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Smart Warehouse management system

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Abstract: The Internet of Things (IoT), in recent decades, has been explored to develop new technologies that work in a variety of ways in various technologies, especially in the food industry. A warehouse is a mercantile architecture for entrepot of stuff. Warehouses are used by producers, dealers, traders, wholesalers, distributors, customs, etc. The use of a smart warehouse management system (WMS) is the cherry on top of all of smart technology. This warehouse should be screened at regular intervals to reduce storage cost of food grains due to atmospheric conditions and are to be documented. With the enlargement of business and the continuous requirements of the food product multiplicity, old style granary management prototype will not meet that, due to its heavy capacity and low proficiency. To mitigate the manual labor work and to make the work easier, a smart warehouse is implemented which is enabled with several sensors and technologies. This work intends to develop an IoT based smart WMS. The system is made up of temperature, humidity, smoke, Passive-Infrared (PIR) and fire sensors connected to the ESP8266 microcontroller, which provide vital information needed to achieve the quality of food. The input information from the sensors is processed by the controller and transmitted to the Blynk cloud wirelessly. The user can track changes in product quality from time to time. WMS provides an easy-to- se visual and analytical sensor data application for an effective and inexpensive monitoring system. The system developed has great advantages compared with the traditional model in terms of Blynk-cloud access of the warehouse data.
Keywords—Internet of Things component, warehouse management system, Passive-Infrared (PIR)

1. Introduction

The fundamental requirement of human beings is sustenance in the form of nourishment. The composition of this substance encompasses a diverse array of essential elements, such as carbohydrates, proteins, lipids, vitamins, and minerals. The inclusion of these nutrients is crucial for the promotion of optimal development, growth, and sustained well-being throughout an individual's lifespan.

According to the World Health Organization (WHO), over 1.7 million fatalities occur globally each year as a result of inadequate dietary intake. Based on the data presented in Figure 1.1, it is reported by the FAO (Food and Agricultural Organization) that the yearly quantity of food losses is approximately 1.3 billion tonnes, which accounts for approximately 33% of the overall production [13]. The consumption of food is seeing a persistent upward trend, with projections indicating a potential increase of 150-170% by the year 2050 [14]. According to the World Health Organization (WHO), malnutrition is identified as a contributing factor in around 1.7 million fatalities on a global scale each year.

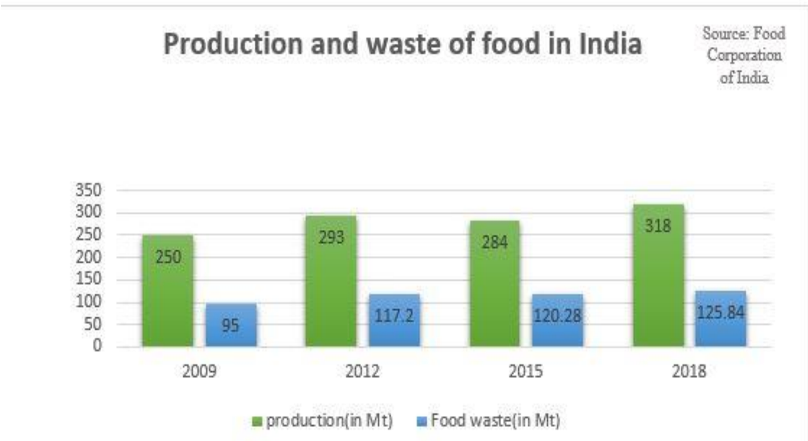

Figure 1.1: Production and waste of food in India

Agriculture constitutes a fundamental pillar of the economic sectors in developing nations, such as India. Food security, a critical concern influenced by the twin issues of food loss and food wastage, necessitates the implementation of effective food storage practices. If the reduction in losses is achieved, there will be a corresponding increase in the quantity of food available in an organic manner.

Each year, a significant proportion of food grains, specifically 24%, are lost due to fluctuations in temperature. It is estimated that approximately 17% of cereal grains are subject to spoilage caused by insects and bacteria. The presence of moisture is responsible for the deterioration of around 14% of grains. Approximately 5% of grains are adversely affected by avian species. Therefore, it is imperative to tackle the challenges associated with food deterioration. Warehouses are considered the primary storage facilities for perishable products such as food grains, fruits, and vegetables.

A warehouse is a physical facility designed for the purpose of storing various types of goods or commodities. Various entities such as manufacturers, importers, exporters, wholesalers, transport companies, customs, and other relevant stakeholders utilize warehouses for their operational needs. Industrial parks located on the outside of urban areas commonly consist of large, rudimentary structures. Stored goods encompass a wide range of resources, including raw materials, packing supplies, spare parts, components, and finished products, which are all associated with manufacturing, agricultural, or production processes. As depicted in Figure 1.2, it is noteworthy that in India and Hong Kong, a warehouse is commonly known as a "go-down."

Figure 1.2: Traditional gunny bag warehouse

Traditional warehouses are characterized by a high degree of reliance on manual labor. These processes need a significant allocation of human labor and entail manual tasks, hence amplifying the potential for errors. The management of warehousing is a crucial component within the broader context of supply chain management. The agricultural sector places significant importance on warehouses due to their vital role in maintaining food security. In previous eras, there existed antiquated techniques for preserving food and grains that relied heavily on physical labor, resulting in time-consuming and inefficient processes. The process of food and grain spoilage commences subsequent to their harvest. The harvested crops must be stored in a location that ensures adequate food security, encompassing the provision of high-quality, safe, and nutritious food. Reducing food waste is a key determinant in enhancing food security. A warehouse offers safeguards against the potential loss and damage of food items caused by factors such as elevated temperatures, excessive dampness, airborne particles, and gusty winds. The primary objective should be to preserve the crop in optimal condition for an extended duration. The storage of crops is a fundamental aspect of warehousing, as it serves to safeguard the crops and mitigate risks associated with their preservation. Moreover, it serves as a preventive measure against potential incidents such as theft or loss. According to research conducted by the Food and Agriculture Organization, it has been noted that there is an inverse relationship between temperature and grain moisture. Specifically, it is recommended that in order to ensure proper preservation of crops, a decrease in grain moisture is necessary when temperature levels rise. As a consequence of elevated temperatures, food undergoes a gradual reduction in weight and ultimately becomes desiccated and decayed. An elevated moisture content might give rise to complications since it promotes the proliferation of fungal and insect infestations. Insufficient provision of adequate care has the potential to result in significant financial losses for agricultural practitioners. This results in a significant decline in their revenue [11].

2. Problem Statement

A warehouse management system (WMS) is a software solution designed to streamline the intricacies associated with warehouse management. This technology offers immediate and up-to-date information regarding the specific location and quantity of inventories. The implementation of warehouse management systems significantly enhances the speed, ease, and efficiency of inventory management. Warehouse management can be a challenging task, but, the results achieved are remarkable. The demand for food is experiencing a constant upward trajectory and is projected to further escalate in the foreseeable future due to the expanding global population, which consequently necessitates greater food production. In India, there is a significant issue of food wastage, with over 40% of food being discarded. This wastage has no value for farmers, as they invest months of effort in cultivating these crops, only for them to be wasted within minutes. Consequently, many farmers are abandoning the agricultural sector due to the lack of profitability and inefficient utilization of the food produced. Therefore, it is imperative to address this problem by emphasizing the importance of food preservation and storage in order to minimize food wastage. The demand for food exhibits a persistent upward trend and is projected to potentially reach a level between 150% and 170% of the present demand by the year 2050.

3. Literature Review

Researchers have conducted studies on several factors, including temperature sensors, humidity sensors, light-dependent resistors (LDRs), smoke sensors, fire sensors, and others. Additionally, I have gained experience in working with many hardware devices and software platforms. Previous studies have been conducted by scholars in the field of warehouse monitoring. Several examples are encompassed.

The creation of a smart warehouse monitoring system based on the internet of things was proposed by the authors [1]. The network of sensors comprises several types of sensors, such as vibration sensors, humidity sensors, temperature sensors, and fire sensors. The transmission of messages is facilitated through the utilization of the Internet of Things (IoT) and the implementation of a Raspberry Pi Zero model controller, which effectively incorporates IoT technology. Python, an open-source programming language, is widely recognized for its effectiveness in software development. The findings of the study indicate that the kit was successfully integrated with sensors and a controller, enabling the transmission of alerts through the utilization of a Wi-Fi module. In the event of an environmental change, this Internet of Things (IoT) system is designed to transmit alerts via mobile phones.

A limited number of The authors [2] put forth a proposition on the secure storage of fruits and vegetables. This paper aims to investigate the impact of environmental factors on the quality of fruits during the warehousing process. It also explores the conventional methods of protecting fruits and proposes a comprehensive monitoring system based on Wi-Fi technology. The proposed system utilizes a PIC16F877A microcontroller, internet of things (IoT) technology, and four sensors including temperature, light, humidity, and gas sensors. All physical parameter values are transmitted to thingspeak.com through connections established between the PIC microcontroller and various devices. The data acquired from the Things Speak server can be utilized by analysts to do various MATLAB analyses and visualizations. These analyses and visualizations can contribute to modifying the design of the warehouse in response to the dynamic changes in its surroundings.

In their study, the authors [3] introduced an Internet of Things (IoT) enabled smart cold storage system designed to enhance the effectiveness of stock management. The prototype integrates an Internet of Things (IoT) based intelligent cold storage system. The study incorporates the utilization of a Raspberry Pi with integrated Wi-Fi, an Arduino HX7111C, and a temperature sensor. The prototype utilizes a webcam for object detection, with ARDUINO serving as the weight scale controller and raspberry pi-3 functioning as a home server. The controller will gather all relevant data and transmit it to the Raspberry Pi-3 using Python programming. This will enable the identification of the weight of an object when it is placed in the storage box.

Several authors [4] have discussed a scholarly topic concerning a system for monitoring and notifying in real time, which utilizes an internet of things (IoT) approach. This system is designed specifically for monitoring temperature, relative humidity, luminosity, and gas concentration in cold storage environments. The paper encompasses various components such as a sensing module, wireless communication technology, an Android application, a microcontroller, IoT integration, and sensors for temperature, humidity, light intensity, and CO2 levels. The C programming language is utilized for software development.

The paper titled "Concept and Implementation of a Smart Warehouse Management System" [5] discusses the development and application of an advanced system for managing warehouses. Distribution firms utilize a software system known as a Warehouse Management System (WMS). Warehouse Management System (WMS) plays a crucial role in enhancing the efficiency of a company's operations. By implementing a smart WMS, one of the leading distribution firms in Bosnia and Herzegovina has simplified its processes and effectively monitored its operations. This system utilizes artificial intelligence and optimization algorithms to optimize the working processes, hence improving overall productivity. The optimized process enhances the efficiency of the temporal environment by implementing the idea defined in the standard Warehouse Management System (WMS). This concept provides users with an optimized solution that improves various aspects of warehouse operations, including stack design, product placement, stock-to-picking zone allocation, transfer processes, order picking, transportation, and tracking.

In their study, the authors [6] put out a proposition for the development of a Warehouse Management System (WMS) that is based on an open source web framework. The growing variety of products has led to an increasing number of organizations considering the implementation of Warehouse Management Systems (WMS) for their warehouse operations. However, the cost of implementing a WMS is significantly greater for small businesses due to the inherent complexity involved in developing such a system. In addition, the software effectively stores and manages the designated storage target. Through the utilization of various operational tasks such as warehouse management, stock taking, and garage shifts, the organization establishes a communication protocol between their mineral monitoring client, enabling the transmission of server information to the programmable logic controller (PLC). This paper presents an overview of the fundamental procedures and methodologies employed in the implementation of a warehouse management system developed by domestic small and medium-sized enterprises. The system in question is an open-source framework that is characterized by its aesthetic appeal and adaptability.

The authors have been proposed [7]. The present study focuses on the design and implementation of a warehouse management system (WMS) that is based on the Advanced Planning and Optimization (APO) framework. The implementation of a warehouse management system has been identified as a solution for decreasing inventory costs and enhancing customer satisfaction levels. Aspect-oriented programming (AOP) is a technique used for separating concerns in software development. It allows developers to construct objects that are clean and effectively contained, without including unnecessary functionality. The implementation of high modularization and structured coding enhances the architecture, ensuring that concerns are isolated and do not propagate throughout the system. The present study focuses on the design and implementation of a warehouse management information system (WMIS) utilizing the principles of Aspect-Oriented Programming (AOP). Empirical evidence demonstrates that the system's architecture effectively satisfies the growing requirements for complexity and accuracy in contemporary warehouse management.

This study [8] focuses on a warehouse management system that utilizes association rules. The system is capable of analyzing the quantity of goods involved in the association rules based on the algorithm of association rules. To conduct the experiment, we analyze the data from the list of goods that have been taken out of the warehouse. The process of mining association rules can be divided into two distinct steps. That is, the process involves identifying groupings of items from the transaction data and subsequently determining the association rules that meet the minimal support threshold. The use of association rules is being utilized in the context of the warehouse management system, specifically when the procurement staff makes the decision to acquire products that have quantities below the minimum inventory threshold. The proposed warehouse management system is designed to operate using association rules. The rules were derived by the analysis of data within the system.

The proposed study by the authors [9] introduces the concept of Smart Warehouse Monitoring utilizing the Internet of Things (IoT). Regular screening of the warehouse is necessary to minimize the storage expenses associated with atmospheric conditions affecting food grain quality. This work aims to propose the development of an Internet of Things (IoT) enabled system comprising smart sensors for monitoring vibrations, humidity, temperature, and fire incidents in the warehouse. The accomplishment is facilitated through the utilization of contemporary technologies, specifically the Internet of Things (IoT). The Raspberry controller utilizes Internet of Things (IoT) technologies to transmit signals. The captured data from the sensor is processed within the software, adhering to predetermined limits. This processed data is then promptly transmitted via SMS to the relevant officials of the Central Warehouse Corporation. The purpose of this communication is to facilitate monitoring and prompt corrective actions in response to any atmospheric conditions that may arise within the warehouse. The audacious endeavor is capturing the dynamic alterations occurring within the confines of the warehouse. The LM35 is utilized for the purpose of capturing variations in temperature. The DTH11 sensor is utilized to measure and monitor moisture levels. The SW420 sensor is designed to analyze seismic activity. The fire can also be detected using light-dependent resistors (LDRs) and infrared technology. The Raspberry Pi is equipped with an integrated Wi-Fi module that facilitates the connectivity of Internet of Things (IoT) devices. Additionally, the device is equipped with an SD slot that is capable of storing a limited range of data for each sensor. The recommended approach for inventory management in the next generation smart warehouse management involves the execution and implementation of existing technologies, specifically utilizing IoT-enabled sensor technology.

The authors (10) discussed a research paper on the topic of Warehouse Logistics Control and Management System that is based on RFID technology. This paper discusses the hardware and software components of a warehouse logistics control and management system that utilizes RFID (Radio Frequency Identification) technology. It further elucidates the design scheme and implementation methodology employed in the development of the system. The process of performing a write operation involves utilizing an electronic tag in conjunction with a tag reader. The implementation of logistics control involves the utilization of Programmable Logic Controllers (PLCs) to establish communication with SIEMENS Win CC setup software and employ OPC technology. The utilization of a SQL Server enables the implementation of several functionalities, including automated data storage, querying, and deletion of items and warehouse information. The hardware components encompass the EFAT/LC experimental equipment, a computer for logistics control and management, an electronic tag system, and a device for displaying tag information. This paper presents a logistics automation management system that utilizes RFID technology, with a specific application example of integrating electronic tag technology and logistics control/management.

A limited number of authors [11] have provided explanations regarding the IoT Instrumented Food and Grain Warehouse Traceability System for Farmers. The authors possess knowledge on the significant significance that proper food storage plays in relation to food security, which is influenced by both food loss and food wastage. The reduction of losses might lead to an increase in the overall availability of food. This study proposes the implementation of an Internet of Things (IoT) enabled monitoring system in geographically remote regions with limited accessibility. The objective is to address the challenges faced by farmers in these areas, particularly in terms of inadequate storage facilities, which contribute to significant food losses and compromise food safety. By using IoT technology, this system aims to mitigate these issues and enhance food security by providing real-time monitoring and control capabilities. The suggested framework is designed to monitor many characteristics inside a warehouse setting, including temperature, humidity, carbon monoxide levels, motion, vibration, and smoke. These elements are particularly significant in relation to their impact on grains. The ESP32 Wi-Fi module is responsible for gathering data from the sensors, and subsequently transmitting this data to the Node-red dashboard via a MQTT broker.

In a previous study, authors [12] conducted research on the application of Internet of Things (IoT) technology for the purpose of detecting and monitoring the quality and quantity of food in cold storage facilities. The authors introduced an Internet of Things (IoT) driven cold storage management system that offers a cost-effective solution to address the challenges associated with monitoring food quality and quantity. The suggested methodology utilizes a combination of heterogeneous Internet of Things (IoT) devices, cloud-based services, and an Android application. In order to monitor the quantity of food, an ultraviolet (UV) sensor has been employed. This sensor provides information regarding the occupancy level of the container in which the food is stored, enabling the calculation of the food quantity. Additionally, a MQ4 gas sensor has been utilized to detect the presence of methane gas in the surrounding environment. This detection serves as an indicator of the quality, or freshness, of the food. After conducting an exhaustive review of the relevant literature, the present study has discovered the following gaps in the existing research.

The majority of writers mostly utilized temperature and humidity sensors in their research, with limited exploration of alternative technologies such as Raspberry Pi and other microcontrollers because to their higher cost compared to the node MCU employed in this study. Furthermore, it is worth noting that a significant portion of the literature focused primarily on cold storage and did not extensively investigate other forms of food grain deterioration. The purpose of this project is to create a Warehouse Management System (WMS) that incorporates several advantages identified in a review poll. The primary goal is to provide farmers with a cost-effective and efficient multimodal system that is user-friendly.

4. Objective

The present project is taken up with the following objectives:

a) To Develop a cost-effective IoT instrumented Warehouse Traceability System.

b) To enable farmers to track live data of temperature, moisture and other parameters.

c) To Reduce the food grain spoilage.

5. Methodology

The current project workflow entails regular monitoring of the parameters related to food spoiling. In the event that food deterioration is detected, the sensors will generate a high output, which will then be processed by a microcontroller. This information will be communicated to the user using the Blynk Mobile application, utilizing Blynk cloud access. If food is not damaged, it will be stored in a designated place for safekeeping on a regular basis.

The primary block diagram of the suggested prototype is depicted in Figure 3.2. Each individual component is provided with a controlled power source in order to facilitate their coordinated operation. The ESP8266 microcontroller is equipped with an integrated WIFI module that enables internet connectivity. The suggested approach utilizes inexpensive device components, hence enabling the establishment of a cost-effective warehouse infrastructure.

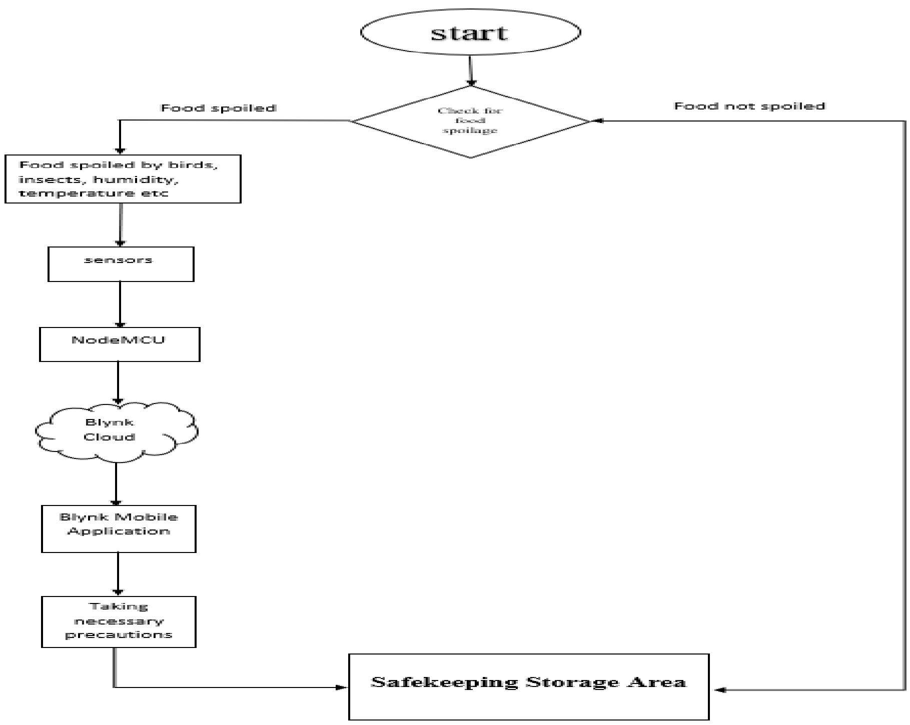

Fig 5.1: main block diagram of the proposed proto type

The primary component of the module is the NodeMCU ESP8266 microcontroller, which serves as the central component of the system. The Internet of Things (IoT) functionality of the system is effectively controlled by the cost-effective and highly efficient Wi-Fi module. The microcontroller is connected to four sensors, namely the temperature sensor and humidity sensor (DHT22), PIR sensor, gas sensor (MQ3), and flame sensor. Additionally, the microcontroller is also connected to the Blynk mobile application. The Arduino Integrated Development Environment (IDE) is utilized for the purpose of uploading code to the NodeMCU microcontroller. The programming language C, which is open-source, is widely recognized for its effectiveness. The data generated by each sensor is captured and transmitted to the Blynk cloud platform. The implementation of distinct thresholds for various grain kinds, such as rice and wheat, is being considered. In the event that the value surpasses the predetermined threshold, the Blynk system will initiate the transmission of a notification via the Blynk platform. The Blynk mobile application is utilized for the remote monitoring of parametric values and the implementation of preventative measures.

The schematic presented in Figure 3.3 depicts the suggested model, which comprises many components including the NodeMCU ESP8226 microcontroller, the blynk application, a temperature sensor, a humidity sensor (DHT22), a PIR sensor, a gas sensor (MQ3), and a flame sensor. All of these components are interconnected with the microcontroller.

The NodeMCU ESP8266 microcontroller is equipped with a built-in WIFI module that enables internet connectivity. Temperature and humidity sensors are employed for the purpose of monitoring real-time temperature and humidity levels within a storage facility. The DHT22 sensor is attached to pin D4 of the NodeMCU microcontroller. This sensor provides measurements for both temperature and humidity. The data obtained from the sensor is transmitted to the Blynk mobile application, where it is displayed on the virtual pins V6 for temperature and V5 for humidity. The PIR sensor is employed for the purpose of detecting infrared-emitting entities, such as humans or animals, within the sensor's operational range. When connected to pin number D5 of the NodeMCU, the output from the PIR sensor is transmitted to the Blynk application, where it is virtually represented using pin V0. The gas detection sensor is linked to pin A0 of the NodeMCU. An output is received when the gas quantity surpasses the predetermined threshold. A buzzer is attached to pin D1 to indicate this output. The output is then virtually shown in the Blynk app using pin V1. The fire detection sensor is linked to pin D7 of the NodeMCU microcontroller. When it detects a wavelength within the specified range, it produces an output signal that activates a buzzer functioning as a fire alarm. Additionally, the fire alarm is connected to the Blynk application by pin V7.

6. Results And Discussion

Figure 4.1 depicts the top view of our suggested model prototype, which is created from common card stock to resemble a warehouse and contains a NodeMCU, four sensors (DHT22, MQ135, PIR, and Fire), two buzzers, one LED, and tiny packets. These little bags, which resemble the gunny bags kept in warehouses and are loaded with grains including rice, wheat, and cereals. According to the top view, the model's right side has a flame sensor and two linked buzzers.

DHT22 and MQ135 sensors are connected at the left side as shown in Figure 4.1. PIR sensor and LED are mounted on the model's backside. The microcontroller (NodeMCU) will use the built-in wi-fi to access Blynk if any variations in the model are detected and analysed by the appropriate sensors.

Every sensor in this model has been temperature adjusted, calibrated, and saved in a type of programme in OTP memory. When the sensor senses something, it will reference the calibration coefficient from memory. Due to its small size, low power consumption, and extended transmission distance of 20 metres, the DHT22 is well suited for many types of challenging application scenarios. four pins in a single-row box, which greatly facilitates the connection. The average room temperature and humidity are displayed in Figure 4.2. The variation in temperature and humidity when applying heat is depicted in Figure 4.3. The aforementioned information was collected from the Blynk smartphone app. The DHT22 Digital Temperature and Humidity Sensor measures the humidity and temperature of the air around it using a thermistor and a capacitive humidity sensor.

PIR Sensor

A pair of pyroelectric sensors is used by passive infrared (PIR) sensors to identify heat energy in the surrounding environment. These two sensors are positioned next to one another, and the sensor will activate when there is a change in the signal differential between them—for example, when someone enters the room. That could imply that it sounds an alert, contacts the police, or perhaps switches on a floodlight.

There is no movement or motion detected in Figure 4.4. The output increases if any things (insects, birds, rodents, etc.) are detected, as seen in picture 4.5. Any infrared emitting object, including people and animals, that is inside the sensor's detection range or moves into it can be detected by the device.

Temperature and Humidity Sensor

Digital signal calibration is output by DHT22. Its unique digital signal collection method and humidity sensor technology ensure its stability and dependability. Its eight-bit single-chip computer is coupled to its sensing components.

Every sensor in this model has been temperature adjusted, calibrated, and kept in a sort of programme in OTP memory. When the sensor senses something, it will reference the calibration coefficient from memory. Due to its small size, low power consumption, and extended transmission distance of 20 metres, the DHT22 is well suited for many types of challenging application scenarios. four pins in a single-row box, which greatly facilitates the connection. The average room temperature and humidity are displayed in Figure 4.2. The fluctuation in temperature and humidity when applying heat is seen in Figure 4.3. The aforementioned information was collected from the Blynk smartphone app. The DHT22 Digital Temperature and Humidity Sensor measures the humidity and temperature of the air around it using a thermistor and a capacitive humidity sensor.

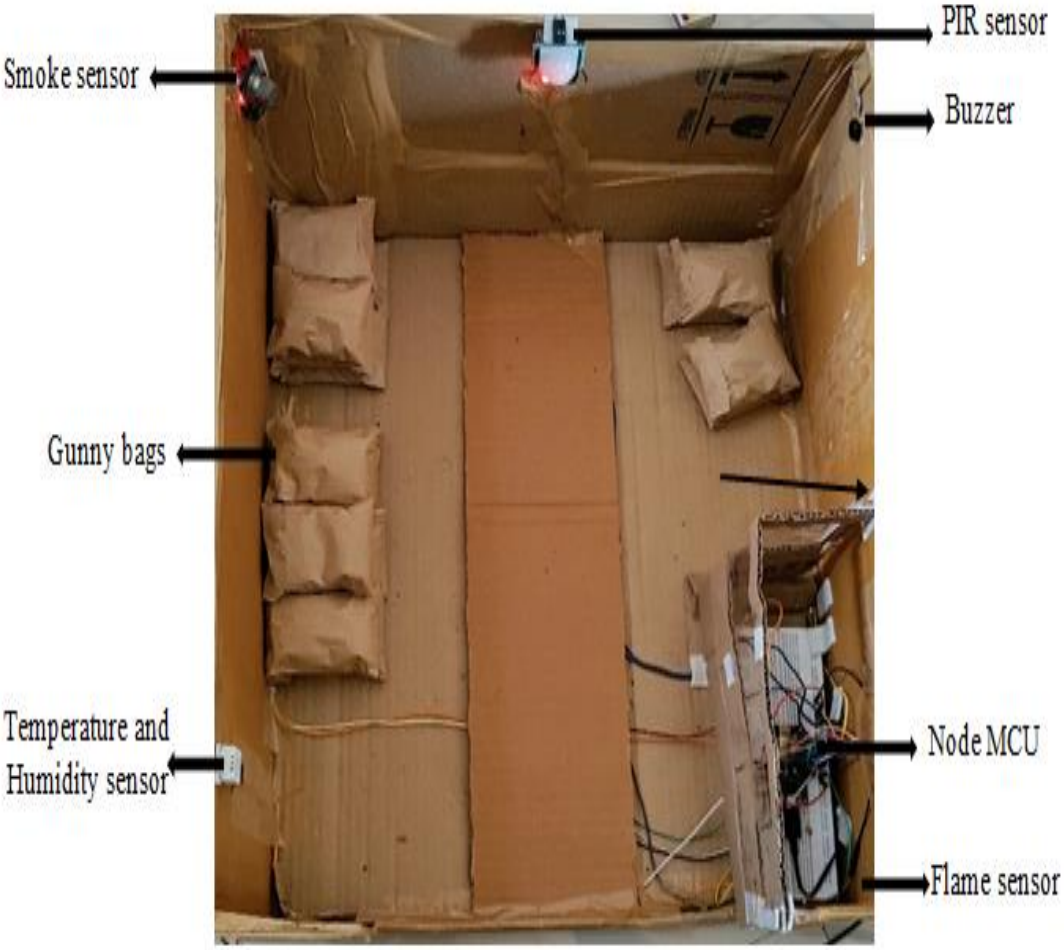

Figure 4.1: Proposed model

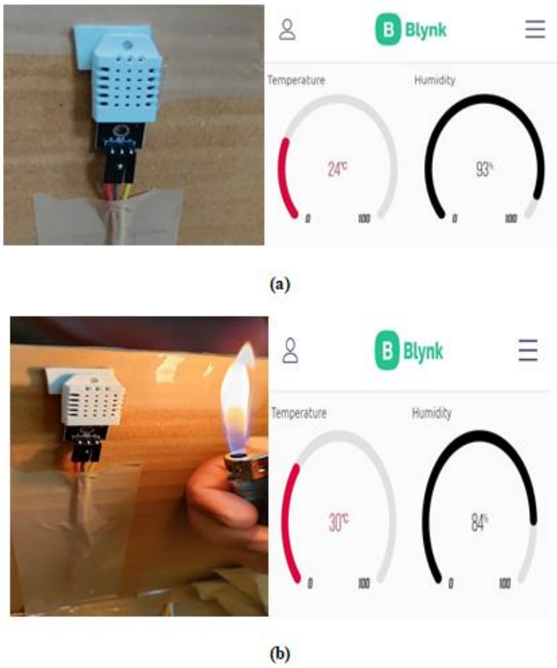

Figure 4.3: a)Temperature and humidity variation
b) Normal temperature and humidity

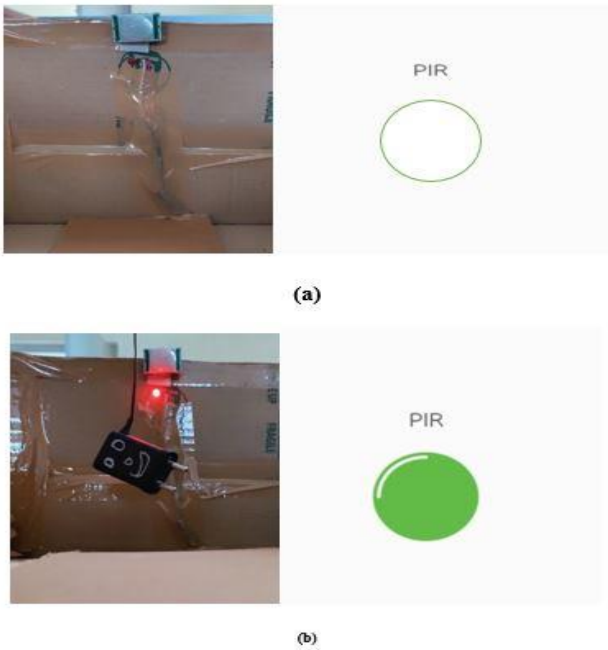

Figure 4.5: a) Motion detected
b) No motion detected

Gas Detection Sensor

When it comes into touch with gaseous reactants, a platinum coil within a catalytic gas sensor heats up. The coil's internal temperature rises as a result. In the event that the temperature change falls within what is regarded as a dangerous range, the catalytic gas sensor will sound the alarm and notify people.

There was no smoke or stench, as shown in figure 4.6. The buzzer will sound when the strength of the smell, smoke or gas exceeds the threshold. The sensor is capable of detecting a variety of gases, including CO_2, NH_3, NOX, alcohol, and benzene.

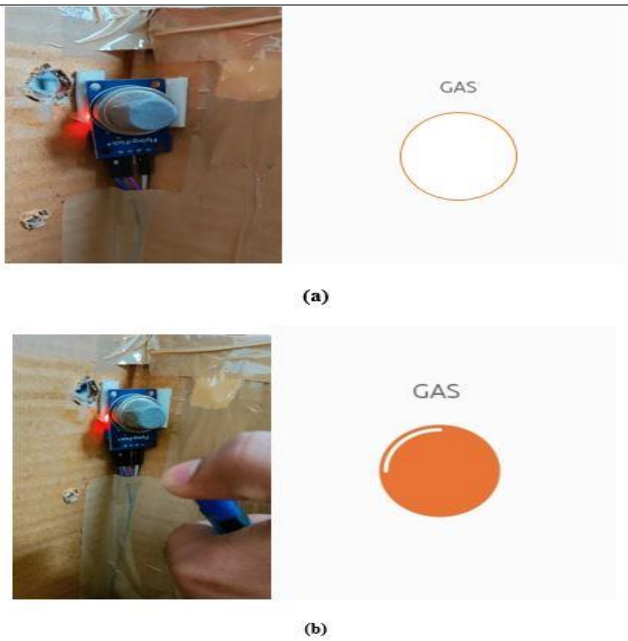

Figure 4.7: a) Odour detected
b) no smoke or Odour detected

Flame Detection sensor

Since flame sensors are the most light-sensitive, flame alarms are typically activated by their reaction. This module can identify flames or light sources with wavelengths between 760 and 1100 nm. One chip and a small plate output interface can be directly linked to the microcomputer's IO port. To prevent the sensor from being damaged by high temperatures, there should be a certain distance between it and the flame. If the flame is larger, test it from a further distance; the shortest test distance is 80 cm. The flame spectrum is extremely sensitive because of the 60-degree detecting angle. We added a buzzer so that we could measure the flame spectrum by hearing sound, as the detection angle is 60 degrees, making the flame spectrum extremely sensitive.

Figure 4.8 displays the absence of flame. As seen in Figure 4.9, the sensor will detect any fire or short circuit that catches fire, switch on a buzzer, and record the reading in the Blynk application.

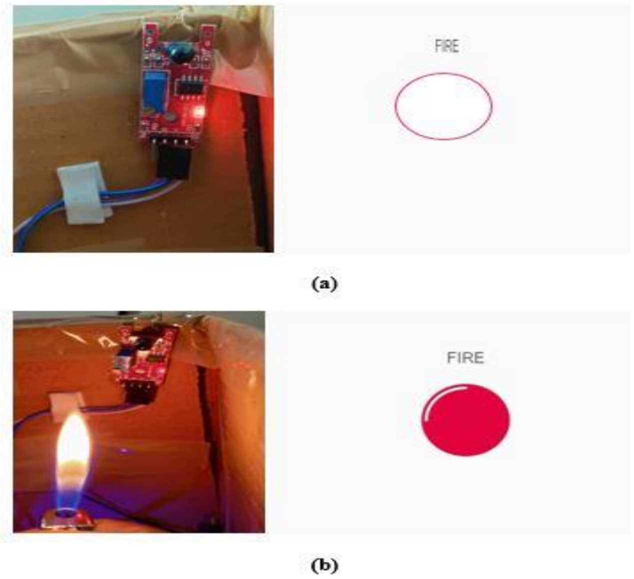

Fig 4.9: a) Flame detected
b) No flame detected

7. Conclusion

A warehouse is an entrepot for goods designed for commerce. Producers, dealers, traders, distributors, wholesalers, customs, etc. all use warehouses. The ultimate use of smart technology is the smart warehouse management system (WMS). In order to lower food grain storage costs caused by atmospheric conditions, this warehouse should be checked on a regular basis. The screening process should also be documented.

Taking into account the proper storage of grains, a food that is essential to both our everyday existence and health. The upgrade of the warehouse management system is encouraged by the real-time monitoring of the food storage environment. This model uses PIR, gas, temperature, humidity, and fire sensors in the warehouse, which can be applied in the storage area. Advanced sensor technologies enabled a successful validation of the proposed system. Based on cloud computing and the Internet, it will drastically lower the mistake rate and increase the efficacy of warehouse management. A smart warehouse management system can notify you when food in the storage area degrades. It is possible for the warehouse's actual owner to conduct continuous surveillance in practically real time. When compared to the sensors utilised in the other works, all of the sensors are incredibly cost-effective and produce nearly identical findings. Using the associated values of the various sensors also significantly reduces computational effort.

Our smart warehouse storage solution has a smaller sensing coverage area whilst being more efficient. Thus, it is necessary to extend the sensing range. No matter where the storage place is located, the system should be able to precisely detect and recognize them thanks to the use of more sophisticated sensors for detection and recognition.

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