

IoT Based Smart Warehouse and Crop Monitoring System

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Technology degree in Information Technology

by

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**DEPARTMENT OF INFORMATION TECHNOLOGY
SCHOOL OF COMPUTING**

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with Grade "A" by NAAC

**JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600
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DEPARTMENT OF INFORMATION TECHNOLOGY

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of Divya Barathi .T (37120024) and Madhumitha Chandrasekar (37120043) who carried out the project entitled “IoT Based Smart Warehouse and Crop Monitoring System” under my supervision from November 2020 to April 2021.

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Submitted for Viva voce Examination held on_____

Internal Examiner

External Examiner

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I wish to express my thanks to all Teaching and Non-teaching staff members of the **Department of Information Technology** who were helpful in many ways for the completion of the project.

DECLARATION

I **Divya Barathi .T (Reg no:37120024)** and **Madhumitha Chandrasekar (Reg no:37120043)** hereby declare that the Project Report entitled **IOT Based Smart Warehouse And Crop Monitoring System** done by me under the guidance of **Ms. Jithina Jose** is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in INFORMATION TECHNOLOGY.

DATE:

PLACE: CHENNAI.

SIGNATURE OF THECANDIDATE

ABSTRACT

In a developing country like India, agriculture is one the most sectors in terms of financial gain and healthy foods to survive. Agriculture is that the primary occupation in our country for ages. Now a day's farmers are facing difficulty while storing agricultural products. Farmer should know information about condition of their agricultural products. In warehouse farmers are keeping their agricultural products to increase the life time of products. Food plays a significant vital role once it involves food security that's littered with each food loss and food wastages. Reports suggests that almost fifty proportion of the food made world-wide doesn't even reach the individuals as they're wasted wither throughout harvest, transportation or storage. One in all the key threats to the farmers is that the loss throughout storage of crops in granaries and warehouse. If crop losses are reduced, it'll mechanically increase the number of food accessibility. Our work takes into thought this drawback that affects a lot of individuals globally and has tried to bring out an easy answer by building a sensing element based mostly module that monitors and additionally controls the deposition system. In order to assist the farmer WHO protects the crops by keeping during a warehouse, AN IOT enabled observation system is planned to be deployed in remote areas wherever the accessibility is incredibly minimum for farmers with smart storage facilities to scale back food losses and increase food safety.

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LIST OF ABBREVIATION

- | | |
|---------------|---|
| 1. PIR | Passive Infrared Sensor |
| 2. IDE | Integrated Development Environment |
| 3. WSN | Wireless Sensing Network |

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

Agriculture plays major role within the economy of the country. Over seventieth of Indian population depends on agriculture for his or her sustenance. Despite being one in all the world's biggest food producers and experiencing years of fast economic process, India is home to 1 / 4 of the world's hungry individuals. Recent Survey reports show that the planet food production should be inflated by seventy percent to produce adequate food production for the aggressive population and urbanization.

The leaf nodes of the network are terribly go on contact with one another with the warehouse or storage areas with tiny scale units. There are only a few warehouses in India to store food grains. Furthermore loss of crops throughout storage has been a significant threat to the farmers as 50,000-60,000 crores of crops is lost thanks to poor post-harvest infrastructure and low provide chain management. Regarding 30-40 per cent of husbandry turn out is wasted annually thanks to inadequate storage and transportation facilities. The losses of grain in storage are chiefly thanks to mildew, pests and respiration of grain itself. Temperature and wetness plays an important role in decisive the standard and productivity of crops.

Although losses occur at every stage of the provision chain from production to shopper level, storage losses are thought of most crucial in developing countries. The most purpose of a well-designed and maintained warehouse is to form positive that the protection of grains is applied as economical as doable. To effectively aid this drawback a system is planned that monitors the crop warehouse unendingly victimization Wireless sensing element Network (WSN) that consists of various devices that use sensors to hand in glove monitor physical or environmental parameters like temperature, sound, vibration and pressure. Information collected from sensors play a key role in warehouse management and protection. In the current generation most of the work is machine-driven by doing the work with the assistance of latest technologies. Economical observation of temperature, humidity, and alternative conditions while not being gift physically at the placement helps

America to induce a more robust outcome. This could save the post-harvest loss of crops in warehouse which might contribute a significant half to the countries food deficiency

1.2 MOTIVATION

- Monitors the physical condition of the inventory stock to prevent from changes.
- Gathers warehouse operations and data and stores on the cloud to prevent loss of data.
- Manage day –to – day warehouse processes without human errors.
- Sends automated notification or alerts to the supervisor about unusual movements.

1.3 OUTLINE OF THE PROJECT:

The project is all about protecting the crops from damage or from theft. We are using sensors to detect the motion and temperature of the crops. So if there are any changes in the data collected from the sensors an alert through notification or alarm will be given to the user via the Blynk cloud.

1.4 PROBLEM STATEMENT

Now a day's farmers are facing difficulty while storing agricultural products. Farmer should know information about condition of their agricultural products. In warehouse farmers are keeping their agricultural products to increase the life time of products. There are many agricultural products needs cold storages to maintain their quality and improve life time. Post-harvest crop has become an alarming threat in the current generation. 1/3rd of the crops stored are lost due to improper maintenance of the warehouse. This mainly happens because of the farmers being unaware of the measures to be taken to protect these crops in the warehouse. So we design a system that will inform collected sensor data on cloud computing server and which will inform also farmer required data. Efficient monitoring of temperature, humidity and other conditions without being present physically at the location helps us to get a better outcome. Here our main purpose is to observe, control and monitor the warehouse atmosphere, thus making the user to manage the data in real time. They are responsible to collect information about light, temperature and other environmental factors to prevent the food from decaying and getting rotten.

CHAPTER 2

AIM AND SCOPE

2.1 AIM

The aim of our project is to design a low cost IOT based application to monitor the crops in the warehouse using different sensors so as to protect the crops preserved or stored in the warehouse from getting rotten, or getting lost due to various reasons.

2.2 PROBLEM DEFINITION

Crop loss is a very critical issue that has been alarmingly rising at present. The losses are incurred at various stages of production and movement in cereals, pulses, oilseeds, plantation crops, spices, vegetables, fruits, milk, fisheries, poultry and meat were studied. The study of farm-level operations included harvesting, collection, sorting, grading, drying, packaging and transportation. The losses in the storage channel included storage at farm level and godown / cold storage, wholesaler, retailer and processing unit. In the case of cereals, losses ranged between 4.65% (maize) and 5.99% (sorghum). In the case of wheat and paddy, the losses were 4.93% and 5.53% respectively.

Moreover, the losses were higher at the level of farm operations. They were 4.67% in the case of paddy and 4.07% in the case of wheat. The loss in storage was only 0.86% for both wheat and paddy. It is clear that the answer to reducing losses in agriculture and horticulture sub-sectors lies not only in setting up cold chains and storage facilities but also in improving the farm-level operations. Reduction of losses during storage of crop is as important as setting up modern storage/cold chain facilities at various levels of marketing after the produce has been sold by the farmers. So we will have to monitor crops at different levels so as to save them from becoming spoilt. There are thousands of people who starve every day without eating the whole day. If the loss of crops can be minimized, we can definitely feed millions of people who stay hungry and suffer a lot for earning their daily bread.

2.3 LITERATURE REVIEW:

In 2020, Keeley Edwards, Nicholas Geddert, Ryan Kruk, Mahomet Asefi and Joe Lovetri projected a system with neural spec to see the amount and sophisticated permittivity of grain hold on in metal bins. The fiber optic detector system developed shows the extra benefits that as a quasi-distributed system, it will be wont to record the temperature and humidness distribution across a longitudinal a part of the grain pile in point of fact reflects the changes in internal wet content.

According to the survey of Sonal Verma, Nikhil Chug, Dhananjay V. Gadre, they developed a Wireless detector Network for Crop Field observance in 2010 International Conference on Recent Trends in info, Telecommunication and Computing. It presents the planning and also the implementation of a Wireless detector Network which will monitor the air temperature, humidness and close candlepower in an exceedingly crop field. This could facilitate the tip users like farmers within the higher understanding of agriculture practices to be adopted for crop management. The system consists of nodes, that square measure equipped with little size application specific sensors and frequency modules. The detector information is transmitted through a frequency link to the pc for information analysis.

In 2011, TongtongYin, WenjieFeng, ZheyinLi projected a system of observance the greenhouse gases mistreatment wireless sensors. It aims at sensing and observance the temperature and humidness in greenhouse surroundings for various distances. The network used is that the star topology. The parameter readings will be detected and monitored. Once the warning device monitors any abnormalities, the warning device can inform the monitor to require some actions.

2.4 SCOPE

India is an agriculture land where on third of the crops are lost due to various reasons like harvest, post- harvest, transport, etc. To aid the post – harvest loss which is one of the major problem we are going to combine different sensors together to monitor the crops effectively and prevent the post –harvest loss of crops. The main reasons of choosing IOT to find a solution to this problem is that we can design a very cost efficient device that can monitor the crops and alert us in case of emergency.

CHAPTER 3

METHODOLOGY

3.1 EXISTING SYSTEM:

Now a day's storehouses need a low operating cost technology hence, required minimum managers for efficient operation of the storehouse management administration. In the last decades, more advanced technologies used in the storehouse management systems. Labor intensiveness is reduced due to efficient and time consuming process. For example: A. Data entry and Paperwork: Data entry and paper work has reduced the time working with the spread sheets and ledger maintenance of the management system. C. Selection efficiency: With the help of computer guided system the operatives can work faster with WMS, because the new modern technology helps us to arrange systematically for efficient and real time management of the WMS. D. Task Interleaving: It becomes more powerful tools so that system guidance will be extended to all the activities. Especially it is used for the operator of forklift.

The existing system is projected supported a Quasi-Distributed Fiber Optic Temperature and humidness detector System for observance of Grain Storage in Granaries. It's primarily based mostly of detection of mildew that is developed on crops hold on in granaries. Constant observance the conditions that helps the mould crops to grow and develop is vital and today's technology cannot promptly be wont to monitor internal humidness in massive quantities. This technique monitors each the temperature of the garner itself which within the grain pile, likewise because the humidness level within the garner. This fiber optic detector monitors the temperature and humidness across a longitudinal section of grains. It reflects the amendment within the wet content. Another existing system which uses a mathematical model to optimize food grains storage and transport for public distribution system in India and the results of the study showed that, improper planning and scheduling of the moment of food grains resulted in uplifted food grains, excess transportation cost and underutilization of available storage capacity, which would in turn increased operational cost of FCI.

3.2 PROPOSED SYSTEM:

This system is designed to develop a very cost effective solution to protect the crops from post-harvest loss. It consist of different types of sensors like DHT11,MQ2,PIR,and Vibration sensors, DC power supply is used to provide current to the entire system. All these sensors are connected to the ESP32 Wi-Fi module. The crop warehouse is monitored continuously using these sensors and modules.

All the data such as temperature, humidity, gas leakage, smoke detection and radiation of motion are collected from the sensors by the Wi-Fi module and it is uploaded to the Blynk Cloud where all these data processed. A threshold value is set for all the data from the sensors. If this threshold limit is exceeded, an alert is sent to the user through a buzzer alarm and a notification will be sent to the mobile through the Blynk application allow us to design the User Interface which we prefer. By implementing this system we can prevent huge loss of crops in warehouse which will contribute a major part to help feed the empty stomach of needy.

3.3 MODULES:

- Temperature and Humidity Sensor
- Motion Sensor
- Gas and Smoke Detection
- Vibration Detection

3.3.1Temperature and Humidity Sensor:

Temperature and humidity plays a major role in preserving the crops. An optimum temperature should be maintained to prevent the loss of crops in granaries. The working of a temperature sensor depends upon the voltage across the diode. The temperature change is directly proportional to the diode's resistance. The resistance across the diode is measured and converted into readable units of temperature and it is displayed. Humidity sensor can enhance the accuracy of predictive analytics for monitoring. They work by detecting changes that alter the electrical currents or temperature in air. To monitor the temperature and humidity level of the warehouse the DHT11 sensor is installed. It measures the relative humidity and temperature. A minimum and maximum range of temperature required by the crop is set so as to maintain an optimal

temperature inside the warehouse. Similarly excessive moist content in the air can initiate the growth of mildew on crops. So the humidity of the warehouse is also monitored

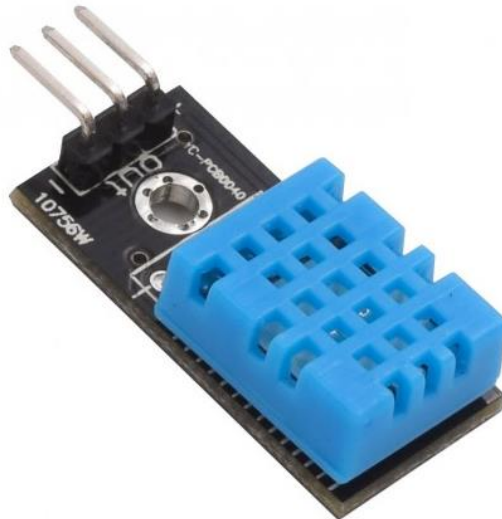


FIG 3.1 DHT11 SENSOR

The humidity sensing component of the DHT11 is a moisture holding substrate with the electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes while lower relative humidity increases the resistance between the electrodes. The DHT11 converts the resistance measurement to relative humidity on a chip mounted to the back of the unit and transmits the humidity and temperature readings directly to the Arduino Nano. To start communication with DHT11, first we have to send the start pulse to the DHT11 sensor. After getting start pulse from the controller, DHT11 sends the response pulse to the microcontroller which will indicate that DHT11 received start pulse. After sending the response pulse, DHT11 sensor sends the data, which contains humidity and temperature value along with checksum.

The Humidity of the warehouse is calculated using the formula:

$$RH = \left(\frac{\rho_w}{\rho_s} \right) \times 100\%$$

RH : Relative Humidity

ρ_w : Density of water vapor

ρ_s : Density of water vapor at saturation

3.3.2 Motion Sensor:

The PIR is a passive infrared sensor. It allows us to sense motion. This is used to detect any movement of human and animals in and around the warehouse. When a warm body like human or animal passes by it intercepts the one half of the PIR sensor which causes a positive differential change and when the body leaves the radius a negative differential change is caused. This is how it detects motion and alerts the person using an alarm and a mobile notification in the Blynk application.

PIR is only one of the technical methods to detect motion, so we will say PIR sensor is a subset of the motion sensor. PIR sensor is small in size, cheap in price, low-power consumption and very easy to understand, which makes it quite popular. A lot of merchants will add “motion” between PIR sensors for the convenience of beginners.



FIG 3.2 PIR SENSOR

The PIR sensor has three output pins VCC, Output and Ground as shown in the diagram below. It has a built-in voltage regulator so it can be powered by any DC voltage from 4.5 to 12 volts, typically 5V is used. The PIR sensor itself has two slots in it; each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and so we see that the two slots can see out past some distance. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. The passive infrared sensor does not radiate energy to space. It receives the infrared radiation from the human body to make an alarm.

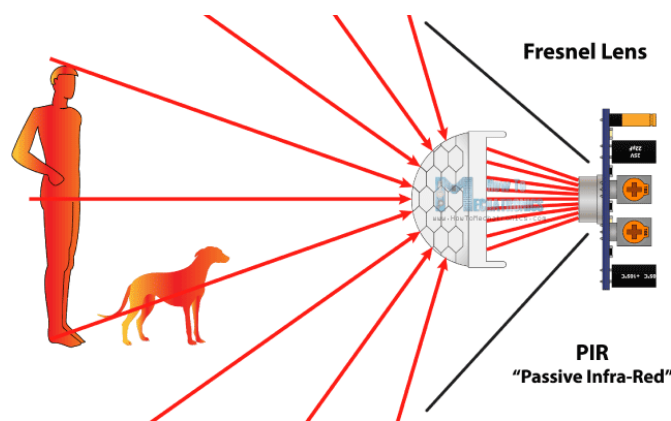


FIG 3.3 WORKING OF PIR SENSOR

Any object with temperature is constantly radiating infrared rays to the outside world. The surface temperature of the human body is between 36°C – 27°C and most of its radiant energy concentrated in the wavelength range of $8\text{ }\mu\text{m}$ - $12\text{ }\mu\text{m}$. One of the reasons of PIR sensor being extremely popular is the fact that PIR sensor is a very versatile sensor that is pretty capable all on its own. And by interfacing it to some microcontrollers like an Arduino you can expand upon its versatility even further. Connecting PIR sensors to a microcontroller is really simple. The PIR acts as a digital output so all you need to do is listen for the output pin to flip HIGH (Motion Detected) or LOW (Not Detected). Power the PIR with 5V and connect ground to ground. Then connect the output to a digital pin #2.

3.3.3 Gas and Smoke Detection

Agriculture field deals with the release of variety of gas such as Nitrous oxide (NO), Carbon dioxide (CO₂), Methane (CH₄), etc. The MQ2 sensor is a gas sensor which is going to detect the excessive presence of any gas inside the warehouse. It can also detect the smoke in a particular area in case of fire accidents that take place. MQ2 Gas sensor works on 5V DC and draws around 800mW. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations anywhere from 200 to 10000ppm. The sensor is actually enclosed in two layers of fine stainless steel mesh called Anti-explosion network. It ensures that heater element inside the sensor will not cause an explosion, as we are sensing flammable gases. It also provides protection for the sensor and filters out suspended particles so that only gaseous elements are able to pass inside the chamber. The mesh is bound to rest of the body via a copper plated clamping ring. It contains a sensing material whose resistance changes when it comes in contact with the gas.

This change in the value of resistance is used for the detection of gas. The concentrations of gas are measured using a voltage divider network present in the sensor. To calibrate the gas sensor you can hold the gas sensor near smoke/gas you want to detect and keep turning the potentiometer until the Red LED on the module starts glowing. Turn the screw clockwise to increase sensitivity or anticlockwise to decrease sensitivity. This sensor is going to monitor the gas levels and detects the presence of smoke; if these levels exceed the maximum level then it is going to alert the person using this application and helps them to save the post-harvest crops from a major loss.



FIG 3.4 MQ2 SENSOR

3.3.4 Vibration Detection:

A vibration sensor is used to measure the vibration levels in and around the warehouse. This sensor uses the piezoelectric effects while measuring the changes within acceleration, pressure, temperature, force otherwise strain by changing to an electrical charge. This sensor is also used for deciding fragrances within the air by immediately measuring capacitance as well as quality. The working principle of vibration sensor is a sensor which operates based on different optical otherwise mechanical principles for detecting observed system vibrations. The sensitivity of these sensors normally ranges from 10 mV/g to 100 mV/g, and there are lower and higher sensitivities are also accessible. The sensitivity of the sensor can be selected based on the application.

So it is essential to know the levels of vibration amplitude range to which the sensor will be exposed throughout measurements. The accelerometers measure the changes of velocity of a given component. A vibration sensor either connects directly to an asset or monitors it wirelessly. Once placed, it will detect vibrations from the asset through various means, depending on the type of sensor. When connected to equipment, any vibration will reflect a change in velocity, which will cause the accelerometer to produce an electrical signal. This is how a vibration sensor works. Sometimes the machineries used in agriculture may be left unnoticed or may get switched on due to short circuit. This sensor alerts the person in such cases through a buzzer alarm as well as a mobile notification through the mobile application. This can also alert in case of earthquakes.



FIG 3.5 VIBRATION SENSOR

CHAPTER 4

SYSTEM REQUIREMENT AND DESIGN

4.1 REQUIREMENTS:

4.1.1 HARDWARE REQUIREMENT:

- Temperature and Humidity Sensor
- Motion Sensor
- Gas and Smoke Sensor
- Vibration Sensor

4.1.2 SOFTWARE REQUIREMENT:

- Arduino IDE
- Blynk Cloud
- Blynk Application

4.2 SOFTWARE DESCRIPTION

ROLE OF Embedded C:

Embedded C is most popular programming language in software field for developing electronic gadgets. Each processor used in electronic system is associated with embedded software. Embedded C programming plays a key role in performing specific function by the processor. Embedded C programming plays a key role in performing specific function by the processor. In day-to-day life we used many electronic devices such as mobile phone, washing machine, digital camera, etc. These all device working is based on microcontroller that are programmed by embedded C. It is used in devices and applications include highway speed checker, street light control, traffic signal control, vehicle tracking software and artificial intelligence. The microcontroller programming is different for each type of operating system. Even though there are many operating system are exist such as Windows, Linux, RTOS, etc. but RTOS has several advantage for embedded system development.

4.3 SYSTEM ARCHITECTURE:

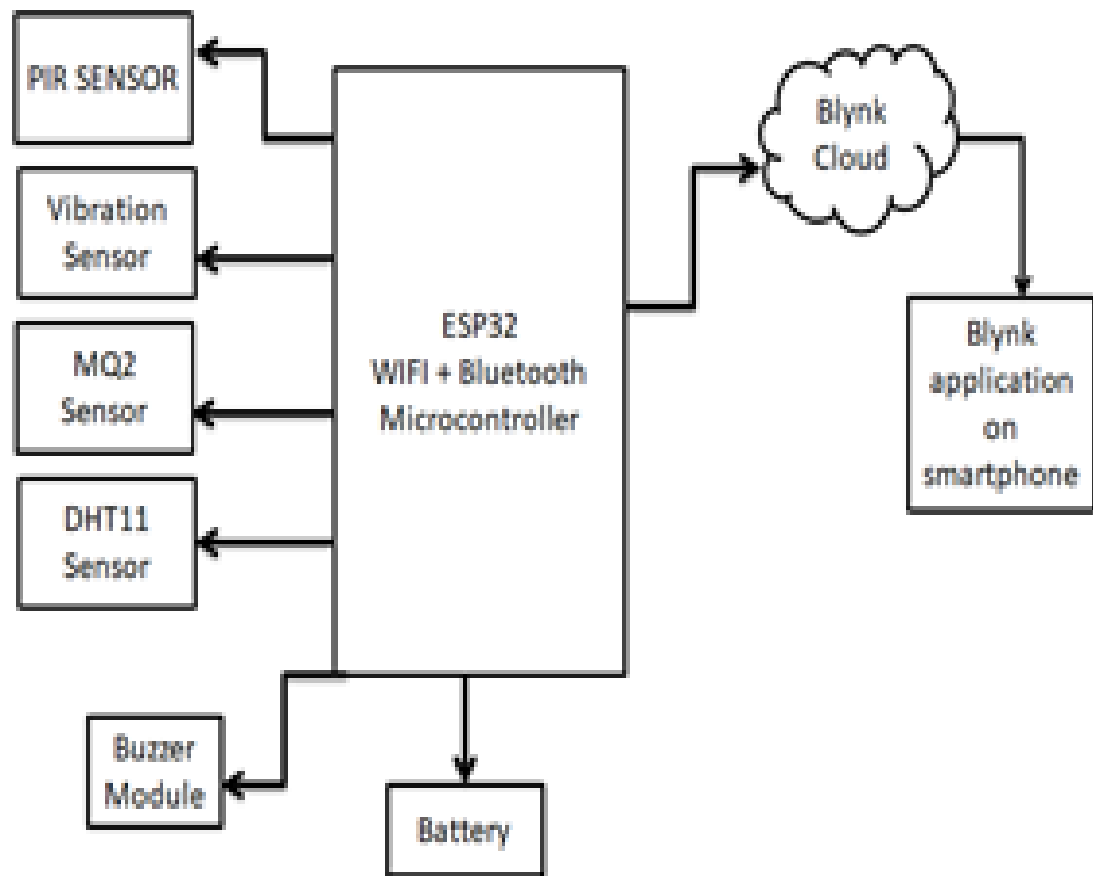


Fig 4.1 Architecture diagram

This system consists of four different types of sensors such as the DHT11, PIR, MQ2 and Vibration sensor to measure the temperature, humidity, motion, gas level and vibration level in the warehouse. It consists of an ESP32 microcontroller which is the heart of the project. It is a Wi-Fi module and a Bluetooth module combined together. All the voltage input of the sensors and the microcontroller is connected together. The power supply to all the sensors and the microcontroller can be given either by connecting batteries in parallel or by using the DC data cable which is used to charge mobile phones so as to provide a stable and even supply of current throughout the setup. All the sensor values can be accessed by the ESP32 microcontroller. This is then uploaded to the Blynk cloud using the Arduino IDE as the software. The instructions are sent to the sensor through the microcontroller which is written in embedded-c language. The data will be processed in the cloud and will be presented for viewing. The data in the Blynk cloud can be viewed in the user's mobile phone through the Blynk application. The data is transferred through the secured Blynk server to give security to the users.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 SOFTWARE SETUP

5.1.1 Arduino IDE

The software we have used in this project is Arduino IDE. Arduino IDE is open source software that is mainly used for writing and compiling the code into the Arduino Module. It is official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. A microcontroller simply intercepts incoming data, processes it according to programmed instructions, and outputs data through its I/O peripherals. This means the program must be organized in specific sections that can handle input data, process data, and control output.

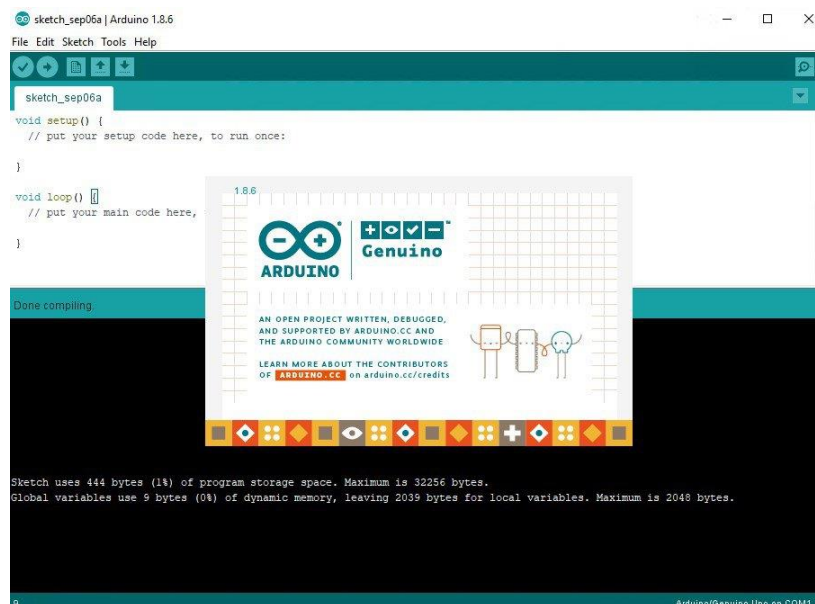


FIG 5.1 ARDIUNO IDE

In the Arduino IDE, we are going to code using the Embedded C language. Embedded programming is designing and writing programs for small computers that are embedded within devices other than traditional PCs, laptops or smartphones. It's that which enables microcontrollers to awaken previously dumb devices e.g.

thermostats, lighting systems, parking meters, etc. and give them some ability to reason about their environment. The code typed in the editor of the arduino ide will be uploaded to the memory of the ESP32 microprocessor which we have setup. This code will be converted as instructions and fed into the respective sensors such as the DT11, MQ2, PIR and Vibration Sensors. These sensors are going to measure the parameters required and they will be sent to the Blynk Cloud through the ESP32 microcontroller.

5.1.2 BLYNK CLOUD

Blynk is a new platform that allows you to quickly build interfaces for controlling and monitoring your hardware projects from your iOS and Android device. After downloading the Blynk app, you can create a project dashboard and arrange buttons, sliders, graphs, and other widgets onto the screen. Using the widgets, you can turn pins on and off or display data from sensors. Whatever your project is, there are likely hundreds of tutorials that make the hardware part pretty easy, but building the software interface is still difficult. With Blynk, though, the software side is even easier than the hardware. Blynk is perfect for interfacing with simple projects like monitoring the temperature of your fish tank or turning lights on and off remotely, etc. Currently, Blynk supports most Arduino boards, Raspberry Pi models, the ESP8266, Particle Core, and a handful of other common microcontrollers and single-board computers, and more are being added over time. Arduino Wi-Fi and Ethernet shields are supported, though you can also control devices plugged into a computer's USB port as well. We are connecting the ESP32 microcontroller with the Blynk cloud so that all the data retrieved from the sensors will be fed into the cloud. This data can be stored in the cloud platform. This data is safe and secured and the privacy policy of the Blynk cloud platform will ensure the security of the data.

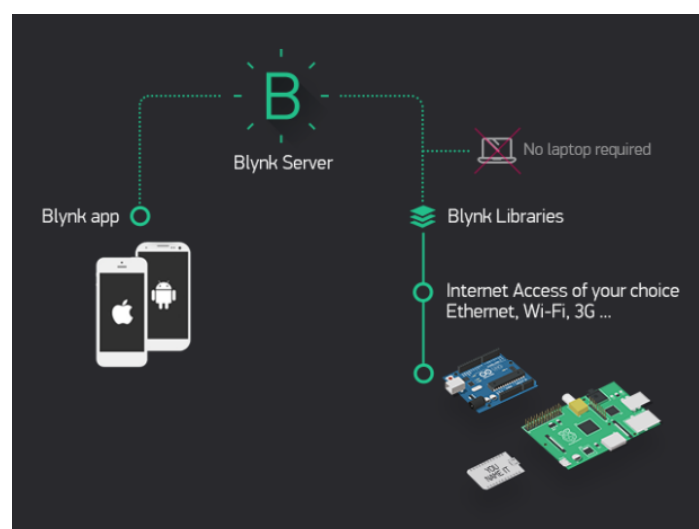


FIG 5.2 BLYNK SETUP

The values stored in the cloud can be accessed by the user without the need of laptops. They can directly access this data from the Blynk mobile application which can be installed in the smartphones from the Google play store or Apps store. The application allows us to design the user interface according to our requirements. Here we have designed 5 buttons so as to display the Temperature, Humidity, Gas Level, Vibration Level and Motion Detection. All these data will be varying according to the detection in the warehouse.

5.2 EXPERIMENTAL RESULTS

The experimental result shows how the values of each parameter readings is fed into the cloud and displayed in the Blynk mobile application on the mobile phone. On the cloud it shows all the readings taken from each sensor. On the mobile phone it displays the current values of readings so as to keep a check on the warehouse instantly. The User Interface of the mobile application can be customized depending on the requirements of the person. When we connect the cloud to the mobile phone an authentication pin is sent to the user. We can connect the cloud and the application only through the authentication pin. After connecting we can design how many buttons we require to be displayed based on the number of sensors we have connected. In this project, five buttons were added to display the values such as Temperature, Humidity, Gas detection, Vibration Detection and Motion Detection.

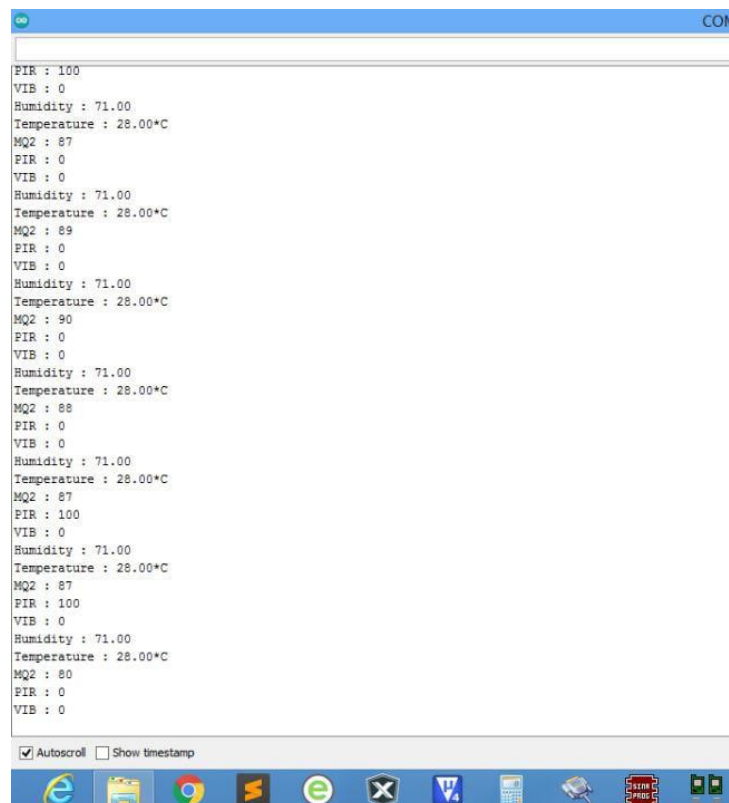


FIG 5.3 PARAMETER READINGS



FIG 5.4 BLYNK APPLICATION

5.3 LIMITATIONS

- As the IoT systems are interconnected and communicate over networks. The system offers little control despite any security measures, and it can lead to various kinds of network attacks. Due to this the sensor values or readings may be affected or it may also result in damage or malfunctioning of sensors.
- The designing, developing, and maintaining and enabling the large technology to IoT system is quite complicated. We have to maintain the sensor carefully as any damage in sensor can cause the whole system to fail.
- This system should get an uninterrupted power supply to work smoothly. As the whole project is based on sensors and microcontroller if there is a power failure, the system doesn't work until the power is resumed. This is one of the major disadvantages of the system.
- As we have used the temperature and Humidity sensor in this system, we cannot alert this using the buzzer as the climate changes the temperature and humidity of an environment keeps varying. If a buzzer is set for this it may result in false alarm in maximum number of cases. Because of the false alarm some situation where really the attention is needed can also be left unattended.

CHAPTER 6

CONCLUSION

6.1 CONCLUSION:

This project completes the design and implementation of maintaining optimum environmental conditions for the storage of crops in warehouse. It also alerts the abnormal parameter variations, if any in the crop warehouse by a buzzer alarm and a notification. It finishes the wireless communication between four sensor node and one main node and successfully, uploading the sensing data into Blynk Cloud, drawing the sensing curve, and the alarm system. In future this can also be applied to minimize the loss other than the storage loss such as the transportation loss, crop loss in field by deploying suitable system in the required area. This is a more cost efficient system which can be very beneficial, useful and can save time and labour. This will help us eradicate the hunger of people and aid in better economic value of crops. This can pace a great path to improve the lives of farmers who consider their job more important than their life but still suffer due to the economical set back in the income of them due to the loss they face. With the implementation of user-friendly user interface the users can easily monitor the crops in the Warehouse without much effort. In future, this innovation can be used in several areas in different applications and many enhancements can be done so that it can be made available to all the sectors.

6.2 FUTURE ENHANCEMENT

The warehouse of the future will take advantage of automated capacity management by leveraging technology for better data driven capacity planning. The result is fewer capacity planning errors that can lead to lost revenue and improved space utilization, which translates to a healthier bottom line. In current system we have shown only four sensors. In future, we can add two more sensors and system parameters. We can use web camera to capture live images or video. It will help to see the actual condition of the product. Currently, the system is monitoring only four

parameters and controlling two parameters but in future system it is possible to monitor and control more parameters.

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APPENDIX

SOURCE CODE:

```
#define BLYNK_PRINT Serial

#include <WiFi.h>

#include <WiFiClient.h>

#include <BlynkSimpleEsp32.h>

BlynkTimer timer;

char auth[] = "EZQ4NC_PGiGiLzMhe0-epOY3Fvrztcng";

char ssid[] = "wifi";

char pass[] = "wifipassword";


#include "DHT.h"

#define DHTPIN 4

#define DHTTYPE DHT11
```

```
const int LED = 2;
```

```
const int MQ2 = 36;
```

```
const int PIR = 39;
```

```
const int VIB = 34;
```

```
int mq2Value = 0;
```

```
int pirValue = 0;
```

```
int vibValue = 0;
```

```
DHT dht(DHTPIN, DHTTYPE);
```

```
void sendSensor1()
```

```
{
```

```
    float h = dht.readHumidity();
```

```
    float t = dht.readTemperature();
```

```
    Blynk.virtualWrite(V5, h);
```

```
    Blynk.virtualWrite(V6, t);
```

```
    Blynk.virtualWrite(V7, mq2Value);
```

```
    Blynk.virtualWrite(V8, pirValue);
```

```

    Blynk.virtualWrite(V9, vibValue);
}

void setup()
{
    pinMode(LED, OUTPUT);

    Serial.begin(9600);

    delay(100);

    Blynk.begin(auth, ssid, pass);

    delay(100);

    dht.begin();

    delay(100);

    timer.setInterval(2000L, sendSensor1);
}

void loop() {

    float h = dht.readHumidity();

    float t = dht.readTemperature();

```

```
Serial.print("Humidity : ");Serial.println(h);
```

```
Serial.print("Temperature : ");Serial.print(t);Serial.println("*C");
```

```
mq2Value = analogRead(MQ2)/40.95;
```

```
pirValue = analogRead(PIR)/40.95;
```

```
vibValue = analogRead(VIB)/40.95;
```

```
Serial.print("MQ2 : "); Serial.println(mq2Value);
```

```
Serial.print("PIR : "); Serial.println(pirValue);
```

```
Serial.print("VIB : "); Serial.println(vibValue);
```

```
if(mq2Value > 80 || pirValue > 80 || vibValue > 80)
```

```
{
```

```
    digitalWrite(LED, HIGH);
```

```
}
```

```
else
```

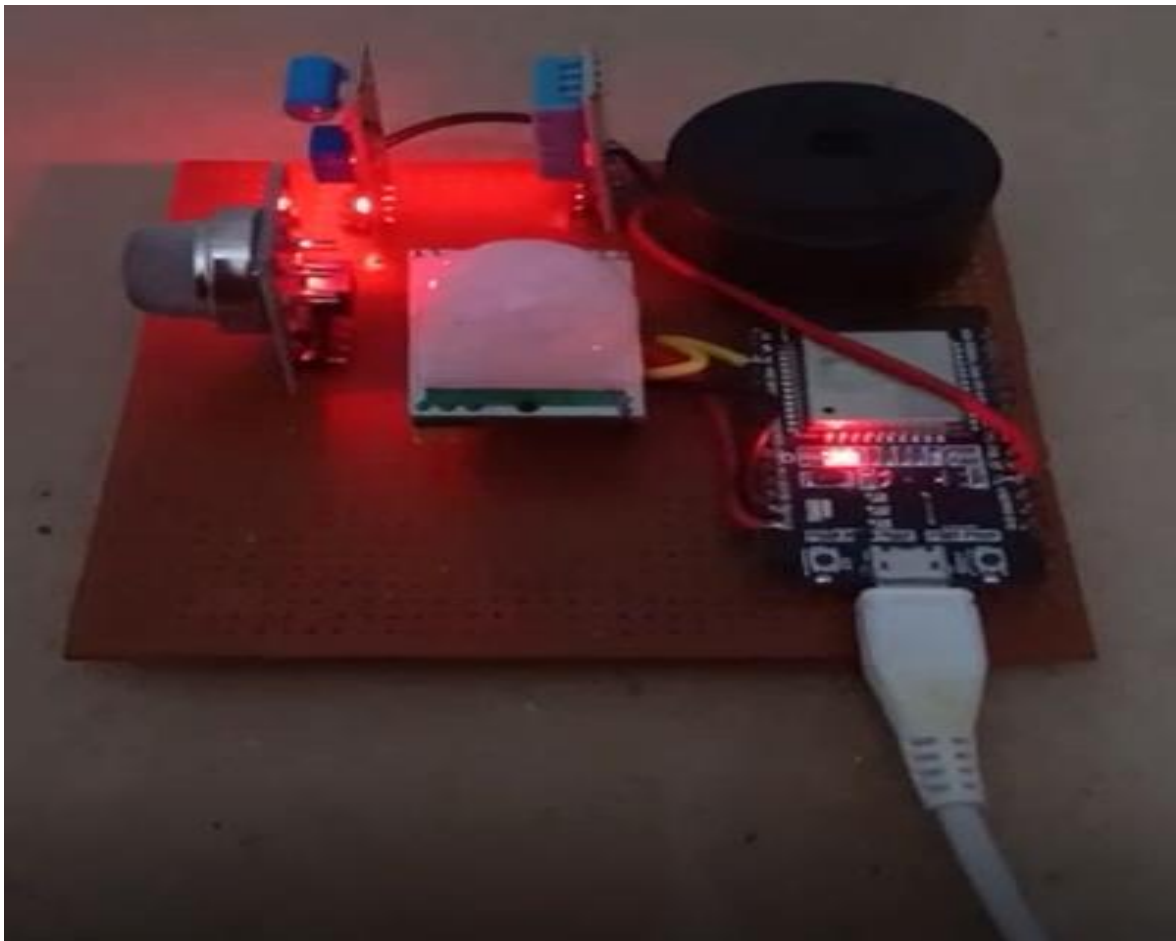
```
{
```

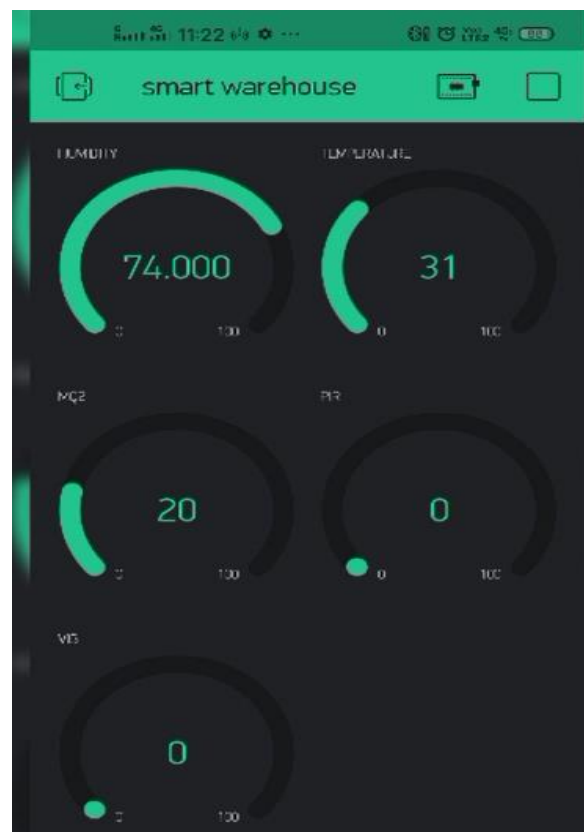
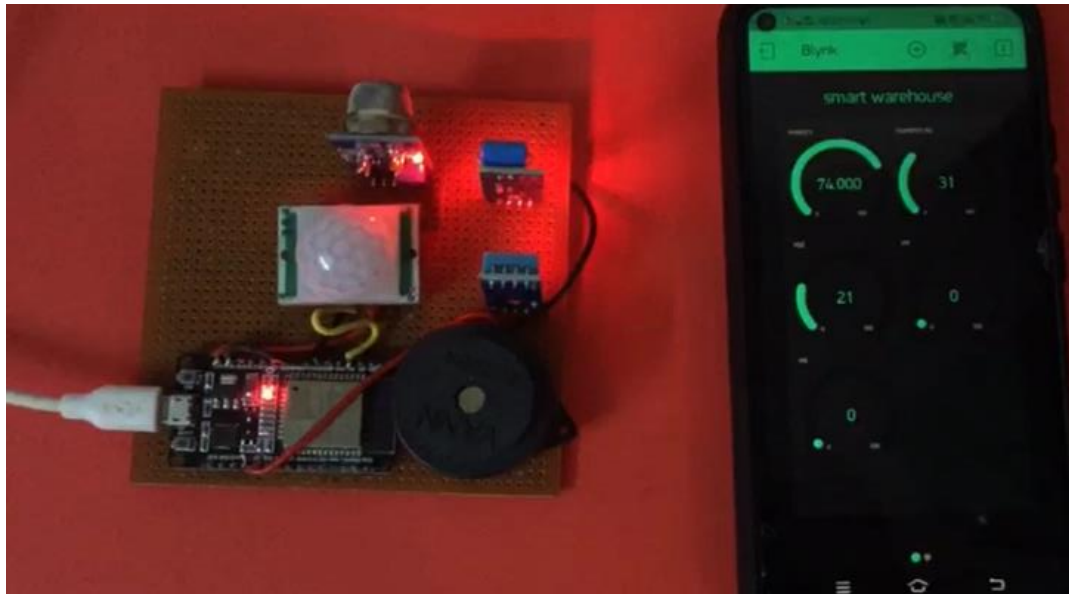
```
    digitalWrite(LED, LOW);
```

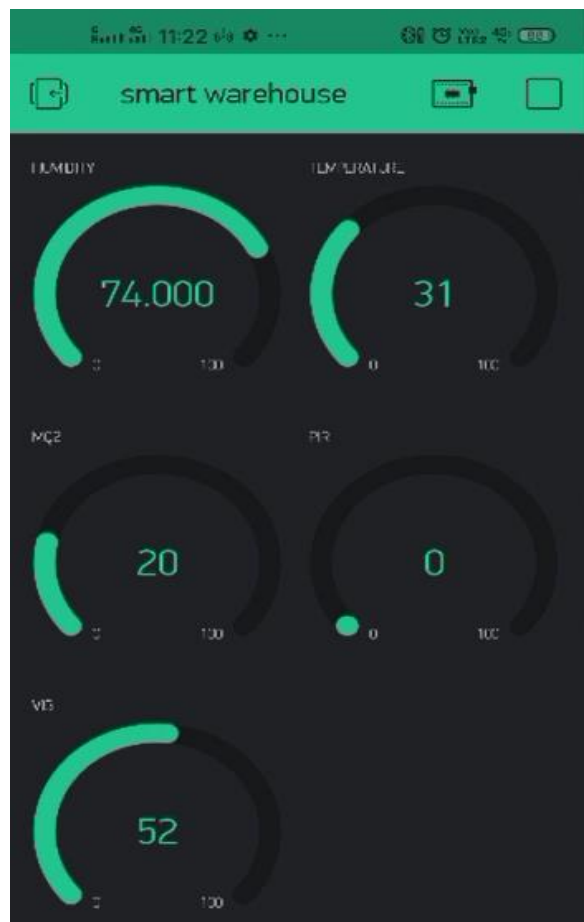
```
}
```

```
Blynk.run();  
  
timer.run();  
  
delay(500);  
}
```

SCREENSHOTS :







PUBLICATION:

 ICOEI 2021	5th International Conference on Trends in Electronics and Informatics (ICOEI 2021) 3-5, June 2021 icoei.com/2021 icoei.conf@gmail.com
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To Divya Barathi.T, Madhumitha Chandrasekar, Jithina Jose, Department of Information Technology, Sathyabama Institute Of science and Technology Chennai, India.	
Greetings!!	
On behalf of the SCAD College of Engineering and Technology Tirunelveli, we take great pleasure in inviting you to attend the “5th International Conference on Trends in Electronics and Informatics (ICOEI 2021)” which is going to be held during 3-5, June 2021 at Tirunelveli, India.	
We are glad to inform you that your submitted article entitled “IOT BASED SMART WAREHOUSE AND CROP MONITORING SYSTEM” [Paper id:ICOEI-024] has been accepted for publication at ICOEI 2021. We welcome you to join us and share your research and views. This conference will offer you an unforgettable experience in exploring new opportunities.	
We look forward to seeing you at Tirunelveli, India.	
With Thanks,	
Yours' Sincerely	
	
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IOT BASED SMART WAREHOUSE AND CROP MONITORING SYSTEM

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Abstract--In a developing country like India, agriculture is one the most sectors in terms of financial gain and healthy foods to survive. Agriculture is that the primary occupation in our country for ages. Smart food plays a significant vital role once it involves food security that's littered with each food loss and food wastages. Reports suggests that almost fifty proportion of the food made world-wide doesn't even reach the individuals as they're wasted wither throughout harvest, transportation or storage. One in all the key threats to the farmers is that the loss throughout storage of crops in granaries and warehouse. If crop losses are reduced, it'll mechanically increase the number of food accessibility. Our work takes into thought this drawback that affects a lot of individuals globally and has tried to bring out an easy answer by building a sensing element based mostly module that monitors and additionally controls the deposition system. In order to assist the farmer WHO protects the crops by keeping during a warehouse, AN IOT enabled observation system is planned to be deployed in remote areas wherever the accessibility is incredibly minimum for farmers with smart storage facilities to scale back food losses and increase food safety.

Keywords— PIR – Passive Infrared Radiation, Detection, Alarm, Notification, Monitoring

I. INTRODUCTION

Agriculture is highly important to the country's economy. Agriculture provides food for more than seventy percent of India's population. Despite being one of the world's largest food producers and having gone through years of rapid economic development, India is home to one-quarter of the world's hungry people.. Recent Survey reports show that the planet food production should be inflated by seventy percent to produce adequate food production for the aggressive population and urbanization.

The leaf nodes of the network are terribly go on contact with one another with the warehouse or storage areas with tiny scale units. There are only a few warehouses in India to store food grains. Further, more loss of crops throughout storage has been a significant threat to the farmers as 50,000-60,000 crores of crops is lost thanks to poor post-harvest infrastructure and low provide chain management. Regarding 30-40 per cent of husbandry turn out is wasted annually thanks to inadequate storage and transportation facilities. Mildew, rodents, and grain respiration are the main causes of grain losses in storage. Temperature and

moisture play a major role in assessing crop quality and productivity.

Although losses occur at every stage of the provision chain from production to shopper level, storage losses are thought of most crucial in developing countries. The most purpose of a well-designed and maintained warehouse is to form positive that the protections of grains are applied as economical as doable. To effectively aid this drawback a system is planned that monitors the crop warehouse unendingly victimization Wireless sensing element Network (WSN) that consists of various devices that use sensors to hand in glove monitor physical or environmental parameters like temperature, sound, vibration and pressure. Information collected from sensors play a key role in warehouse management and protection.

In the current generation most of the work is machine-driven by doing the work with the assistance of latest technologies. Economical observation of temperature, humidity, and alternative conditions while not being gift physically at the placement helps America to induce a more robust outcome. This could save the post-harvest loss of crops in warehouse which might contribute a significant half to the countries food deficiency.

II. LITERATURE SURVEY

In 2020, Keeley Edwards, Nicholas Geddert, Ryan Kruk, Mahomet Asefi and Joe Lovetri projected a system with neural spec to see the amount and sophisticated permittivity of grain hold on in metal bins. The evolved fibre optic detector system has the benefit of being able to record the temperature and humidity distribution over a longitudinal section of the grain pile, which in fact incorporates changes in internal wet content as a quasi-distributed system.

According to the survey of Sonal Verma, Nikhil Chug, Dhananjay V. Gadre, they developed a Wireless detector Network for Crop Field observance in 2010 International Conference on Recent Trends in info, Telecommunication and Computing. It describes the design and implementation of a wireless sensor network to control air temperature, humidity, and near

candlepower in a heavily cropped area. This could help tip consumers, such as farmers, gain a greater understanding of agriculture methods that can be used for crop management. The system is made up of nodes, each of which is outfitted with small application-specific sensors and frequency modules. The information from the detector is sent to the device through a frequency connection for analysis.

TongtongYin, WenjieFeng, and ZheyinLi proposed a framework for tracking greenhouse gas mistreatment using wireless sensors in 2011. Its aim is to detect and track temperature and humidity in greenhouse environments over a wide range of distances. The star topology was used as the network. The readings of the parameters will be detected and tracked. When the system senses any deviations, it will alert the monitor and suggest that certain measures be taken.

III. Existing System²

The current system is intended to support a Quasi-Distributed Fiber Optic Temperature and Humidity Detector System for Grain Storage in Granaries monitoring. It's primarily based mostly of detection of mildew that is developed on crops hold on in granaries. Constant observance the conditions that helps the mold crops to grow and develop is vital and today's technology cannot promptly be wont to monitor internal humidness in massive quantities. This technique monitors each the temperature of the garner itself which within the grain pile, likewise because the humidness level within the garner. This fibre optic detector tests temperature and humidity through a grain's longitudinal portion. It represents the wet content's change.

IV. Proposed System:

This system is designed to develop a very cost effective solution to protect the crops from post-harvest loss. It consist of different types of sensors like DHT11, MQ2, PIR, and Vibration sensors, DC power supply is used to provide current to the entire system. All these sensors are connected to the ESP32 Wi-Fi module. The crop warehouse is monitored continuously using these sensors and modules. All the data such as temperature, humidity, gas leakage, The Wi-Fi module gathers smoke detection and motion radiation from the sensors, which is then submitted to the Blynk Server, where it is processed. For all of the data from the sensors, a threshold value is set. An alert is sent to the user through a buzzer alarm and a notification will be sent to the mobile through the Blynk application allow us to design the User Interface which we prefer. By implementing this system we can prevent huge loss of crops in warehouse which will contribute a major part to help feed the empty stomach of needy.

V. Methodology

Methods proposed in the smart warehouse monitoring system are:

- a) Temperature and Humidity Monitoring
- b) Vibration Detection

A) Temperature and Humidity detection

Temperature and humidity plays a major role in preserving the crops. An optimum temperature should be maintained to prevent the loss of crops in granaries. The voltage across the diode defines how well a temperature sensor operates. The resistance of the diode is directly proportional to the temperature rise. The resistance across the diode is measured and converted into temperature units that can be read. Humidity sensor can enhance the accuracy of predictive analytics for monitoring. They operate by detecting changes in electrical currents or air temperature. The DHT11 sensor is used to monitor the warehouse's temperature and humidity levels. It measures the relative humidity and temperature. A minimum and maximum range of temperature required by the crop is set so as to maintain an optimal temperature inside the warehouse. Similarly excessive moist content in the air can initiate the growth of mildew on crops. So the humidity of the warehouse is also monitored.

$$RH = \left(\frac{\rho_w}{\rho_s} \right) \times 100\%$$

RH : Relative Humidity

ρ_w : Density of water vapor

ρ_s : Density of water vapor at saturation

B) Vibration Detection

A vibration sensor is used to measure the vibration levels in and around the warehouse. The accelerometers measure the changes of velocity of a given component. When connected to equipment, any vibration will reflect a change in velocity, which will cause the accelerometer to produce an electrical signal. This is how a vibration sensor works. Sometimes the machineries used in agriculture may be left unnoticed or may get switched on due to short circuit. This sensor alerts the person in such cases through a buzzer alarm as well as a mobile notification through the mobile application. This can also alert in case of earthquakes.

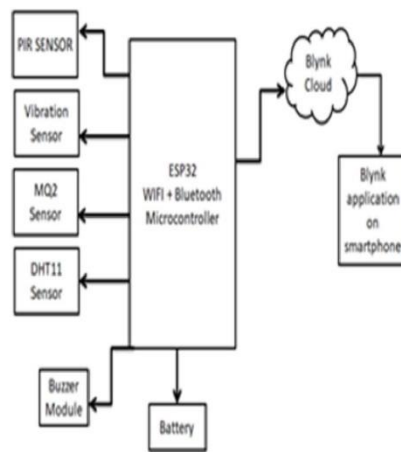
C) Motion Detection

The PIR is a passive infrared sensor. It allows us to sense motion. This is used to detect any movement of human and animals in and around the warehouse. When a warm body like human or animal passes by it intercepts the one half of the PIR sensor which causes a positive differential change and a negative differential shift occurs as the body leaves the radius. This is how it senses motion and sends a warning to the user through the Blynk app, which includes an alert and a smartphone notification.

D) Gas and Smoke Detection

Agriculture field deals with the release of variety of gas such as Nitrous oxide (NO), Carbon dioxide (CO₂), Methane (CH₄), etc. The MQ2 sensor is a gas sensor which is going to detect the excessive presence of any gas inside the warehouse. It can also detect the smoke in a particular area in case of fire accidents that take place. When it comes into contact with the gas, the resistance of the sensing material changes. The detection of gas is based on a change in resistance value. A voltage divider network built into the sensor is used to determine gas concentrations. The presence of smoke will be detected by this sensor, which will track gas levels. If these levels exceed the maximum level then it is going to alert the person using this application and helps them to save the post-harvest crops from a major loss.

VI. System Architecture:



VII. Result:

The proposed system consisting of 4 sensor node is deployed in the crop warehouse or granaries. Each sensor node measures temperature, humidity, composition of gas, motion of living beings and vibration in and around the warehouse. Periodical sleep and wake up modes of the sensor nodes are used to save power and prolong the lifetime of the system. All the data's collected from the sensor through the ESP32 microcontroller or the Wi-Fi module is successfully uploaded to the cloud.

The backbone of this data retrieval from sensor is done by programming in embedded-c. Warehouse can take the necessary steps to prevent these losses.

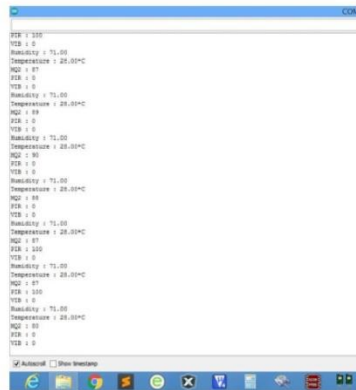
VIII. Conclusion:

This project completes the design and implementation of a system for preserving optimal environmental conditions in warehouses where crops are processed. It also alerts the abnormal parameter variations, if any in the crop warehouse by a buzzer alarm and a notification. It successfully completes wireless communication between four sensor nodes and one main node, uploading sensing data to Blynk Cloud, drawing the sensing curve, and triggering the alarm system.

In future this can also be applied to minimize the loss other than the storage loss such as the transportation loss, crop loss in field by deploying suitable system in the required area. This is a more cost efficient system which can be very beneficial, useful and can save time and labour. This will help us eradicate the hunger of people and aid in better economic value of crops. This can pace a great path to improve the lives of farmers who consider their job more important than their life but still suffer due to the economical set back in the income of them due to the loss they face.

IX. Experimental Results:

The experimental result shows how the values of each parameter readings is fed into the cloud and displayed in the Blynk mobile application on the mobile phone. On the cloud it shows all the readings taken from each sensor. On the mobile phone it displays the current values of readings so as to keep a check on the warehouse instantly. The User Interface of the mobile application can be customised depending on the requirements of the person. When we connect the cloud to the mobile phone an authentication pin is sent to the user. We can connect the cloud and the application only through the authentication pin. After connecting we can design how many buttons we require to be displayed based on the number of sensors we have connected. In this project, Five buttons were added to display the values such as Temperature, Humidity, Gas detection, Vibration Detection and Motion Detection



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