CONVERSION OF REGULAR REFRIGERATOR INTO A SMART REFRIGERATOR USING IOT

RAHUL – 18BCE0018

A report submitted for the J component of

CSE3009- Internet of Things

Slot : B2+TB2

Supervisor: DR. SATHIYA KUMAR C

School of Computer Science and Engineering

Vellore institute of Technology, Vellore

June 03, 2021

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

School of Computer Science and Engineering

DECLARATION

I/We hereby declare that the project entitled

"Conversion of Regular Refrigerator into a Smart Refrigerator using IOT"

submitted by me/us to the School of Computer Science and Engineering, VIT University, Vellore-14 has not been submitted and will not be submitted, either in part or in full of this institute or of any other institute or university.

RAHUL (18BCE0018)

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

School of Computer Science and Engineering

CERTIFICATE

The project report entitled "**Conversion of Regular Refrigerator into a Smart Refrigerator using IOT**" is prepared and submitted by **Rahul (18BCE0018).** It has been found satisfactory in terms of scope, quality and presentation as partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering** in VIT University, India.

Guide

(Dr. Sathiya Kumar C)

Table of Contents

List of Figures:

1. ABSTRACT

Smart objects are everywhere around us and specifically in our homes. We use objects like Smart Phones and Smart TVs on a regular basis and out life seems incomplete without them. Smart Living has become a norm these days. So the Domain of the following work is Smart Living. The kitchen is regarded as the central unit of the traditional as well as modern homes. It is where people cook meals and where our families sit together to eat food. The refrigerator is the pivotal of all that, and hence it plays an important part in our regular lives.

A simple refrigerator can be upgraded into a smart cost-effective machine using small smart refrigerator modules which consist of sensors like ultrasonic sensor, gas sensor, infrared sensors etc. IoT based refrigerator looks at the status of the nourishment of food for e.g, quantity, quality and freshness, etc.

Significance of this work will be diminishing of food spoilage, and providing an easier lifestyle for today's humans.

2. INTRODUCTION

2.1. Objective

The idea of this project is to improvise the normal refrigerator into a smart one by making it detect food item quantities, measure liquid item quantities like milk etc and notifying the user using a virtual interactive environment when the quantity is low or even ordering the items that are low in quantity automatically. The fridge will also be able to track the quality of the food inside the fridge.

2.2. Motivation

Smart Fridge are super expensive and they are not smart in a real sense. They allow the user to browse internet on the fridge door which does not make sense. The real requirements that a user need fulfilled through a smart fridge is too keep a check on its food quality and quantity. Spending Lacs of Rupees for such simple requirements does not make sense. People already have regular refrigerators in their houses which cost decent amount of money. Hence the motivation of this project is to tackle this problem of cost and to convert a regular fridge into a smart fridge using IOT in a very cost-effective method and make it smart in a real sense.

2.3. Background

Refrigerator is the most common kitchen electrical appliance found in kitchens all over the world for food storage. It is used for various tenacities like storing vegetables, fruits etc.
IoT based refrigerator is designed to sense the food products that are stored in it and notify to the user when the products are scarce via alerts and emails. The basic functionality of the IoT based refrigerator is to maintain, with less effort, any food items which one wishes to purchase when the items are unavailable. As a result, the user is notified every time if eggs are finished, or if the milk is less or if the food has gone bad in the system.
Automation is the most essential piece of our life in the present time. Automation accommodated home enables us to control IoT devices such as Light, entryway, fan, AC, fridge, and so on. An automated smart fridge is going to be the next common thing.
We will be using IoT devices like Node-MCU, Infrared Sensors, and Ultrasonic sensors for accomplishing this.

3. PROJECT DESCRIPTION & GOALS

3.1. Project Description

We are Implementing technologies that can allow the fridge to determine the quantities of various products inside the fridge like eggs, milk etc and alerting user to purchase more, via Blynk app alerts and even though Email alerts.
The proposed method will be able to reduce the cost of upgrading to smart fridges and will help tackle the problem of electronic waste because the existing fridge is not getting discarded.
We will be using IoT devices like NodeMCU, Infrared Sensors, and Ultrasonic sensors for accomplishing this.

3.2. Problem statement

Smart Devices have become very popular in recent years like Smart Phones, Smart TVs etc, but a Refrigerator is such a regular everyday object that rarely people think that fridge can also be Smart in various ways. There are Smart fridges in Market today but the main problem with them is that they are extremely costly. The Smart fridge from a well-known brand like Samsung or LG, starts with a minimum Price of Rs.2 Lakhs. The most you can do with these smart fridges is that you can control the temperature inside the fridge or close the fridge doors if left open. Some of them even have big screens which allow them to browse Internet which is quite unnecessary. Cost of the smart refrigerators can be reduced by converting the existing regular refrigerators into smart refrigerators. The components that are to be used into creating this new smart fridge must be cheap and easily accessible. Reduce unnecessary stuff from the smart fridge that is not required by the fridge and does not make sense to be put into the fridge, e.g Internet Browsing, Listening to songs etc.
A lot of people already have expensive refrigerators in their homes which are not smart. The question is here is how can we make their existing fridge into a Smart one in a very cost-effective method and make them smart in a sense that enhances the functions that a refrigerator does, like sensing the quantity for food inside and letting the user know, etc.

4. OVERVIEW OF PROPOSED SYSTEM

The technical system architecture consists of 5 different components which includes different kinds of Sensors, a micro-controller (Node MCU) and the Blynk app on smartphone to get active updates and control the system.

A block diagram for the basic overall structure of the project is displayed below.

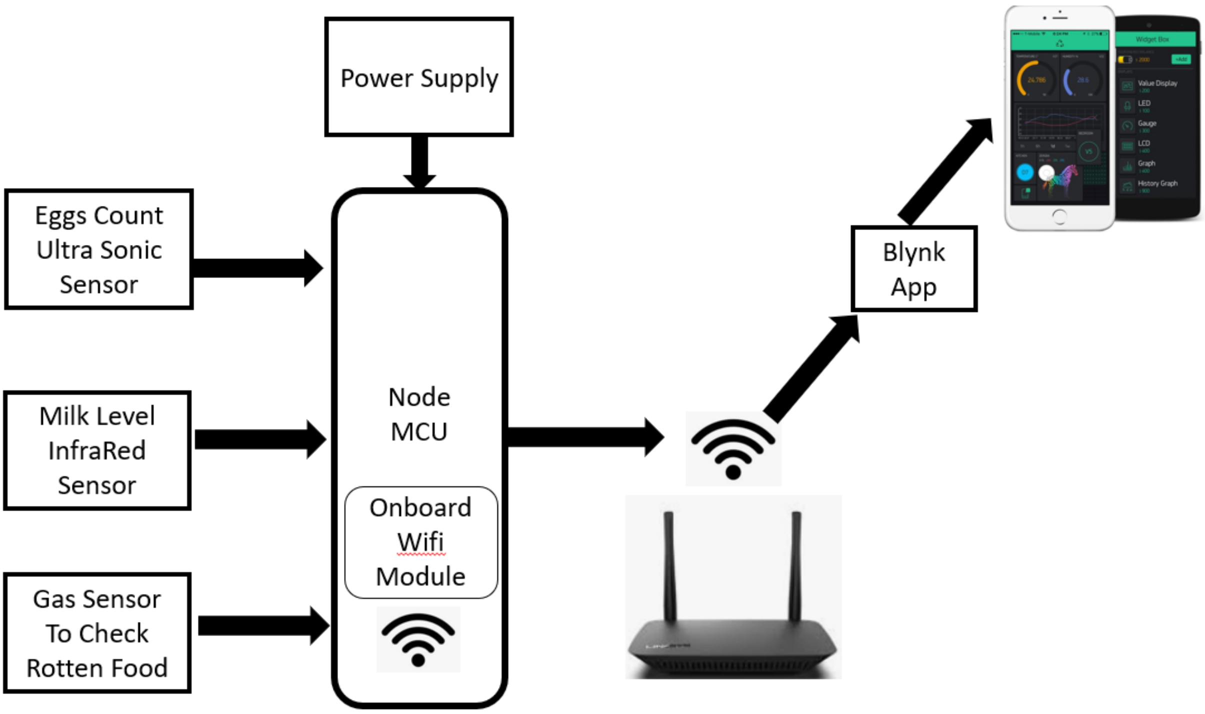


Fig 1 : Basic Architecture for Smart Fridge.

Cheap components like Node MCU, Wi-Fi Modules, and pre-developed apps like Blynk to reduce the cost to make a smart refrigerator and to make the fridge smart, I will use Ultrasonic and Infrared sensors to calculate and trace the quantity of the food inside the fridge. A Gas sensor module will be used to sense the bad smell inside the fridge is the food has gone bad.

The fridge will be able to communicate with the user using the Blynk App to alert them when the quantity of an item is low. Smart Lids and Trays are a good option to put food in, which will allow a regular fridge to work as smart fridge.

Hardware Requirements:

1. Bread Board
2. Jump Wires
3. Node MCU
4. Ultra Sonic Sensor
5. Gas Sensor
6. Infrared Sensor.
8. Egg Trays
9. Jars
10. Mounts

Sensors:

1. Ultrasonic Distance Sensor Module - HC SR04

To calculate the distance between the eggs and the sensor. Which ultimately helps to calculate no. of eggs in the gg tray.

Fig 2: Ultrasonic Sensor

2. Infrared Sensor TCRT5000L

To find if the milk surface in the milk jar is in level proximity of the sensors. Which determines if the milk is low in quantity or high.
If the sensor detects obstacle, the milk level is high and if it does not detect obstacle, it means the milk quantity is low.

Fig 3: Infrared Sensor

3. MQ135 Gas Sensor Module

It is used to calculate the odour levels in the fridge, which can increase if the food has rotten.

Fig 4: MQ-135 Gas Sensor

Micro-Controller:

1. Node MCU

It is a microcontroller, which will manage all the inputs and outputs from the sensors.

Fig 5: Node MCU

We selected Node-MCU because of following reasons

i. Development is easy

ii. The higher version of ESP8266
iii. Low cost
iv. Small size
v. On-chip Wi-Fi Module.
vi. Wide range
vii. UART interface with the microprocessor

5. PROPOSED SYSTEM ANALYSIS & DESIGN

Here, we will see the approach for designing the entire system. We will have a look at all the connection specifications of the components.

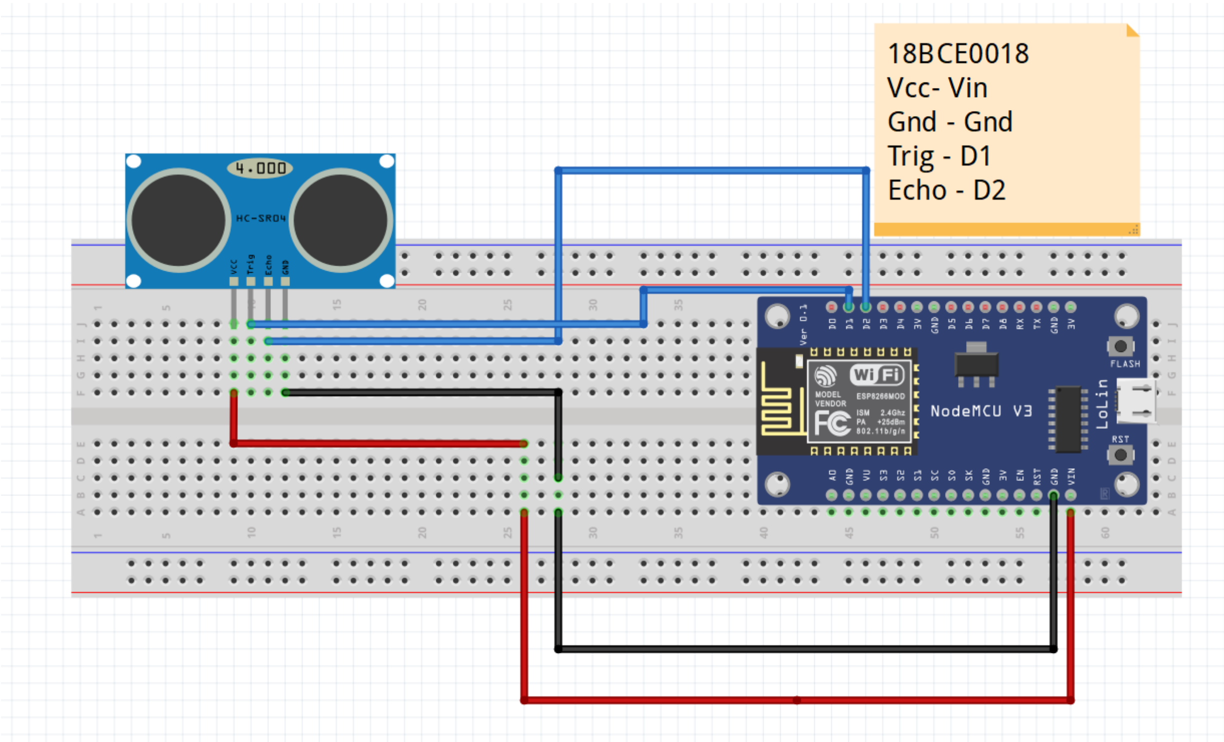
5.1. Proposed Approach & Connections

5.1.1. Egg Counter – (Using Ultrasonic Sensor HC-SR04)

The Egg Counter is made using the Ultrasonic sensor. Connection for connecting the Ultrasonic sensor with the Node MCU Micro-controller and the working procedure are given below.

- Breadboard Connection:

Fig 6: Connection for Ultrasonic Sensor



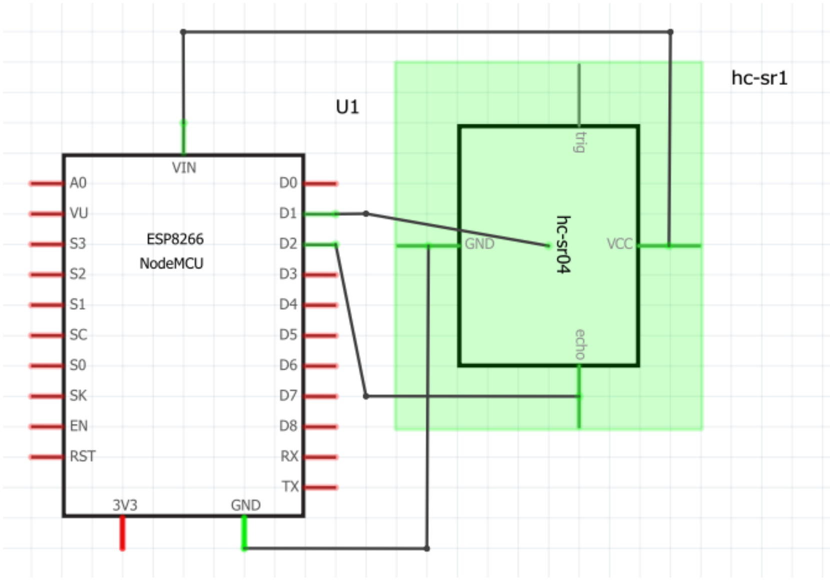


Fig 7: Semantic Diagram for Ultrasonic Sensor

5.1.2. Milk Measurement– (Using Infrared Sensor)

The Milk Measure is made using the Infrared sensor. We used Infrared sensor instead of the ultrasonic sensor in this case, because we do not need an exact quantity of milk in the bottle. We just need to know when it is low in quantity.

- Breadboard Diagram:

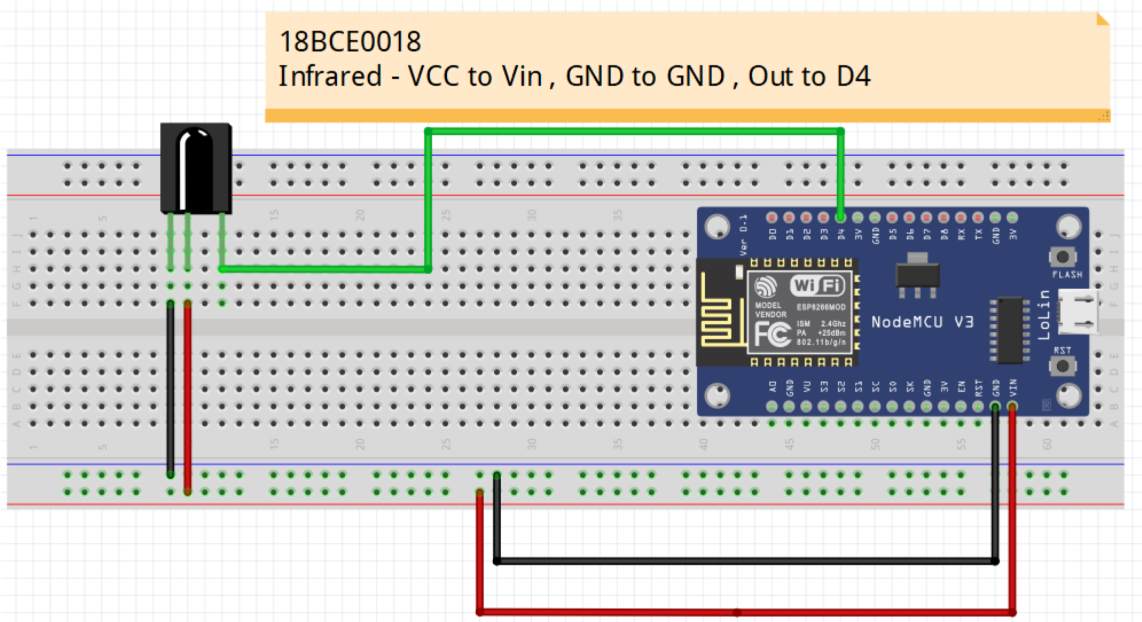


Fig 8: Connection for Infrared Sensor

- Semantics Diagram:

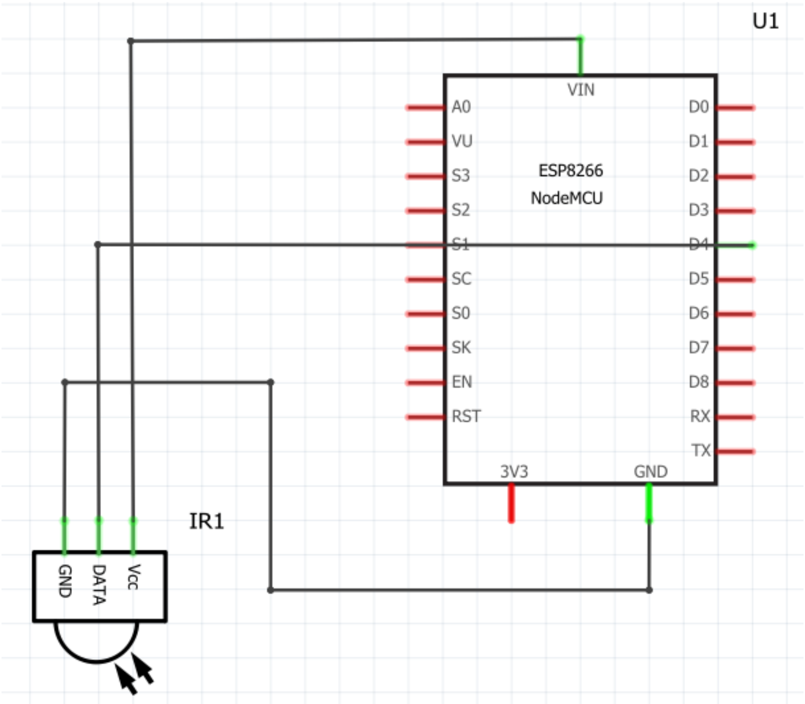


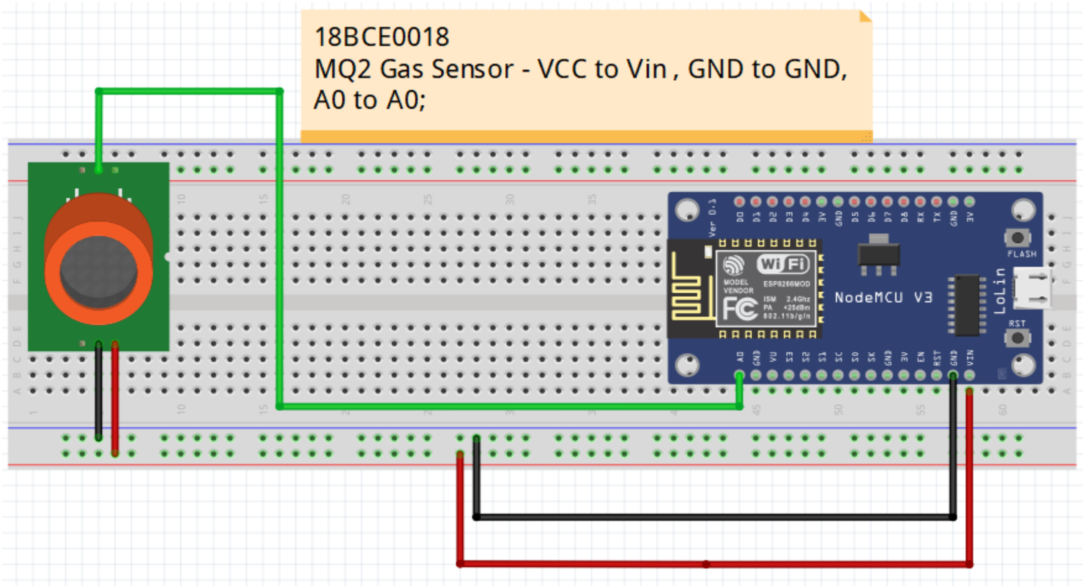
Fig 9: Semantic Diagram for Infrared Sensor

5.1.3. Odour Detection

Bad odour is a sign of rotten food inside the fridge. To detect that, we have used a MQ-135 Gas sensor to detect the fumes inside the Vegetable tray in the fridge.

- Breadboard Connection:

Fig 10: Connection for Gas Sensor



- Semantics Connection:

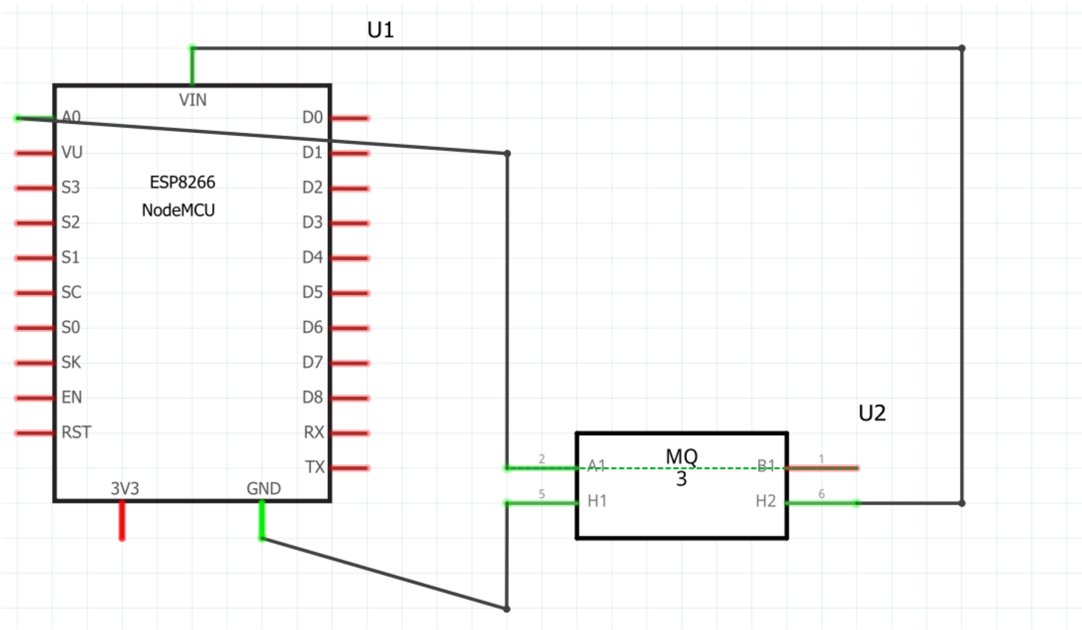


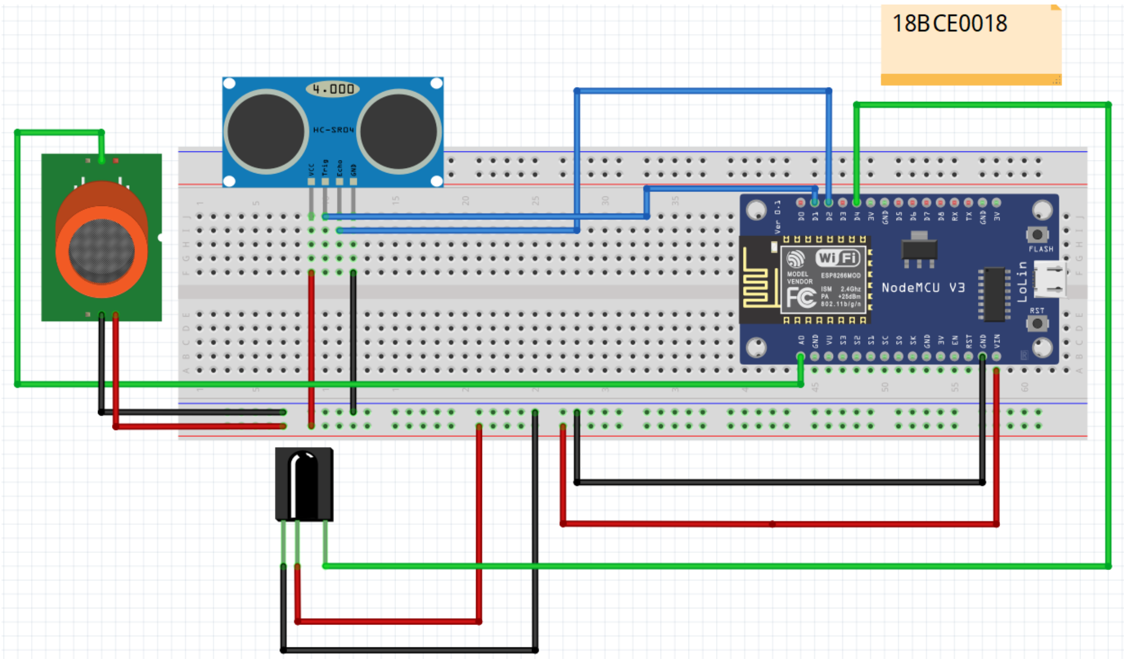
Fig 11: Semantic Diagram for Gas Sensor

5.1.4. Complete Circuit Diagram

After combining all these components in a single circuit, we can create the entire system using s single Node-MCU and all the sensors on a single breadboard.

- Breadboard Diagram:

Fig 12: Connection for Complete Circuit



- Semantics Diagram

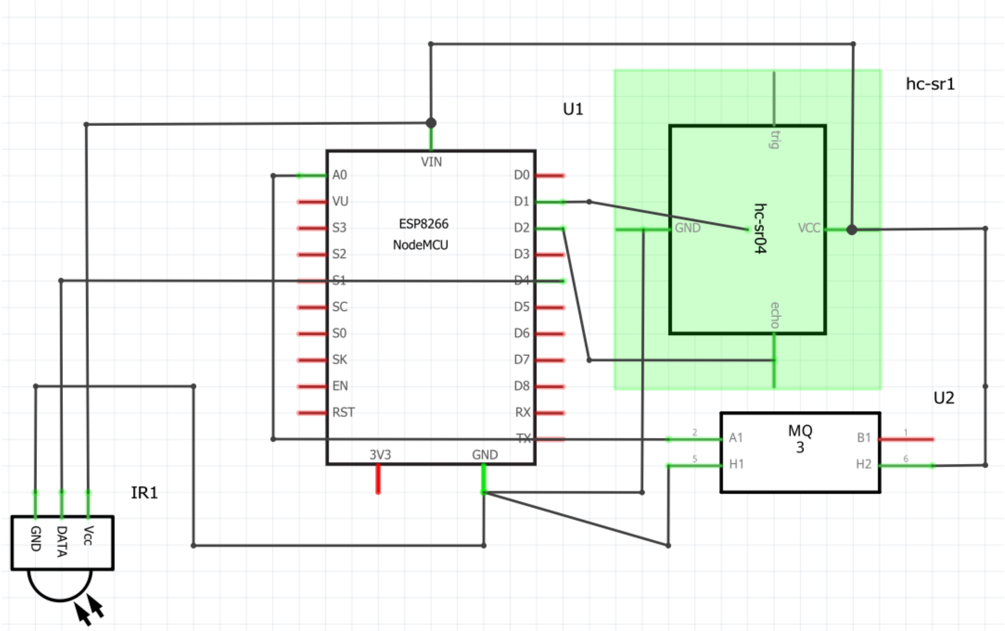


Fig 13: Semantic Diagram for Complete Circuit

5.2. Working Principle

5.2.1. Egg Counter

- Working Principle

The Ultrasonic Sensor works by sending ultrasonic waves to wards the front using a transmitter. It then records the time until the receiver senses the return wave. This calculation is then used to calculate the distance to the obstacle.

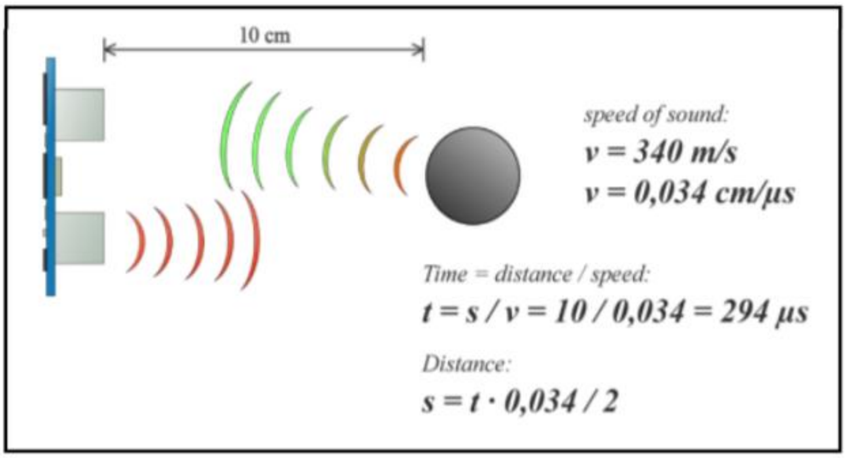


Fig 14: Egg Counter Working Principle

The egg-counter works by finding the distance between the nearest egg in the egg tray to the ultrasonic sensor. Then we have calibrated these distances to the number of eggs in the tray. For this system to work, the eggs must be organized in an orderly manner in the tray and they have to be picked up in that order.

Calibration:

Distance to Egg(cm)	No. of Eggs
2 - 5	3
7-10	2
>10	1

5.2.2. Milk Measurement

- Working Principle:

The Infrared Sensor works by sending infrared rays towards the front using a transmitter. When an object comes close to the sensor, the infrared light from the LED reflects off of the object and is detected by the receiver.

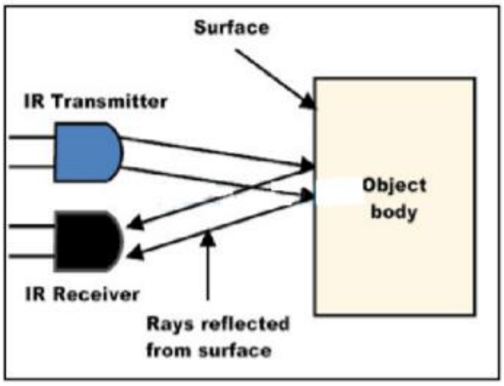


Fig 15: IR Sensor Working Principle

The Milk Measure works by attaching a IR sensor on the top of a lid of the milk jar. Then we have calibrated the distance of obstacle to about 10 cm. If no obstacle detected, that means the milk is low, if detected, milk quantity is high.

- Calibration:

Distance (cm)	Milk Quantity

<10	High
>10	Low

5.2.3. Odour Detection

- Working Procedure:

The Odour detection works by putting a MQ-135 sensor in the vegetable section of the fridge. Here, the Mq-135 sensor is used because it is capable of detecting fumes and Methane gas. Methane is usually produced by decaying matter. SO if a food item has been sitting too long in the fridge, it will produce Methane which will be detected by the sensor and an alert would be provided by the application to the user that the food has gone bad.

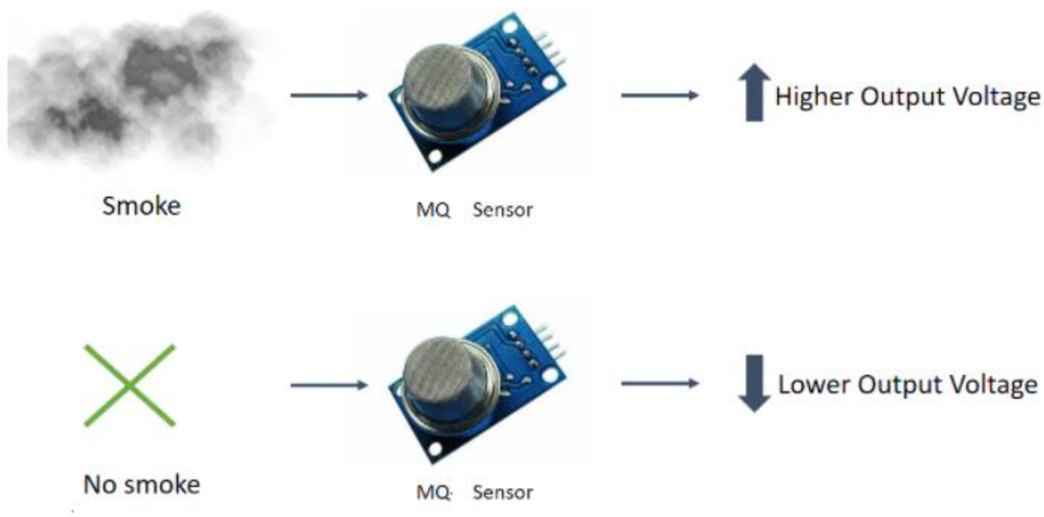


Fig 16 : Gas sensor working Principle

- Calibration:

Gas Levels	Food Rotten
<500	No
>500	Possible

5.2.4. Blynk App

Blynk is an application for iOS and Android to control micro-controllers like Arduino, Raspberry Pi, Node MCU etc over the

Internet. It provides a digital dashboard where you can build a graphic interface for your project by adding different widgets provided by the app to control the microcontrollers and show outputs on the screen.

The app will provide you with a unique authentication token that you can use in your Code in the Arduino IDE along with the Blynk Library, and it will help you to connect to your Node MCU.
Few Screenshots from the app:

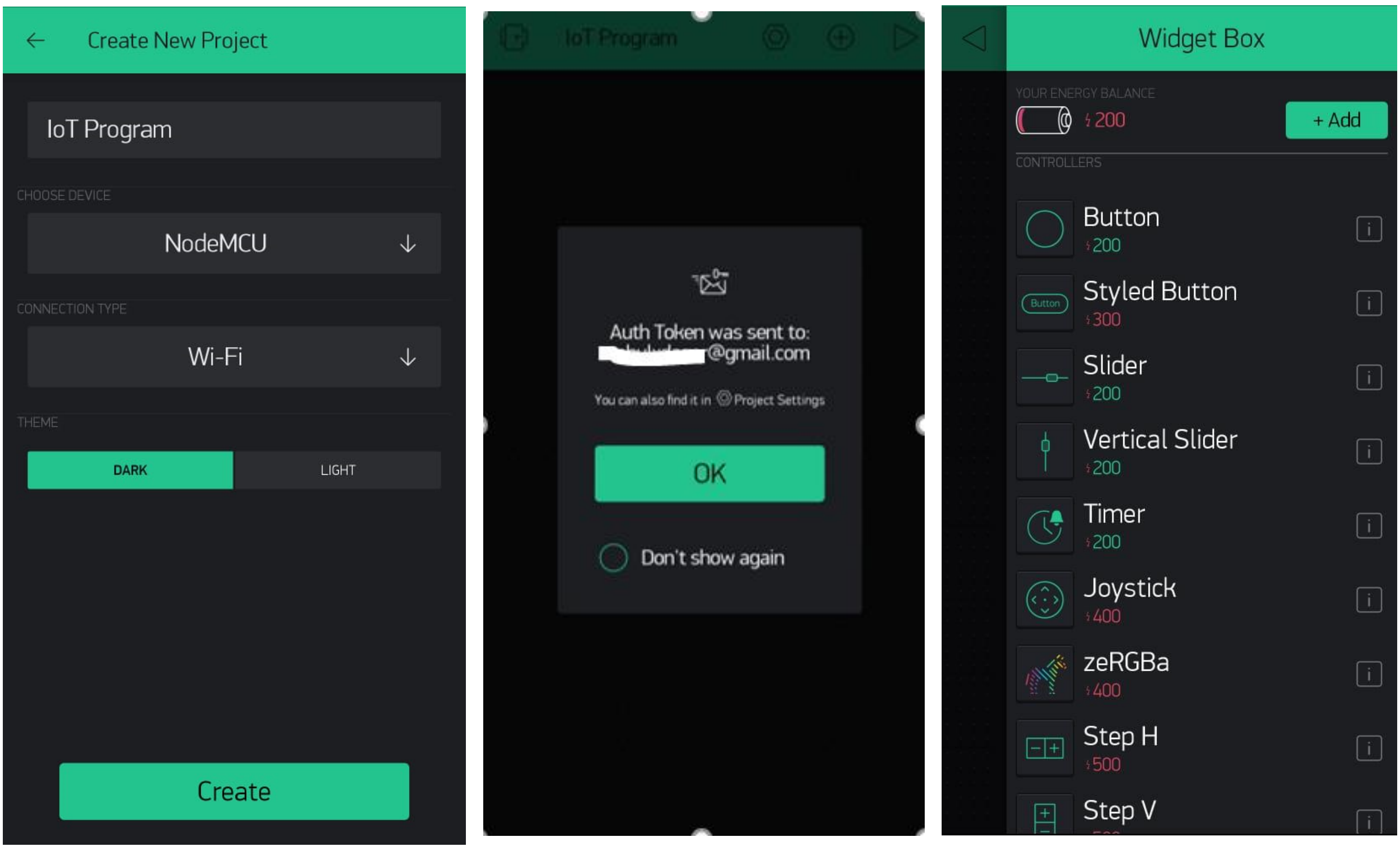


Fig: 17 Blynk App Setup

5.3. Code for the system

We use Arduino IDE to code the micro-controller. The code is given below:

```
//Rahul 18BCE0018
//Connections:
```

```
//Connect Ultra Sonic - VCC to Vin , GND to GND near Vin ,
Echo to D2, Trig to D1
//Connect Infrared - VCC to Vin , GND to GND near Vin , Out
to D4
//Connect MQ2 Gas Sensor - VCC to Vin , GND to GND near Vin
, A0 to A0;
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#define TRIGGERPIN D1
#define ECHOPIN    D2

// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
BlynkTimer timer;
int flag=0;
char auth[] = "XH8FggY90xQFzRQk";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "RAHUL";//your wifi name
char pass[] = "1234"; //your wifi password
int eggs=0;
int noti=0;
int mq2 = A0; // smoke sensor is connected with the analog
pin A0
int data = 0;
WidgetLCD lcd(V1);
WidgetLCD lcd1(V2);

void notifyOnThings()
{
  int isButtonPressed = digitalRead(D4);
  if (isButtonPressed==1 && flag==0) {
    Serial.println("Milk quantity Low!");
    Blynk.notify("Alert : Milk Quantity Low, Buy Milk!");
    Blynk.email("myemail@gmail.com", "Subject: Buy Milk",
"Milk is about to get over. Please buy Milk!");
    flag=1;
  }
  else if (isButtonPressed==0)
  {
    flag=0;
  }
}
```

```
int calceggs()
{
   // use: (position X: 0-15, position Y: 0-1, "Message you
want to print")
  long duration, distance;
  digitalWrite(TRIGGERPIN, LOW);
  delayMicroseconds(3);
  digitalWrite(TRIGGERPIN, HIGH);
  delayMicroseconds(12);
  digitalWrite(TRIGGERPIN, LOW);

  duration = pulseIn(ECHOPIN, HIGH);
  distance = (duration/2) / 29.1;
  if (distance <= 5 && distance>=2) {
  eggs=3;
  Serial.println("No. of Eggs: 3");
  }
  else if (distance >=7 && distance<=10) {
    eggs=2;
  Serial.println("No. of Eggs: 2");
  }
  else {
    Serial.println("No. of Eggs: 1");
    eggs=1;

  }
  return eggs;
}
void getSendData()
{
  data = analogRead(mq2);
  Blynk.virtualWrite(V4, data);
   if (data > 500 )
  {
    Blynk.notify("Fumes Detected : Possible Rotten Food!");
    Blynk.email("myemail@gmail.com", "Subject: Food has
Rotten", "Your Vegeables and Fruits in the Vegetable
compartment has gone bad. Buy fresh vegetables.");

 }
}
void setup()
{
  // Debug console
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
```

```
  pinMode(D4,INPUT_PULLUP);   //For IR Sensor
  timer.setInterval(1000L,notifyOnThings);
  timer.setInterval(1000L, getSendData); //For Gas Sensor
  pinMode(TRIGGERPIN, OUTPUT);  //For Ultra sensoor
  pinMode(ECHOPIN, INPUT);

  lcd.clear(); //Use it to clear the LCD Widget
  lcd1.clear(); //Use it to clear the LCD Widget
  lcd.print(0, 0, "No of Eggs:");
  lcd1.print(0, 0, "Milk Quantity:");

}
void loop()
{ int num=0;
  int milk;

  //Display and Alert for Milk
  lcd1.clear();
  milk=digitalRead(D4);
  lcd1.print(0, 0, "Milk Quantity:");
  if(milk==0)
  {
    lcd1.print(7, 1, "High");
  }
  else
  {
    lcd1.print(7, 1, "Low");
  }
  //Display and Alert for eggs
  lcd.clear();
  lcd.print(2, 0, "Eggs in tray");
  num=calceggs();
  lcd.print(7, 1, num);
  if(num>1){
    noti=0;
  }
  if(num<2 && noti==0){
    Blynk.notify("Alert : Only 1 Egg left! Buy Eggs");
    Blynk.email("myemail@gmail.com", "Subject: Buy Eggs",
"Only 1 Eggs is left. Buy More Eggs!");
    noti=1;
  }
  Blynk.run();
  timer.run();
  delay(1000);
}
```

6. RESULTS

We have implemented the circuits shown above with hardware and got the desired results as expected. We managed to connect our proposed IoT network with the internet and control the smart fridge with an app. Following are some photos of the hardware implementation.

1. **Photo of the entire system.**

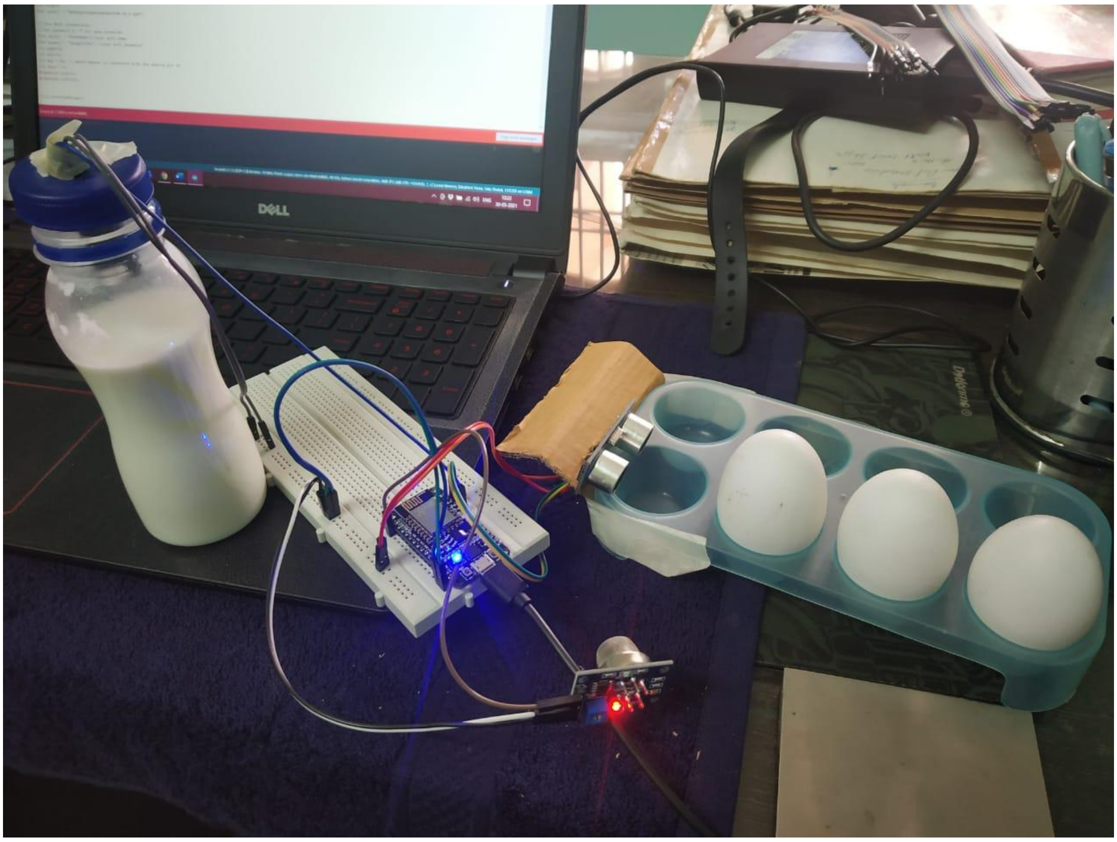


Fig: 18 Complete Hardware Setup

2. **Egg counter**

The Ultrasonic sensor is mounted to the egg tray to make it a smart egg tray.

Fig: 19 Eggs Full

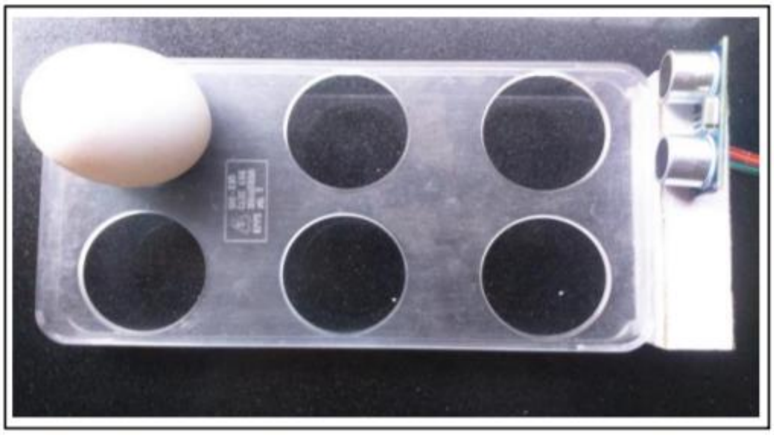
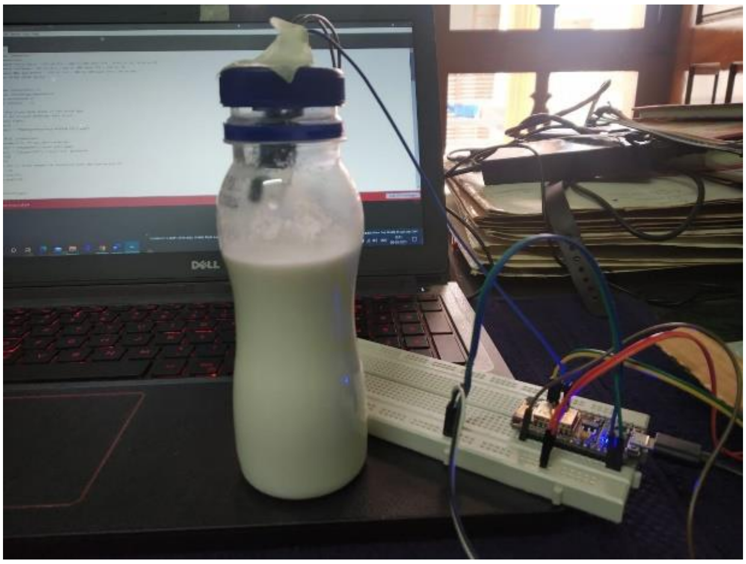


Fig 20 : Threshold Reached

3. Milk Measurement

For milk measure, an infrared sensor is mounted on the lower bottom of the bottle or jar lid.

Fig 21: Milk Measurement Setup



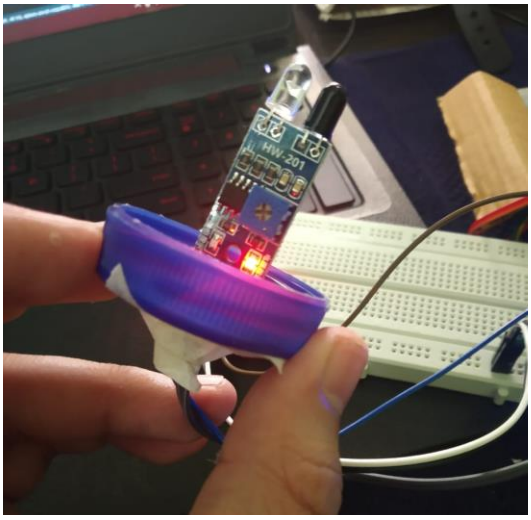


Fig 22: IR Sensor Mounted on Bottle Cap

4. Odour detection: Rotten food.

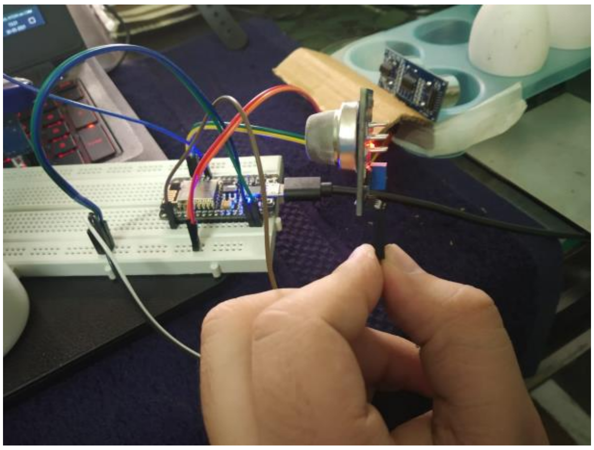


Fig 23: Mq-135 gas sensor setup

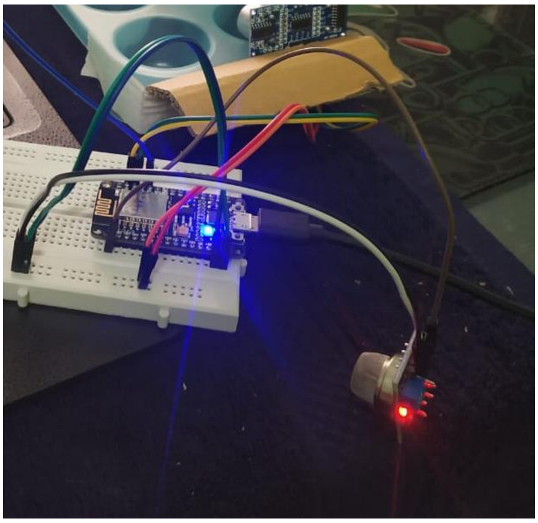
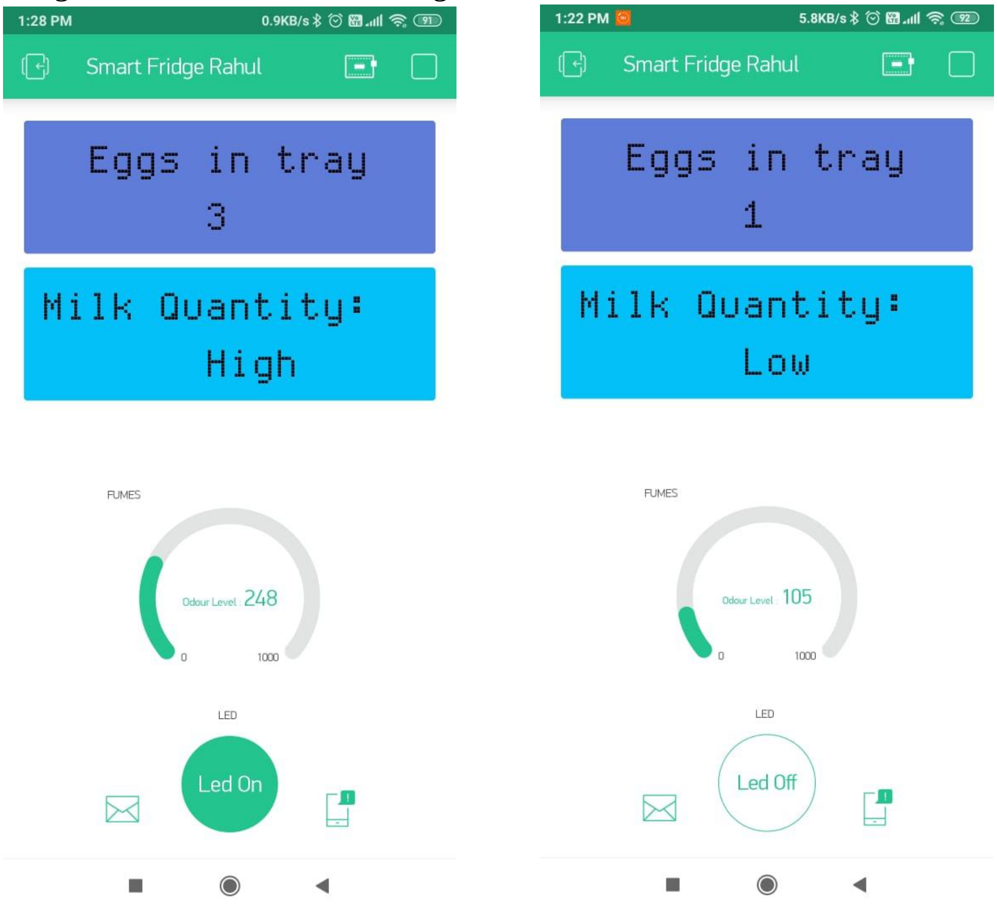


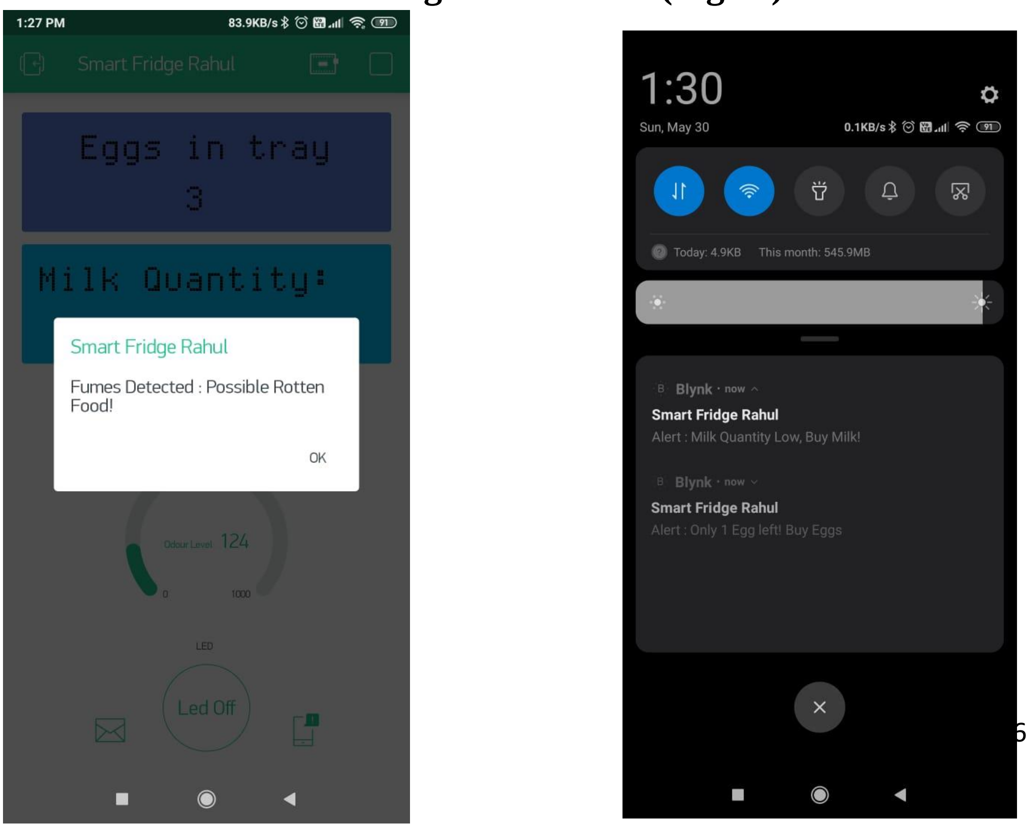
Fig 24: Mq-135 gas sensor setup

5. Mobile App to control the system.

Fig: 25 Status of the Smart Fridge



Alerts Notifications during the events: (Fig 26)



Automatic Email alerts to buy grocery or during rotten food:

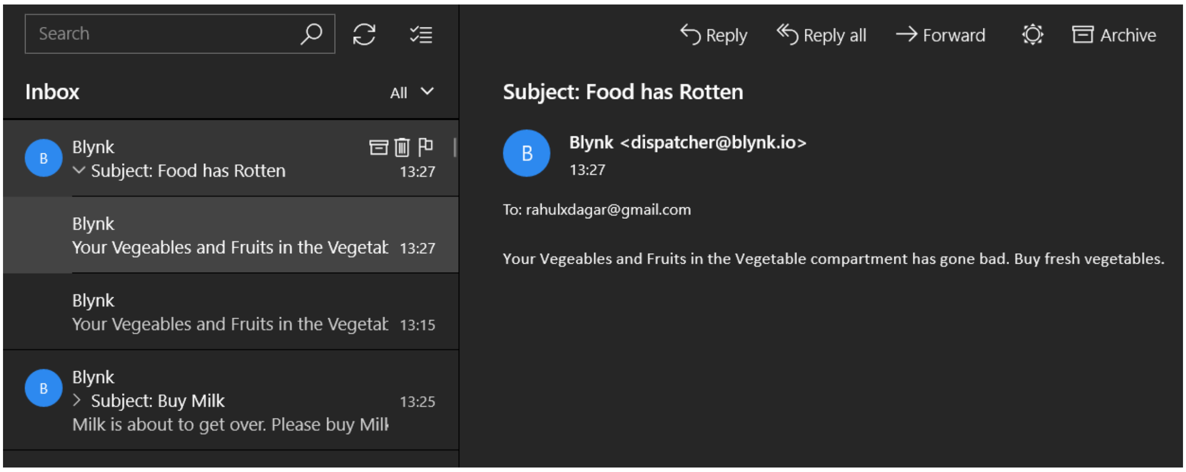


Fig 27: Email Alert When Food is rotten

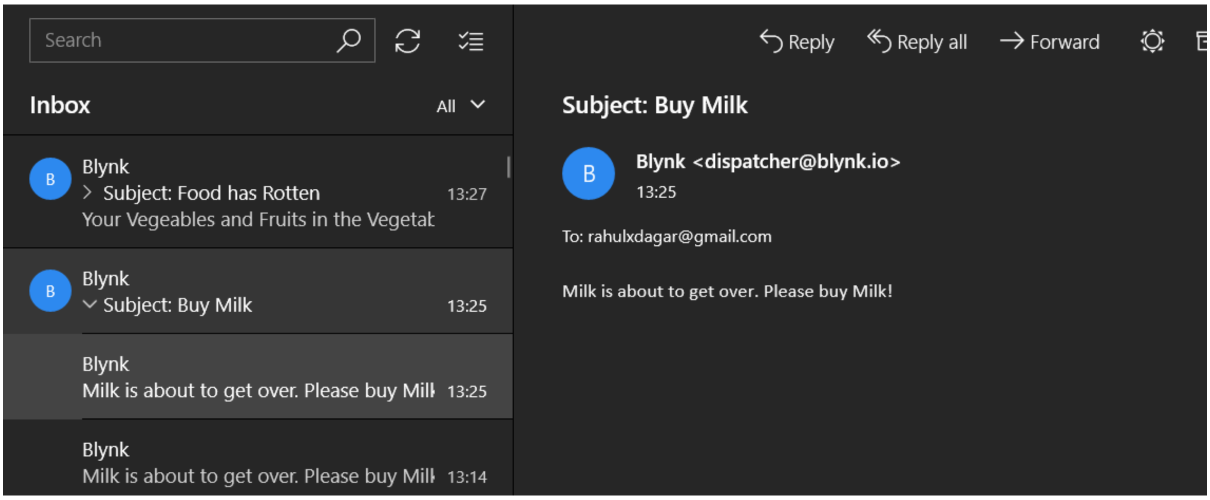


Fig 28: Email Alert to buy milk

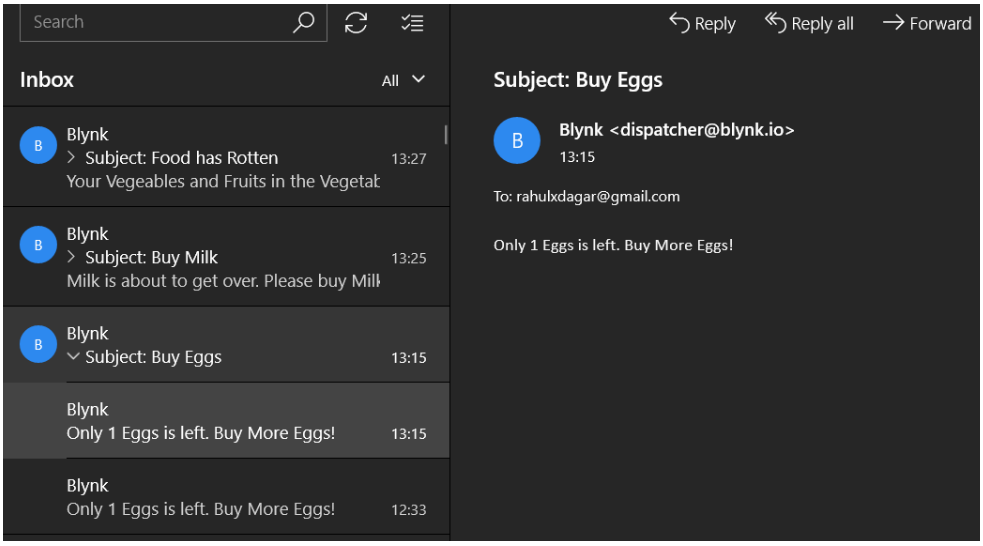


Fig 29: Email alert to buy more eggs.

REFERENCES

Base Paper :

1. M. Bayya, "Low cost Smart Refrigerator," TENCON 2019 - 2019 IEEE Region 10 Conference (TENCON), Kochi, India, 2019, pp. 1702-1705, doi: 10.1109/TENCON.2019.8929291.

Other References:

2. H. Wu and Y. Chuang, "Low-Cost Smart Refrigerator," 2017 IEEE International Conference on Edge Computing (EDGE), Honolulu, HI, 2017, pp. 228-231, doi: 10.1109/IEEE.EDGE.2017.41.
3. Aurel-Dorian Floarea; Valentin Sgârciu, “Smart refrigerator: A next-generation refrigerator connected to the IoT”, 2016 8th International Conference on Electronics, Computers and Artificial Intelligence (ECAI).
4. Shouming Qiao; Hongzhen Zhu; Lijuan Zheng; Jianrui Ding, “Intelligent Refrigerator Based on Internet of Things”, 2017 IEEE International Conference on Computational Science and Engineering (CSE) and IEEE International Conference on Embedded and Ubiquitous Computing (EUC).
5. Suhuai Luo; Hongfeng Xia; Yuan Gao; Jesse S. Jin; Rukshan Athauda, " Smart Fridges with Multimedia Capability for Better Nutrition and Health", 2008 International Symposium on Ubiquitous Multimedia Computing.
6. Victor R. Kebande; Nickson M. Karie; Antonia Michael; Semaka M.G. Malapane; H.S. Venter, " How an IoT-enabled “smart refrigerator” can play a clandestine role in perpetuating cybercrime", 2017 IST-Africa Week Conference (IST-Africa).
7. Deepti Singh, Preet Jain, “IoT Based Smart Refrigerator System”, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Volume 5, Issue 7, July 2016.
8. Emily Moin, "Smart Refrigerator for Grocery Management", Technical Disclosure Commons, Defensive Publication Series, May 05, 2015.