MONITORING SYSTEM OF FOOD WAREHOUSES BY USING SINGLE BOARD COMPUTER

A Project report submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

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DECLARATION

I hereby declare that this project **MONITORING SYSTEM OF FOOD WAREHOUSES BY USING SINGLE BOARD COMPUTER** represents my own work which has been done in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications. I have attempted to identify all the risks related to this research that may arise in conducting this research, obtained the relevant ethical and safety approval (where applicable), and acknowledged my obligations and the rights of the participants.

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APPROVAL

The project entitled **"MONITORING SYSTEM OF FOOD WAREHOUSES BY USING SINGLE BOARD COMPUTER"** submitted by **Ramit Arko (181-33-4450) & Mita Sarker (181-33-4498)** has been done under my supervision and accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** in **February, 2024.**

Signed

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Dedicated

To

Our Parents

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LIST OF ABBREVIATIONS

AHT20	Adafruit Temperature and Humidity Sensor
AIB	American Institute of Banking
ARM	Advanced RISK Machine
ASUS	Computer Manufacturer Company
BAETE	Board of Accreditation for Engineering and Technical Education
BDT	Bangladeshi Taka
CPU	computer processing unit
CSDs	Central Storage depots
DHT22	Temperature and Humidity Sensor
DIU	Daffodil International University
DSI	Display Serial Interface
EEE	Electrical and Electronics Engineering
FDA	Food and Drug Administration
GDP	Gross Domestic Product
GFSI	Global Food Safety Initiative
GPIO	General purpose Input/Output
HDMI	High-Definition Multimedia Interface
HUB	Common connection point
IOT	Internet of Things
LSDs	Local Storage depots
MIPI	Mobile Industry Processor Interface
MQ4	Methane gas sensor
MSRP	Manufacturer’s suggested retail price
OS	Operating System
PC	personal computer
POE	Power over Ethernet
RAM	random access memory
SBC	Single Board Computer
SSD	Solid State Drive
UN	United Nation
VGA	Video Graphics Array
WSN	Wireless Sensor Networks

LIST OF SYMBOLS

Symbol	*Name of the symbol*
%	Percentage

ACKNOWLEDGEMENT

First, by the grace of **Almighty**, we are able to complete our work with the best effort. We want to pay our utmost respect to our Supervisor **Ms. Sutapa Debnath, Senior Lecturer** of the **Department of EEE, Daffodil International University** for who has given us the chance to work on an impactful idea and taken care of every issue of development of this concept. Then we would like to take this opportunity to express gratitude to our supervisor for being dedicated in supporting, motivating and guiding us throughout this project. This project couldn’t be done without her useful advice and help. Also thank her very much for giving us the opportunity to work with this project.

ABSTRACT

Problem arose when the price of the daily consumed foods suddenly increased and the quality dropped significantly due to reinless syndicates and poor food management as the daily news were flooded by the reports in the year of 2022 and 2023 at an alarming rate in Bangladesh. Where investigations of Director of National Consumer Rights Protections described the lack of data records is the prime culprit for the situation. We collected data from different food suppliers from Dhaka to narrow down the problem and create a sustainable solution for the issue which is digitally collecting data by implementing Wireless Sensor Networking System and monitoring the value in real time. Sensors will be installed in warehouses where foods are being stored for collecting data then a single board computer will act like a hub which will send the data to the cloud server so that multiple devices can connect to the server aiming to monitor the real-time value. We created a project using Raspberry Pi 4B as single board computer and DHT 22 sensor for collecting the data of both the humidity and the temperature and ran the project for several months for collecting the value difference. Then we analyzed the outcome which led the conclusion for better waste management, strong monitoring and easy data record that will slow down the issue and will help in total GDP in Bangladesh.

Keywords: IoT, Sensors, Single board Computer, Sensors, Cloud Server, Digital Monitoring, Food Management.

CHAPTER 1
INTRODUCTION

1.1 Motivation

172,954,319 is the population of Bangladesh [1] with a hunger rate of 11.40% [2]. Fish and grains are the main food chain of Bangladeshi people, where over 36604[3] Metric Ton rice produced on 2019-2020 and major carp fishes were produced over 875624 Metric Ton [3] annually. A large quantity sells in farmer's markets, wholesale as well as retail markets. The retail market size is 208,700 crores [4]. According to Statista, over 2 billion tons of waste are produced every year where 1.4 hectors of land, which 28 percent of the world's agricultural area is used annually to produce food that is lost or wasted [5]. Beyond the environmental impacts, food wastage costs some $750 billion annually to food producers, UN report says [6]. Bangladesh's annual food waste is over 10 million tons which is about 5.5% of the total procured food, with 3% being made during procurement and preparation stage, 1.4% during serving and another 1.1% from the plates [7]. From many reasons, population growth and development of living standards, lack of knowledge and defective implementation of policies, lack of proper waste management infrastructure, misuse of waste bin are significant. Proper monitoring using advance technology can reduce food wastes and cause less economical damage for Bangladesh. Vast amount of food and spoilage materials is being stored in warehouses where 36 million metric ton of rice and 2.6 million metric ton of wheat produced in a year in Bangladesh [8]. Due to humid and warm climate food grains are stored in various facilities. Foods are currently being stored in six silos. 12 Central Food Warehouses (CSDs) and 635 Local Storage depots (LSDs) under the Food Department of Ministry of food [9]. The capacity of food grains in these warehouses is 21.8 million metric tons. For better security, this number of foods need proper monitoring. Everything is now digitalized; Bangladesh is also entering the path of being smart technologies. A lot of digital single board computers are available in local electronics stores which are very cheap in price and can be used for digital monitoring systems. That can provide proper preserve efficiencies and help to fight against the money inflation.

1.2 Problem Statement and Proposed solution

Traditionally manual monitoring methods are used in most food warehouses. Lack of proper waste management, better food quality providence and strong data record causes the disruption in economic efficiency which makes food warehouse companies to pay heavy cost in long run and causes suffering for civilians. Collecting data from daily newspapers and physical outlets from specific region visualize actual traditional manual monitoring situations:

Table-1: Distribution of Companies according to Category, Nature, Monitoring employees and monthly product wastes (%)

Name	**Category**	**Outlets** (in Dhaka)	**Warehouses** (in Dhaka)	**Monitoring employees per warehouse** (average)	**Average monthly product wastes** (%)
Chaldal	Online groceries service provider	0	27	15	17
Shwapno	Supermarket chain	56	unknown	45	8
Tasty Treat	Bakery and pastry shop	200	23	6	6
Green Grocery	Online groceries service provider	0	8	10	11
Panda Mart	Online groceries service provider	0	11	unknown	6

Reports from 24th May 2023 of The Daily Star on artificial price hike of onion [10], 12th August 2023 of The Business Standard article on egg price hike [11], 1st November 2023 of The Daily Prothom Alo news highlighted on price hike of potatoes which indicates the lack of surveillance over food warehouse data cause the syndicates over the market price which leads to a huge corruption and food waste [12]. Digital era makes surveillance easier to reach. Whereas implementing computer and sensors combined in a food warehouse, the job of waste management and data record of the products can become quite fruitful than the regular system by providing implacable food quality and economic efficiency value as well as reducing extra human workload.

1.3 Objectives

The design and implementation of a wireless sensor network (WSN) for monitoring temperature and humidity in food warehouses aiming to reduce the food waste and labor costs as well as increasing the data collection accuracy and security. Which can have several benefits and impact on the economy of a company and thus government inventory.

Improved food safety and quality: By monitoring the environmental conditions in food warehouses, the WSN system can help ensure that the food is stored in optimal conditions to prevent spoilage, contamination, and other quality issues. This can result in better food safety and quality and reduce food waste.aa

Increased efficiency and cost savings: The WSN system can provide real-time monitoring and control of the food warehouses, allowing for prompt action in case of environmental deviations. This can result in improved efficiency, reduced energy consumption, and lower operating costs.

Better resource management: By providing real-time data and insights into the environmental conditions of the food warehouses, the WSN system can help with better resource management and decision-making. This can result in reduced energy consumption, lower operating costs, and more sustainable use of resources.

Increased transparency and accountability: The WSN system can provide real-time data and insights into the environmental conditions of the food warehouses, allowing for greater transparency and accountability. This can help to ensure that food is stored and managed in a responsible and sustainable manner.

1.4 Brief Methodology

In this Internet of Things (IOT) project, a food monitoring device has been built using Single Board Computer (SBC) to monitor the temperature and humidity of the stored environment. Raspberry Pi has primarily been chosen as SBC due to its diversity and efficiency as well as cheap. To collect the data of temperature and humidity the DHT22 sensor module is used. In the future, if needed we can also use an IOT based MQ4 gas sensor module to determine the status of the food as well as weight sensor to monitor the food quantity in the storage area.

The real-time values of the temperature and humidity will be measured by the sensor and will be sent over to the Raspberry pi, which will be the hub for data collection and processing alongside providing the data security. Then the data will be sent over to the cloud service platform to be displayed on it.

HARDWARE SPECIFICATIONS:

Raspberry Pi 4B

DHT22 Sensor

Power Cable for SBC

Monitor

Internet Connection

SOFTWARE SPECIFICATIONS:

Raspberry Operating System

Blynk Cloud Service

Text Editor

Terminal

LANGUAGE USES:

Python

JavaScript

Circuit Python

LIBRARY USES:

Adafruit_DHT

adafruit_circuitpython_dht

1.5 Implementation Schedule / Gantt Chart

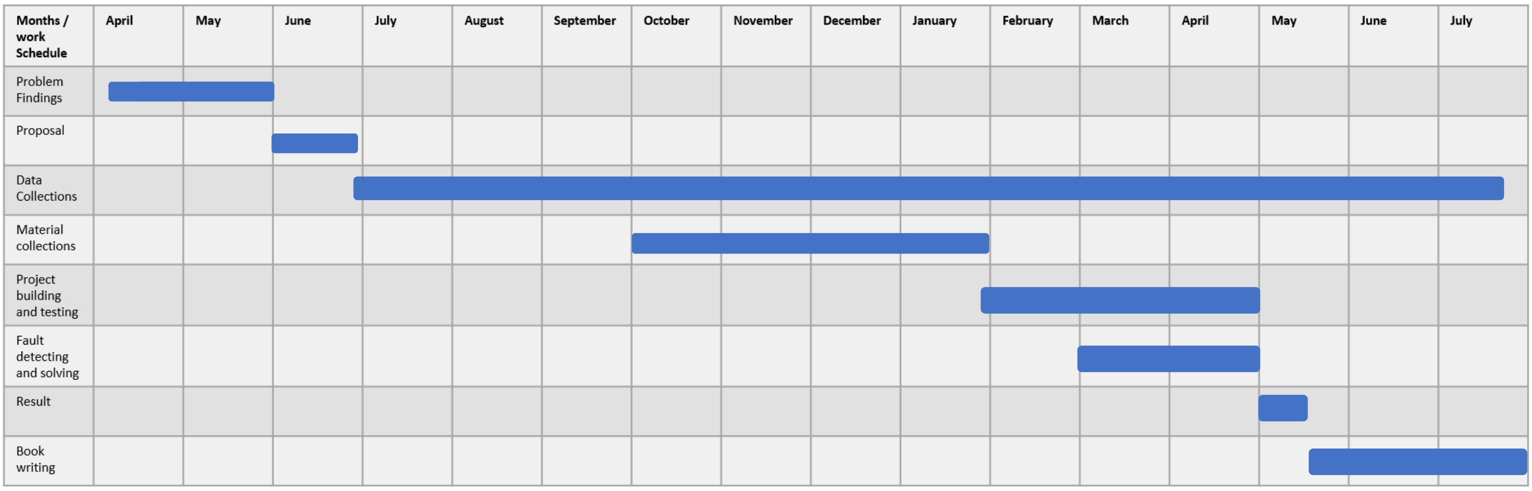

Figure-1: Gantt Chart

1.6 Structure of the Report

Introduction: In this section, Background and problem statements have been described. The objectives for the situation have been discussed. Brief methodology for the projects is also noted here. Then we created a Gantt chart as the schedule for the implementation carries on.

Literature Review: Here we light up the related research and works. Then we compare the contrast and create a summary based on that.

System Design: Material and components for the method have been discussed here as well as design specifications. Standards and constraints are also described here. Then we focused on system analysis after building the project. Then we ran the project and the outcome of the system was discussed.

Result and Discussion: The overall outcome of the system has been disclosed here.

Project Management: the way of creating tasks and managing the schedule as well as reaching the milestone is noted here. Resources and cost management are also described.

Impact Assessment of the Project: Economical, societal and global Impact environmental and ethical issues utilization of existing standards or codes are discussed here.

Conclusion and Recommendations: summarized the whole project and its outcome here. Future recommendations are also noted.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Wireless Sensor Networks (WSNs) have emerged as a promising technology in the field of monitoring and control systems, offering significant advantages over traditional systems. In the context of food warehouses, where maintaining optimal conditions for storage and preserving food quality is of paramount importance, WSNs have shown great potential in enhancing operational efficiency and minimizing food spoilage.

The management and control of environmental conditions within food warehouses are critical factors in ensuring the freshness and quality of stored food products. Temperature, humidity, and air quality are key parameters that need to be monitored and controlled to prevent food spoilage, reduce waste and comply with regulatory requirements. WSNs offer a wireless and distributed approach to monitor these parameters in real-time, enabling proactive decision-making and timely intervention when deviations occur.

This literature review aims to explore the existing research and advancements in the use of WSNs for food warehouses. It will provide an overview of the key challenges faced in food warehouse management and highlight the benefits and limitations of employing WSNs in this domain. By examining the current state of the art, this review seeks to identify gaps and opportunities for further research and development in this area.

The review will delve into various aspects related to WSNs in food warehouses, including the selection and deployment of sensor nodes, data collection and transmission protocols, data analytics and interpretation, and the integration of WSNs with existing warehouse management systems. Additionally, it will examine the impact of WSNs on energy efficiency, scalability, reliability, and cost-effectiveness in food warehouse environments.

2.2 Related Works

The efficient management of food warehouses is crucial for ensuring the quality and safety of stored food products. Factors such as temperature, humidity, and air quality play a significant role in preventing food spoilage and maintaining optimal storage conditions. However, traditional monitoring systems often rely on manual inspections or wired sensors, which can be time-consuming, labor-intensive, and prone to human errors.

Wireless Sensor Networks (WSNs) have emerged as a promising solution to address the limitations of traditional monitoring systems in food warehouses. WSNs enable the deployment of a large number of wireless sensors that can autonomously collect and transmit data on environmental conditions in real-time. This allows for continuous monitoring and timely intervention when deviations occur, leading to improved operational efficiency, reduced waste, and enhanced food quality.

Definitions and Concepts:

Wireless Sensor Network (WSN): A network of spatially distributed autonomous sensors that cooperatively monitor physical or environmental conditions, such as temperature, humidity, and air quality, and communicate the collected data wirelessly to a central monitoring system [13].

Food Warehouse Management: The systematic process of planning, organizing, and controlling various activities related to the storage, preservation, and distribution of food products within a warehouse facility, with the aim of ensuring food safety, quality, and regulatory compliance [14].

Sensor Node: A self-contained unit within a WSN that consists of a sensor for data collection, a microcontroller for data processing, a transceiver for wireless communication, and a power source [15].

Similar Designs and Techniques:

Several studies have explored the use of WSNs for monitoring environmental conditions in various domains, including agriculture, healthcare, and industrial settings. In the context of food warehouses, WSNs have been applied to monitor temperature, humidity, and other parameters relevant to food storage. For example, research by Zhang, Zhao, and Chen (2016) demonstrated the effectiveness of a WSN-based system for monitoring and controlling temperature in a food storage warehouse, resulting in improved energy efficiency and reduced food spoilage [16].

Other designs and techniques, such as wired sensor networks and manual monitoring, have been widely used in food warehouses. However, these approaches often suffer from limitations such as limited coverage, high installation costs, and the potential for human errors. WSNs offer advantages such as scalability, flexibility, and real-time data collection, making them a promising alternative for overcoming these limitations [17].

In terms of coursework, previous studies in areas such as wireless communication, sensor networks, and data analysis provide a foundation for understanding the underlying principles and concepts of WSNs. This knowledge forms the basis for designing and implementing an efficient WSN solution for monitoring environmental conditions in food warehouses.

2.3 Compare and Contrast

In many food warehouses, environmental conditions are monitored manually by human operators. This method involves periodic inspections and recording of temperature, humidity, and other parameters. However, manual monitoring is labor-intensive, time-consuming, and prone to human errors. It also lacks real-time data, making it challenging to detect and respond to deviations promptly.

Some food warehouses utilize wired sensor networks to monitor environmental conditions. Wired sensors are connected to a central monitoring system through physical cables. While this approach provides reliable data transmission, it has limitations in terms of flexibility and scalability. The installation of wired systems can be expensive and disruptive to warehouse operations.

Another approach involves using standalone sensors placed at various locations within the warehouse. These sensors collect data on temperature, humidity, and other parameters and store it locally. However, standalone sensors lack a centralized monitoring and control system, making it difficult to manage and analyze data from multiple sensors efficiently.

Manual monitoring and standalone sensors do not provide real-time data, which hinders the ability to detect and respond to environmental deviations promptly. Real-time monitoring is crucial for maintaining optimal storage conditions and preventing food spoilage. Wired sensor networks have limitations in terms of coverage and scalability. The installation of physical cables can be challenging and costly, especially in large warehouse facilities. Additionally, expanding the network or reconfiguring it to accommodate changes in the warehouse layout is cumbersome.

Data Management and Analysis:

Existing systems often lack advanced data management and analysis capabilities. Storing, processing, and analyzing the collected data from multiple sensors can be complex and time-consuming, impeding effective decision-making.

Recommendation:

To address the limitations of existing systems, a Wireless Sensor Network (WSN) solution is recommended for monitoring environmental conditions in food warehouses. WSNs offer several advantages, including:

Real-time Monitoring: WSNs enable continuous and real-time monitoring of temperature, humidity, and other parameters. This allows for timely detection of deviations and proactive intervention to maintain optimal storage conditions.

Scalability and Flexibility: WSNs can be easily expanded or reconfigured to accommodate changes in the warehouse layout. Wireless sensors can be deployed in a flexible manner, providing comprehensive coverage of the warehouse.

Advanced Data Management and Analysis: WSNs can leverage advanced data management and analysis techniques to process and analyze the collected data. This enables efficient decision-making and facilitates predictive maintenance and optimization of storage conditions.

By implementing a WSN-based solution, food warehouses can improve operational efficiency, reduce food waste, and enhance the quality and safety of stored food products. Further research can focus on op analysis and work performance, developing intelligent algorithms for data analysis, and integrating the WSN with warehouse management systems to enable seamless control and automation.

2.4 Summary

This chapter discusses the limitations of current systems like manual monitoring, wired sensor networks, and standalone sensors, which lack real-time monitoring, have limited coverage and scalability, and face challenges in data management and analysis. The review identifies research gaps and proposes a WSN solution to overcome these limitations. WSNs offer real-time monitoring, scalability, flexibility, and advanced data management and analysis capabilities. The implementation of a WSN-based solution can enhance operational efficiency, reduce food waste, and improve the quality and safety of stored food products. The review is supported by definitions, concepts, and information from reliable sources such as textbooks, handbooks, technical papers, reports, websites, codes, and regulations. It also suggests that the design process may have been influenced by previous coursework. In essence, the review provides a comprehensive overview of the research problem, critiques existing systems, highlights research gaps, and advocates for a WSN-based solution.

CHAPTER 3
SYSTEM DESIGN

3.1 Introduction

Chapter 3 will be the discussion of system design where the full procedure will be disclosed.

First, we must talk about the material selections. As it is an IoT (Internet of Things) based system of WSN will require a hub for collecting data and transmitting to the cloud through the internet. For collecting data, the collections of sensors will do the job. A comparison of other components which are available in the market will be noted.

After material selections, the implementations and overall planning will be discussed in the design specifications. Step by step connections, implementation planning for the components, programs, and software to run the device will be described in the design specifications. Set upping the cloud system to the hardware will be discussed.

After planning and setting up the full set up from design specifications we will analyze the system in design analysis. Where addressing the technical aspects and business needs for the system that we will be using. In this passage we will try to attain the maximum outcome from the system without regard to cost or expense.

After setting up the plan and system, we will run the system in a suitable environment. The data will be collected, and any errors will be monitored. Total highlights will be discussed in the simulation passage.

3.2 Methods and Materials

IOT based method is used here which is known as Wireless Sensors Networking (WSN). Sensors are the electrical ways to collect data from the physical environment. The way a sensor works is where an open circuit turns into a continuous or harmonized or non-harmonized close circuit or vice versa by interacting with the physical environment. Physical environmental conditions generate electrical signals which later process in microchips. In this electronics generation era, sensors are a very important part of electronics and can commonly be found in almost every device.

Wireless Sensors Networking (WSN) is a system where several same or different types of sensors will be placed in a single or in a large place, wirelessly connected to a single hub or a server or a computer to monitor the condition of that place. The monitoring system is farther improved by utilizing the cloud server system. Through cloud system data can be monitored from anywhere.

In this system, Raspberry Pi 4B which is a single board computer (SBC) has been used as a central hub. Sensor used DHT22 for humidity and temperature data collection. For cloud savings Blynk Cloud system is used as a cloud broker. For power connection, power brick comes with Raspberry Pi 4B which converts AC to DC and provides 5V to 9V for stable connection to the Raspberry Pi 4B.

The way DHT22 works as a sensor by providing the information of humidity and temperature where it uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin.

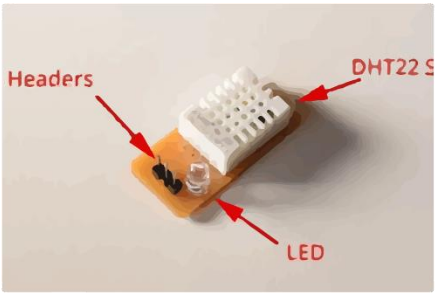

Figure-2: DHT22 sensor (frontside)

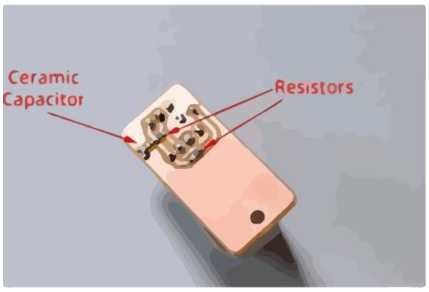

Figure-3: DHT22 sensor (Backside)

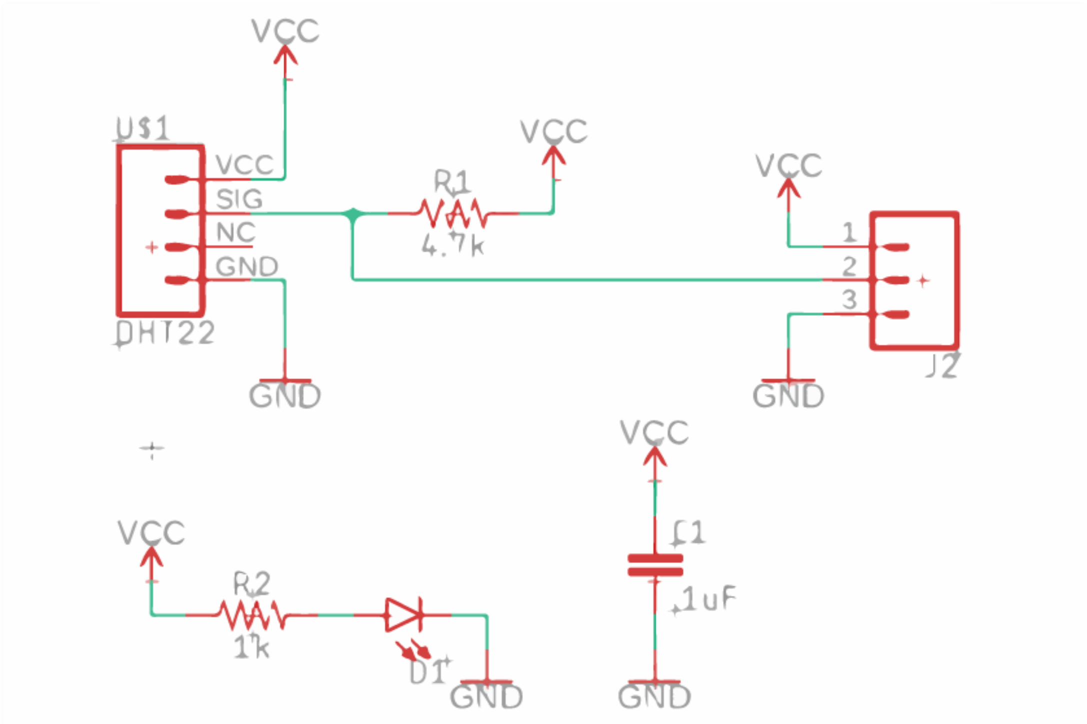

Figure-4: Schematics for DHT22 sensor

Even though DHT22 sensor is cheap and viable. It relies on single wire communication protocol which is difficult to read on the microcontroller side. Instead of sending signal the low voltage into 0 and high voltage into 1, this sensor first pulse signal low indicates the start of a single bit. Then raise signal high for 28 microseconds to represent the binary 0 or 70 microsecond to represent binary 1. Which leads to sometimes inaccurate and inefficient data and limits the microsecond count in data collection.

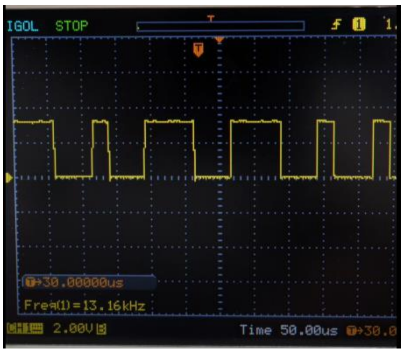

Figure-5: DHT22 sensor voltage count on digital oscilloscope

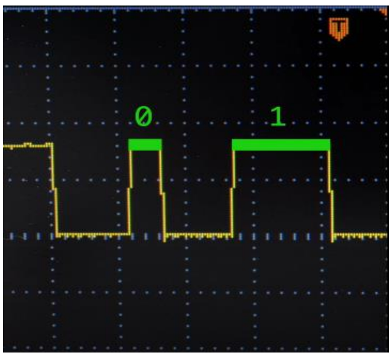

Figure-6: DHT22 Voltage magnitude count as Binary 0 or 1.

Very sensitive workloads may need accurate sensor information for the specific work. There are more advanced options in these modern days. In example Adafruit AHT20 sensor is more accurate for providing the signals information but it comes much costlier than DHT22.

Figure-7: Sensor AHT20 for Temperature and humidity picture

For the HUB where the data will be sent, Raspberry Pi 4B has been chosen for the task. Raspberry Pi 4B is a single board computer (SBC). A complete computer includes a computer processing unit (CPU), random access memory (RAM), with or without on-board memory baked in a single circuit board that offers input/output facilities is known as Single Board Computer (SBC). Despite being small and powerful at the same time Single Board Computers (SBCs) come fairly cheap and have diverse applications which make these more efficient. As example, smart phone’s mother board, laptop mother board, Raspberry Pi, Orange Pi, Beagleboard, Latte Panda, Rock Pi, ASUS Tinker Board and many more.

SBC is chosen over microcontroller because microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. It is designed to run only one program repeatedly and has far fewer resources than an SBC. On the other hand, an embedded system is a computer system—a combination of a computer processor, computer memory, and input/output peripheral devices—that has a dedicated function within a larger mechanical or electronic system. The main difference between an SBC and a microcontroller is that an SBC is a self-contained computer with the ability to run an operating system, while a microcontroller is just a chip with far fewer resources and is intended to run only one program repeatedly.

Raspberry Pi 4B is chosen for this system for better values and flexibility. Raspberry Pi 4B is an ARM (Advanced RISK Machine) architecturally based Single Board Computer. It has 40 General purpose Input/Output (GPIO) pins to work with. On board Gigabit Ethernet Connection helps providing the internet connection to the board as well as powering the board at the same time through PoE (Power over Ethernet) which acts as remote powering.

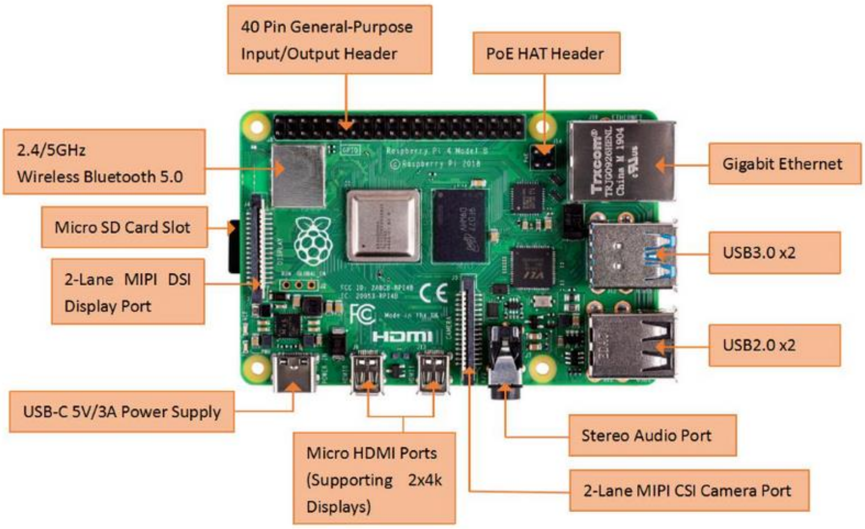

Figure-8: Raspberry Pi 4B Single Board Computer

Raspberry pi 4B model also offer onboard Bluetooth and Wireless dual Band Wi/Fi connection which offers versatile wireless connection and provide easy connection to router or other wireless devices which considers perfect for this project that it will be helpful for the system to synchronize with cloud server. Large number of users and community provide better support than other SBCs.

The Raspberry Pi 4B model has two micro-HDMI ports and a two lane MIPI DSI (Display Serial Interface) Display port to connect to a monitor or a Screen display for viewing the programs. Raspberry Pi 4B does not come with on board storages rather uses external storage micro-SSD (Solid State Drive) for running Operating System (OS). Its OS is Linux for ARM based known as Raspberry OS.

3.3 Design Specifications. Standards and Constraints

The initial plan involves collecting data from several warehouses using sensors then the data will be stored and processed in a hub, later the data will be uploaded to the cloud. Any device that can engage with clouds can be seen through the data that has been collected from.

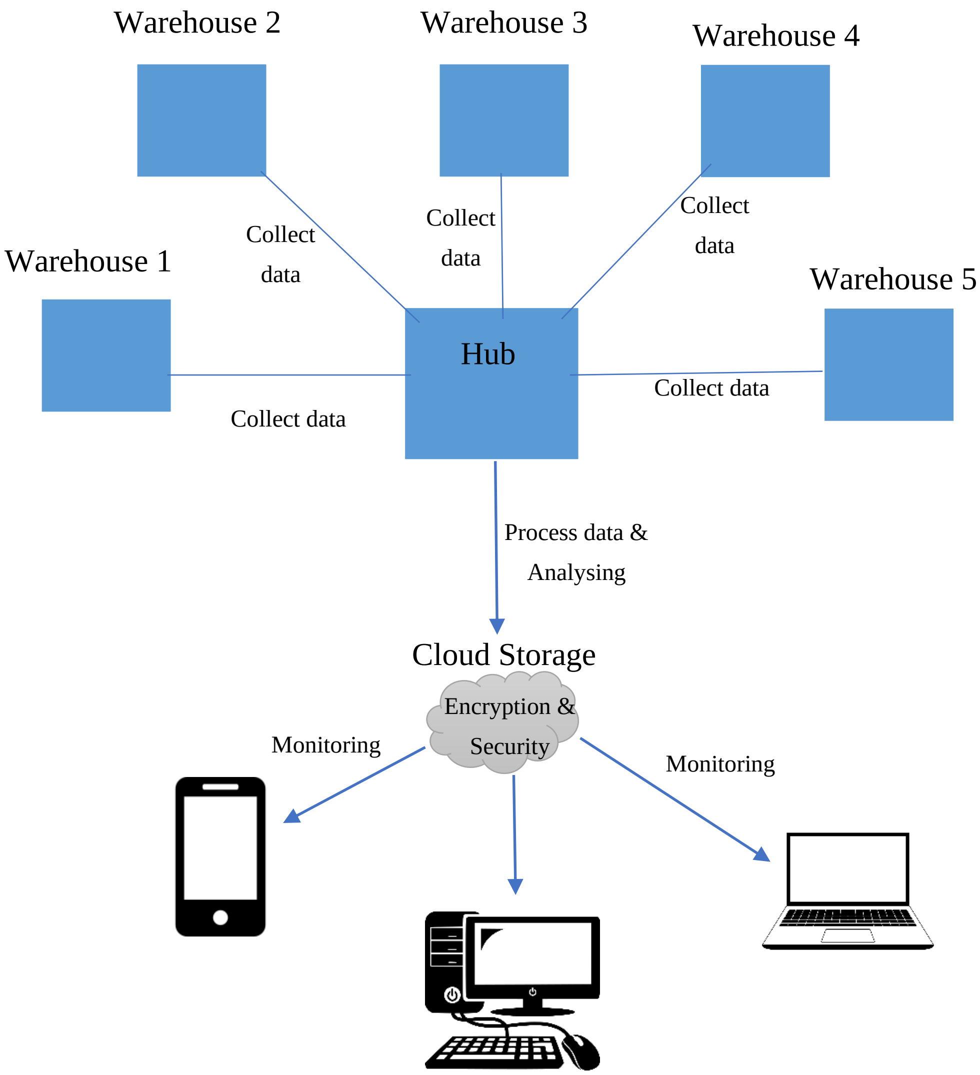

Figure-9: Block diagram of the proposed system architecture.

Here sensors will be implemented in the warehouses and the end connection will meet Raspberry Pi 4B which will act as a HUB. Raspberry Pi will collect the data from the sensors and process the information. Then a Cloud Client will be connected to the Raspberry Pi 4B where the data will be sent by using internet. Raspberry Pi 4B has 40 General Purpose Input/Output (GPIO) pins for external multipurpose uses.

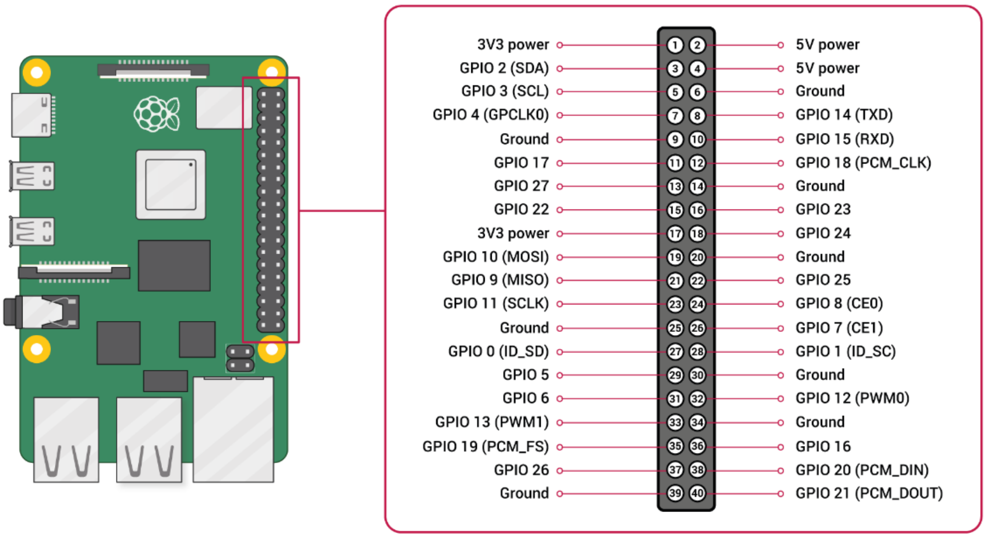

Figure-10: Pin layout of Raspberry Pi 4B

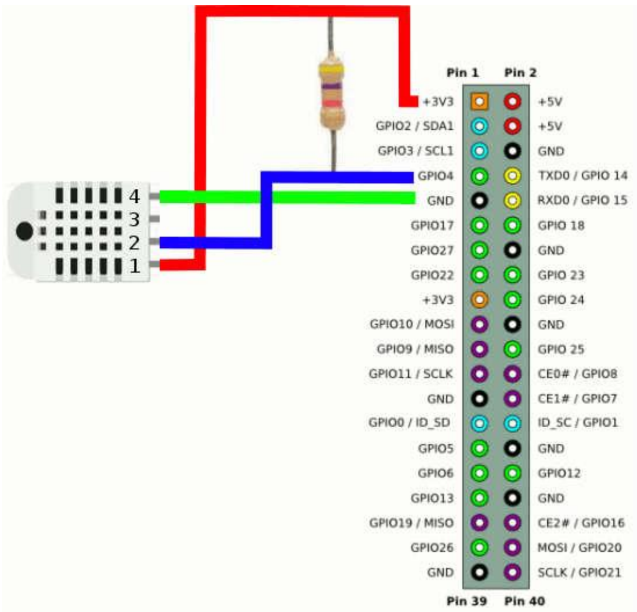

Figure-11: for data connection GPIO pin no 4.

After connections, the power adapter needs to be connected. Then program code needs to be written.

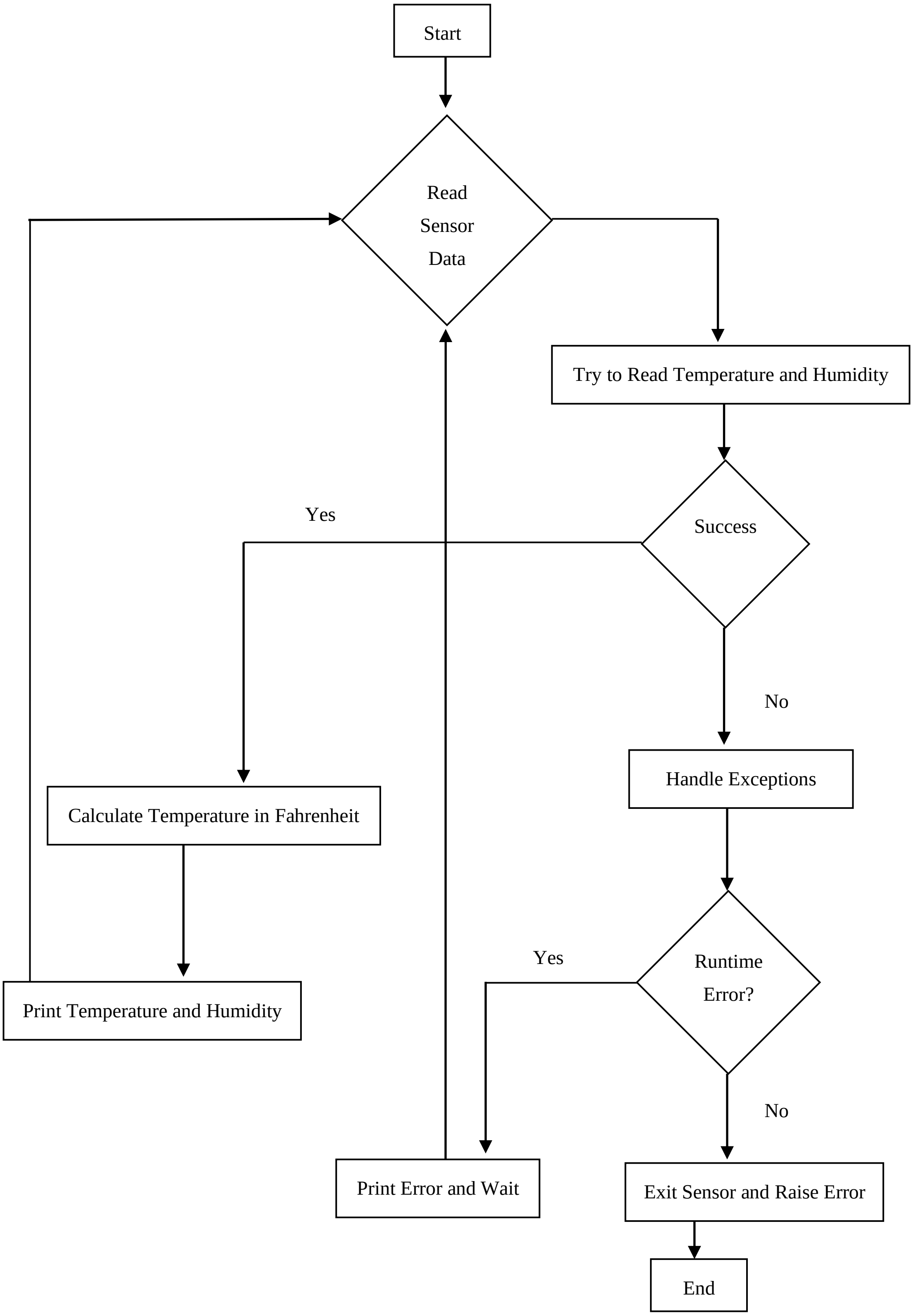

Figure-12: Flowchart Diagram of the Programming Code

By running this code, this will check the connections and the sensors runtime success and errors.

After this, cloud broker needs to be fixed. Here Blynk Cloud has been used for initial purposes. To set up the clous first, it needs a profile creation. Then by creating a new temple, the project can be added manually later. After template creation, Blynk will provide the credentials to connect to the device. (Credentials code may very time to time after logging in for security purposes)

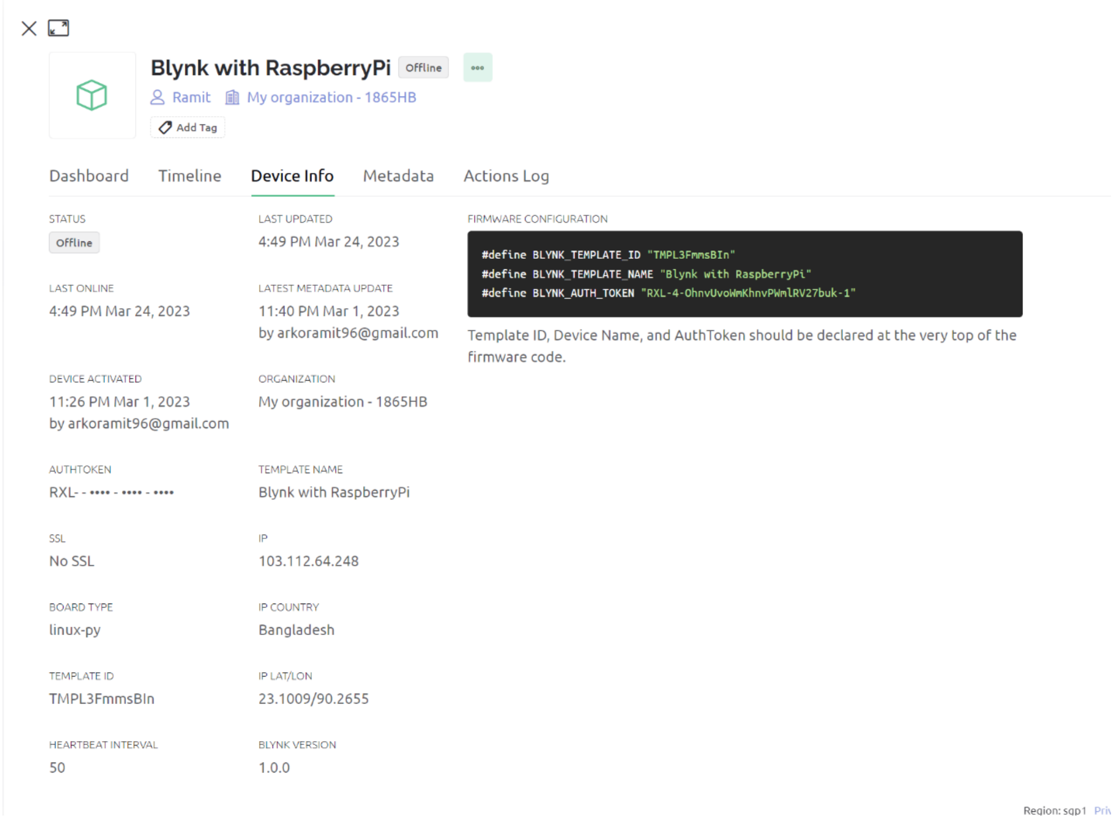

Figure-13: User Interface of Blynk Cloud system Authorization Token.

Then Virtual pins need to be created for the cloud connection for the DHT22 sensor of humidity and temperature sensor. After that, web widgets need to be set up for visuals.

After that, Credential code needs to be added in the code to integrate the cloud.

File Edit Search View Document Help

```
import BlynkLib
import RPi.GPIO as GPIO
from BlynkTimer import BlynkTimer

import time
import board
import adafruit_dht

dhtDevice = adafruit_dht.DHT22(board.D4, use_pulseio=False)

BLYNK_AUTH_TOKEN = 'RXL-4-OhnvUvoWmKhnvPWmlRV27buk-1'

# Initialize Blynk
blynk = BlynkLib.Blynk(BLYNK_AUTH_TOKEN)

# Create BlynkTimer Instance
timer = BlynkTimer()


# function to sync the data from virtual pins
@blynk.on("connected")
def blynk_connected():
    print("Hi, You have Connected to New Blynk2.0")
    print(".......................................................")
    print("................... By Ramit Arko ...................")
    time.sleep(2);

# Functon for collect data from sensor & send it to Server
def myData():
    humidity = dhtDevice.humidity
    temperature = dhtDevice.temperature
    if humidity is not None and temperature is not None:
        print("Temp={0:0.1f}C Humidity={1:0.1f}%".format(temperature, humidity))
    else:
        print("Sensor failure. Check wiring.");

    blynk.virtual_write(0, humidity,)
    blynk.virtual_write(1, temperature)
    print("Values sent to New Blynk Server!")

timer.set_interval(2, myData)


while True:
    blynk.run()
    timer.run()
```

Figure-14: Final code for the cloud to run.

After uploading the code, the program will run and will show us the value.

3.4 Design Analysis

Food warehouses tend to have enormous size and capacities. Large number of quantities manually monitoring is lengthy and labor intensive. On the other hand, some food inventories in retail markets and remote cold storage tend to have small storage systems. Due to WSN being small and handy, it fits well in large areas as well as small areas.

Generally, running food warehouses meets food grade requirements. To fulfill to become a moder warehouse and cost effective, warehouse need to be GFSI (Global Food Safety Initiative) certified.

According to industry standards warehouses must meet some criteria or rules including: No leaks in the walls, roof, or foundation edges. Storage of all cleaning agents, pesticides, and other chemicals is located away from the food shelves. Ensuring the outside of the building has no standing water, weeds, trash, or indications of rodents or other small animals inhabiting the area. The exterior of the building must have no damage, such as cracks or holes. Workers and employee Sanitation. Traceability and First-In/First-Out data location. Pest Control documents. Training and personal hygiene for employees and workers. FDA (Food and Drug Administration) Registration. Safe Quality Food Certification. AIB International for Prerequisite and Food Safety Programs Support.

This large amount of workload is needed to run a warehouse by workers. A good business term is, the more compact and simpler the workload is, the better the output will get. WSN compresses the workload by cutting some of tasks in these fields.

Besides, all the data will be stored in the cloud system. Which will allow the data to be monitored from any device. As well as the cloud system will provide extra security layer for ransomware or malware to attack the data to breach.

The maintenance cost is very low and easy to repair. Being small makes the system to very convenient.

3.5 Simulation

The simulation is placed in a domestic room with normal environmental setup. After running the code, the sensor immediately detects the room temperature and humidity.

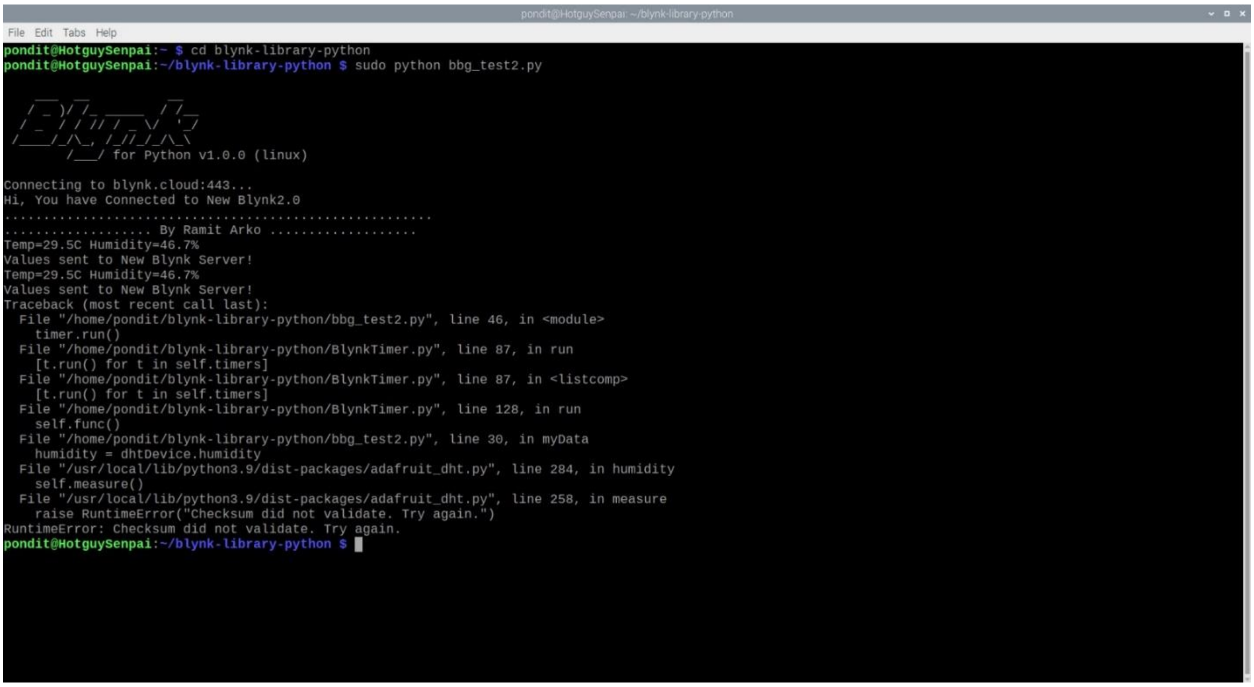

Figure-15: Code simulation on Raspberry Pi 4B

After detecting the parameters, the function sends the data to the cloud broker – Blynk.com where further processing will occur. Then by logging in the cloud server the full documents will be shown.

3.6 Implemented Project

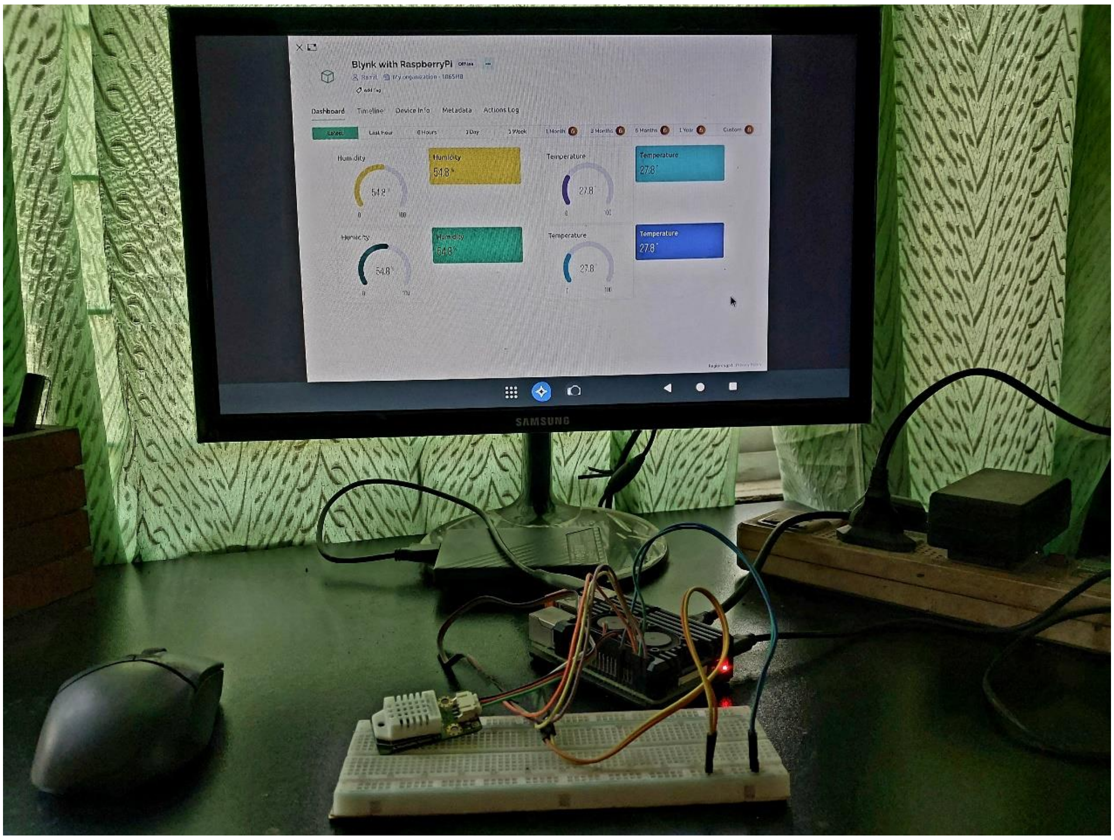

Figure-16: Picture of implemented project

3.7 Summary

In this chapter, methods and materials have been discussed abroad with specifications. First, the theoretical matter described. The procedure that was taken place has been described thoroughly. The reason for choosing specific materials discussed. Design specifications and schematics for the methods are elaborated. Results of using wireless sensor networking in warehouses disclosed. If any potential errors happened or were faced during the test that was mentioned. Problem solving for traditional monitoring methods compared.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Observations

The system was running randomly in the past 12 months. Averaging 1hour, 4 days in each month calculating the average value of the temperature and humidity of each month by collecting the highest value of the day and the lowest value of the day.

(The highest value + The lowest value) / 2 = average value of the day

The average temperature that has been collecting through the sensors from past 12 months are shown in the chart below:

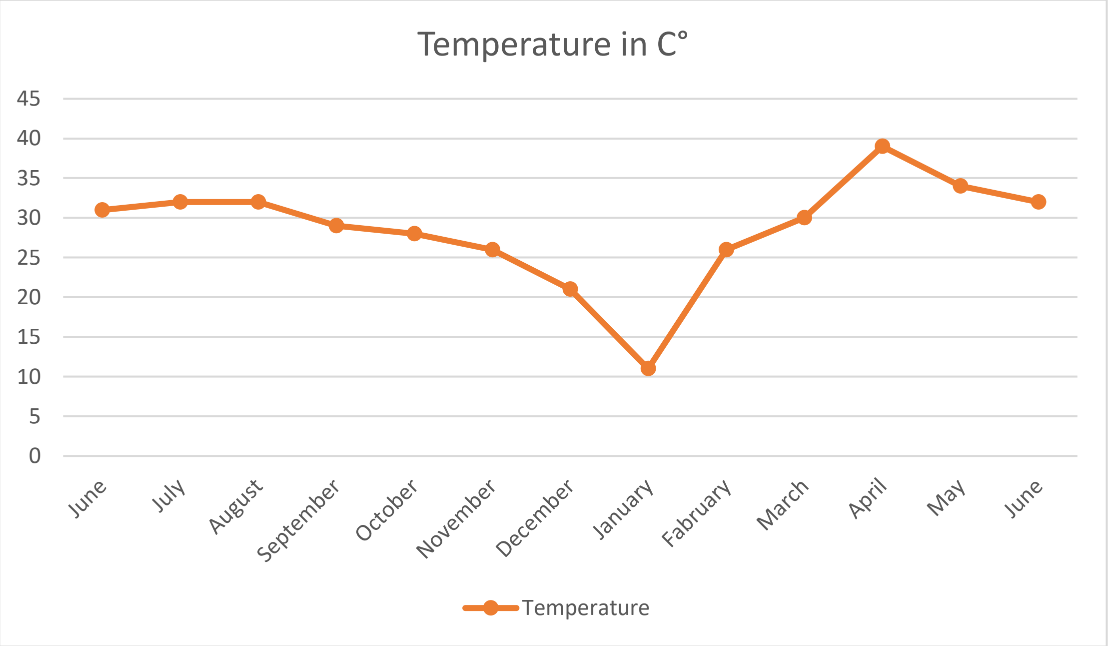

Figure-17: Temperature obtained during different months

The average humidity that has been collecting through the sensors from past 12 months are shown in the chart below:

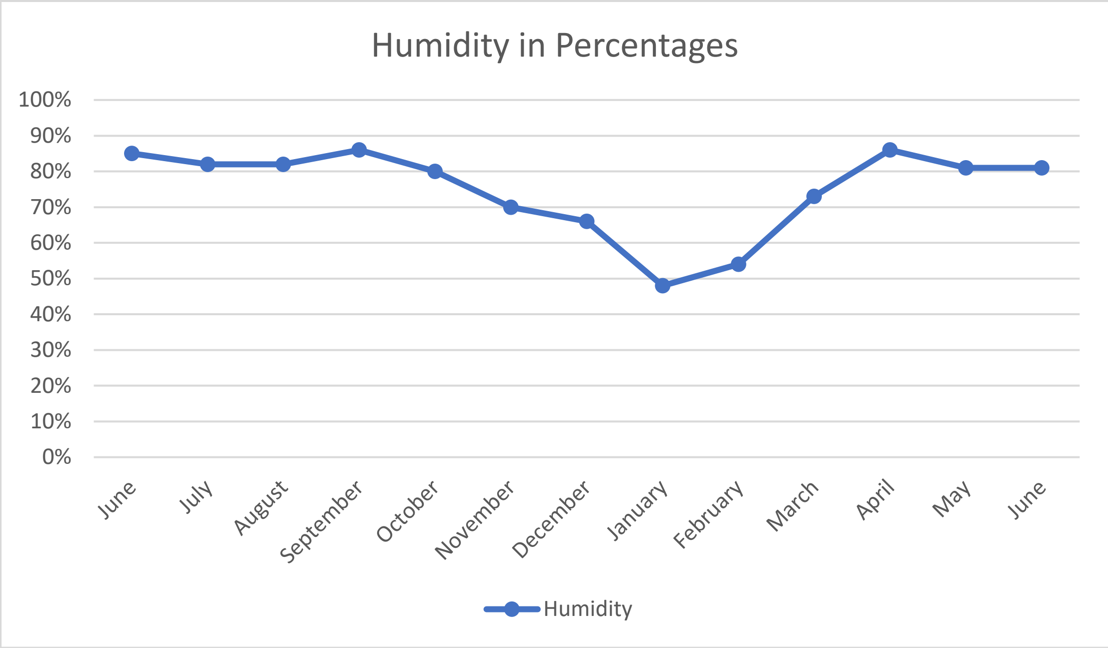

Figure-18: Humidity in Percentages obtained during different months

While the simulation was running, the cloud graphical user interface will be:

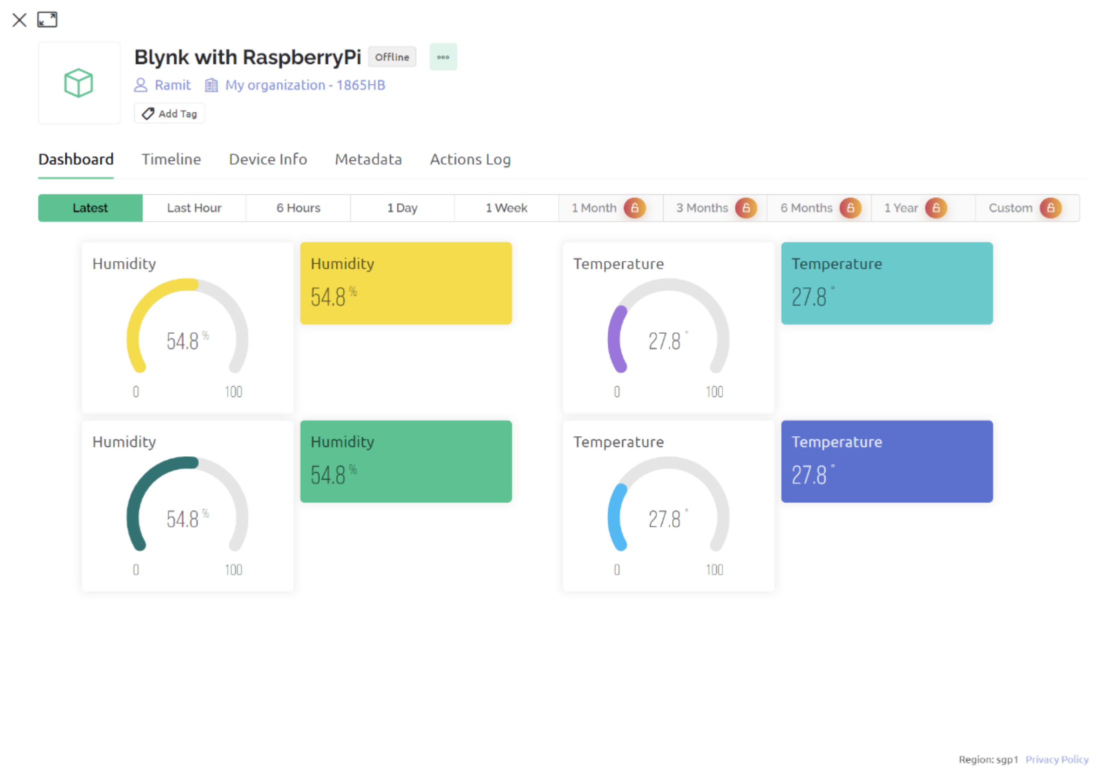

Figure-19 (a): The cloud graphical user interface during running the simulation on PC

Cloud is accessible from any devices. Blynk.com has its own smartphone apps in Ios and Android version. Because of that data can be observed remotely.

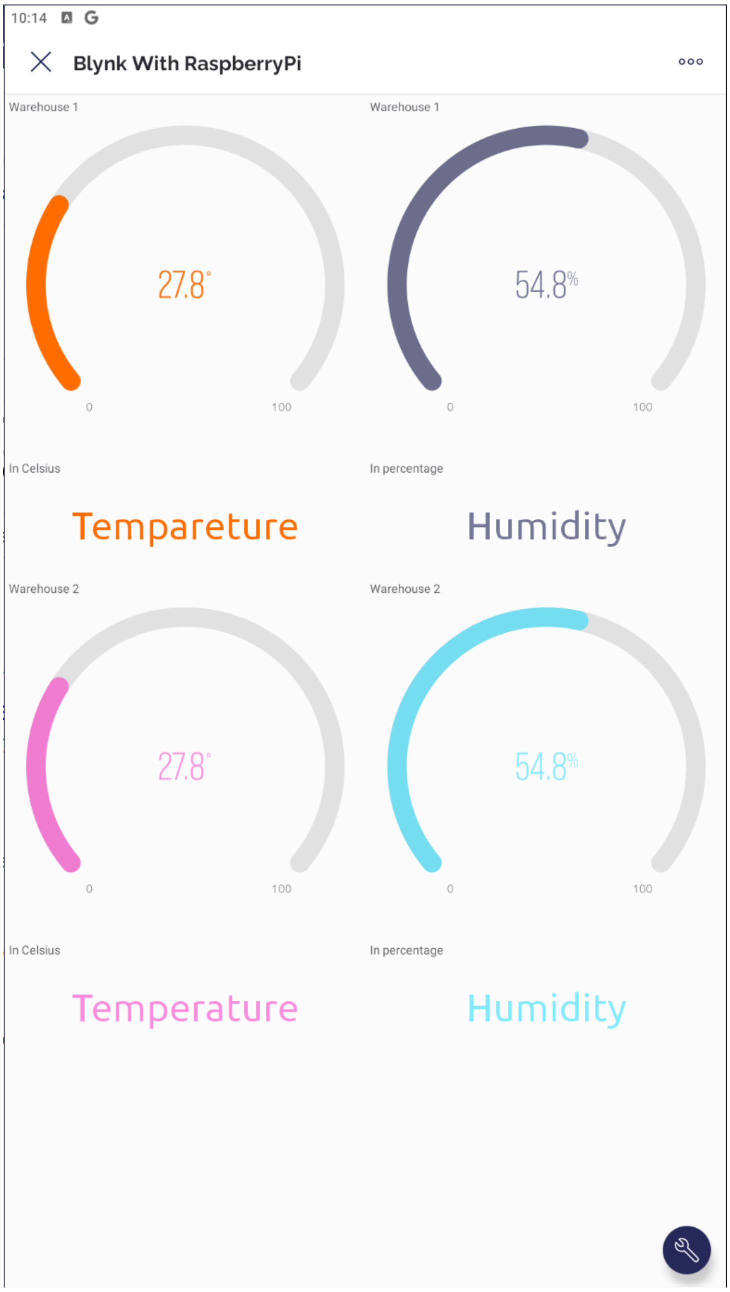

Figure-19(b): The cloud graphical user interface during running the simulation on Android

4.2 Discussions

The result shows the precision of collecting data through time. Same amount of data collection by manually may cost several times and manpower as well as the cost.

Such as,

if a food warehouse requires minimum 15 employees to take care the monitoring of the fresh foods regularly manually and the payment of them is 10,000/- to 15,000/- per month for each of them. Where a Wireless sensor networking system for digital monitoring requires only 15,000/- to build for one time and maintain cost is 500/- per month, the efficiency for using WSN will be:

Let's say the minimum salary of an employee is 10,000 BDT and the maximum salary is 15,000 BDT. The average salary will be (10,000 + 15,000)/2 = 12,500 BDT.

The monthly cost of manual labor is 12,500 BDT/employee × 15 employees = 187,500 BDT.

The one-time cost of the wireless sensor networking system is 15,000 BDT.

The monthly maintenance cost of the wireless sensor networking system is 500 BDT/month.

So, the total cost of wireless sensor networking per month is 15,000 BDT + 500 BDT = 15,500 BDT.

The total cost efficiency of using wireless sensor networking over manual labor per month is:

(187,500 BDT - 15,500 BDT) / 187,500 BDT = 92.22%

This means that wireless sensor networking can save the food warehouse 92.22% of the monthly cost of manual labor.

Besides, the average human error rate is typically around 5% to 10%. This means that for every 100 tasks performed, there will be about 5 to 10 errors. However, the actual error rate can vary depending on the task, the environment, and the individual. A study by National Aeronautics and Space Administration (NASA) found that the error rate for astronauts performing routine tasks was about 1% [18]. However, the error rate increased to 10% for astronauts performing complex tasks. Where, A study by the International Organization for Standardization (ISO) found that the average error rate for machines is about 0.1% to 0.2%. This means that for every 10,000 tasks performed, there will be about 1 to 2 errors. In this case, the cause the human error rate to 0.05 and the machine error rate to 0.001. So, the efficiency of causing errors by machine over human is:

$0.001 / 0.05 = 0.02$

This means that machines are about 20 times less likely to cause errors than humans.
So, using WSN system occurrence of creating errors will be significantly reduced.

CHAPTER 5
PROJECT MANAGEMENT

5.1 Task, Schedule and Milestones

The Project starts with the problem findings. It took two months for whole sections. The problem was clear enough from the very beginning but the solution to the problem took most of the time. Then a proposal was sent to the supervisor. After getting the permission, the data collection period started and took almost five months to get enough data to work with. In the meantime, we started to work on collecting the materials for the project. After finishing collecting materials, project build up begins. Then the project was run, data were collected accordingly. Then the result came out. The whole process took almost 10 months. On the way of creating the project a lot of phenomena issued troubles. Such as material shortage, driver failure cost huge times. Although we planned to finish the project within nine months some issues took the time more than we anticipated.

5.2 Resources and Cost Management

Due to being low cost and simple to build, the whole project was self-funded. Although availability and inflation disrupted the overall purchasing rate of the products. The single board computer (SBC) Raspberry Pi was facing a market shortage and the providers were unable to fulfill the market demands. Due to this reason the initial price was much higher than the regular price. It costed 17,000 BDT whereas the MSRP of the product is 5000 BDT. But other component price was on the point. Such as, the sensor price and MSRP met the same value and costed 1000 BDT. A cooler for the SBC costs 980 BDT.

Table-2: Price distribution of different products (components)

Serial	Products	Quantity	Price in BDT
1	Raspberry Pi 4B	1	17,500
2	Case with Cooler	1	980
3	Gravity: DHT 22	1	1054
4	Memory Card	1	500
5	HDMI to VGA converter	1	300
6	Connector Wires	50	130
7	Bread board	1	1067
Total Cost			21,531

Total cost stands 21,531 BDT for the whole project to build. But there are some mismanagements of costing because of buying some materials that did not go as planned. Such as we bought various amount of heat sink for the Raspberry Pi for the purpose of cooling but due to the size difference any of the heat sink did not fit on the board. Also, some converter cables like HDMI to VGA cable also fell into failed stage because of fitting issue. Aside that other properties like cloud server, Digital Libraries are used completely free. For resource hunting public libraries and university libraries are used completely free of charge.

5.3 Lesson Learned

After conducting the project, we have come to learn about kernel, Linux Operating System, terminal in Linux. Cost management for the whole project let me learn about money management and savings. Communicating with strangers is a huge game change in the field of convincing people. Patience is the key to success for completing the whole management. Various difficulties may raise some concern in time to time and must tackle the whole situation with calm mind-set and fulfill the goal.

CHAPTER 6
IMPACT ASSESSMENT OF THE PROJECT

6.1 Economical, Societal and Global Impact

The projects aim for better food security and quality at a low cost. Which will improve citizens' health beneficial and nutrition. As health-parameters go up the overall productivity increases, which will directly impact on the economy. Besides being an autonomous machine, physical workload will be reduced and the cost of food will be decreased. Digitally recorded factor will help reducing the market syndicate that Bangladesh is facing in a long run, which will directly affect total GDP per capita of the country.

6.2 Environmental and Ethical Issues

This project operates with remarkable energy efficiency, consuming minimal electricity. This not only minimizes our carbon footprint but also contributes to responsible resource utilization. By reducing our reliance on fossil fuels, we actively combat climate change and promote a cleaner future. No animals were harmed or abused during any phase of the project. We recognize the intrinsic value of all creatures and strive to co-exist with them in harmony. This commitment extends to responsible waste management, ensuring no harmful chemicals or pollutants enter the environment, safeguarding both ecosystems and human health. Our project leaves no negative mark on the environment. We prioritize responsible land use and resource extraction, ensuring minimal disruption to natural habitats and ecological processes. This commitment to conservation allows us to contribute to a healthier and more resilient planet for generations to come.

The prior clearance for this project was taken from the institutional board or ethical committee maintaining the proper procedure.

6.3 Utilization of Existing Standards or Codes

I have conformed to all the laws. Codes and safety regulations are properly maintained. All the standards met their own criteria.

6.4 Other Concerns

No other issues need to be concerned.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

At the end the project runs smoothly fulfilling the expectation for the purpose of monitoring the food warehouse and satisfies the requirements for sending data wirelessly on any devices both personal computer (PC) and smartphone.

Using this method food warehouses can conduct surveillance digitally and can monitor the situation in real time.

Accomplishing the aim of digital monitoring and sending data wirelessly by collecting data using sensors and a single board computer, the system will open up more opportunities for warehouses to manage their document freely as they needed.

7.2 New Skills and Experiences Learned

Conducting this project, we have come to learn about a lot of new things including new software experiences like Linux. As Microsoft Windows operating system (OS) being vastly popular with most users Linux stays very underrated under the shadows of major OS.

Like Windows OS versions such as Dos, 95, 98, Vista, XP, 7, 8, 10 and 11, Linux has distros as its user interfaces for various real time applications as required. We have worked with Debian distros of Linux for our project.

We have also learned about the origin of the operating systems that now exist for our work. At first came out the Unix as core for the operating system then came out Linux kernel. Based on Linux a lot of operating systems run in recent time as example Android.

Commanding terminal in distro is a new knowledge that we acquired by conducting the project.

Sensor’s interaction with the motherboard is a new experience for us. The way the sensor collects data from the real world and converts it into digital signal as well as the calculations for it, is a valuable lesson for us.

Managing server and cloud hosting is first time experience for us. A lot of valuable lessons we learned by conducting the project.

Bugs and fault finding in programming code is a new experience by facing numerous errors while running the programming script.

7.3 Future Recommendations

- This project has future recommendations such as for covering a large field for surveillance in a warehouse other module can be added.
- Wi-Fi modules are recommended for large area communication for internal connection of the system. Modules like Digi Xbee 1mW Wire Antenna – series 1 (802.15.4) can be used for large area coverage.
- Connecting to control system with the core, ass example thermal control panel of the warehouse or Air conditioner, the temperature can be control remotely through the system.
- Other modules can be equipped like humidity control system, sound and pest control system as per the situation.

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APPENDIX A

TURNITIN REPORT

Turnitin Originality Report

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APPENDIX B
PROGRAM CODE

```
# SPDX-FileCopyrightText: 2021 ladyada for Adafruit Industries
# SPDX-License-Identifier: MIT

import time
import board
import adafruit_dht

# dhtDevice = adafruit_dht.DHT22(board.D4)

dhtDevice = adafruit_dht.DHT22(board.D4, use_pulseio=False)

while True:
    try:
        # Print the values to the serial port
        temperature_c = dhtDevice.temperature
        temperature_f = temperature_c * (9 / 5) + 32
        humidity = dhtDevice.humidity
        print(
            "Temp: {:.1f} F / {:.1f} C    Humidity: {}% ".format(
                temperature_f, temperature_c, humidity
            )
        )

    except RuntimeError as error:
        # print(error.args[0])
        time.sleep(2.0)
        continue
    except Exception as error:
        dhtDevice.exit()
        raise error

    time.sleep(2.0)"
```