.9.2 Functional Requirements

It will be evaluated based on the effectiveness of the power unit, display unit, processing unit and sensor and actuators. It will also be evaluated based on its response to requests, user-friendliness, safety, security, management, and tolerance.

3.9.3 User Evaluation

Generally, the notification system performance must be excellent; it must have zero tolerance to theft and it must not be easily manipulated. The software interface must be user friendly such that, it can be easily accessed by those who have little knowledge about the use of mobile phones

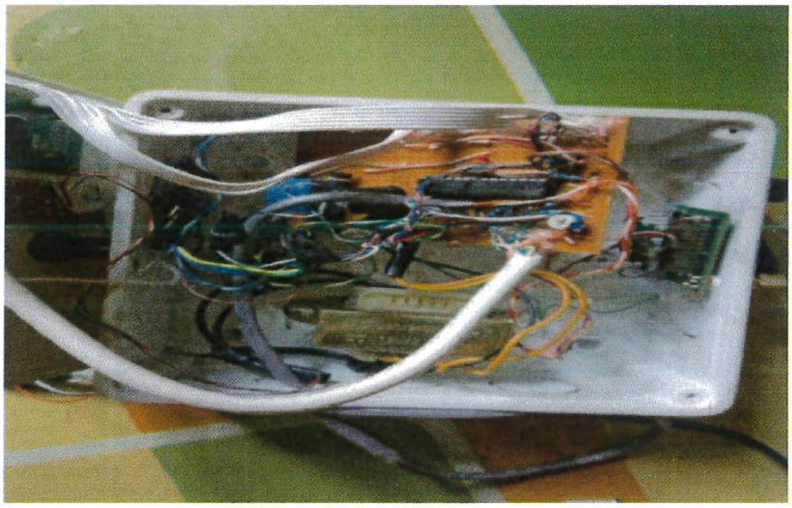

Figure 3.14: The system

CHAPTER FOUR

4.0 IMPLEMENTATION AND RESULTS

4.1 SIMULATION RESULTS

When the simulation of the design of the Gas leakage detector was carried out using Proteus simulation tool, the LCD display of the system design showed a result 'Environment Update: CRITICAL ALERT!' (see Figure 21 below), indicating that the program is compatible with the system design and that the GSM module will send an update to the mobile device that has been programmed to work with it

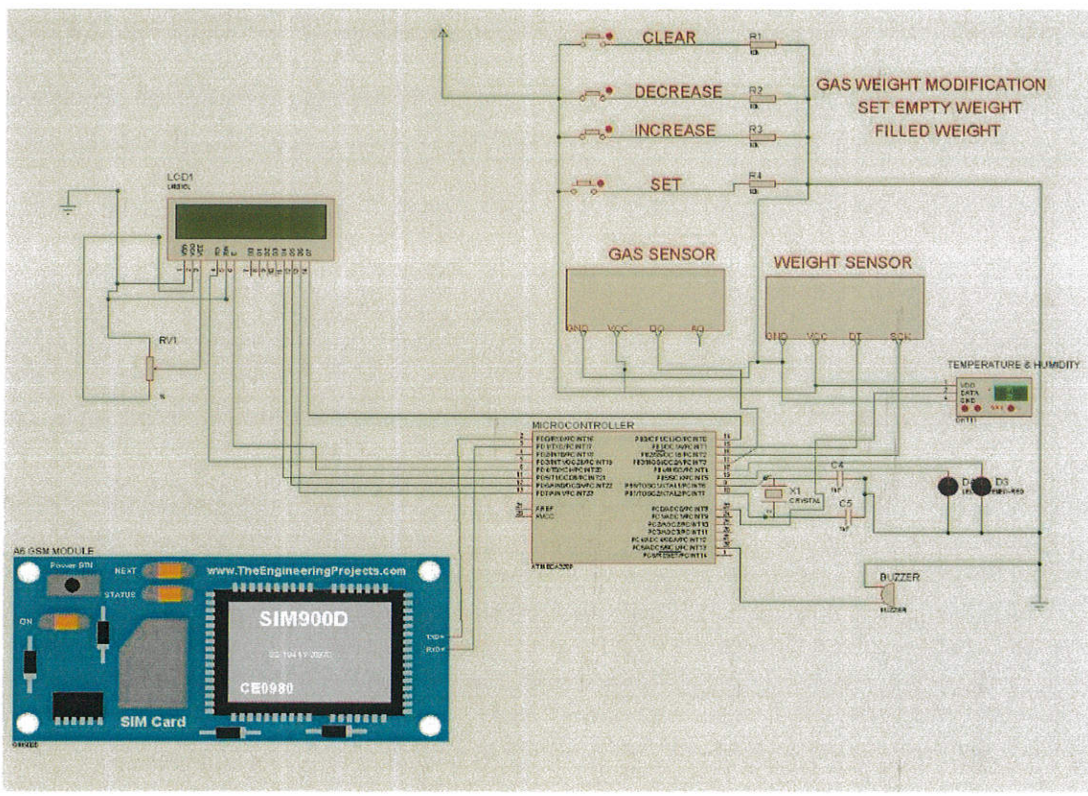

Figure 4.1: Simulation Setup on Proteus Application

4.2 SYSTEM IMPLEMENTATION

The construction of this project was done in four different stages: Firstly, the implementation of the components in the system design onto a solderless experiment board (breadboard). Next is the transfer of components from the solderless experiment board to the development board, and then soldering the components permanently on the development board. Thirdly, the development board was connected to the power source and the system was tested to ensure it was connecting and sending notifications correctly to the connected GSM mobile device. Finally, the entire project was coupled together into a casing. The Bill of Engineering Measurement and Evaluation (BEME) which highlights all the components used for the system implementation are listed in the Appendix section of this report.

4.3 COMPONENTS IMPLEMENTATION ON SOLDERLESS EXPERIMENT BOARD (BREADBOARD)

Firstly, the microcontroller (after it has been programmed using the universal programmer), the GSM A6 module, the MQ-5,load cells, DHT11 sensor module and the 5V DC power source were all setup on a breadboard and interconnected to each other. Interconnections were done using jumper wires and a multimeter was used to test every component to verify whether or not they are in good conditions. The multimeter was also used to measure the voltage and current that gets to every component present in the connection.

4.4 COMPONENTS IMPLEMENTATION ON DEVELOPMENT BOARD

After a successful components layout and testing on the breadboard, the components were then transferred to the development board and were permanently soldered to the development board as seen in Figure 4.2 below. The microcontroller was placed on an IC holder before soldering it to the development board. Connection ports (12V and GND) were used to connect the development board to the power source.

Figure 4.2: Development Board after Component Implementation

4.5 DEVICE TESTING

After a successful layout of components on the development board, there is need to interconnect the development board with the electromagnetic door lock and the power source using connecting cables. The working process of the system is shown in the Figures 4.3 and 4.4 below. The GSM A6 module requires a 5V power supply, and this power is supplied by the power source. The development board is also connected to the power source through its ports 5V/12V and GND. There are three situations upon which the system sends notifications to the mobile; firstly, when there is a gas leaks, when there is increase in temperature beyond the threshold value and lastly, when the gas cylinder weight is below the threshold value device,. When the device started working, it sent an SMS notification to the mobile device as seen in Figure 4.4 below. Also, the system will alert the user automatically whenever the temperature reach critical point. If the status of the environment is requested by the user, the system alerts the microcontroller does not only respond by sending a SMS notification to the mobile device, it also shows the status on the LCD screen in front of the system.

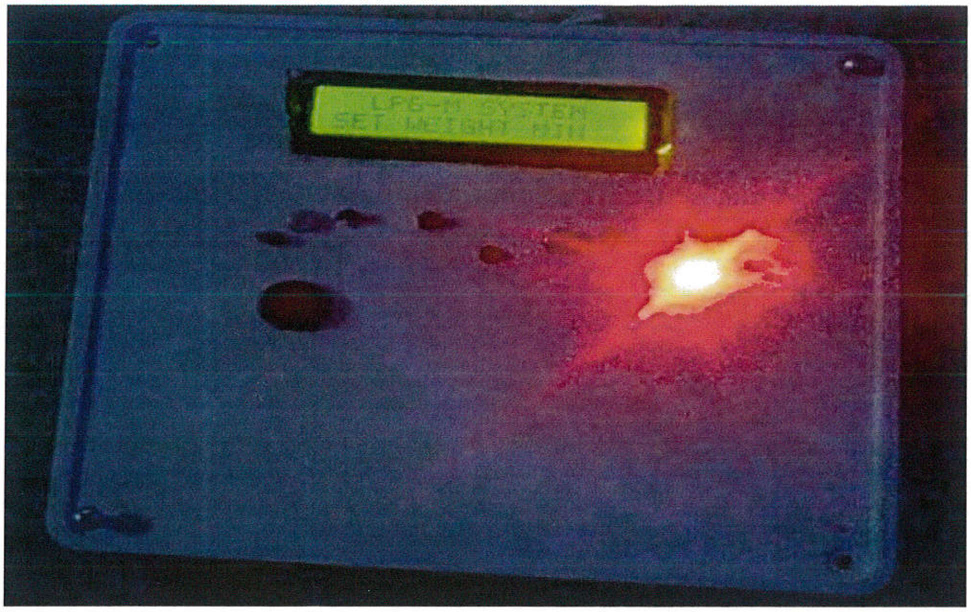

Figure 4.3: the system displaying the status on LCD

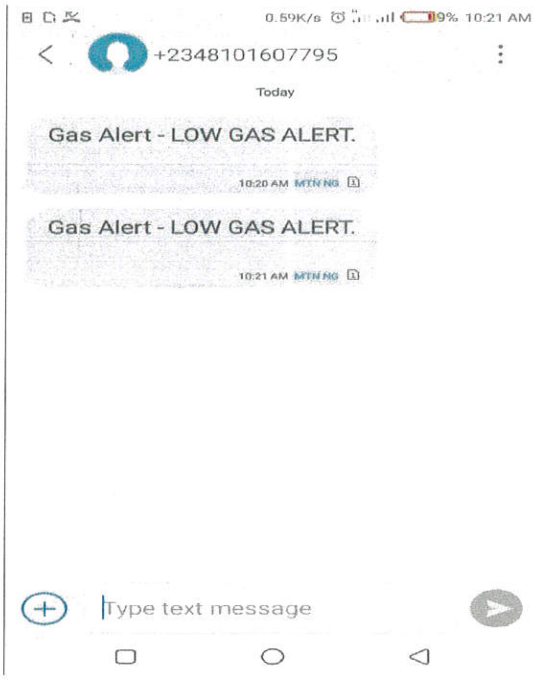

Figure 4.4 : System Testing (Working stage)

4.6 TESTING OF PROTOTYPE OF DESIGNED SYSTEM

After a successful components interconnection, the whole connection is tested to check whether or not it is in good working condition. If the connections perform the desired operation, then there is need to couple the components together into a casing. For this project, the casing used is made up of plastic which has been formed into the shape of a box, and the components are well laid and screwed to the box. The LCD is placed in front of the designed system so as to be the first point of contact whenever a user wants to access the system. The power source is as well housed inside the box.

Figure 4.5: Prototype of the Gas Detector System (buttons)

The four black buttons labelled from 1 – 4 in Figure 24 above have their respective functions: button 1 is used to clear/cancel the displayed status, button 2 is used to decrease the value of temperature/weight (i.e. for minimum temperature/weight settings), button 3 is used to increase the value of temperature (i.e. for maximum temperature/weight settings) and, button 4 is used to set and reset the values. The antenna is used to carry out some hidden functions which are: whenever the network is bad and message sent to the system is delaying, tap this button for five seconds so as to reset the GSM network.

4.7 SYSTEM EVALUATION

In order to ensure that all the necessary specifications and requirements are met, the performance of the system has been evaluated according to real life situations. Both the simulation program and the hardware have been tested in real scenarios by many users. The two major metrics that have been used are hardware testing and functional requirements.

4.7.1 HARDWARE TESTING

Under this section, all system hardware were tested independently using a Multimeter to ensure that every component is in good working condition. The system hardware components that were tested are the power source, the GSM A6 module, the microcontroller, MQ-5,Load cell and the DHT 11 sensor module.

1. Testing the Power Source

It is important that the power source must be tested since it provides power to the entire system. Any damage that results from the power source may damage the entire system. The result of testing the power source shows us that, the voltage of the power source must be 5V, as any voltage that is less than or greater than 5V will not make the system work or will damage the system respectively. Also, the AC current to be used to power the power source must be within the range of 110-240V; any voltage greater than 240V will damage the power source itself.

2. Testing the GSM Module

The GSM A6 module requires a power supply within the range of 4.5V-5.5V and a minimum current of 2A. It works best within the temperature range of 10°C to 55°C and within a humidity range of 0 to 95%. The GSM module supports dual-band GSM/GPRS network for SMS message data remote transmission.

4.7.2 FUNCTIONAL REQUIREMENTS

The system has been evaluated by different users using different GSM devices, and based on its response to different mobile devices, whether or not it sends correct information after reading soil properties, whether or not it sends notification in time, data management, and theft tolerance. See Table 4.1 below.

Table 4.1: Performance evaluation of the Gas leakage detector system

Functional Requirements	Yes	No
Response to diverse mobile phones	Yes	
Send correct information	Yes	
Read correct environment status	Yes	
Send notification within normal time range		
Data management		No
Theft tolerance		No

According to the diverse users who tested the system, the system performance is excellent; the system has no tolerance for theft and its data cannot be altered. The system is user friendly and it can easily be used by everyone. The scope of its application also extends beyond kitchen environment only.

CHAPTER FIVE

5.0 CONCLUSION

The goal of this project was to fabricate and design a device that detect Gas Leakages effectively using a gas sensor and alert people either by using GSM to send a message to their mobile phones or by activating the LED, Buzzer and also the designed system is capable of notifying the user about the level of the gas in the cylinder through the weight sensor. The goals were fulfilled with quite good results and the idea is realized at our fingertips.

If the device should sense a gas leakage, to avoid the user running to and fro once the alert is sent, a way of shutting down the gas flow was fabricated through open and close valve to assist with such operation.

The design has not caused any sort of disturbances to the user, it only alert the user to take necessary action when it's convenient.

The system is so user friendly that, it can be deployed even by those who do not have good knowledge of electronics. It can not only be implemented for domestic usage, it can be adapted for usage in industries. Improvements definitely can be made in order to make the system safer, more reliable and better.

5.1 Recommendations and Future Research

Several improvements can be made on the system to make it a more efficient detector system. Some of the improvements are the use of Internet of Things (IOT) instead of SMS alert notification for the proper monitoring and control of the system, the load cells capacity can also be increased for industrial use. To ensure uninterruptible power supply, solar power can be incorporated into the design. Another improvement can be made to ensure it can also be powered using a battery as ac power cannot be stored

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