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IoT and mobile app-based food spoilage alert system

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***Abstract*---**Food is one of the necessities of human life. It is mandatory to maintain a balanced diet with fresh fruits and vegetables to maintain good health conditions. In this fast-forwarded generation, consumers often expect faster delivery of fruits, vegetables, and even food products. For this purpose, the food materials are stored in bulk storage areas. Every type of food requires its environment to stay fresh for a long time. When different types of food materials in enormous amounts are stored in one area, it becomes tougher for the one who manages the storage area to maintain optimum values for all parameters. It also becomes difficult to identify whether the food inside a compartment is fresh or rotten. To help this scenario, this study aims the development an Internet of Things (IoT) system which is capable of monitoring the necessary

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parameters. This system consists of sensors, a controller, and software. The sensors are directly linked to the food materials that need to be monitored. The nodeMCU module receives and processes the data collected from the sensors. The information gathered is sent to the Blynk mobile application. The collected data is then analyzed or compared to the parameter threshold values. The primary parameters monitored are temperature, humidity, moisture, and methane levels. The measured parameters are then compared to the ideal values. There is no process when the recorded values match the optimum values. When the values do not match the threshold values, action is taken to maintain the optimal values. When the damage is beyond repair, a mobile application notification sends an alert message to the user.

Keywords---Food monitoring, IoT, temperature sensor, mobile application, alert messages.

I. Introduction

After air and water, food is the third maximum critical component for dwelling beings to offer electricity and development, preserve lifestyles, or stimulate growth. Food is genuinely a complicated mixture of chemicals. It offers us vitamins like fats, carbohydrates, vitamins, and so forth to assist us in staying a healthful lifestyle and keeping away from diseases. Without meals, our bodies lack vitamins, which could cause fitness issues or maybe diseases. A healthful eating regimen promotes healthful being pregnant outcomes, helps everyday growth, development, and aging, aids withinside the upkeep of healthful frame weight, and lowers the chance of persistent disease, all of which make contributions to usual fitness and well-being. But food wastage is one of the major concerns in recent society. Over 40% of the food produced in the country is thrown away every year because of the country's fragmented food systems and poor supply lines. It is believed that the water needed to produce food in the United States is ruined since agriculture uses the most water. Food materials like raw fruits and vegetables are often stored in bulk amounts in storage areas. The freshness of the food materials can be only maintained when many parameters are maintained within an optimum range. When the size and the number of food materials stored in such places increases, it becomes tougher to maintain optimum values for all parameters.

To resolve this issue, this study aims the development of an IoT system. This system consists of sensors like temperature sensors, moisture sensors, etc, and a controller module. Output devices like a light bulb, exhaust fan, and a water sprayer are also used. It also includes software that is used to display the results to the user. The construction and working of this system are explained clearly in the upcoming chapters.

II. Literature Survey

Food safety is a major issue that has to be handled properly and efficiently. A study helps in the monitoring of food safety along with its pricing, coordination of supply, etc. This study derived the optimality situations of corresponding fashions and used the consequences to examine the lard oil delivery chain to decide the most effective order quantity, buy-lower back price, rebate/penalty, and income goal with the proposed framework. It has been located that delivery chain contracts, while used together with the food protection mechanism, can substantially enhance food protection, patron confidence, and the ensuing income of the food delivery chain [1]. Food delivery is also one of the fastest-growing jobs in the current world. Many studies and researches have been performed to optimize the food delivery system and even to make it environmentally friendly. One such study states that the plastic pollutants are due to the sizeable use of plastics withinside the food shipping enterprise. Stopping the usage of single-use plastics withinside the OFD enterprise is one viable answer for decreasing pollutants. Unfortunately, consumers, restaurants, and OFD structures are unwilling to prevent the use of plastic, and the authorities can not immediately reveal eating place behavior. Thus, in this study, a technique referred to as convergence is proposed to coordinate the conflicts of the hobby of the authorities, OFD structures, restaurants, and consumers. [2]. The IoT, or IoT, is the number one generation hired in this study. IoT is likewise used withinside the improvement of many circuits and the creation of clever homes. A study reviewed the usage of IoT in diverse aspects. The aim of the IoT, consistent with them, is to offer seamless services to anything, at any time and in any location. IoT generation is everywhere, ushering withinside the fourth disruptive technology revolution following the internet, data, and communication technology. Their paper gives the maximum latest kingdom of the artwork of IoT sensible pillars and rising programs so that you can inspire academicians and researchers to broaden real-time, energy-efficient, scalable, dependable, and steady IoT programs. Their paper gives an in-intensity exam of the maximum latest kingdom of communication necessities and application layer protocols utilized in IoT. They additionally highlighted the problems encountered throughout the improvement of IoT systems [3]. As formerly stated, IoT is getting used withinside the improvement of clever homes. IoT studies become used to create a clever domestic. Domestic automation structures, they claim, have obtained little interest as the communications era has advanced. A clever domestic is an IoT utility that uses a domestic automation tool to show and control a domestic system over the Internet. The proposed IoT-based home automation tool can control domestic systems over the Internet effortlessly and efficiently, in addition to helping home safety through the self-sufficient operation. The tool designed for this exam is a low-value and reliable automation tool that reduces electricity intake whilst additionally imparting SH residents' convenience, safety, and safety [4].

The NodeMCU module is a simple yet effective microcontroller board that is widely used in applications that involve the IoT. A study also develops a smart cradle using IoT and the NodeMCU module. The contemporary percentage of operating moms has notably increased. As a result, for lots of families, infant care has to turn out to be an everyday challenge. They proposed a Baby Monitoring System

primarily based totally on the IoT. Sensors are used withinside the proposed gadget to display the infant's essential parameters. A prototype of the proposed infant cradle become designed with the usage of software, and the hardware is made from pink meranti wood. When the infant cries, the gadget structure consists of an infant cradle that swings mechanically the usage of a motor. According to the prototype, the infant tracking gadget has been proven to be powerful in tracking the infant's state of affairs and surrounding conditions. [5]. The NodeMCU module is so versatile that it can be used in many fields of technology. A study uses the NodeMCU module even in the construction of a dual-band antenna. This was also done using the combination of IoT and NodeMCU. The information is then dispatched to a cloud server thru the IoT and is viewable on smartphones thru the Blynk cell utility thru the IoT. CST Studio Suite turned into used to run simulations to acquire a satisfactory antenna design. Following that, prototype antennas had been constructed and incorporated into the gadget board for IoT-connected close to-and far-area verbal exchange. The simulation and measured outcomes agree well. The incorporated antenna scheme turned into able to reach close to area communications and extremely excessive frequency verbal exchange frequency bands, making it best for IoT applications [6]. Temperature size is needed in nearly every industry. The want for a temperature sensor is unavoidable, as is the usage of a temperature sensor. There is research being carried out to increase an isopropanol resonator. The whole research is primarily based totally on a temperature sensor. Because the resonator's access factors are all fiber handles, the micro bottle resonator (MBR) became selected for its ease of fabrication and extraordinary package deal properties. The modes in MBR have been well known to be characterized through various parameters in different modes, Which represented the sector distributions across the resonator, withinside the bottle axis, and alongside the radial direction, correspondingly [7]. A Humidity sensor is a device that is used to measure relative humidity. There are different types of humidity sensors. Researchers also try to develop various kinds of humidity sensors to increase the efficiency of the sensor. A study develops a humidity sensor using graphene oxide. This study proposes an all-fiber humidity sensor primarily based totally on the photoelectric properties, and other properties of oxide of graphene. A fiber fusion splicer is used to create core-offset areas. The refractive index of the GO adjustments because the outside humidity surroundings adjustments, and humidity modulates the mild withinside the SMF. The humidity of the outside atmosphere is measured by detecting adjustments withinside the wavelength of the sensing structure's transmission spectrum. [8].

Just like the humidity sensor, the moisture is also researched by many to achieve high sensitivity and accuracy. A study develops a moisture sensor using a phase shifter. This study uses a dispersive phase shifter or a DPS to measure moisture with high sensitivity. The proposed sensor's soil moisture dimension technique is primarily based totally on the superior permittivity sensing property of a dispersive phase shifter withinside the time domain. The relative permittivity of the ground is measured with the aid of using burying the DPS underneath a soil mass and converting its section distinction even as excited with a high-frequency sine wave. The section and significance of the DPS output sign are in comparison to the reference sign and measured the usage of a section/loss detector [9]. Gas sensors play a major role in many chemical plants and laboratories. Sometimes a

sensor is limited to a single gas while sometimes many gases can be detected using a single sensor. Many updates were also done to gas sensors to increase the sensitivity and accuracy of the sensors. A study amplifies the metal oxide gases so that it will be easier for the sensors to detect the presence of the gases. This study states that the detection of trace concentration gases stays tough for transportable sensors, in particular low-value and without difficulty operated metal-oxide-semiconductor sensors. In this paper, a broadly relevant amplification circuit is designed and constructed to absolutely enhance the sign of MOX sensors via way of means of incorporating a subject impact transistor (FET) into traditional circuits. This study becomes capable of attaining a better sensitivity than the marketplace sensors via way of means of making a few modifications. It is likewise easy to mix with different resistive sensors. [10].
The Blynk software is an application that is exclusively designed for IoT systems. This software is also used in various applications that involve IoT. A study uses this software in monitoring the humidity levels of a farm. In this study, a smart capsule prototype was created to degree the humidity in paddy luggage saved in diverse places for the duration of a warehouse. The Node MCU microcontroller and a humidity sensor had been used on this smart capsule to ship records to the Blynk server via a Wi-Fi network. To program the microcontroller, the Arduino IDE become used. The virtual dashboard becomes used to reveal and show real-time humidity records thru the Blynk cellular utility. According to the study's findings, the advanced clever capsules and Blynk utility can efficaciously collaborate and are appropriate to be used in clever farming. [11].

III. Proposed Methods

As mentioned earlier, this study aims in monitoring the necessary parameters and also sends an alert notification when something seems out of ordinary. The scenario where the values mismatch the optimum values are where the certain factors that determine the freshness of the food are not at their best. The factors that determine the spoilage and the freshness of the food are shown in figure 1.

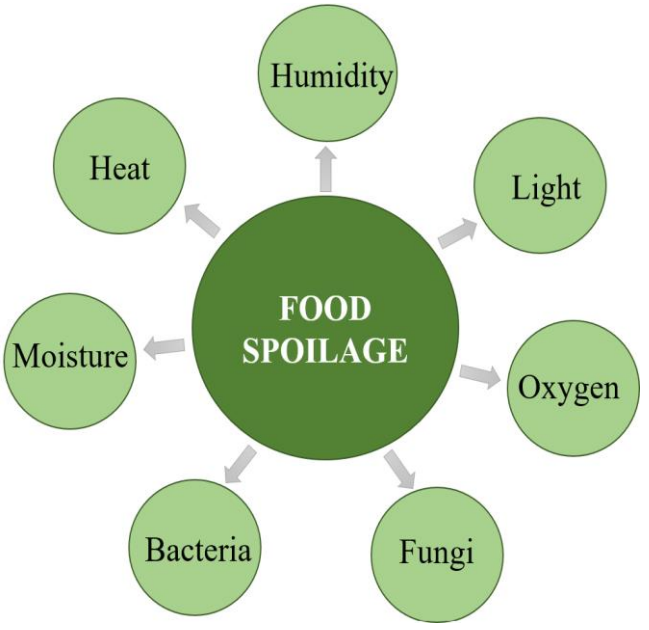

Figure 1. Factors affecting the freshness of food

From figure 1, it can be seen that a lot of parameters are responsible for food spoilage. Thus, it is necessary to maintain optimum conditions for all of the parameters to ensure the food stays good for long. This is achieved using an IoT system which will be linked with the user's mobile phone using a software application. The overview of the proposed research is displayed in figure 2.

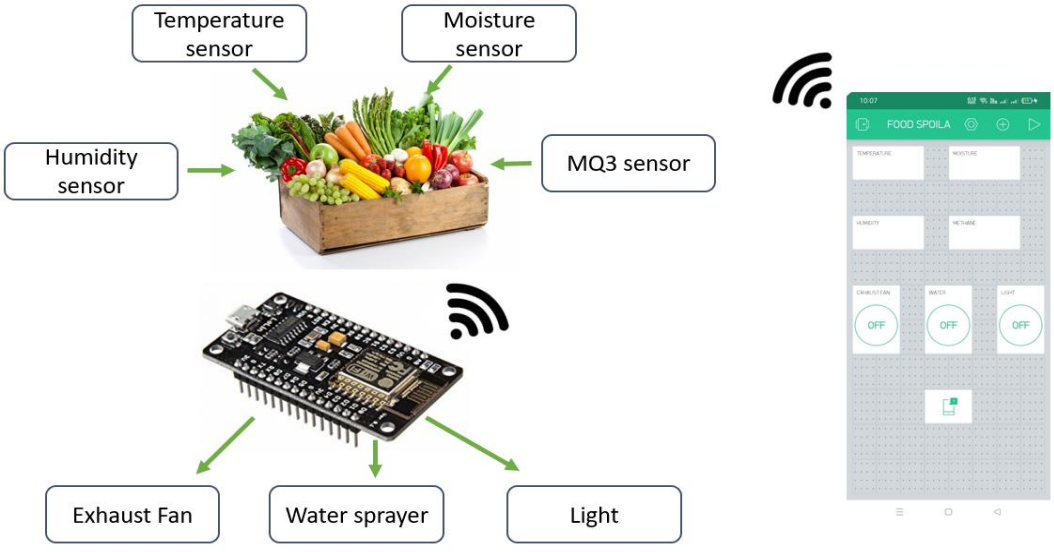

Figure 2. Proposed system

Sensors like temperature sensors, moisture sensors, humidity sensors, and MQ3 sensors constantly record their parameters. A NodeMCU module is also connected exhaust, water sprayer, and an electric bulb. This system monitors the factors that may affect the food and sends it to the mobile application. The complete construction and working of the research are presented in figure 3.

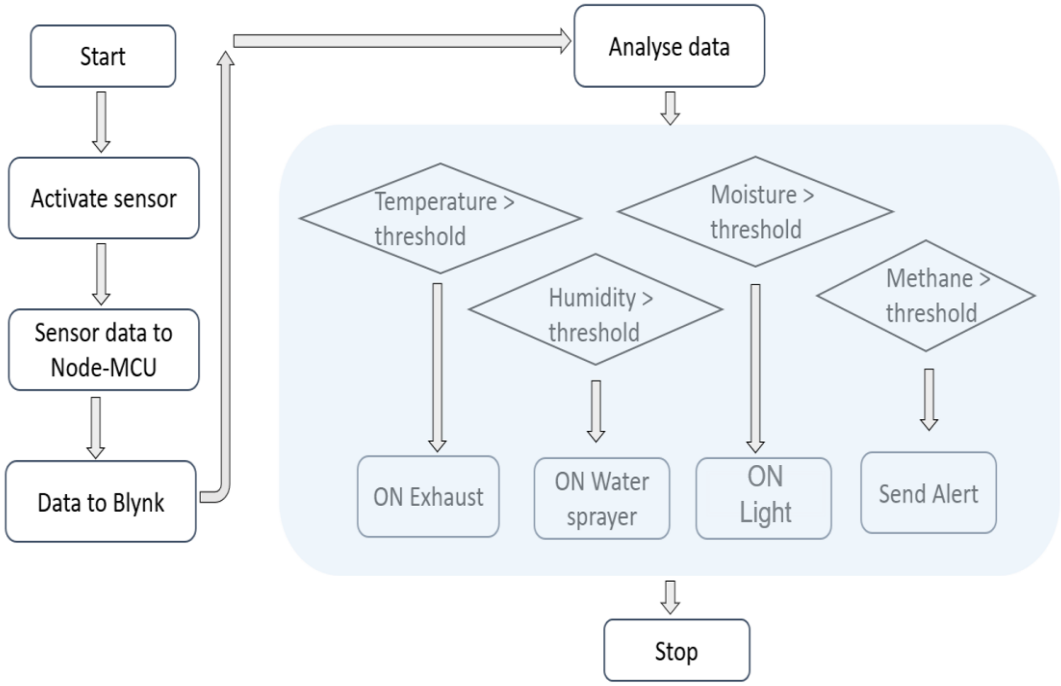

Figure 3. Block diagram

The process begins with the activation of all the sensors that are connected to the food materials. The data collected from the sensors are then sent to the NodeMCU module and processed. The collected data is then sent to the mobile application named Blynk. The data collected is then analyzed i.e., it is compared to the threshold values of all parameters. The major parameters that are monitored are the temperature, humidity, moisture, and methane level. When the temperature of the food is greater than the threshold level, the exhaust fan which was connected to the NodeMCU has energized automatically. When the humidity of the food products is low, the water sprayer is energized wetting all the materials. When the moisture of the content s higher than the threshold level, it has to be dried. In such situations, the light bulb is on to dry them. When the methane level of the food is higher than the threshold, it indicates that the food product is probably rotten or spoilt. This damage is beyond repair and a notification text is sent to the user's mobile phone via notification.

IV. Hardware And Software Requirements

The IoT system built in this study is a grouping of hardware and software components. In addition to the hardware and software components. This chapter describes all of the necessary hardware and software components.

A. Hardware Requirements

The hardware components like the sensors play a major role in monitoring the food spoilage parameters. The sensors used in this study and other hardware components are explained below.

a) Input devices

Certain devices are used to collect data from the food item and send it to the NodeMCU module. The input devices are explained below.

- A temperature sensor is a temperature measuring device. This will be the temperature of the air, a liquid, or the temperature of a sturdy be counted number. Temperature sensors work by transmitting electric indicators that provide measurements. Metals are used to build sensors that generate resistance or voltage while measuring the voltage across the diode terminals to determine temperature changes. The temperature rises as the voltage rises.

- A humidity sensor is a device for measuring the Relative Humidity (RH) of the air it is placed in and outputs a voltage pulse as a result. The RH is described because of the ratio of moisture withinside the air to the very best quantity of moisture at a given air temperature. Humidity sensors locate adjustments in electric currents or temperature withinside the air. An absolute humidity sensor's normal accuracy is +3, that's notable for a sensor

- A moisture sensor is an easy tool that measures the moisture content material of soil, food, and different materials. The moisture sensor is easy to operate. The huge uncovered pad’s function sensor probes, appear as a variable resistor whilst combined. These sensors may be constant or mobile, including hand-held probes. A hygrometer is any other call for this sensor. They generally calculate the moisture degree of a product by measuring the distinction between the environmental moisture and the moisture content material of the product.

- The Gas Sensor (MQ3) module is beneficial for detecting gas leaks. In general, those sensors are used to degree numerous gases together with hexane, methane, and others. Measurements may be taken as rapidly as viable because of their excessive sensitivity and brief response time. Based on the attention of alcohol, this sensor produces an analog resistive output. When alcohol fuelling is present, the sensor's

conductivity will increase in share to the attention. It also can discover smoke in addition to its attention.

b) Output devices

The data collected by the input devices are processed. The results of the process have to be used properly. For this purpose, three output devices are used. The devices are the water sprayer, electric light bulb, and an exhaust fan. NodeMCU is an open supply IoT platform with a low cost. It is primarily based totally on the ESP8266, which could join items and switch facts thru the Wi-Fi protocol. By default, the term "NodeMCU" refers back to the firmware in preference to the dev kits. The Lua scripting language is used withinside the firmware. The important advantages of NodeMCU are its low cost, including WiFi community support, the smaller board size, and decreased strength consumption. It has 17 GPIO pins, which let's use several enter and output elements.

B. Software Requirements

Even if the hardware components play a major role in this study, software named Blynk is also extremely important in displaying the results and even sending alert messages. This software is explained below. A powerful framework, Blynk enables the rapid creation of user interfaces for managing and recording any physical operations from an iPhone or Android phone. It allows the introduction of 1 or extra tasks. Each mission can also additionally encompass graphical widgets inclusive of digital LEDs, buttons, price displays, or even a textual content terminal, in addition, to engaging with one or extra devices. Blynk became created for the IoT. It is possible to manage hardware virtually, display physical parameters, shop data, and do plenty of different cool things.

V. Results and Discussion

A sensor and a NodeMCU module are used to build an IoT system. The module's sensors are directly connected to the food materials that need to be monitored. The NodeMCU module receives and processes the data collected from the sensors. The information gathered is then sent to the Blynk mobile application. The collected data is then analyzed or compared to the parameter threshold values. The primary parameters monitored are temperature, humidity, moisture, and methane levels. The measured values are then displayed on the homepage of the Blynk software. The homepage of the Blynk software is shown in figure 4.

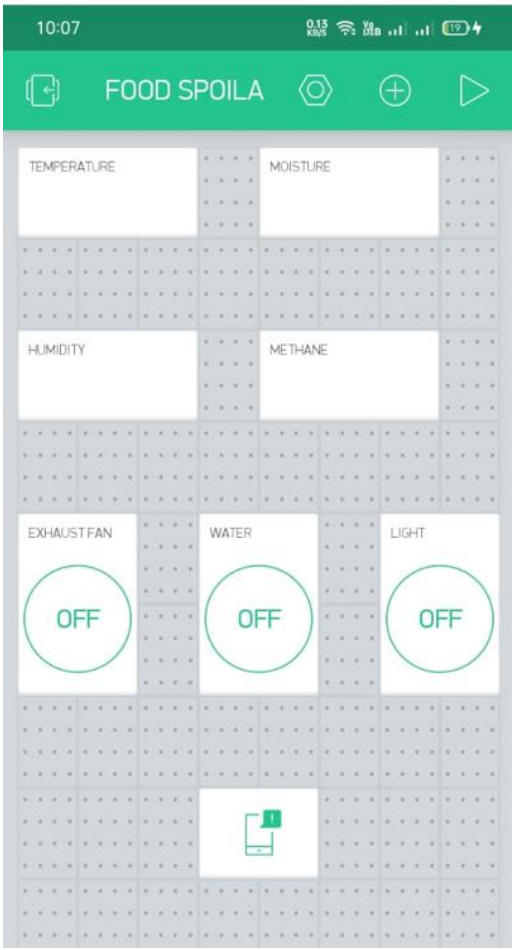

Figure 4. Homepage of the application

The snapshot shown in figure 4 is the homepage of the website when no sensors are activated. The same is applicable for the output devices like the exhaust fan, water sprayer, and the light bulb too. When the sensors are activated, the homepage of the Blynk application seems like the one depicted in figure 5.

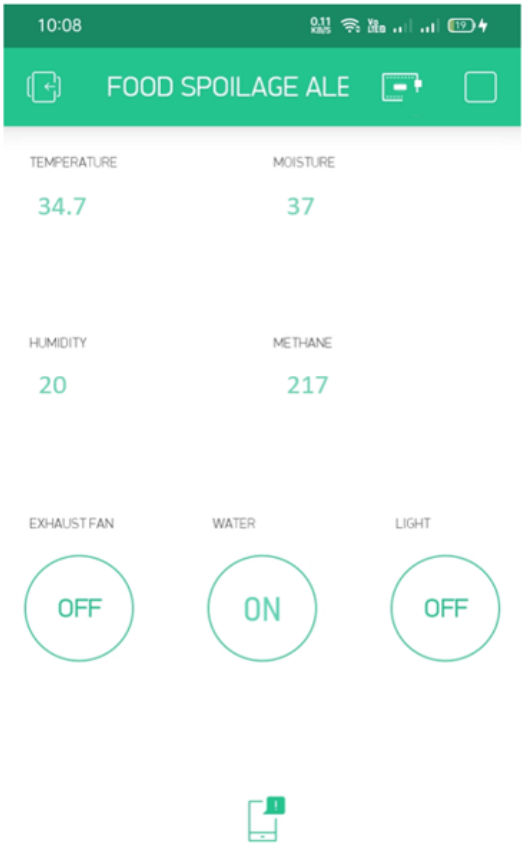

Figure 5. The output of the sensors displayed

Figure 6. Alert notification from the application

In figure 5, it can be seen that the humidity of the food products is lesser than the optimum values and thus the water sprayer is energized to produce some humidity. Even when the parameters stay within the threshold range, the output elements like the fan, sprayer, and the light bulb can be energized by tapping the respective icon on the application. It is also observed that the methane range of the food product is quite more. As stated before, when the methane range is more, it indicates that the food is rotten or spoilt. This has to be removed from the storage area to prevent the other fresh products from being contaminated. For this purpose, a notification text is delivered to the user's mobile phone as a notification. This message is also sent using the Blynk application. The alert message from the application is shown in figure 6. Another advantage of the alert system is that the application can send the alert message even when the application is not running on the user's mobile phone.

VI. Conclusion

An IoT system consisting of sensors and a NodeMCU module is constructed. The sensors of the module are directly connected to the food materials which should be monitored. The data collected from the sensors is then sent to and processed

by the NodeMCU module. The collected data is then sent to the Blynk mobile application. The collected data is then analyzed, or compared to the threshold values of all parameters. Temperature, humidity, moisture, and methane levels are the primary parameters monitored. The recorded parameters are then compared with the optimum values. When the recorded values match with the optimum values, no process is done. But when the values mismatch the threshold values, necessary action is taken to maintain the optimum values. When the harm is farther than restoration, a notification from a mobile application sends an alert message to the user. The Blynk software is used for this purpose. The homepage of the software itself displays all the values like temperature, moisture, humidity, and methane. The notification is also sent to the user when the software is not open. It is tough for the managers of huge food storage areas to maintain many parameters resulting in enormous food wastage. When the IoT system proposed in this system is used for this purpose, it becomes easier to maintain them. The system is also cost-efficient. The Blynk application can also be deployed into an individual software application.

Reference

[1] D. Lin, C. Juan, and C. Chang, "Managing Food Safety With Pricing, Contracts, and Coordination in Supply Chains," in IEEE Access, vol. 7, pp. 150892-150909, 2019, doi: 10.1109/ACCESS.2019.2946137.

[2] K. Li, Y. Chen, J. Liu, L. Zhang, and X. Mu, "Online Food Delivery Platforms and Restaurants' Interactions in the Context of the Ban on Using Single-Use Plastics," in IEEE Access, vol. 9, pp. 96210-96220, 2021, doi: 10.1109/ACCESS.2021.3095296.

[3] S. N. Swamy and S. R. Kota, "An Empirical Study on System Level Aspects of IoT (IoT)," in IEEE Access, vol. 8, pp. 188082-188134, 2020, doi: 10.1109/ACCESS.2020.3029847.

[4] W. A. Jabbar et al., "Design and Fabrication of Smart Home With IoT Enabled Automation System," in IEEE Access, vol. 7, pp. 144059-144074, 2019, doi: 10.1109/ACCESS.2019.2942846.

[5] W. A. Jabbar, H. K. Shang, S. N. I. S. Hamid, A. A. Almohammedi, R. M. Ramli and M. A. H. Ali, "IoT-BBMS: IoT-Based Baby Monitoring System for Smart Cradle," in IEEE Access, vol. 7, pp. 93791-93805, 2019, doi: 10.1109/ACCESS.2019.2928481.

[6] A. Romputtal and C. Phongcharoenpanich, "IoT-Linked Integrated NFC and Dual Band UHF/2.45 GHz RFID Reader Antenna Scheme," in IEEE Access, vol. 7, pp. 177832-177843, 2019, doi: 10.1109/ACCESS.2019.2958257

[7] .Y. Yin, T. Nie, and M. Ding, "Temperature Sensor Based on Microbottle Resonator Immersed in Isopropanol," in IEEE Photonics Journal, vol. 13, no. 3, pp. 1-7, June 2021, Art no. 7100807, doi: 10.1109/JPHOT.2021.3081716.

[8] Z. Wang et al., "Fiber Core-Offset Humidity Sensor Based on Graphene Oxide Characteristics," in IEEE Photonics Journal, vol. 13, no. 3, pp. 1-8, June 2021, Art no. 7100608, doi: 10.1109/JPHOT.2021.3083699.

[9] R. Keshavarz and N. Shariati, "High-Sensitivity and Compact Time Domain Soil Moisture Sensor Using Dispersive Phase Shifter for Complex Permittivity Measurement," in IEEE Transactions on Instrumentation and

Measurement, vol. 71, pp. 1-10, 2022, Art no. 8001010, doi: 10.1109/TIM.2021.3132367.

[10] X. Zhou et al., "Amplifying the Signal of Metal Oxide Gas Sensors for Low Concentration Gas Detection," in IEEE Sensors Journal, vol. 17, no. 9, pp. 2841-2847, 1 May 1, 2017, doi: 10.1109/JSEN.2017.2678985.

[11] P. Serikul, N. Nakpong, and N. Nakjuatong, "Smart Farm Monitoring via the Blynk IoT Platform: Case Study: Humidity Monitoring and Data Recording," 2018 16th International Conference on ICT and Knowledge Engineering (ICT&KE), 2018, pp. 1-6, doi: 10.1109/ICTKE.2018.8612441.

[12] Rinartha, K., & Suryasa, W. (2017). Comparative study for better result on query suggestion of article searching with MySQL pattern matching and Jaccard similarity. In *2017 5th International Conference on Cyber and IT Service Management (CITSM)* (pp. 1-4). IEEE.