THADOMAL SHAHANI ENGINEERING COLLEGE

DEPARTMENT OF INFORMATION TECHNOLOGY

MINI - PROJECT Report

on

Gas Leakage Detector

Submitted in partial fulfillment of the requirements
of the degree of

THIRD YEAR OF ENGINEERING

in the subject

INTERNET OF THINGS (IoT)

by

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1.1 Introduction

*A **gas leak** refers to a leak of natural gas or another gaseous product from a pipeline or other containment into any area where the gas should not be present. Because a small leak may gradually build up **an explosive concentration** of gas, leaks are **very dangerous**.*

In addition **to causing fire** and **explosion hazards**, leaks can kill vegetation, including large trees, and may release powerful greenhouse gases to the atmosphere. The most important gas leak issue is that of **household natural gas leak**. Pure natural gas is colourless and odourless, and is composed primarily of methane. Unpleasant scents in the form of traces of mercaptans are usually added, to assist in identifying leaks. This odour may be perceived as rotting eggs, or a faintly unpleasant skunk smell. Persons detecting the odour must evacuate the area and abstain from using open flames or operating electrical equipment, to reduce the risk of fire and explosion.

However sometimes it gets **too late** before a person actually **smells and detect**s the gas leak. While the added scent is a great safety measure it's certainly **not reliable**. A person may not be able to smell properly or he may mistake the smell of the gas for something else. In most cases there is **no one around** to smell the scent in time. By the time someone actually smells the gas the situation is already dangerous and the concentration of the gas is already **beyond safety limits**.

Hence as a part of this **IoT** project we propose a solution to create a cheap gas detector that can detect this leakage before it crosses the hazardous level. We wanted to build a simple but flexible gas detector so that it can be applied to various use case scenarios. The **Internet of Things** will come into picture to make **autonomous alert** possible even when the user is not at home. This simple device finds it application even in the industries especially chemical plants and factories. Sure all factories have gas detectors but there is always room for error in those. The device being cheap can be used by individual employees who roam around the factory to ensure their own safety regardless of the sensor in factories.

Gas leaks are horrible but preventable. This device can help prevent the mishap. For a nominal amount it can help prevent considerable damage to life and property. The gas sensor is highly flexible and can be calibrated to detect any particular gas. Therefore it has alternate use cases as well:

1. **Smoking detection:** The gas sensor can be calibrated to detect smoking in prohibited areas.
2. **Drink and drive detection:** Alcohol in a person's breath can be detected using this device.
3. **Car exhaust and PUC analysis:** Sensor can be trained to detect concentrations of smoke in a Car exhaust.
4. **Furnace related CO pollution monitoring:** Indoor furnaces release a lot of Carbon Mono oxide. When left unattended (when user sleeps with the furnace burning) it can build up to a lethal concentration leading to death or poisoning. This device can ring an alarm when such an event happens and wake up the user in time.

While the device is flexible our main focus is to calibrate the device to detect a household gas leak. Even so during the project demo and testing phase we use a deodorant to trigger the sensor. Since the sensor can be triggered by the gas released by the deodorant. Our device makes use of a small device called Arduino Node MCU and a website called Ubidots.

The gas company is required to inspect gas meters and inside gas piping from the point of entry into the building to the outlet side of the gas meter for gas leaks. This may require entry into private homes by the natural gas companies to check for hazardous conditions. This sensor can do this job as the sensor is portable. It can be moved across the pipeline and near the meter to detect any gas leak or faulty pipelines.

At its worst gas leak disasters cost a very high toll on life. Often these occur due to negligence. The best example of such an event is The Bhopal disaster, also referred to as the Bhopal gas tragedy, a gas leak incident on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh, India. It is considered to be the world's worst industrial disaster. Over 500,000 people were exposed to methyl isocyanate (MIC) gas. The highly toxic substance made its way into and around the small towns located near the plant.

Estimates vary on the death toll. The official immediate death toll was 2,259. The government of Madhya Pradesh confirmed a total of 3,787 deaths related to the gas release. A government affidavit in 2006 stated that the leak caused 558,125 injuries, including 38,478 temporary partial injuries and approximately 3,900 severely and permanently disabling injuries. Others estimate that 8,000 died within two weeks, and another 8,000 or more have since died from gas-related diseases. The cause of the disaster remains under debate. The Indian government and local activists argue that slack management and deferred maintenance created a situation where routine pipe maintenance caused a backflow of water into a MIC tank, triggering the disaster.

Such a disaster is easily avoidable if we popularise the use of such devices. Through our project we aim to do the same.

1.2 Aim & Objectives

Aim: *To build an ideal, full proof, Budget friendly and Flexible device that can detect gaseous leakage before it reaches a hazardous concentration level and notify the user or the authorities in time to prevent loss of property and life***.**

Objectives:

1. To build a device that is capable of **detecting gas** leaks.
2. Come up with a **reliable** device with **minimal failure** rate.
3. Design a device with **minimum false positive** rate.
4. Reduce the **response time** of the device.
5. Employ the power of IoT to connect the device to **the internet** so that alerts can be conveyed to the user at **any given location** and **at any given** point in **time**.
6. Make the device as **portable** as possible while at the same time provides a facility for a wall mount.
7. In case of network failure come up with reliable **fall back options**.
8. Make the device as **affordable** as possible so that the technology reaches maximum households and saves maximum lives.
9. Device should be **battery operated** so that it does not fail due to power outage and can be used in villages and towns as well.
10. **Reduce the power consumption** of the device.
11. Make the device **flexible through code** so that it can be used to detect **multiple varieties** of gaseous substances. If so the device can **adapt itself to various environments** and gaseous compositions. Extending its application beyond households into industries.
12. Make use of **multiple IoT platforms** (**Ubidots & Blynk**) to eliminate possibility of failure due to platform dependency.
13. Make the device **User friendly** and **hassle proof**.

Chapter 2: Review of Literature

2.1 Requirements for Real World Problems

Gas leak detection is the process of identifying potentially hazardous gas leaks by sensors. Additionally a visual identification can be done using a thermal camera These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Exposure to toxic gases can also occur in operations such as painting, fumigation, fuel filling, construction, excavation of contaminated soils, landfill operations, entering confined spaces, etc.

Depending upon the environment our **requirements** for a gas sensors change. Different applications and environments require different types of sensors.

Common sensors include:

1. **Catalytic bead sensors(pellistors):** Commonly *used to measure combustible gases* that present an explosion hazard when concentrations are between the lower explosion limit (LEL) and upper explosion limit (UEL). Active and reference beads containing platinum wire coils are situated on opposite arms of a Wheatstone bridge circuit and electrically heated, up to a few hundred degrees C. The active bead contains a catalyst that allows combustible compounds to oxidize, thereby heating the bead even further and changing its electrical resistance. The resulting voltage difference between the active and passive beads is proportional to the concentration of all combustible gases and vapours present.
2. **Photoionization detectors**: Use a high-photon-energy UV lamp to ionize chemicals in the sampled gas. If the compound has ionization energy below that of the lamp photons, an electron will be ejected, and the resulting current is proportional to the concentration of the compound. Recently PIDs with pre-filter tubes have been introduced that enhance the specificity for such compounds as benzene or butadiene. Fixed, hand-held and miniature clothing-clipped PIDs are widely used *for industrial hygiene, hazmat, and environmental monitoring.*

3. **Infrared point sensors:** Infrared (IR) point sensors use radiation passing through a known volume of gas; energy from the sensor beam is absorbed at certain wavelengths, depending on the properties of the specific gas. Infrared point sensors can be used to detect hydrocarbons and other infrared active gases such as water vapour and carbon dioxide. IR sensors are commonly found in *waste-water treatment facilities, refineries, gas turbines, chemical plants, and other facilities where flammable gases are present and the possibility of an explosion exists. The* ***remote sensing*** capability allows large volumes of space to be monitored. Engine emissions are another area where IR sensors are being researched. The sensor would detect high levels of carbon monoxide or other abnormal gases in vehicle exhaust and even be integrated with vehicle electronic systems to notify drivers.

4. **Ultrasonic sensors:** Ultrasonic gas leak detectors are not gas detectors per se. They detect the acoustic emission created when a pressured gas expands in a low pressure area through a small orifice (the leak). They use acoustic sensors to detect changes in the background noise of its environment. These detectors cannot measure gas concentration, but the device is able to determine the leak rate of an escaping gas because the ultrasonic sound level depends on the gas pressure and size of the leak. They are mainly used for remote sensing in outdoor environments where weather conditions can easily dissipate escaping gas before allowing it to reach leak detectors that require contact with the gas to detect it and sound an alarm. These detectors are commonly found on *offshore and onshore oil/gas platforms, gas compressor and metering stations, gas turbine power plants, and other facilities that house a lot of outdoor pipeline.*

5. **Electrochemical gas sensors**: 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 of the gas is oxidized at the electrode, indicating the concentration of the gas. Used in a wide variety of environments such as *refineries, gas turbines, chemical plants, underground gas storage facilities,* and more.

6. **Semiconductor sensors:** Semiconductor sensors detect gases by a chemical reaction that takes place when the gas comes in direct contact with the sensor. One of the most

common uses for semiconductor sensors is in *carbon monoxide sensors*. They are also used in *breathalysers*. Because the sensor must come in contact with the gas to detect it, semiconductor sensors work over a smaller distance than infrared point or ultrasonic detectors.

7. More recently, **infrared imaging sensors** have come into use.

In totality all of these sensors are used for a wide range of applications:

1. Industrial plants,
2. Refineries,
3. Pharmaceutical manufacturing,
4. Fumigation facilities,
5. Paper pulp mills,
6. Aircraft and shipbuilding facilities,
7. Hazmat operations,
8. Waste-water treatment facilities,
9. Vehicles,
10. Indoor air quality testing and homes.

Our second requirement is the proper calibration of these sensors:

All gas detectors must be calibrated on a schedule. Of the two form factors of gas detectors, portables must be calibrated more frequently due to the regular changes in environment they experience. A typical calibration schedule for a fixed system may be quarterly, bi-annually or even annually with more robust units. A typical calibration schedule for a portable gas detector is a daily "bump test" accompanied by a monthly calibration. Almost every portable gas detector requires a specific calibration gas which is available from the manufacturer. In the US, the Occupational Safety and Health Administration (OSHA) may set minimum standards for periodic recalibration.

Challenge (bump) test: Because a gas detector is used for employee/worker safety, it is very important to make sure it is operating to manufacturer's specifications. Australian standards specify that a person operating any gas detector is strongly advised to check the gas detector's performance each day and that it is maintained and used in accordance with the manufacturer’s instructions and warnings.

A challenge test should consist of exposing the gas detector to a known concentration of gas to ensure that the gas detector will respond and that the audible and visual alarms activate. It is also important inspect the gas detector for any accidental or deliberate damage by checking that the housing and screws are intact to prevent any liquid ingress and that the filter is clean, all of which can affect the functionality of the gas detector. The basic calibration or challenge test kit will consist of calibration gas/regulator/calibration cap and hose (generally supplied with the gas detector) and a case for storage and transport. Because 1 in every 2,500 untested instruments will fail to respond to a dangerous concentration of gas, many large businesses use an automated test/calibration station for bump tests and calibrate their gas detectors daily.

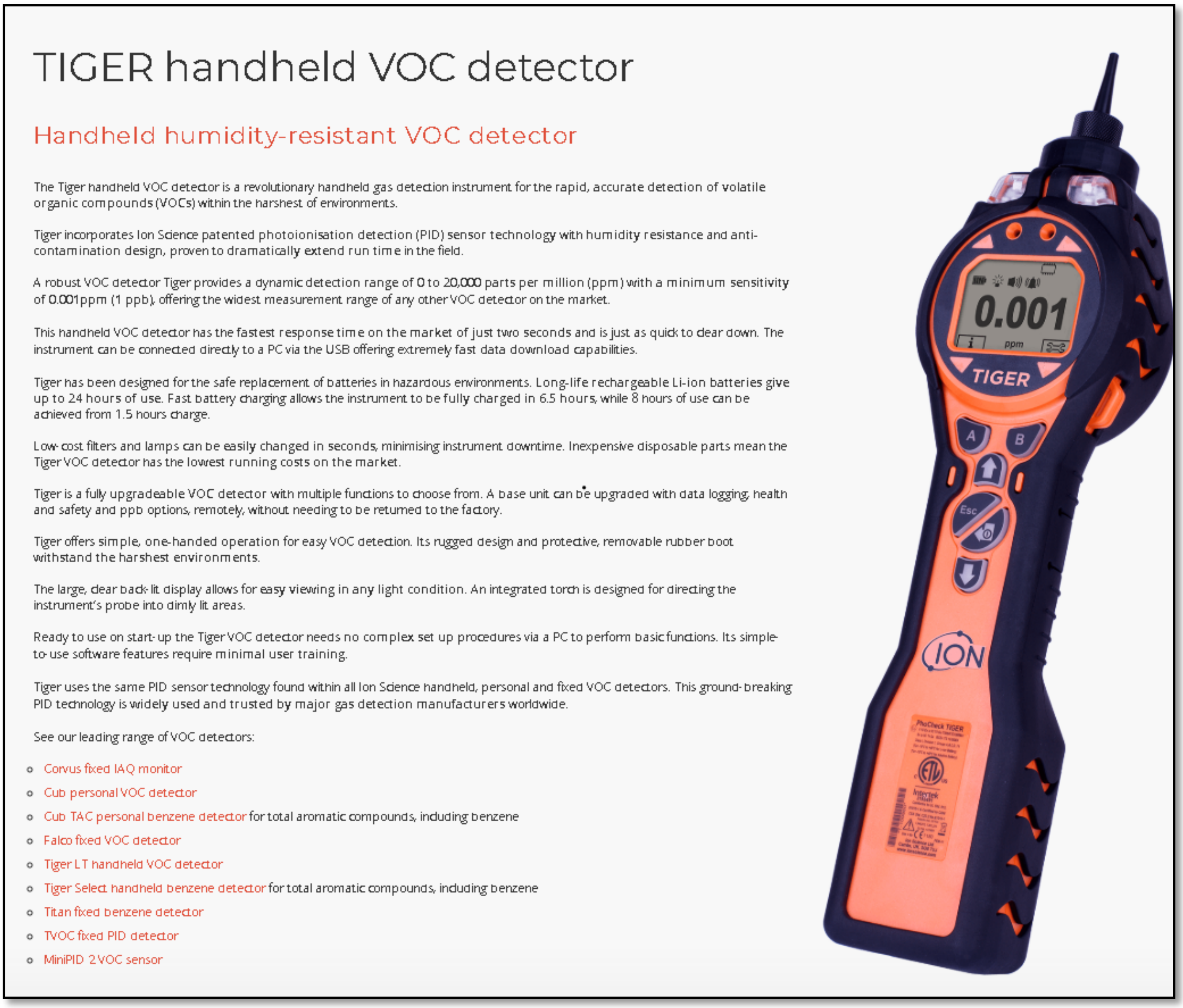
2.2 Existing Solutions

This has been a common problem for decades hence a lot of solutions already exist for this problem.
Here is a list of gas of portable gas detectors manufactured and sold to companies by Tritech(Since 1997):

Fig 1

Each of these is manufactured specifically for a purpose. They come in various types operating methods shapes and sizes. However none of them suit household needs. They do not provide IoT based alert systems. And their functionality is complex to understand without proper training.

Another solution is provided by a Company Called Ion which calls its detector Tiger:



TIGER handheld VOC detector

Handheld humidity-resistant VOC detector

The Tiger handheld VOC detector is a revolutionary handheld gas detection instrument for the rapid, accurate detection of volatile organic compounds (VOCs) within the harshest of environments.

Tiger incorporates Ion Science patented photoionisation detection (PID) sensor technology with humidity resistance and anti-contamination design, proven to dramatically extend run time in the field.

A robust VOC detector Tiger provides a dynamic detection range of 0 to 20,000 parts per million (ppm) with a minimum sensitivity of 0.001ppm (1 ppb), offering the widest measurement range of any other VOC detector on the market.

This handheld VOC detector has the fastest response time on the market of just two seconds and is just as quick to clear down. The instrument can be connected directly to a PC via the USB offering extremely fast data download capabilities.

Tiger has been designed for the safe replacement of batteries in hazardous environments. Long-life rechargeable Li-ion batteries give up to 24 hours of use. Fast battery charging allows the instrument to be fully charged in 6.5 hours, while 8 hours of use can be achieved from 1.5 hours charge.

Low-cost filters and lamps can be easily changed in seconds, minimising instrument downtime. Inexpensive disposable parts mean the Tiger VOC detector has the lowest running costs on the market.

Tiger is a fully upgradeable VOC detector with multiple functions to choose from. A base unit can be upgraded with data logging, health and safety and ppb options, remotely, without needing to be returned to the factory.

Tiger offers simple, one-handed operation for easy VOC detection. Its rugged design and protective, removable rubber boot withstand the harshest environments.

The large, clear back-lit display allows for easy viewing in any light condition. An integrated torch is designed for directing the instrument's probe into dimly lit areas.

Ready to use on start-up the Tiger VOC detector needs no complex set up procedures via a PC to perform basic functions. Its simple-to-use software features require minimal user training.

Tiger uses the same PID sensor technology found within all Ion Science handheld, personal and fixed VOC detectors. This ground-breaking PID technology is widely used and trusted by major gas detection manufacturers worldwide.

See our leading range of VOC detectors:

- Corvus fixed IAQ monitor
- Cub personal VOC detector
- Cub TAC personal benzene detector for total aromatic compounds, including benzene
- Falco fixed VOC detector
- Tiger LT handheld VOC detector
- Tiger Select handheld benzene detector for total aromatic compounds, including benzene
- Titan fixed benzene detector
- TVOC fixed PID detector
- MiniPID 2 VOC sensor

Fig 2

The above two solutions are targeted for industrial use and involve complex functionality and readings that cannot be understood by the common man even if he manages to buy it.

There is a household gas detector available on amazon:

Fig 3

However this is a simple buzzer based system that sounds an alarm once it detects gas leakage. There is no functionality of a remote alert email or smartphone notification. Our device aims at including all this functionality at the cost offered for this product.

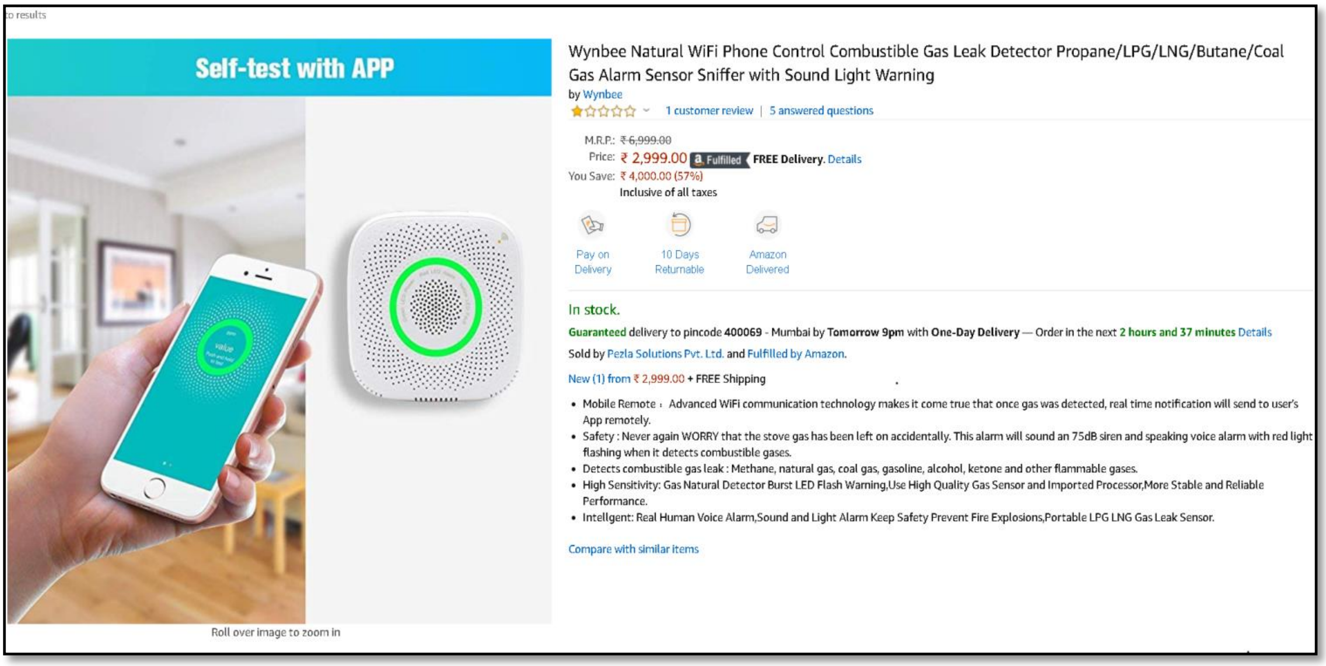


Fig 4

There are a few devices that match our model available on Amazon.in but they are poor in terms of sales. Overpriced and no one seems to buy them. According to reviews they apparently don't even work. Or maybe the users cannot figure out how to make it work.

Hardware/Software Requirements & Cost Analysis

Sr.No	Hardware	Rate(₹/piece)	Quantity(Nos)	Cost(₹)
1	Arduino Node MCU	350	1	350
2	MQ135 Gas Sensor	150	1	150
3	Buzzer	10	1	10
4	Bundle of wires	70	1	70
5	Casing	100	1	70
6	12V Battery	30	1	30
7	Super Bright LEDs	2	2	4
Total ➔				684
Sr.No	**Software**	**Rate(₹/piece)**	**Quantity(Nos)**	**Cost(₹)**
`1	Ubidots IoT platform	1 Month free + 3500/month for up to 20 devices	20 devices Can be Supported	3500
2	Blynk App	Free of cost	Free	Free

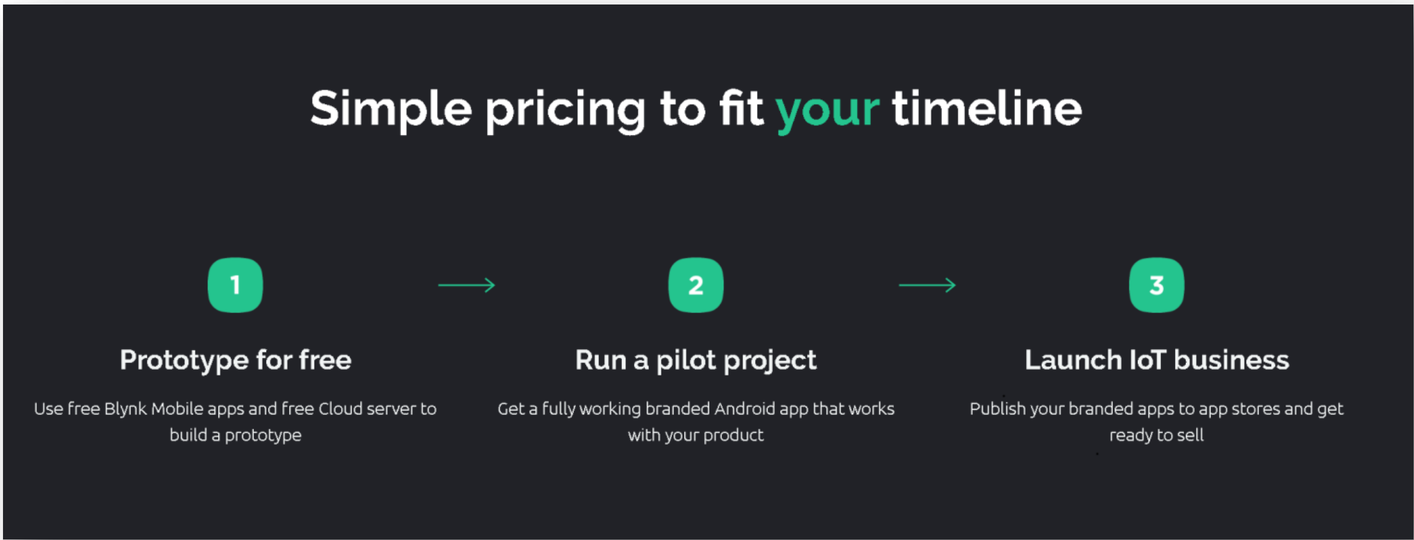
Take away:

- The hardware cost per device is fixed and a one-time cost. The cost of manufacturing one device physically is ₹ 684.
- For platform independence we are using 2 platforms. However this is not necessary we can make use of just the Blynk App and Reduce software cost. The following points need to be noted:

<u>Ubidots Pricing</u>

	IoT Entrepreneur	Professional	Industrial	Scale
	$49 /month	$199 /month	$499 /month	$1,799 /month
	REQUEST A FREE TRIAL	REQUEST A FREE TRIAL	REQUEST A FREE TRIAL	REQUEST A FREE TRIAL
Devices 1 device = 20 variables	25	200	1,000	4,000
Data Ingestion	2 Million dots per month	15 Million dots per month	50 Million dots per month	200 Million dots per month
Data Extraction	2 Million dots per month	15 Million dots per month	50 Million dots per month	200 Million dots per month
End Users	-	50	200	800
Organizations	-	Unlimited	Unlimited	Unlimited
Additional devices	N/A	$50 per block of 50 devices ($1 per device)	$25 per block of 50 devices ($0.50 per device)	$20 per block of 50 devices ($0.40 per device)

<u>Blynk App Pricing</u>



The Blynk app works on the following policy. No matter how many devices we sell and even if all of them use the Blynk app it will cost users no additional software cost. However they will have to undergo the complex technical task of setting up their app(downloadable) from Playstore or Apple Appstore. Downloading is still free of cost however set up is not easy. To get an app that's directly connects with the app without hustle we have to pay Blynk.

Both options are feasible and will cost only Rs. 30 per device per month. We can build our own hosts and servers but this will be a cheaper option. Considering the fact that we will save all the cost of holding up a server that runs 24X7 . Also we can choose to charge the users nominally during sale to include this cost in the sale price. For all prototyping purposes these platforms were available to us for free. We can choose later. Also there are other options as well.

Some other IoT platforms are:

1. Amazon Webservices (AWS IoT).
2. Microsoft Azure IoT Suite
3. Google Cloud Platform
4. ThingWorx IoT Platform
5. IBM Watson IoT
6. Samsung Artik

Chp3: Design and Implementation

3.1 Design Consideration

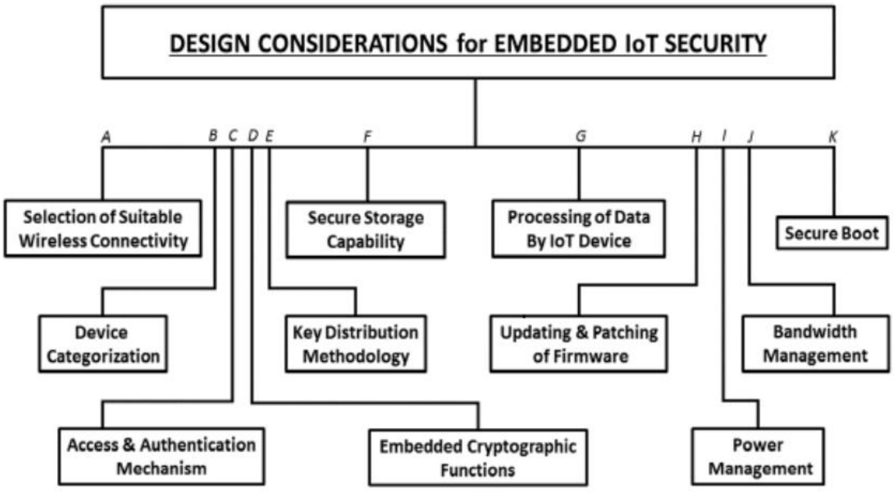


Diagram for General IoT design Consideration

Fig 7

A. **Selection of Suitable Wireless Connectivity:** For connectivity purposes we are using 2.4 Ghz Wifi Connection.
B. **Device Categorization:** Iot devices fall under 3 main categories:
    1. Devices with Transmitting Module Only
    2. Devices with Receiving Module Only
    3. Devices with both Modules

C. Access and Authentication: Through Token provided by Ubidots and Blynk platforms.

D. Embedded Cryptographic Functions: Also handled by the IoT platforms.

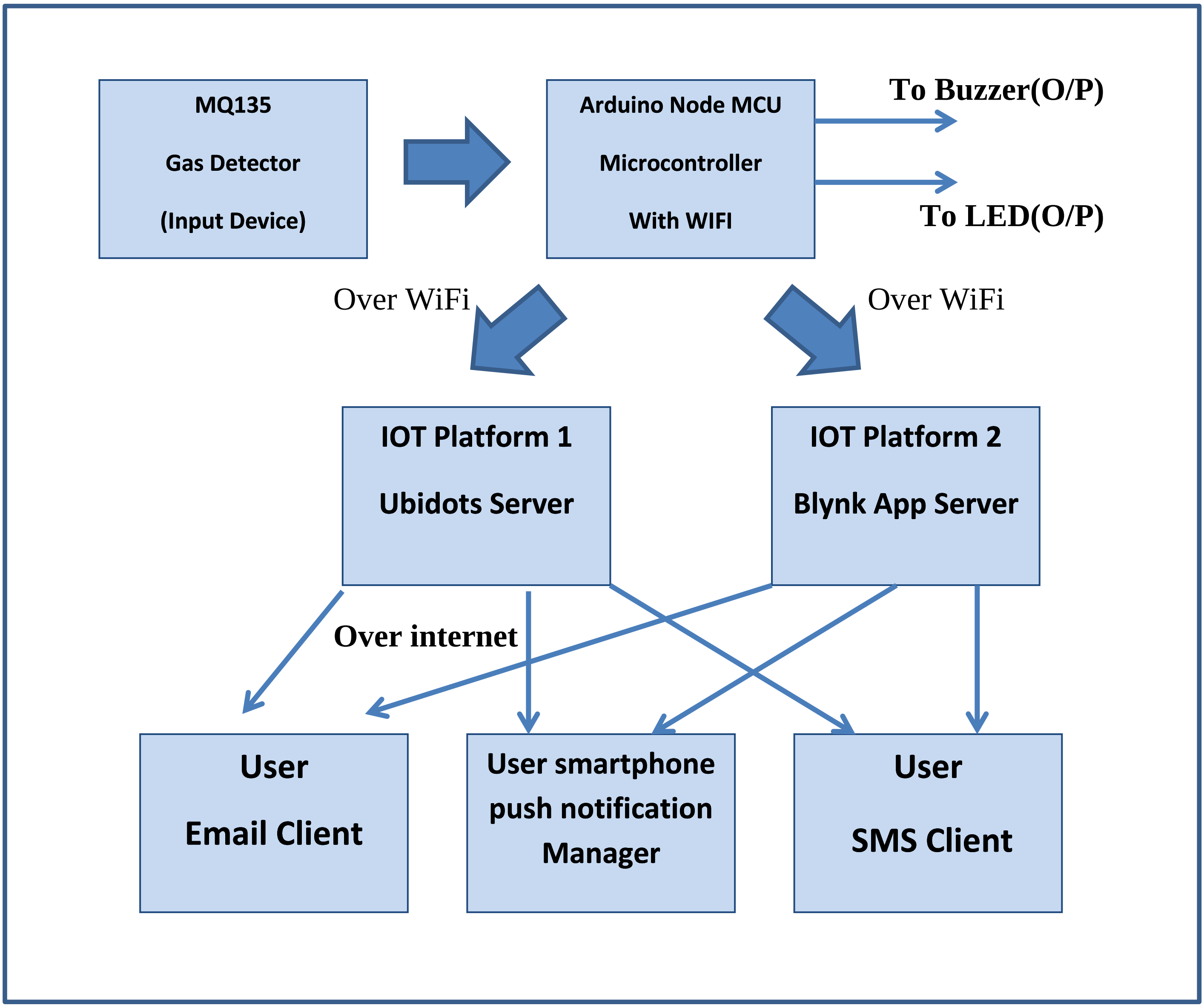
E. Secure Storage Capability within the Device: Data is securely stored within the RAM of the Arduino Node MCU. If used in a WiFi secured with WPA/WPA2 security. The data is generally safe. Also note that the data we collect is merely of gas readings. Such an information is of little use to any attacker. Hence we are good to go here.

F. Processing of Data by IoT Device: All the data is processed within the device By Node MCU. The sensor reading are read and sent to the IoT platform by the Arduino. However the processing of those values to convert them in to GUI based widgets happens at server side. When the value exceed a certain point a notification and email has to be sent to the user. This processing also occurs at server side.

G. Power management: Arduino Node MCU is a power efficient device and can be operated on a steady 12V power supply or battery. This power consumption can be further optimised through code.

3.2 Design Details

Block Diagram:



Hardware design:

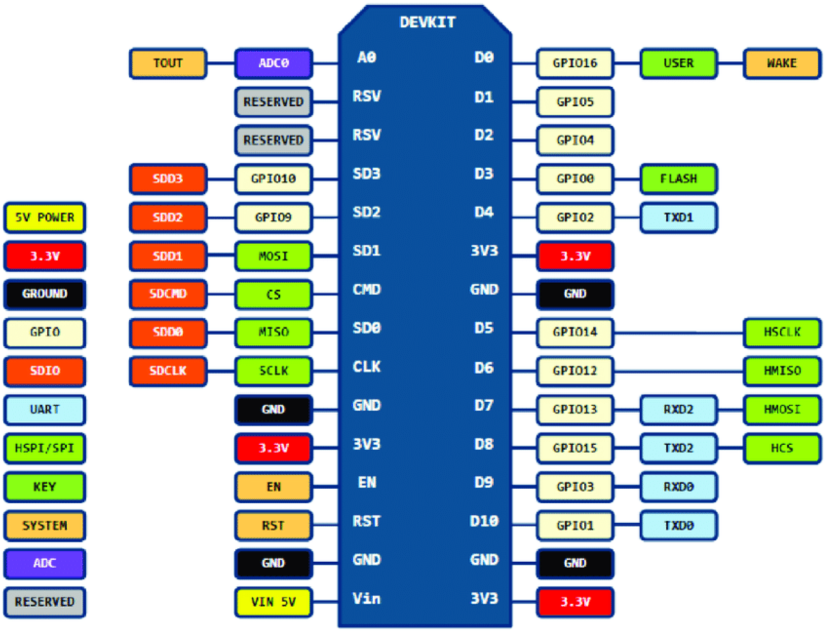
NODE MCU:

The NodeMCU (Node MicroController Unit) is an open source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains all crucial elements of the modern computer: CPU, RAM, networking (wifi), and even a modern operating system and SDK. When purchased at bulk, the ESP8266 chip costs only $2 USD a piece. That makes it an excellent choice for IoT projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You have to solder wires, with the appropriate analog voltage, to its PINs for the simplest tasks such as powering it on or sending a keystroke to the "computer" on the chip. And, you have to program it in low-level The NodeMCU project aims to simplify ESP8266 development. It has two key components.

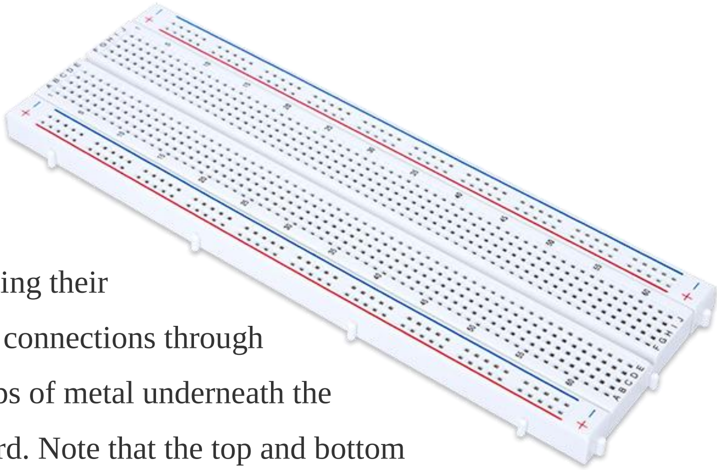
- An open source ESP8266 firmware that is built on top of the chip manufacturer‟s proprietary SDK. The firmware provides a simple programming environment based on eLua (embedded Lua), which is a very simple and fast scripting language with an established developer community. For new comers, the Lua scripting language is easy to learn.

A DEVKIT board that incorporates the ESP8266 chip on a standard circuit board. The board has a built-in USB port that is already wired up with the chip, a hardware reset button, wifi antenna, LED lights, and standard-sized GPIO (General Purpose Input Output) pins that can plug into a bread board.



Pin Diagram

BreadBoard:



A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connect the holes on the top of the board. Note that the top and bottom rows of holes are connected horizontally and split in the middle while the remaining holes are connected vertically.

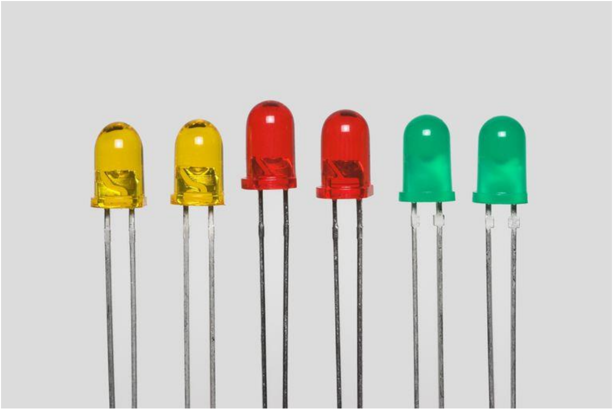
Wires:

A jump wire (also known as jumper, jumper wire, jumper cable, DuPont wire, or DuPont cable – named for one manufacturer of them) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

LED:

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the

form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band



gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

Buzzer:

A **buzzer** or **beeper** is an audio signalling device,[1] which may be mechanical, electromechanical, or piezoelectric (*piezo* for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

MQ135 Gas sensor:

Air quality sensor for detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2. Ideal for use in office or factory. MQ135 gas sensor has high sensitivity to Ammonia, Sulphide and Benzene steam, also sensitive to smoke and other harmful gases. It is with low cost and particularly suitable for Air quality monitoring application.

TECHNICAL DATA MQ-135 GAS SENSOR

FEATURES

Wide detecting scope Fast response and High sensitivity
Stable and long life Simple drive circuit

APPLICATION

They are used in air quality control equipments for buildings/offices, are suitable for detecting of NH3,NOx, alcohol, Benzene, smoke,CO_2 ,etc.

SPECIFICATIONS

A. Standard work condition

Symbol	Parameter name	Technical condition	Remarks
Vc	Circuit voltage	5V±0.1	AC OR DC
V_H	Heating voltage	5V±0.1	ACOR DC
R_L	Load resistance	can adjust	
R_H	Heater resistance	33Ω±5%	Room Tem
P_H	Heating consumption	less than 800mw	

B. Environment condition

Symbol	Parameter name	Technical condition	Remarks
Tao	Using Tem	-10 -45	
Tas	Storage Tem	-20 -70	
R_H	Related humidity	less than 95%Rh	
O_2	Oxygen concentration	21%(standard condition)Oxygen concentration can affect sensitivity	minimum value is over 2%

C. Sensitivity characteristic

Symbol	Parameter name	Technical parameter	Ramark 2
Rs	Sensing Resistance	30KΩ-200KΩ ($100ppm\ NH_3$)	Detecting concentration scope 10ppm-300ppm NH_3 10ppm-1000ppm Benzene 10ppm-300ppm Alcohol
α (200/50) NH_3	Concentration Slope rate	≤0.65	
Standard Detecting Condition	Temp: 20 ±2 Vc:5V±0.1 Humidity: 65%±5% Vh: 5V±0.1		
Preheat time	Over 24 hour		

D. Structure and configuration, basic measuring circuit

	Parts	Materials
1	Gas sensing layer	SnO_2
2	Electrode	Au
3	Electrode line	Pt
4	Heater coil	Ni-Cr alloy
5	Tubular ceramic	Al_2O_3
6	Anti-explosion network	Stainless steel gauze (SUS316 100-mesh)
7	Clamp ring	Copper plating Ni
8	Resin base	Bakelite
9	Tube Pin	Copper plating Ni

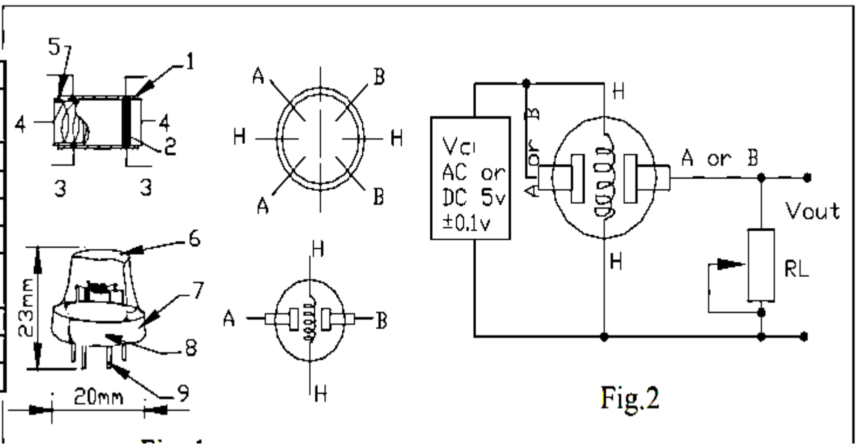


Fig.2

Technical sheet of the Sensor

Schematic Diagram:

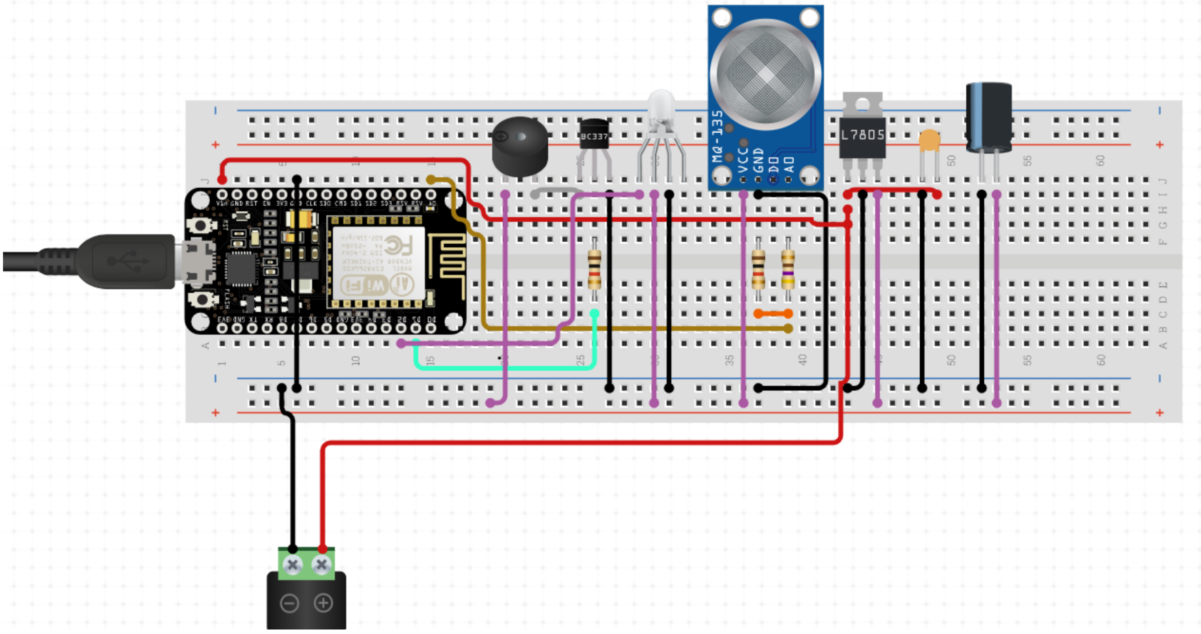


Fig 8.

Fig 8 shows the schematic diagram for connecting the Node MCU to the Gas Sensor. The Capacitors and L7805 Power Regulator along with resistors are present only to defend the sensor and the i/o circuitry from Power surges and fluctuations. We are also using Buzzers and Led to provide in house offline alerts to users.

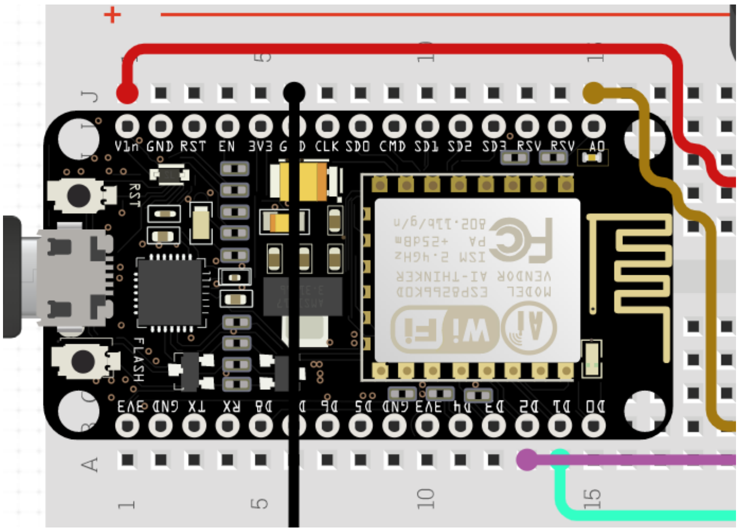


Fig 9

Fig 9 shows the exact connections that need to be made to Node MCU.

- GND Is Connected to Cathode of whiteboard.
- Vin of MCU is connected to power supply Anode.
- A0 pin of Node MCU goes to Gas sensor circuitry.
- D2 pin is used to control the LED.

- D1 pin is used to control the buzzer.
- All other components are safety mechanisms.

Software design:

The software part is implemented using the following software:

1. **Arduino IDE**: **Used to write code and embed it into Arduino in the form of Hex code.** The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

    2 & 3 are used at backend to enable IoT functionality

2. **Blynk App**: Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things. There are three major components in the platform:
    - **Blynk App** – allows to you create amazing interfaces for your projects using various widgets we provide.
    - **Blynk Serve**r – responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.
    - **Blynk Libraries** – for all the popular hardware platforms – enable communication with the server and process all the incoming and out coming commands.
3. **Ubidots IoT platform:** Ubidots is an IoT Platform empowering innovators and industries to prototype and scale IoT projects to production. Use the Ubidots platform to send data to the cloud from any Internet-enabled device. You can then configure actions and alerts

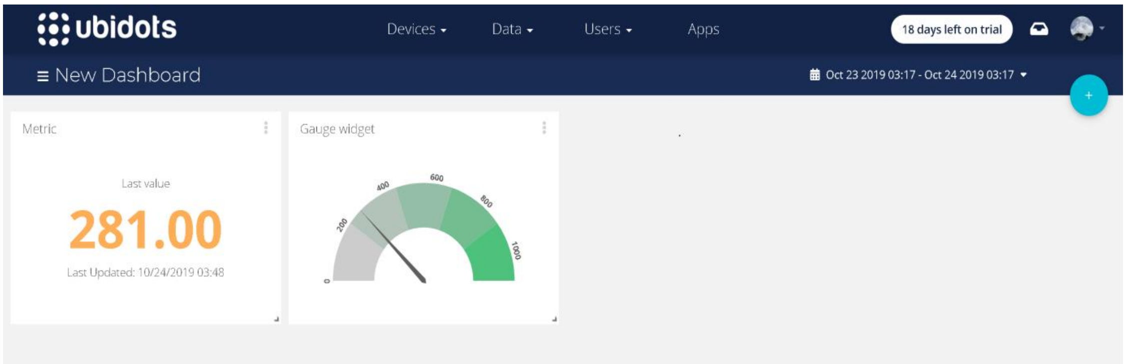
based on your real-time data and unlock the value of your data through visual tools. Ubidots offers a REST API that allows you to read and write data to the resources available: data sources, variables, values, events and insights. The API supports both HTTP and HTTPS and an API Key is required. Your data will be protected with two more replication, encrypted storage and optional TLS/SSL data support. You can also customize permission groups to each module of the platform, making sure the right information is shown to the right user.

CODE:

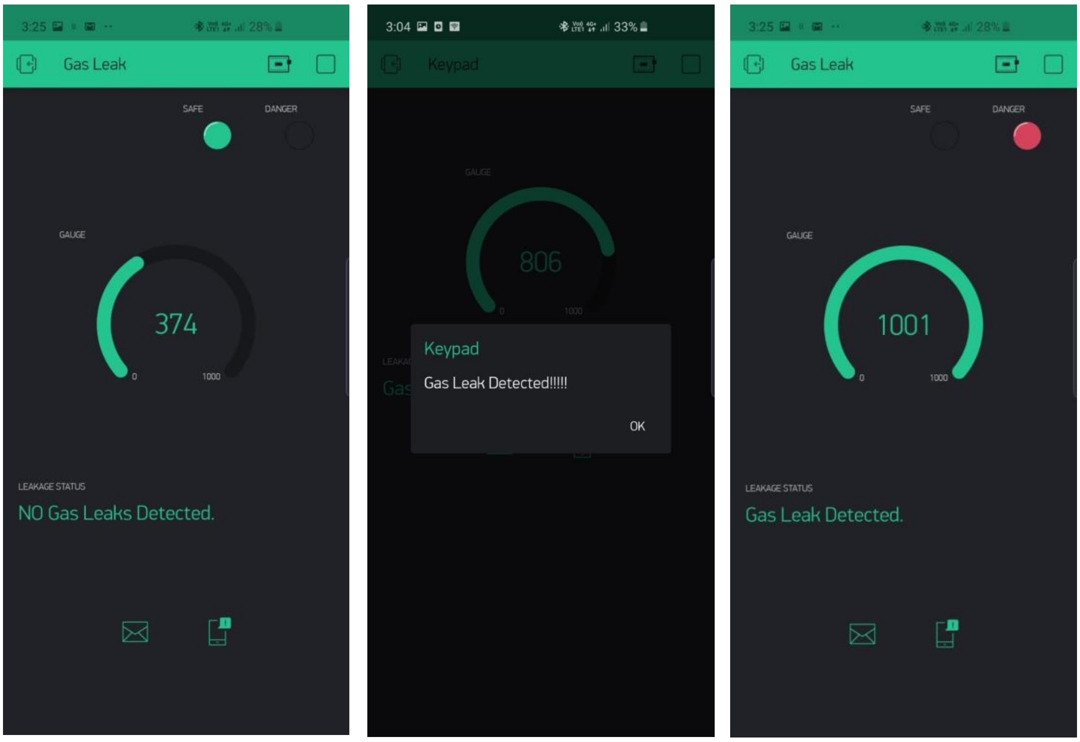
```
#include "UbidotsMicroESP8266.h"
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#define TOKEN  "BBFF-EGEN31ho5xgqOylskN74F6m4pYFjbJ"
char auth[] = "8sl1lR6EMRsWVw-MZtJ-2e0lqytxcy2i";
#define WIFISSID "Girish's $10"
#define PASSWORD "12345678"
Ubidots client(TOKEN);
unsigned long lastMillis = 0;
WidgetLED leds(V1);
WidgetLED ledd(V2);
 BlynkTimer timer;
int LDR = A0;
int ldr_data = 0;
int buzer= 4;
int flag=0;
int sig=1;
int led=2   ;
void setup(){
    Serial.begin(115200);
    pinMode(LDR, INPUT);
    pinMode(led, OUTPUT);
    digitalWrite(led,LOW);
    digitalWrite(buzer,LOW);
    pinMode(buzer,OUTPUT);
    delay(10);
    Blynk.begin(auth, WIFISSID, PASSWORD);
    timer.setInterval(10L, myTimerEvent);
    client.wifiConnection(WIFISSID, PASSWORD);
}
void loop(){
  Blynk.run();
  timer.run();
  ldr_data = analogRead(LDR);
  sig=digitalRead(16);

  if(sig==0){
```

```
    Serial.println("Accessing the sensor and current sensor value is greater than normal
value ");
    Serial.print(ldr_data);
    Serial.print("DANGER!!!");
    digitalWrite(buzer,HIGH);
    digitalWrite(led,HIGH);
    if(flag==0)
    {
    Blynk.email("omigirish1999@gmail.com","Gas Leak Alert","A Gas leak is detected in
your house.");
    Blynk.notify("Gas Leak Detected");
    Blynk.virtualWrite(V4, "Gas Leak Detected.");
    leds.off();
    ledd.on();
    flag=1;
    }


  }
  else
  {
    Serial.println("accessing the sensor and current sensor value is ");
    Serial.print(ldr_data);
    Serial.print("every thing is NORMAL!!!");
    Blynk.virtualWrite(V4, "NO Gas Leaks Detected.");
    digitalWrite(buzer,LOW);
    digitalWrite(led,LOW);
    flag=0;
    leds.on();
    ledd.off();
  }
client.add("GasLeakage", ldr_data);
  client.sendAll(true);

}
void myTimerEvent()
{
  Blynk.virtualWrite(V5, ldr_data);
}
```

3.3 GUI Design



This is the output user sees at the Website on Ubidots Dash Board. The Sensor data is shown in real time graphically. As we can see the value is 1024 units which indicates a Gas Leak.



Screenshots of the GUI of Blynk App

CHAPTER 4: RESULT AND ANALYSIS

4.1 Implementation Details

1. The connections are made as given in the schematics.
2. For portability we use an additional 12 V battery power supply.
3. The gas sensor needs to be placed in a location where there are chances of gas leaks.
4. The gas sensor needs to be calibrated:

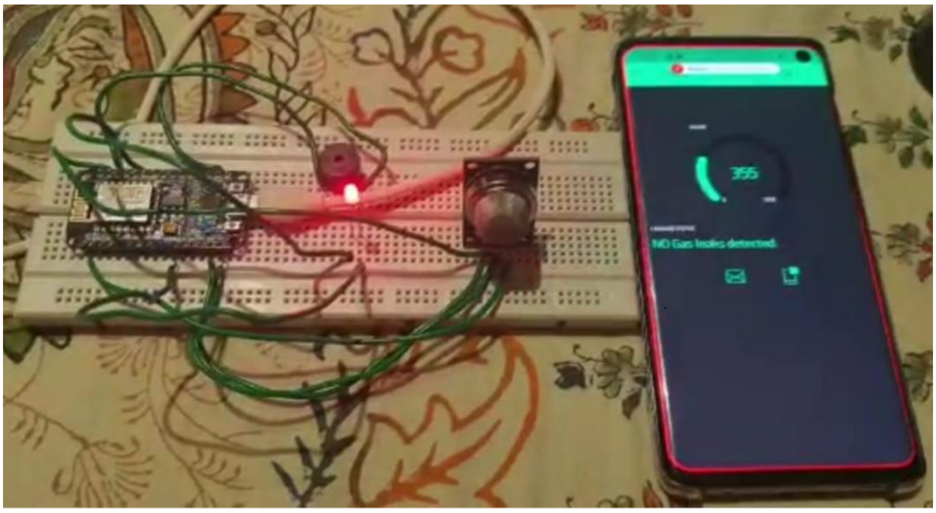
   For this we turn on the gas burner without igniting it and hold the sensor close to the burner fob. We measure the readings of the sensor. This current value is to be set as the threshold value of the sensor.
5. If during normal operation the gas sensor crosses the threshold value that is set during calibration it means that there is a gas leakage and a potentially hazardous concentration of gas is building up.
6. In this case the user need to be alerted the following operations are performed:
   a. The Siren light turns On (In prototype just an led).
   b. The siren rings. (In prototype a buzzer).
   c. Ubidots sends an alert message to all the numbers specified in its list.
   d. Ubidots also sends an email to the user along with the timestamp of the leak.
   e. Blynk app sends a push notification to the android or ios device.

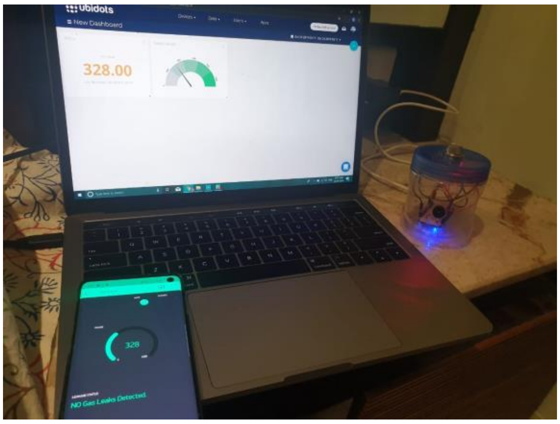
      Both the apps work independently hence network delays or errors at platform side are reduced. It might be possible that a potential reading might me missed by one platform but in that case the other one will catch it.
7. The sensor reading is continuously being displayed on the website and on the app. A user has the facility to monitor these readings in real time from any location.
8. Depending upon the environment the trigger value of the sensor can be changed.
9. There is an added functionality where we can set the trigger to be triggered only when the value is higher than the threshold for a specified amount of time. This will reduce the false positive rate of the system.
10. Even if a false positive occurs. The sensor readings are still live. User can monitor the readings and based on it he can easily figure out if the alarm was real or not.
11. Use of multiple gas sensors in the room with the same Arduino can further reduce false positive rates.

4.2 Results Evaluation

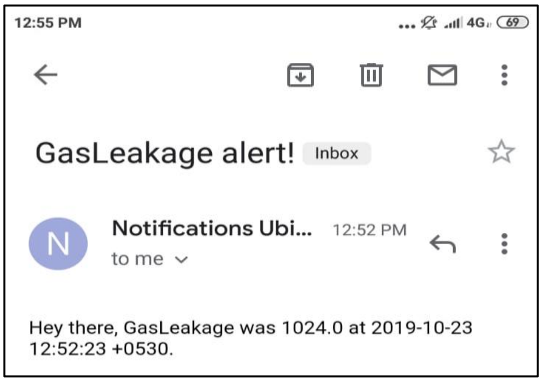
1. The device was tried and tested with Deodorant.
2. The device worked well with very little to no false positives.
3. Sometimes the device fails to detect the gas. This is in a case when the gas Is sprayed at a considerable distance from the sensor.
4. The loss of WiFi connectivity is a serious issue as it sabotages the entire IoT functionality. The sensor readings are not sent to servers and hence the system doesn't send any alerts.
5. There is a case in which continuous false positive is triggered. This occurs when the spray is directly sprayed onto the gas. The spray gets caught in the sensor and keeps triggering it for a long time until it evaporates. Hence sensor contamination is an issue.
6. Here are the results of a trial:

Final prototype Build:

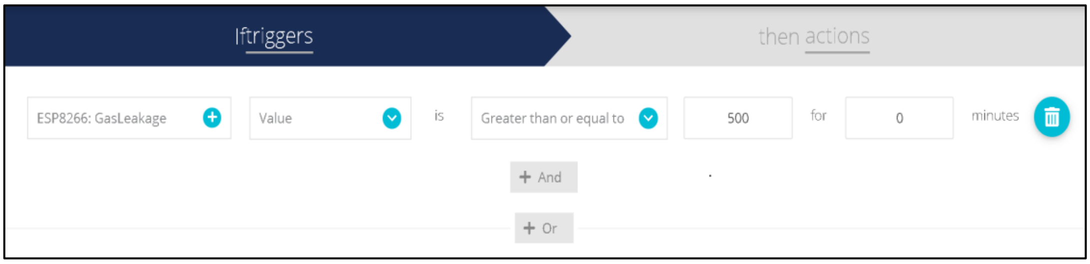


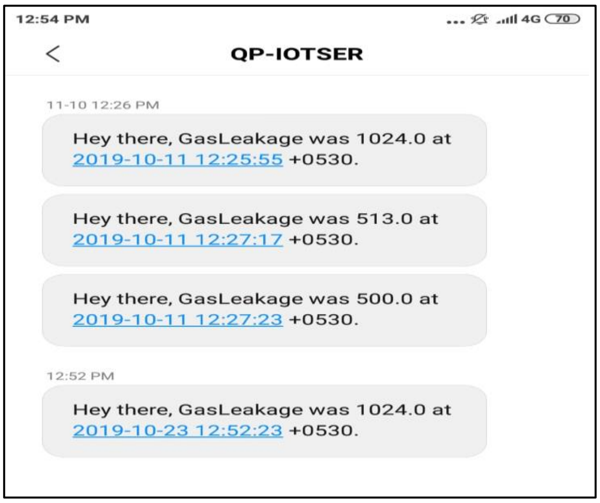


Email Notification



Message Notification:





5. Conclusion & Future Scope

5.1 Conclusion

The project has proposed the idea of Gas Leakage Alert System that can support an email based electronice Alert System. A Gas Leak Alert System contains a connection between wireless communication, sensors, monitoring and sending email. Gas leak Alert System includes technologies and applications that can be used to provide efficiency and control of receiving mail easily. A alarm is a device that detects the presence of gas leak and atmospheric changes relating to smoke. The alarm operates to alert people to evacuate a location in which a gas accumulation is present after opening windows and turning of electric supply. When functioning properly, an alarm will sound to notify the people of an immediate fire emergency. This distinct sound exists to allow notifications to be heard. The alarm constructed by this work is reliable at low cost. In this project, an efficient approach for Gas Leak alert System was proposed and implemented.

5.2 Future scope:

There are a variety of enhancements that could be made to this system to achieve greater accuracy in sensing and detection.

We can make this project locomotive by adding wheels along with the motor and water pump and help to put off the fires in case a fire breaks out. A camera can be attached to the robot so that the situation in-charges can view the working of the robot, search for trapped people and assess the damage. It is obvious that during a fire breakout the electricity connection is cut, so the robot can be battery operated which will be very useful. Water pump attached to it can pump up to 120 litres per hour. So basically the system can detect gas leaks and in case of fire it can take appropriate action, without any human intervention. This provides us the opportunity to pass on to robots tasks that traditionally humans had to do were inherently life-threatening. Fire fighting is an obvious candidate for such automation.

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