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Sensor Based Industrial Kitchen Foodstuffs Monitoring System

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Abstract: Artificial Intelligence based foodstuff monitoring system is used for inventory management in industrial kitchens, restaurants, canteens, vegetable stores and so on. If the store keeper is not available to monitor the grocery and orders, the process will be risky. The proposed method considers the level estimation detection using ultrasonic sensor and if the container is empty then the information is sent to the store keeper. By this method, the intimation about availability of specific food item can be found and items not available can be ordered for purchasing. The DHT11 sensor is used to monitor the humidity and temperature inside the container, if any of these two is high then the notification will be sent. Decomposed organic items are identified by MQ3 sensor based on detection of alcoholic gas produced by organic items. The sensors data such as grocery level, humidity, temperature and decomposition range of organic items are collected from the corresponding smart container. This data transaction happens via micro controller known as Node MCU. The level of the groceries present, and spoiled organic items can be identified and mail notification can be triggered in the early stage with the help of mobile application called IFTTT.

Keywords: Cloud storage, DHT11 sensor, Industrial kitchen, Internet of Things, Microcontroller, MQ3 sensor, Node MCU, Smart grocery monitoring, Smart Kitchen, Ultrasonic Sensor.

1. Introduction

The grocery is the primary part of the restaurant, a multi-action region where store in charge stores our grocery. The cook basically utilizes the grocery by his/her thought. There is no estimation tool so far available for estimating the availability of groceries. This project gives a specific programmed solution for a user of the industrial and restaurant kitchen managers by providing a smart grocery monitoring system. Its ensures to purchase every one of those food fixings well in time for the ends of the week and other occupied days. Directing ordinary stock screen will likewise assist you with sparing food costs and extraordinarily diminish the kitchen

squander. The expansion of innovation is unpreventable. Each development is made to have helpful effect on human life [1].

The Internet of Things is an altogether clear thought as it infers taking all of the things on the planet and interface them to the web. When something is related with the web that infers that it can send information or get information, or both. This ability to send or get information makes things adroit. To be keen, a thing doesn't must have super storing or a supercomputer inside it. All of the things need to do is to interface with a supercomputer. At the point when physical articles or things are implanted with material science, sensors and programming then the system called IOT is shaped. IOT licenses the identification of articles and also controlling them remotely across existing system framework. Subsequently, a system makes an extension for a great deal of direct joining between the physical world and PC based frameworks. These prompts improved exactness, power and financial benefit [2]. In this smart food item level administration framework, there is zero chance for passing up on anything or chances for purchasing additional amounts. Also, the quality of grocery item can be monitored with respect of decomposition and humidity level. Along these lines, the whole storage area lies in our grasp [3]. Fixing the sensors in the food stuff container is totally depends on that specific item. For example, if it is a rice container Temperature, Humidity and Level estimation sensor is enough, there is no meaning of MQ3 that is gas sensor. By means of any vegetable's, fruits or any organic stuff container its mandatory to keep watching the emission of gas, so in this scenario all the three sensors are employed. Some items emits alcoholic gas by its nature for example cold drinks like fresh juice, beer and some alcoholic drinks.

Problem Statement

More often basic food item requests will be going to risky or something probably won't be rattled off. Need to designate a specific individual for the procedure of monitoring grocery and food. Because of deficient basic food items, and may misfortune the client. The decay of natural things, organic products, vegetables will occur due to in-focus. Some basic food items may be contaminated because of moistness and over temperature. Every one of these things leads to misfortune in business. Nothing is more terrible than coming up short on key ingredients in the supper rush. It is likewise significant not to squander food either so routinely review your standard requests to check whether there are a few fixings you aren't generally utilizing any longer [4,3,5].

This paper covers Introduction in first section. Literature review in the second part. The third section will cover the Proposed system and flow chart. Fourth and Fifth part will cover the Requirement specification and System Architecture respectively. The Result and conclusion will be covered in sixth and seventh part.

2. Literature Survey

K. Sakthisudhan et al. [6] proposed a system with sensors to found the level of the grocery in kitchen. Arduino Uno is used to sense and load sensor data to the cloud with the help of Wi-Fi module. Thing speak cloud platform is used to store the sensor data in cloud. If the sensor value less than the threshold value then the information sent to the user. Additionally, data analysis is done to detect the frequently used items in the kitchen, for this they used the historical data of the sensor. Finally, the outcome was smart grocery management system in Internet of Things. [2] represents that better approach for shopping and grocery management in the kitchen. This structure makes us keep up the quick fundamental need the board which is a basic essential for every family person. Here, the authors consider the measurement estimation distinguishing using the ultrasonic sensor of solid or liquid substances, and according to that, the solicitation will be put for shopping of that particular fundamental inventory. The sensor data will be stored in the cloud unit, if the grocery level getting low then the system will indicate to the corresponding mobile. This structure familiarizes us with the direct utilization and usable application without hardly lifting a finger answer for the common man.

Salah Uddin et al. [7] designed a smart IoT system for monitoring groceries in the kitchen. They used different sensors for each grocery, ultrasonic sensor for solid items, Linkit Smart 7688 Dou for liquid items and egg minder to monitor the egg counts. Everything will be connected to micro controller then to the data base. If the level of groceries monitored by the mobile application. Nagaria, [8] designed the stock management system using Internet of everything. Load cell sensor is used to measure the weight of the items inside the container. The measured weight is compared to the threshold value if it is less than the message will be passed to the mobile. They used Node MCU as microcontroller and also as wi-fi module, also Loadcell amplifier module is used. The sensor data will be stored in the cloud for future analysis.

Rezwan, Sifat, et al. [9] provided a smart kitchen Inventory System for grocery monitoring. The authors used Arduino Mega and Node MCU as microcontrollers. Load cell sensor for measuring the weight of the particular inventory and LED to show the measurement. The smart inventory system contains nine number of small compartments each holding different sensors. Node MCU act as a wi-fi module to connect with the network and storing data. Finally, the mobile application and the website will show the result from the inventory system and orders will be placed. Arya, [10] provided a smart refrigerator based on IoT. The authors used MQ3 sensor to detect the alcoholic gas produced by the fruit, vegetables and other organic items in the container. Also, they used DHT11 sensor to detect the temperature of the container. These sensors connected to the microcontroller and sensor data stored in the thing speak cloud platform. After the data analysis the information sent to the mobile phone. [11] provided a smart system for mega kitchens. The authors used the sensors, micro controller and GSM module to sense and store the data in cloud. The measurement of food items will be monitored by the android mobile application.

D. Narendhar et al. [12] providing an Android application for kitchen grocery monitoring with the help of IoT prototype. Which includes Arduino Nano as micro controller and Bluetooth for communication, the end devices are DHT11 sensor and Ultrasonic sensor. Li, [13] propose an secure smart shopping system, in which all products in the shop are equipped with the less expensive RFID tag to monitoring that specific thing. With the help of this RFID reader the system will automatically reads the specific item which is placed in the shopping cart. Therefore, charging can be directed from the shopping basket itself, a long line at checkout with customer will reduced. In addition to that with the help of RFID smart shelving can be possible in this system. To validate the possibility a sample system prototype is designed with secure communication protocol.

Jayanth et al. [14] proposed a Inventory monitoring framework using Internet of thing. Here the authors used Ultrasonic sensor for measuring the grocery level in the container. The Ultrasonic sensor is utilized to quantify the time taken for a signal to go from the highest point of the holder to the outside of the filled compartment and return back. The distance is decided by the time the good ways from the highest point of the compartment to the outside of the stock. On the off chance that the worth is not exactly the edge an incentive then intimation is sent to the provider.

Pendbhaje, et al. [15] used IoT system as a Management system for Home Grocery. Load cell is used by them to measure the weight of the grocery. The microcontroller used by them is Raspberry pi which utilizes the MQTT protocol. The accessibility of the kitchen grocery items will follow by this framework, this would be the main goal of this system. Also, it provides web-based business alternatives to arrange the items and showcases on the smart phone of clients, via this smartphone the client can arrange and buy those things with low cost, it gives better results by scanning the day-to-day activity. This considers the test details by the day-by-day use of ingredients in the kitchen. [16] present the essential presentation of the web of things. IoT is a system of physical items or things installed with gadgets, programming, sensors, and network to empower articles to trade information with producers, administrators, and associated gadgets. It tends to be portrayed as interfacing regular articles like cell phones, sensors, and actuators to the Internet where the gadgets are shrewdly connected together empowering new types of correspondence among things and individuals, and between things themselves.

The following inferences are produced using the above writing study

1. Using ESP8266 NodeMCU will reduces the cost by providing wi-fi module and microcontroller altogether.
2. Connecting with the Thingspeak platform will provide the cloud storage and the data can be exported for further analysis purpose.
3. Ultrasonic sensor can replace the work of camera and loadcell in the sense of level monitoring.

4. Providing the functionality of all the three sensors (Ultrasonic, MQ3, DHT11) will increase the feature of the prototype.
5. Trigger a mail notification when sensor value meets certain conditions.

3. Proposed System

This framework will assist the client in getting the appropriate administration of grocery in our kitchen/store. The client no longer needs to stress over constantly observing ingredients. Here, notification will trigger when the level of the item in the container jugs will be low, at that point promptly can put a request for that specific ingredient. Level estimation is the ceaseless task going on here by level estimation sensor (ultrasonic sensor). At the same time this framework will give us thought regarding the temperature inside the container so securing the grocery as per the climate conditions is possible, and reasonable temperature can keep up for various groceries according to its prerequisite. Temperature is estimated by the temperature sensor. This process is done using Internet of Things [6,2,7]. Decompose of organic items can be detected in early stage by MQ3 sensor, it is used to detect the alcoholic gas produced by organic items stored in the container. Figure1 shows the flow chart of grocery monitoring system, this flows from measuring the sensor values from the corresponding containers, these measured values will be stored in the cloud. At the time of storing sensor values it will be compared with the threshold value to send the mail notification.

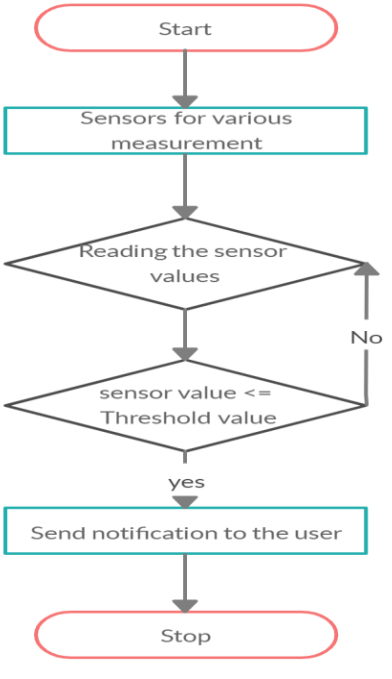

Figure 1. Flow chart of proposed system

Threshold value: Setting up threshold value is unique for all the sensors. For the Ultrasonic level estimation sensor, it would be zero that means that container is empty so need to refill the container. For the DHT11 sensor two threshold values must needed for temperature and humidity, this will take based on the food stuff because some can be kept in room temperature some might be keep inside the cold area. By means of room temperature the threshold value will be 90°F, inside refrigerator in the sense it is 40°F. When comes to humidity it should not exceed 55% for all [17]. The sensor values of MQ3 are like zero's and one's if it is "0" there is no presence of gas, if it is "1" then it means there is some odour has found.

Objective:

- Estimating the level of grocery using sensors.
- Detecting decompose of organic items in early stage.
- Monitoring the quality of food items.
- If the sensor value is less than the threshold value, sent notification to the user.
- If the sensor value is in normal range then keep on monitoring the system.
- Automate the ordering of kitchen items via mail.

4. Requirements Specification

Hardware and software requirement specification of the smart monitoring system is listed.

Hardware:

1. ESP8266 Node MCU
2. Ultrasonic sensor
3. DHT11 sensor
4. MQ3 sensor
5. Power Supply Module

Software:

1. Arduino IDE
2. Thing Speak
3. IFTTT

A. Microcontroller

This can be described as a minimized incorporated circuit or a little PC that contains a processor, memory, and peripherals. In our system, the Node MCU microcontroller is utilized

it depends on the ESP8266. This microcontroller is an open-source platform, this can be used to build any Internet of Things prototype. That is staggeringly simple to-use for equipment and programming. It is utilized to get the helpful information from sensor. This can be characterized by a gathering of guidelines customized through the Arduino IDE. It can essentially be associated with a battery to charge. This also can be chargeable by any personal computer system or micro-USB cable. By basic programming, can build up a Wi-Fi association and characterize input/yield pins as per our requirements, transforming into a web server, cloud and much more. Sensors are connected to the microcontroller board and this sent sensor data to cloud using wi-fi module [8,1].

B. Sensors

There are three types of sensors used in our project. To measure the distance Ultrasonic sensor is used. Ultrasonic waves transmitted from the sensor to calculate the distance. The distance is calculated by finding the difference between received and transmitted waves. So, this sensor used to measure the grocery level [6]. To find the temperature and humidity inside the container DHT11 sensor is used. This humidity sensor figures relative stickiness by estimating the electrical obstruction between two cathodes. A moister holding substrate is playing a major role to detect the humidity [9]. To find the decomposition stage of the fruits, vegetables and other organic items MQ3 sensor is used. MQ3 used to find the alcoholic gas present inside the container. It is appropriate for recognizing Alcohol, Benzine, Methane (CH4), Hexane, LPG (Liquefied Petroleum Gas), Ethanol and Smoke. The delicate material utilized for this sensor is SnO2 [9]. The MQ3 can active at 10 to 50° C temperature range. The needed power supply is under 150 Ma to 5V. The detecting range is from 0.04 mg/L to 4 mg/L, which is appropriate for breathalysers.

C. Wi-Fi Module

In our model, it uses ESP8266 wi-fi module. The ESP8266 WiFi Module is an independent SOC with coordinated TCP/IP convention stack that can give any microcontroller access to your WiFi arrange. The ESP8266 is able to do either facilitating an application or offloading all Wi-Fi organizing capacities from another application processor. In our system wifi module and microcontroller is interconnected and is called ESP8266 NodeMCU [8].

D. Arduino IDE

The Development Environment used here is Arduino IDE. This connects the things in Internet of Things. The Arduino IDE helps to interaction between things in Internet. The IDE controls the things by programming language. Arduino IDE is open-source programming that is for the most part utilized for composing and incorporating the code into the microcontroller. Making code execution and upload too simple that even a typical individual with no earlier specialized information can consider making the plunge with the learning procedure. It is effectively accessible for working frameworks like MAC, Windows, Linux, and runs on the Java

Platform that accompanies inbuilt capacities and orders that assume an indispensable job in troubleshooting, altering, and accumulating the code in nature [17].

E. Things peak

Cloud space for storage resembles the information stockpiling some portion of the PC where information is put away in different remote servers. This put away information can be gotten through the web. One of the best open-source cloud frameworks is ThingSpeak. In our smart system this most wildly used cloud framework is used. The information with respect to the basic food item level and is put away in the cloud using the Arduino IDE and through the wi-fi module that is ESP8266[6,18]. One of the applications provided by Thing's peak is Thing HTTP. Interfacing with any web administration is possible with HTTP over the internet or system by the help of microcontroller. Thing HTTP underpins POST, GET, PUT, SSL, DELETE and some basic authentication [18]. React is an another kind of application in Things peak, when the channel data meets a particular condition this triggers the message notification through IFTTT, Thingtweet also can be used [18].

F. IFTTT

IFTTT is the free method to get all your applications and gadgets conversing with one another. This is named based on conditional statement of our computer programming, IFTTT means that, If This, Then That. What the organization gives is a product stage that interfaces applications, gadgets and administrations from various designers so as to trigger at least one robotizations including those applications, gadgets and administrations.

5. System Architecture

The figure 2 shows the block diagram of Grocery Monitoring System for restaurants and retail stores using Internet of Things.

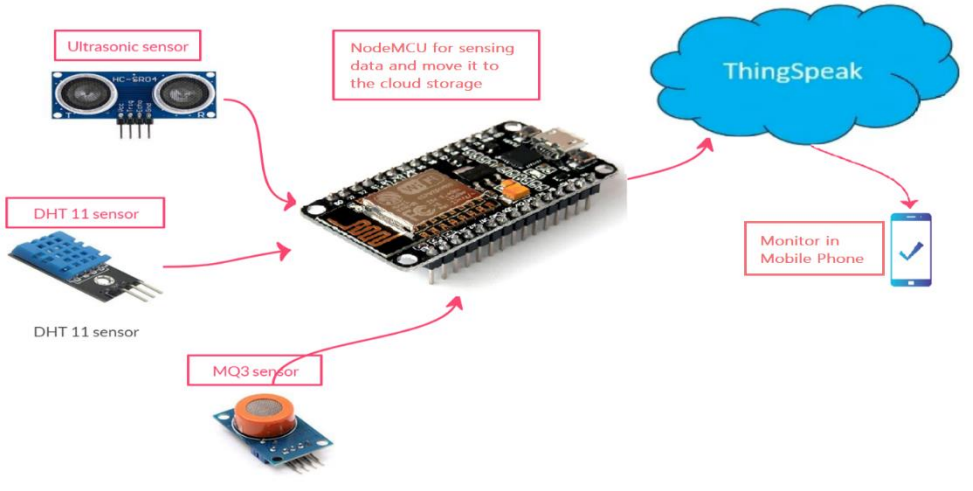

Figure 2. Block diagram of Grocery Monitoring System

Our smart system having the engineering architecture as above. The sensors are connected with the Arduino micro controller. Three types of sensors have used for different purpose. These sensor data is collected stored in Thing Speak cloud framework via Microcontroller and the wi-fi module ESP8266. Depending on the sensor data the intimation sent to the user. If the sensor value is less than the threshold value then the system generates mail by the help of IFTTT and sent to the corresponding user.

The reason to choose ultrasonic sensor rather than using load cell or camera

- Some groceries might be less in weight by nature so neglect load cell, since this measures weight to detect the level of the item.
- The cupboard and the container should be transparent if the camera has used to find the grocery level, it leads more cost.

6. Result and Discussion

Have implemented the system with the Ultrasonic sensor, temperature humidity sensor and Gas sensor. In Figure 3 connection of sensors with the wi-fi module has shown. All the three sensors are connected with the ESP8266 NodeMCU module with the help of breadboard. All the inter connected components are powered by the basic power supply module which contains two capacitors to control the flow of current, regulator to limit the voltage, Female headers to pin the wi-fi module, heatsink to absorb the temperature, and the adaptor to provide the power supply. The ESP8266 is powered by connecting with the mobile hotspot with the help of ssid and network password as shown in figure 5. All the sensor data will store in the Thing Speak platform by creating new channel in the Thing Speak. When creating the new channel each sensor data will take different fields namely temperature, humidity, distance and gas. Using Channel ID and Write API key sensor data stored in cloud through Arduino IDE.

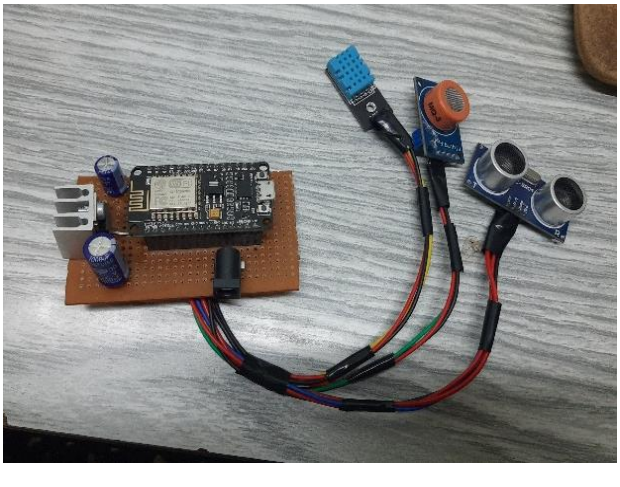

Figure 3. Implemented Module

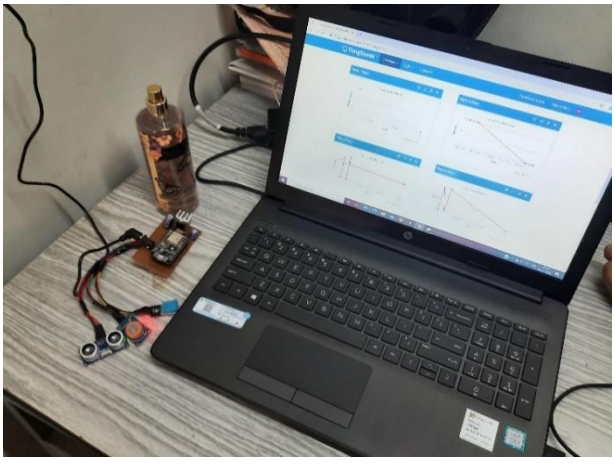

Figure 4. Implemented Module with thing Speak result

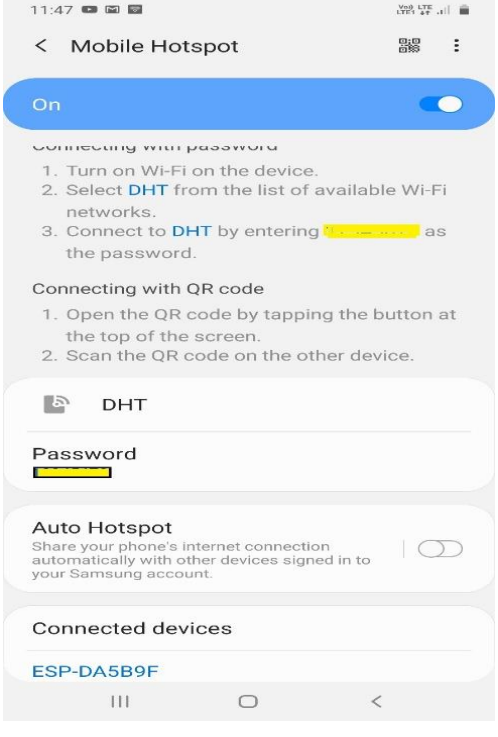

Figure 5. Connecting Wi-Fi Module with Mobile Hotspot

After connecting to the thingspeak via hotspot, all the sensor readings are shown as graph. The implemented module with thingspeak graph is shown in figure 4. Here our channel named as Grocery monitor and our channel ID is 1079726 with private access. The full view of the channel is in figure 6. All these measured values can be monitored through mobile phone or

by mobile computer. In our channel field 1 is correspondence to temperature, that reading is shown in figure 7 with appropriate date and time. Likewise, humidity, distance and gas sensor reading also have shown with date and accurate time as in the figures 8,9 and 10 respectively. Ultrasonic sensor reading is in the field3 as distance, which is used to monitoring the level of grocery inside the container. If the distance is very low or zero order can be placed. Gas sensor results were stored in field 4. Value one in the graph indicates the presence of Alcoholic gas inside the container which is holding organic food items. Value zero in the graph indicates that Alcoholic Gas is not yet produced. Due to this process spoiling of fruits and vegetables detected in early stage before affecting all the other fruits or vegetables in the same container.

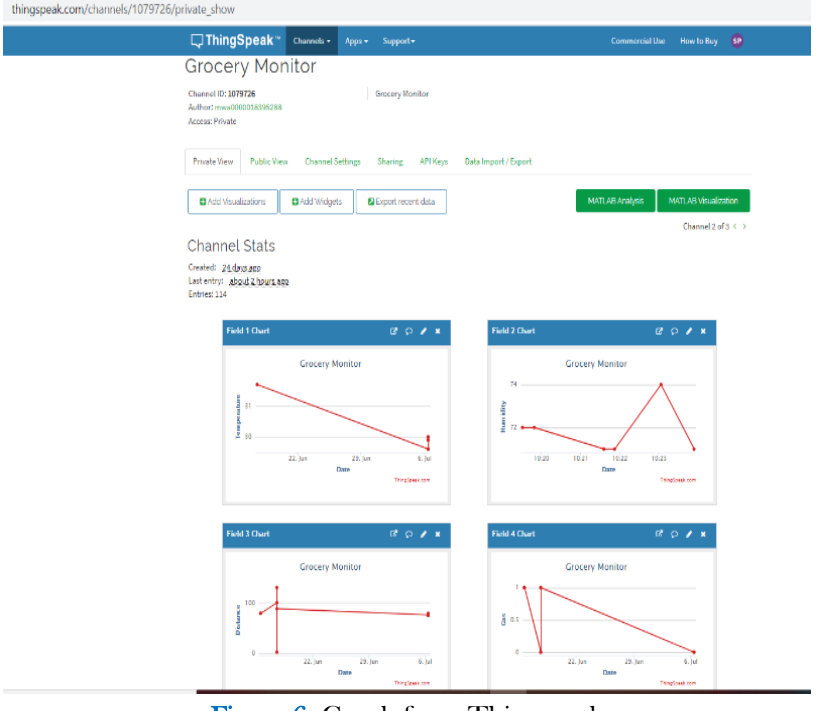

Figure 6. Graph from Thingspeak

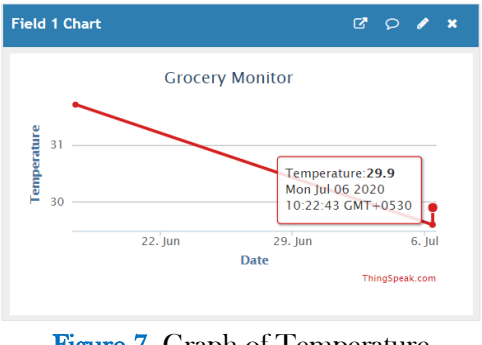

Figure 7. Graph of Temperature

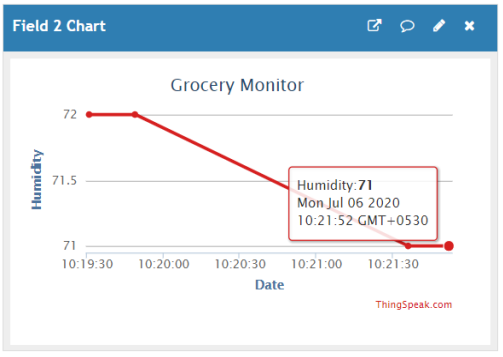

Figure 8. Graph of Humidity

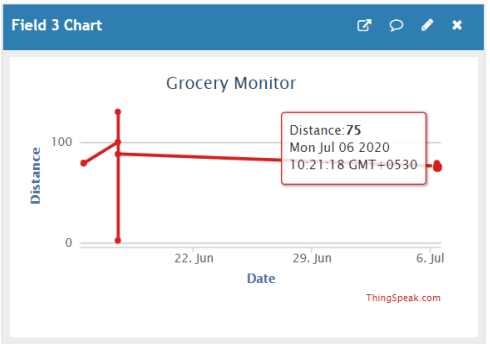

Figure 9. Graph of Distance

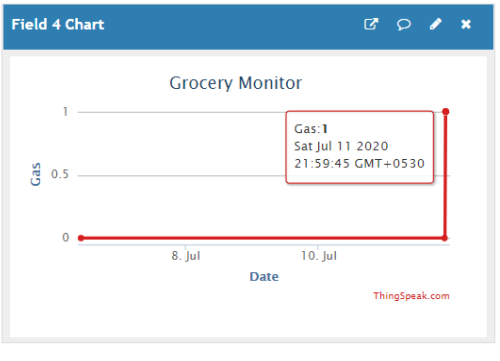

Figure 10. Graph of Produced Gas

Numerical representation of the sensor reading will display in thingspeak as shown in figure 11. All the sensor readings are uploaded in the Thingspeak cloud and displayed as graph. All these sensor readings can be exported for the future use, they might be exported in the form of JSON, XML or csv files. The exported csv data is shown in the Figure 12

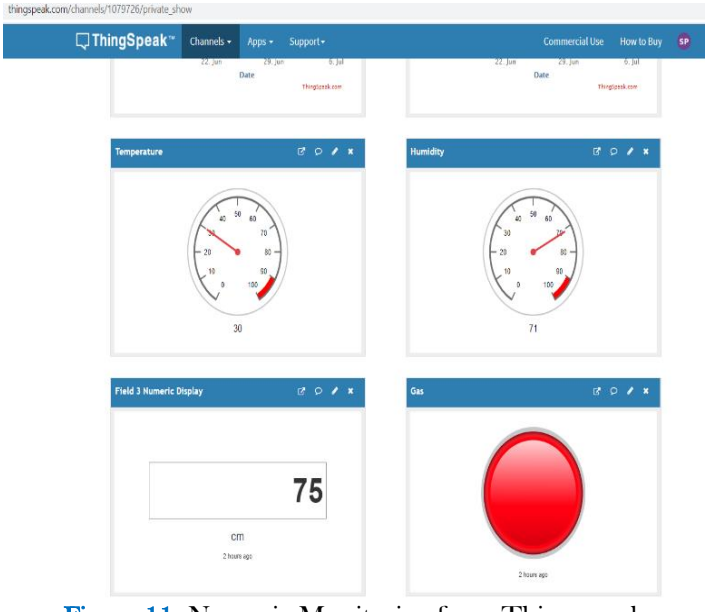

Figure 11. Numeric Monitoring from Thing speak

A	B	C	D	E	F
created_at	entry_id	field1	field2	field3	field4
2020-06-17	88		nan		
2020-07-06	89	nan			
2020-07-06	90	nan			
2020-07-06	91		nan		
2020-07-06	92			76	
2020-07-06	93				0
2020-07-06	94			79	
2020-07-06	95			75	
2020-07-06	96		72		
2020-07-06	97		72		
2020-07-06	98	29.6			
2020-07-06	99	29.6			
2020-07-06	100			75	
2020-07-06	101			75	
2020-07-06	102		71		
2020-07-06	103		71		
2020-07-06	104	nan			
2020-07-06	105		nan		
2020-07-06	106	29.9			
2020-07-06	107		74		
2020-07-06	108	29.9			
2020-07-06	109	29.9			
2020-07-06	110		71		
2020-07-06	111	29.9			
2020-07-06	112	30			
2020-07-06	113	30			
2020-07-06	114				0

feed (4)

Figure 12. Exported CSV data from Thingspeak

The mail notification had done using IFTTT client and the Thing HTTP, Thing speak React. The Thing HTTP has used to interact with the IFTTT using the communication URL and POST the information to the user. Thing speak React is to trigger the Thing HTTP when the channel data meets certain condition. The figure 13 shows the mail notification that has triggered when bad gas produced by the organic items. From figure 14 to 16 have shown the mail notification for humidity, level of container and temperature respectively.

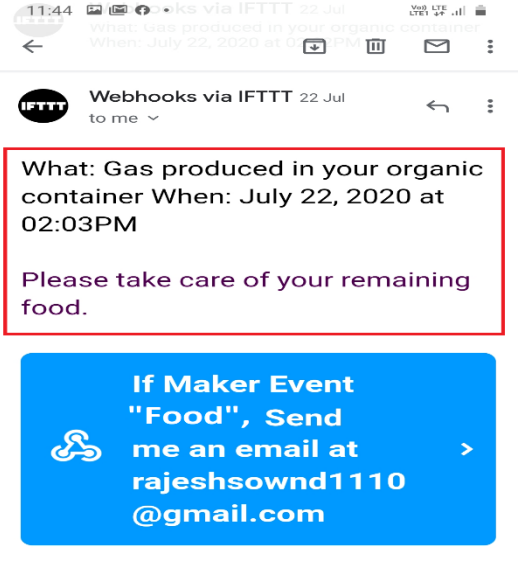

Figure 13. Mail Notification for Gas

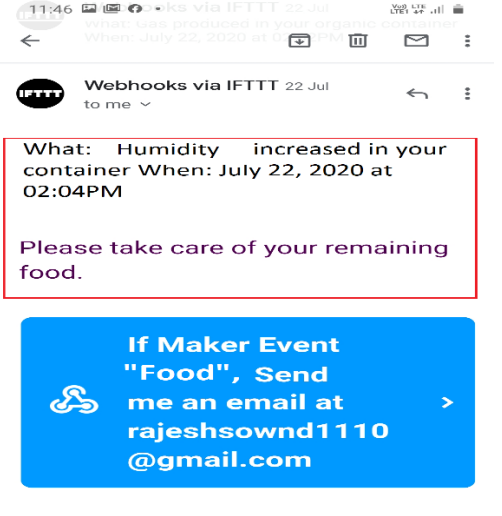

Figure 14. Mail Notification for Humidity

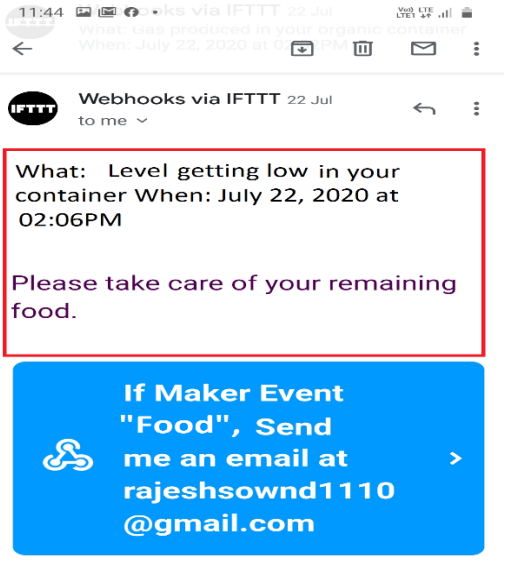

Figure 15. Mail Notification for Level of Container

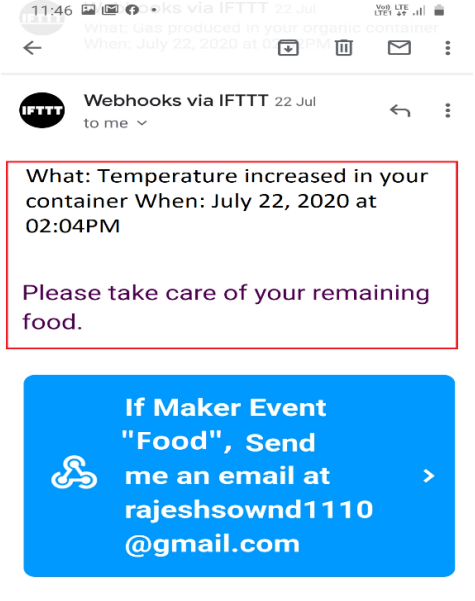

Figure 16. Mail Notification for Temperature

7. Conclusion and Future Scope

This model is all about smart monitoring system for groceries in retail stores and large kitchens like restaurants using Internet of Things. Smart basic food item framework utilizing IoT is a financially savvy and easily understandable framework for clients. It, not just assists with actuating sorted out for shopping for food, it moreover sets aside our time and cash. With this

smart framework, one can unwind and quit stressing of consistently being in follow and checking the basic food item compartments. Can detect the spoiling of grocery in early stage. Mail notification will be triggered for low degree of grocery and can put a request for a specific thing as a future enhancement. This model can also be useable in grocery shops, supermarkets, fruit shops, vegetable shops and so on. Dust bin level monitoring and water tank level monitoring also can be done by this way.

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