A Project Report

(Review III report)

On

Perishable Food Detector

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For

New Product Development

MEE1009

Slot: E2, J Component

B.Tech. in Computer Science and Engineering

VIT®

Vellore Institute of Technology

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

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Acknowledgement

We would like to express our profound gratitude to Dr. Devendranath Ramkumar, Dean of SMEC department for allowing us to complete our project. We would like to express our special thanks to our mentor Dr. V J Sridhar, of SMEC department for his time and efforts he provided throughout the semester. Your useful advice and suggestions were really helpful to us during the project's completion. In this aspect, we are eternally grateful to you. We would also like to extend our thanks to our family and friends for their support, guidance and motivation without which we couldn't have completed the project. We would like to acknowledge that this project was completed entirely by our group.

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PAIN POINT:

Perishable foods are those likely to spoil, decay, or become unsafe to consume if not kept refrigerated at 40 °F or below, or frozen at 0 °F or below. Examples of foods that must be kept refrigerated for safety include meat, poultry, fish, dairy products, and all cooked leftovers. Various factors cause food spoilage, making items unsuitable for consumption. Light, oxygen, heat, humidity, temperature, and spoilage bacteria can all affect both the safety and quality of perishable foods. When subject to these factors, foods will gradually deteriorate.

Spoilage of food leads not only to monetary losses but consuming food that is spoilt could lead to health problems and diseases like Norovirus, Salmonella, Clostridium perfringens, Campylobacter, and E. coli. Children are among the most affected by the food that is spoilt. Reports across India show that nearly 40% of the food produced in India is wasted in a year due to fragmented food systems and inefficient supply chains. All sections and stakeholders in the food industry suffer from the same.

A significant portion of the food waste wasted due to unnecessary decaying was still in edible condition. Recent surveys also show that nearly half of perishable food products produced are wasted thanks to the inadequate maintenance of the environment where the food is kept/ housed. As per studies by experts from the University of Birmingham, a dire lack of a sustainable cold chain contributes to 4.4 billion GBP worth of fruit and vegetables being wasted annually in the Asian region.

EXISTING SOLUTION:

The existing solutions include the use of the human sense of touch, smell, taste, and sight to recognize if the food is spoiled or not. Spoiled food emits odour and could be slimy to touch, also they could be discoloured and the formation of mold can also be used to detect whether the food is spoiled or not. Some advanced methodologies include using chemically responsive dyes that change colour when exposed to particular compounds (gases). Some techniques use peptides that grab onto volatile chemicals and change the way light travels through it branch and thus create a pattern that is analyzed to find if the food item is spoiled. Another common method is to review the expiry dates to check for spoiled food.

- MRE time-temperature indicator
- Food shelf life testing labs
- Vitsab's FreshTag TTI indicator
- RipeSense indicator to indicate the ripeness of the fruit

- FoodSniffer is a handheld gizmo that measures the levels of gases given off by raw meat and fish. Price: 10,000/-

OUR ADVANTAGE

- As the proposed IoT project takes 3 different parameters into consideration, the device provides accurate results and remains cost-effective and handy due to the use of Arduino sensors.
- Since the device is hand-held, it is user-friendly.
- There are currently no patents filed/granted for our product therefore there wont be any entry barrier.

OBJECTIVE:

Food safety & hygiene are pressing concerns to prevent rampant food wastage in our everyday life. We must regularly check and prevent the decay of our perishable food. Therefore, it is helpful to employ some smart quality monitoring devices at food stores and vegetable markets. As part of this project, an IoT framework will be developed to facilitate the process of food monitoring in order to protect perishable food products such as fruits and vegetables from contamination/ spoilage during storage and transportation. In the current scenario, the output achieved by many such systems is in terms of the sensed values that have been recorded; however, advanced automated/controlled IoT systems are not widely present in the industry. The proposed IoT-based solution analyses temperature, moisture, and exposure to gases as these conditions affect fruits and vegetables' nutritional value & makes the analytical result accessible to the user via a mobile application. The system will not only monitor the temperature and humidity of the surroundings but also monitor the gas levels coming out of the food, to indicate when the food is about to get spoiled. If the concentration of gases crosses the threshold set in the program, we can consider the food as spoilt and summarily discard it. This IoT device sends the measured real-time sensor data to an IoT platform. The data is accessible to the user via a mobile application. The aim of the project is to eliminate the wastage of food in our society. Through this project, we wish to minimize the food spoilage & food wastage process common in vegetable & fruit markets, as well as, in our homes, through an easy-to-use IoT prototype.

LITERATURE REVIEW:

1. A Zompanti and others published a paper, "A Sensor System for Non-Destructive Monitoring of Food Ripening Processes," in the 'IEEE International Workshop on Metrology for Industry 4.0 & IoT, 2020.' carried out the experiment where dry-cured ham was selected as a food product for the pilot study. The aroma sample was analyzed

with a gas sensor array based on quartz microbalances. The sensor system was also able to identify meat origin and place of ripening. They uploaded the classification model to the cloud and moved the sensors inside the sampler-tester.

2. A Prajwal and others published a paper, "Food Quality Detection and Monitoring System" in the 'IEEE International Students' Conference on Electrical, Electronics and Computer Science (SCEECS), 2020' & proposed that this paper represents the use of various sensors in the field of the food industry. The sensors like pH sensor, gas sensor, and temperature sensor help identify the condition of food. This system makes an influential presence in restaurants, households, and small-scale industries.

3. Shivani Bhandari and others published a paper "IoT Based Smart Food Monitoring System" in the 'International Journal of Current Engineering and Scientific Research (IJCESR), 2019' & this paper shows how to analyze temperature, moisture, and light as these parameters affect the nutritional values of food items such as fruits and vegetables & other presents the sensor data to the consumer.

4. P. Sundaravadivel and others published a paper, 'Smart-Log: A Deep-Learning Based Automated Nutrition Monitoring System in the IoT' in the 'IEEE Transactions on Consumer Electronics, 2018' & this paper presents a new IoT-based fully automated nutrition monitoring system, called Smart-Log. For the realization of Smart- Log, a novel 5-layer perceptron neural network and a Bayesian network-based accurate meal prediction algorithm were discussed.

5. SV Dusenko published the paper "Digital Technology in Ensuring the Safety of Food Services in the Hospitality Industry" in the 'IEEE International Conference "Quality Management, Transport, and Information Security, Information Technologies" (IT&QM&IS), 2018' & this paper is based on the principles of HACCP & discussed the systematic monitoring of the state of products and processes at all stages of the life cycle production, storage, transportation, sale and disposal of food products.

6. Liliana G Fidalgo, Mauro D Santos and others published a paper called “Hyperbaric storage at and above room temperature of a highly perishable food” in the Food and Bioprocess Technology, 2013 which proposed hyperbaric storage as a possible new food preservation method.

7. H Nasir and others published a paper "The Implementation of IoT Based Smart Refrigerator System" in the '2nd International Conference on Smart Sensors and Application (ICSSA), 2018' & this paper presented three modules of the IoT system which work as follows: sensing module which consists of load cell and odour sensor while control module consists of Arduino UNO & power supply unit and last but not least, the transmission module consists of the LCD module and Wi-Fi module. These modules work together to determine the status of the content inside the refrigerator and notify the user.

8. P. P. Ray and others published a paper called "IoT Based Fruit Quality Measurement System" in the 'Online International Conference on Green Engineering and Technologies (IC-GET), Coimbatore, India, 2016' & this paper is based on an IoT platform for acquiring, storing and analyzing nutrients in food data. The experimental results are based on the analysis of 8172 items for 1000 foods, with 98.6% classification accuracy.

9. Huy Quoc Nguyen and others published a paper called “Carbon nanotube-based gas sensor for expiration detection of perishable food” in IEEE-NANO 2013 in which they proposed analyzing the levels of CO2 that is released by food products to check the freshness of the food. The CO2 levels were monitored using Carbon Nanotubes as sensing elements and these were integrated onto silicon-based circuits.

GOOGLE PATENTS:

1. https://patents.google.com/patent/US20180045700A1/

   The computing system can determine whether at least one perishable food item within the range of the moisture sensors is damaged or decomposing based on the amount of moisture detected.

2. https://patents.google.com/patent/WO2016087084A1/

   The present invention relates to a refrigerator (1) comprising a storage unit (3) wherein a single type of foodstuff such as vegetables, fruits or meat is stored, a gas sensor (4) that detects the organic compounds diffusing into the medium from the foodstuffs placed into the storage unit (3), a weight sensor (5) that detects the amount of foodstuffs placed in the storage unit (3), a temperature sensor (6) that detects the temperature in the storage unit (3) and a control unit (7) that compares the limit organic compound amount (VOCmax) determined by means of the measurements of the weight sensor (5) and the temperature sensor (6) with the organic compound amount (VOC) measured by the gas sensor (4).

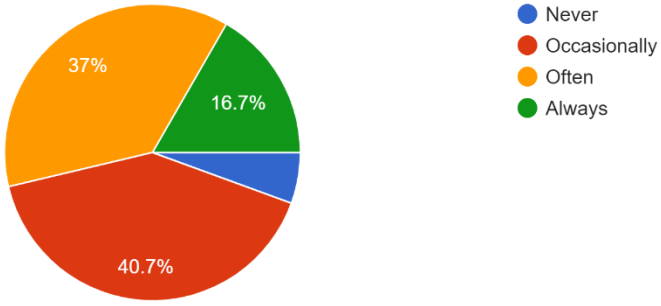
3. https://patents.google.com/patent/WO2017172444A1/

   Determining, using a processor, a freshness level of the perishable goods based on the at least one environmental parameter; and displaying, using a monitor, an alert identifying the at least one sensor that detected the at least one environmental parameter outside the selected range.

SURVEY:

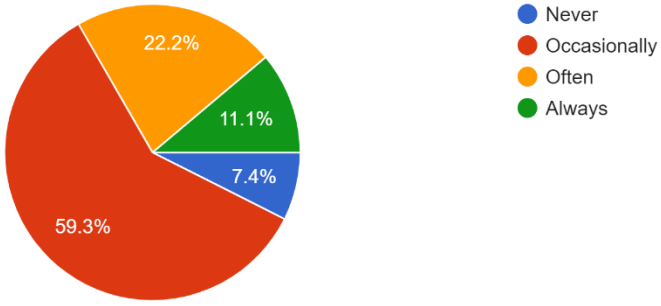
How often do you buy short shelf life food?

54 responses



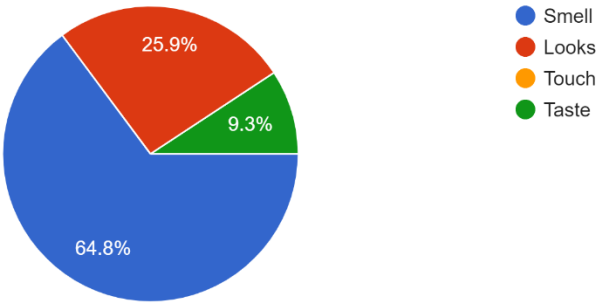
How frequently do you throw food because it's rotten?

54 responses



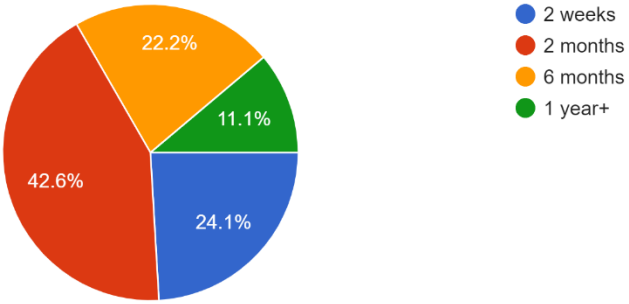
How do you come to the conclusion that a food item is spoilt?

54 responses



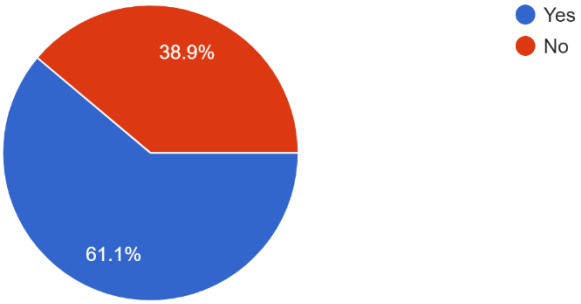
How often do you clean out your refrigerator?

54 responses



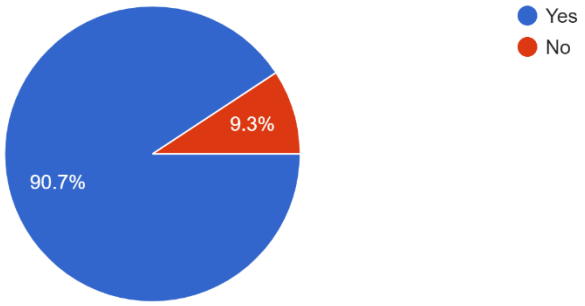
Do you put fruits and vegetables in one compartment?

54 responses



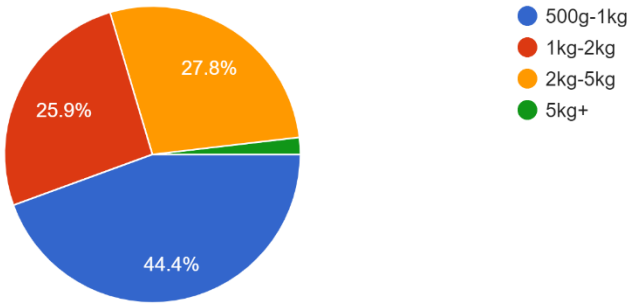
Do you believe in expiry dates?

54 responses



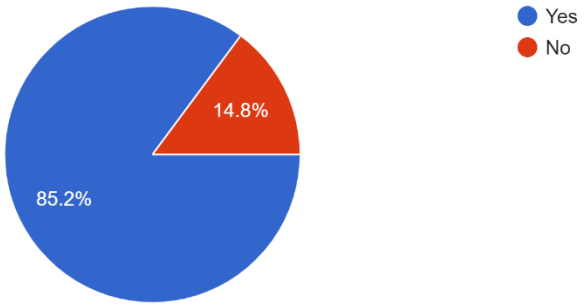
On an average how much perishable food do you waste in a week?

54 responses



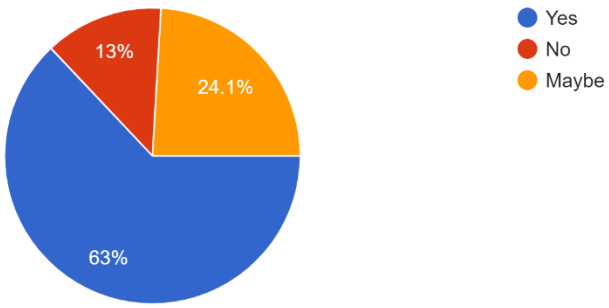
Have you experienced any discomfort after consuming spoilt food?

54 responses



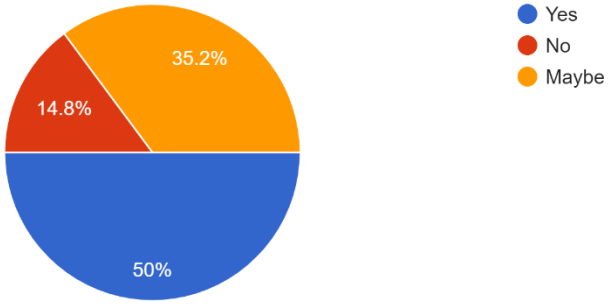
Do you feel the need for a device to detect when a food is perishing?

54 responses



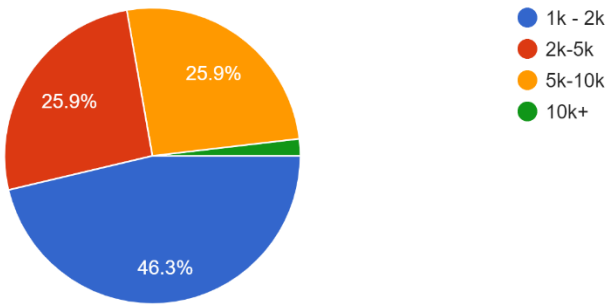
Would you be willing to spend money on such a product?

54 responses



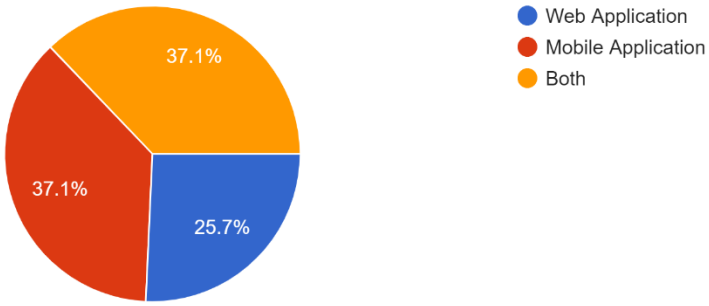
If yes, How much would you be willing to spend?

54 responses



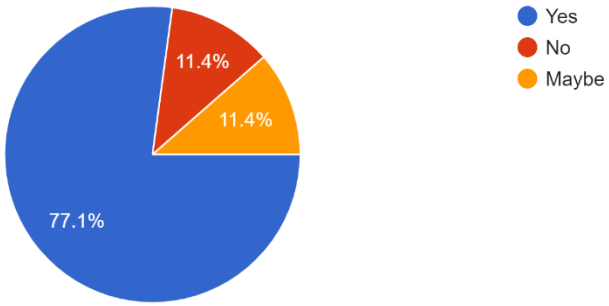
Do you prefer a web application or a mobile application to monitor the food through this invention?

35 responses



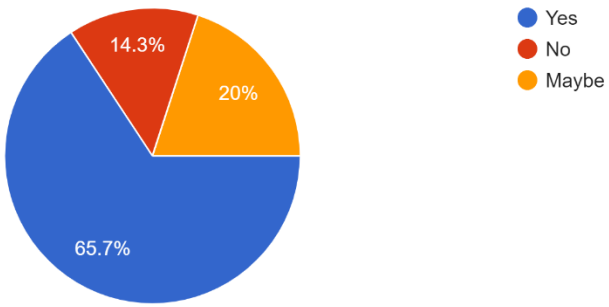
Do you feel that a notification would be useful when the food as gone rotten?

35 responses



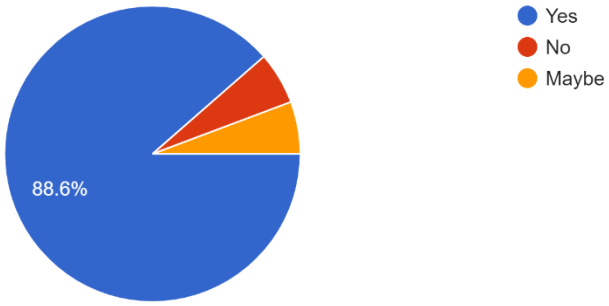
Would an alarm be useful to detect if the food is spoiled?

35 responses



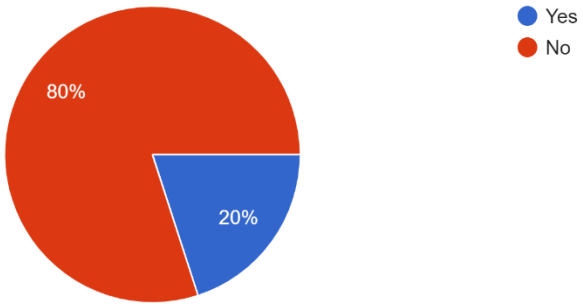
Do you feel the need to integrate this invention within a fridge?

35 responses



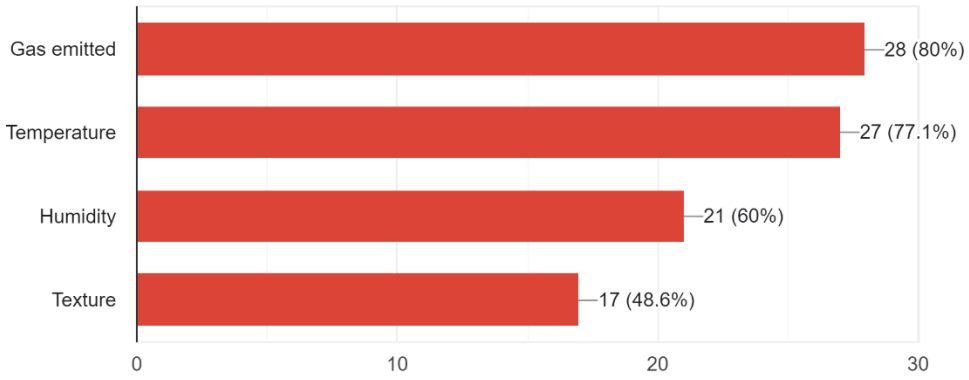
Have you heard of perishable food detection device before?

35 responses



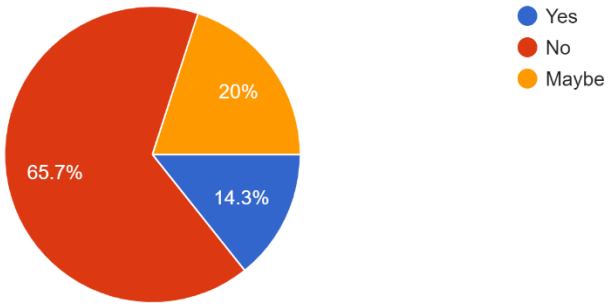
Which all parameters do you think should be considered while implementing the device?

35 responses



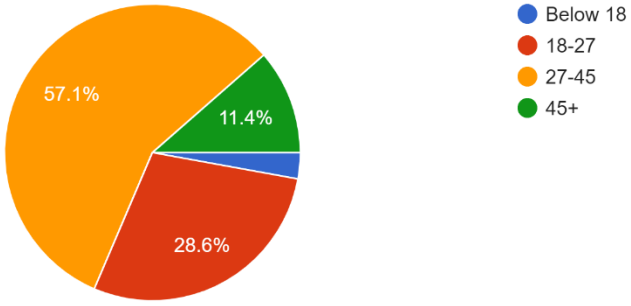
Do you think such an innovation can cause harm to the environment?

35 responses



Which age group do you think will make the appropriate consumer for this innovation?

35 responses



Interpretation:

It is clear from the survey that a majority of the consumers purchase food with a short life span regularly and often tend to throw it away as they have gone spoiled. It is also clear that people tend to rely on the smell of the food to check if it is still edible.

The average wastage of perishable food per week is around 2.5kg with some even claiming to be wasting around 7kg per week. It is also clear that when people have consumed spoiled food, they have experienced discomfort and thus they feel the need for a device that can detect if the food is still fresh. Most consumers are ready to spend money (around 2k – 5k on average) for such a device and also feel such devices should be integrated into refrigerators for ease of use.

Most respondents prefer both a web application and a mobile application to monitor the food and feeling notification and an alarm when the food is going rotten would be useful. Most users have not heard of a perishable food detection device and this opens up the possibility to

commercialize the product. The survey brought to light the fact that people believe the fact that this innovation would not cause any environmental damage and that this device could help the working age group (18 - 45) the most. The majority of the respondents felt the need to use multiple parameters such as gas emitted, temperature, and humidity to detect if the food item is spoiled or not.

GAP:

The existing techniques to detect whether a food item is spoiled or not are susceptible to human errors as they make use of human senses and thus are not fully accurate. Further the scientific methods are sophisticated to design and costly to implement as they use peptides and a wide variety of dyes. Utilizing the Internet of Things in the food supply chain (FSC) enhances the quality of life by tracing and tracking the food condition and live sharing the obtained data with the consumers or the FSC supervisors.

Currently, the complete application of IoT in the FSC is still in the developing stage, and there is a big gap for improvements. Thus, there is space for a development that is accurate and cost-effective at the same time. Since the proposed IoT project takes 3 different parameters into consideration, the device provides accurate results and remains cost-effective and handy due to the use of Arduino sensors. The handy nature of this device makes it perfect to be used within refrigerators to detect if the food is going rotten. Most users have not heard of a perishable food detection device and this opens up the possibility to commercialize the product and target the users who would want to try it out to prevent wastage and health issues.

VALUE PROPOSITION:

1. Reduce the amount of food wasted and thus reduce monetary losses. An average of 68 percent of all food discarded (as tracked in kitchen diaries) was potentially edible.

2. Remote monitoring and surveillance of perishable food items. Warnings and alert notifications to detect food spoilage and thus prevent diseases.

3. It is an one time investment that could save the user from repeated wastage of money by purchasing food under the assumption that food has been spoilt.

4. Device helps user in detecting whether a food is edible or is spoilt thus preventing infections and diseases.

WORKING METHODOLOGY:

The device consists of a power supply unit, Node MCU Wi-Fi module, DHT11 sensor, LED/ buzzer, MQ4 sensor, etc. Hardware implementation deals with drawing the schematic on paper according to the application, testing the schematic design over the breadboard to find if the design meets the objective, interfacing the sensors with the Node MCU and then, testing the designed hardware.

The firmware part deals in programming the microcontrollers to control the operation of the sensors and other electronic components used in the implementation. In the present work, we briefly used the Orcad design software for basic circuit design, alongside the Arduino software development tool, to write and compile the source code, which has been penned down in the Embedded C language.

This system will not only monitor temperature and humidity around the food item but also keep track of the methane gas amount coming out of the food. If the concentration of gases crosses the threshold, we can consider the food rotten. This IoT system sends the measured real-time sensor data to an IoT platform. The data is accessible via a mobile application. The ESP8266 Wi-Fi Module is interfaced with the sensors for it to be able to connect to the internet via Wi-Fi Router.

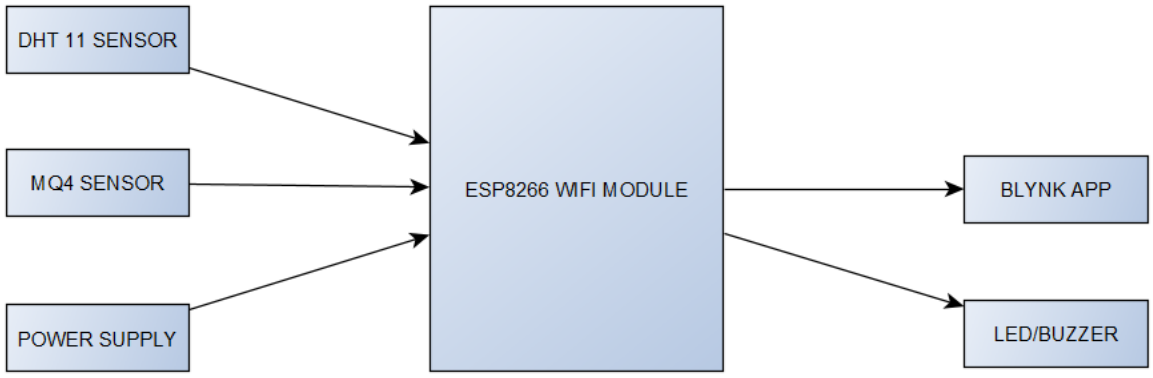
The two main sensors - MQ4 and DHT11 are interfaced with the Node MCU. The sensor data is then sent to the Node MCU by serial communication. This sensor data is then uploaded to the Blynk IoT platform using the ESP8266 WiFi Module. The sensor values are displayed to the user through the app under normal conditions. When the values exceed the pre-set conditions and the food may be spoilt, the user gets an alert notification on Blynk app.

When the values cross the threshold (around 350 ppm for methane), red LED also glows near the food to help the user locate it. The user can then take action about the spoilt food/change its surrounding conditions, based on the glowing LED and the alert notification. Once the system is effectively installed and powered on, it connects to the internet via the Wi-Fi modem and starts reading data from the interfaced sensors – DHT-11 temperature and humidity sensor and MQ4 Sensor. DHT-11 Temperature and Humidity Sensor is a digital sensor with inbuilt capacitive humidity sensor and a thermistor. The MQ4 sensor detects the emission of ethanol type of gases. In our project, it detects release of methane gas, CH4.

If the fruit chosen get spoiled, it would emit CH4 gas. This sensor detects the concentration of such gases and gives an output of an analog voltage proportional to the concentration of the methane gas. The analog output is passed to the analog pin of the Node MCU which has an inbuilt analog-to-digital converter that converts the analog value to a corresponding digital value, ready for transfer to the cloud. The ESP module collects data from all the sensors and convert the values to necessary strings. The ESP8266 uploads the data to Blynk App.

INPUT	ACTIVITIES	OUTPUT
DTH 11 Sensor	Detects humidity and temperature	Temperature and humidity readings
MQ4 Sensor	Detects emission of ethanol types of gas	Detects release of methane gas
ESP8266 Wifi Module	Uploads sensor data to Blynk app	Data uploaded to the App
ESP8266 Wifi Module	Controls operation of sensors	Analog values of methane gas are received from MQ4 sensor and digital values of temperature and humidity are received from DHT11 sensor ready to transfer to Blynk app
LED/Buzzer	Blinks when values cross threshold	Blue LED glows and buzzer goes on when spoilage detected

BLOCK DIAGRAM:



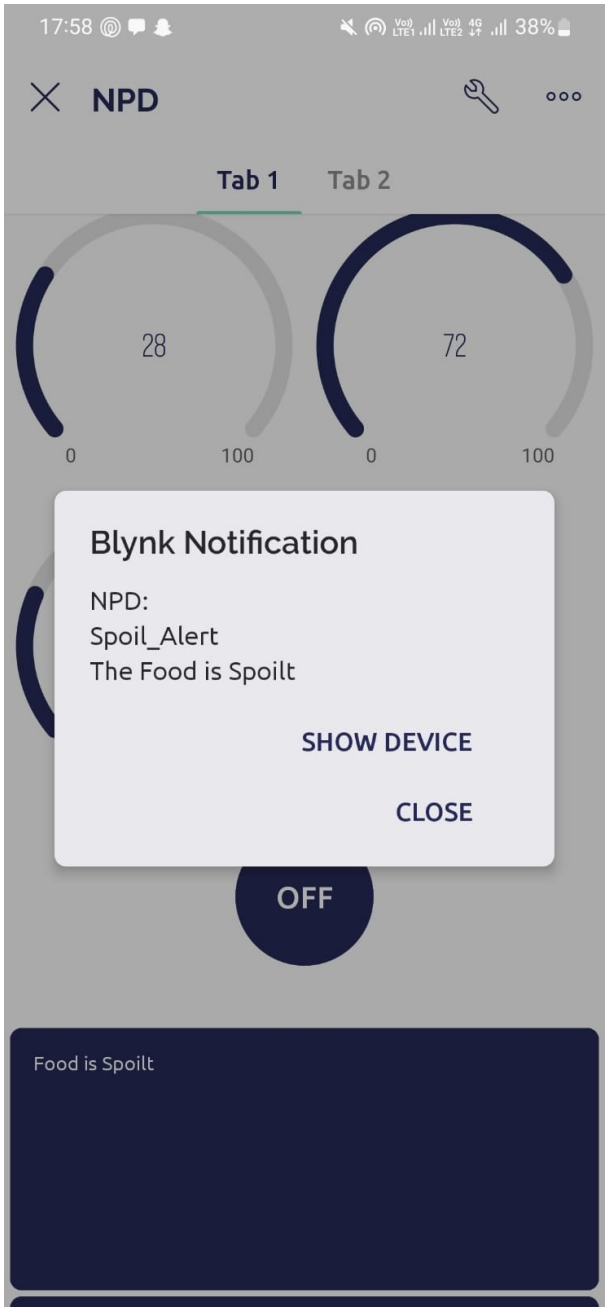
CODE:

```
#define BLYNK_TEMPLATE_ID "TMPLIOY3kvUU"
#define BLYNK_DEVICE_NAME "NPD"
#define BLYNK_AUTH_TOKEN "MbSQCmgF3saysAsegGHG9Os52YSbPhN9"

#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>


#include <DHT.h>
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "Aadharsh";  // type your wifi name
char pass[] = "A@567890";  // type your wifi password
#define DHTPIN 12          // Mention the digital pin where you connected
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

BlynkTimer timer;


void sendSensor(){

  float h = dht.readHumidity();
  float t = dht.readTemperature(); // or dht.readTemperature(true) for Fahrenheit
  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  float gas;
  gas=analogRead(A0);


  Blynk.virtualWrite(V1, h);
  Blynk.virtualWrite(V0, t);
  Blynk.virtualWrite(V2, gas);
    Serial.print("Temperature : ");
    Serial.print(t);
    Serial.print("    Humidity : ");
    Serial.print(h);
    Serial.print("    Gas: ");
    Serial.println(gas);


  if(t > 20 && gas>630){
   // Blynk.email("shameer50@gmail.com", "Alert", "Temperature over 28C!");
    Blynk.logEvent("spoil_alert","The Food is Spoilt");
    Blynk.virtualWrite(V3,"Food is Spoilt");
    digitalWrite(5,HIGH);
```

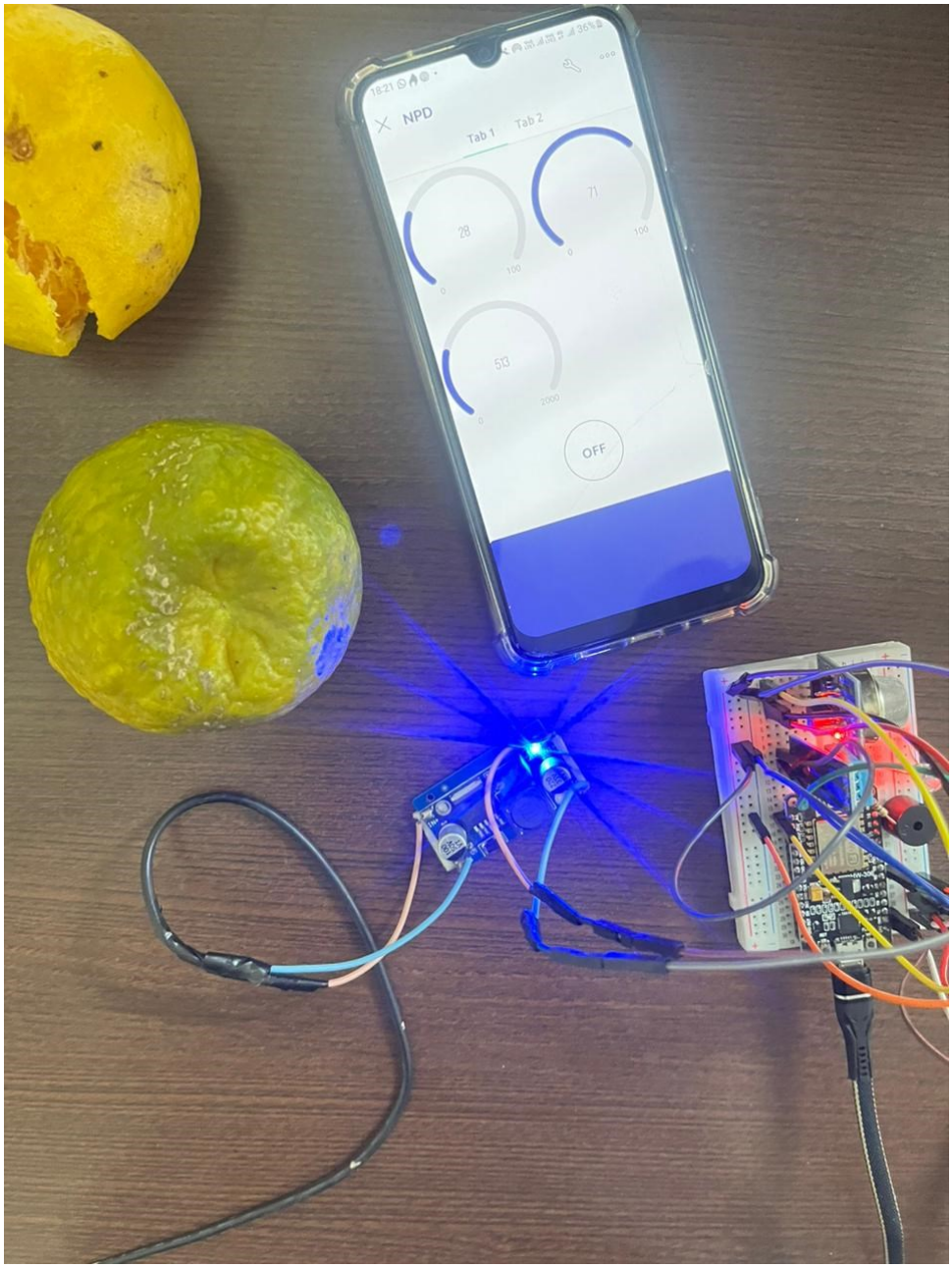
```
    digitalWrite(4,HIGH);
    delay(500);
    digitalWrite(5,LOW);
    digitalWrite(4,LOW);
  }

  else{
    Blynk.virtualWrite(V3,"Food is safe to consume");
  }
}

BLYNK_CONNECTED(){
  Blynk.syncVirtual(V4);
}

BLYNK_WRITE(V4){
    int pinvalue=param.asInt();
//    Serial.print("Slider value is: ");
//
//    Serial.println(pinvalue);

    if(pinvalue==1){
        Serial.println("The Device is ON");
//      timer.setInterval(2500L, sendSensor);
         sendSensor();
    }
    else{
      Serial.println("The Device is OFF");
    }



}
void setup(){
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
  pinMode(5,OUTPUT);
  pinMode(4,OUTPUT);
  dht.begin();
}



void loop(){
 Blynk.run();
 timer.run();

}
```

OUTPUT:

BLYNK APP NOTIFICATION:



DEVICE:



CONCLUSION:

Perishable food detector could prove a game changer in the food supply chain industry by preventing wastage of food products. It helps to detect spoilt food and thus can ensure that food that is worthy of consumption is not wasted unnecessarily. It can also prevent the spread of diseases caused by the consumption of spoiled food. This IotT device can detect food that has been spoiled by measuring its methane gas ppm and its temperature and humidity and inform the user that the food has been spoilt through a buzzer and through the notification in the Blynk app. In the future a dedicated app could be developed for this device and could be made more easily accessible to all the users. Through this project, food spoilage & food wastage common in vegetable & fruit markets, as well as, in our homes, can be eliminated.