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Intelligent Grain Storage Management System based on IoT

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Abstract: ***India is an Agriculture country where 70% of the population depends on farming, the storage of grains plays a crucial role in national economy. During the grain storage, temperature, humidity and carbon dioxide concentration are important atmospheric factors that can affects the quality of the stored grain inside the go-downs and warehouses. The traditional methods are limited to simply testing the temperature and humidity conditions which are relatively backward as the other factors have to be checked and monitored independently for contributing to their effective storage and maintenance. The approach of monitoring grain storage system at real-time is designed by using DHT11, MQ2, MQ135 and PIR sensors based on IoT. Also the Blynk application will regularly update the system through notifications in continuous time stamps. The experimental results shows that the intelligent grain storage management system proposed in this paper involves multiple features such as online detection, regular updation and easy system maintenance. This improves the quality factor of stored grain and reduces the grain wastage during storage interval, man power and manual attention.***

Keywords: IoT, Blynk, MQ135, MQ2, PIR

1. Introduction

In many countries Grains are the main source of food and many staple food products are prepared from them, so every human life depend on Grains food products for survival in one or the other way. Hence cultivation and storage of grains has dominating importance in economy of nation and overall development of the society. Economies of developed and developing nations depend directly or indirectly on storage of cultivated grains since they are related to the several millions of people. Maintaining threshold temperature, proper humidity and relative carbon dioxide content in the storage environment are the important problems faced in Go-downs. The fluctuations in seasonal and daily environment influence the quality of grain and these are reasons to increase mold growth, insect activities. Inside the go-down, the mold growth occurs at around 25-30°C threshold temperature, insect growth and reproductionoccurs at ideal temperature of 15°C and above. Insect metabolic activity in dry storage below 15% moisture content can result in heating up to 42°C [5]. A major factor that contributes to the grain spoilage is growth of various mold species which release mycotoxins. Fungi produce natural chemicals called mycotoxins that are hazardous to grain health. These activities release CO2 gas in the stored grain. Hence, CO2 concentration is the effective factor to determine the early spoilage stage of stored grain [5].

Mold Activity: Stored grain mostly get infected by the large varieties of mold at certain extent. Temperature and Moisture will enhancemold growth and reduces the quality of stored grain. The mold releases mycotoxins which in turn increases concentration of CO2 during storage. [6]

Infestation: The temperature of stored grain is always increased by Insect activity. Insect reproduction gives rise to in warm grain. Hence certain rise in temperature can be the detective measure against insect growth. [6]

The project of Intelligent Grain Storage Management will provide that efficient way to maintain the grains stored in governmental or private warehouses in good content with maintaining their nutritional level and with less wastages. The system will monitor, detect, analyse and control all those accidents happening in the go-downs. The developed product will help to monitor the go-down through the various sensors and microcontroller that will reflect the data on the desktop system automatically. According to that data, the caretaker or mentor will comes to know the conditions inside the warehouse. If the content shown on desktop system is beyond the threshold contents then he can take the proper steps to recover the management. Also the blynk application will regularly provide the notifications to the remote owner or the manager about the warehouse. If in case of any emergency like fire or leakage etc. occurs then the control system will provide the alert notifications to the caretaker by turning on the buzzer. As, the temperature, humidity and atmospheric gases plays important role in the growth of insects inside the stored grain, hence monitoring the level of this factors inside go-downs will be the main goal of this system. The temperature above 15°C (Celsius) will be suitable condition for the growth of insects, hence the system will maintain the grain storage always below that threshold temperature [3]. Also if the animal enters the go-down then, the sensor will capture the undesired movements inside go-down and will alert the caretaker about such unwanted entry. All these activities will efficiently help the vendor to maintain the storage of grain at proper situation without their loss and with less manual attention.

2. Related work

2.1 Intelligent System for Monitoring and Controlling Grain Condition Based on ARM 7 Processor [1].

The author Vinayaka and Roopa had proposed a system for monitoring and controlling the grain conditions. The aim of grain storage facility is mainly to provide safe storage

condition and to maintain quality of stored product. Grain loss occurs by adverse environmental conditions and from the activities of insects and microorganisms.

The general model proposed for grain storage framework comprised of two parts, one is the host PC which assembles Grain environment i.e. Sensor data, it procedure and forecast of grain circumstance, the other one lower level control terminal in the silo/depot with grain information obtaining. Hence, the proposed system involves the use of ARM7 processor, LPC2148 and different types of sensors. The parameters such as temperature, humidity and carbon dioxide percentage is displayed on the interface. If the values are above certain threshold conditions then controlling actions are taken manually.

The recent technology allows to develop the system which can monitor and store the grain in good condition with less efforts. Using IoT, the solution over the wastage of grain is provided in great extent. It makes easier to monitor, control and observe the system from any time and any place.

2.2 Grain Storage Management [2].

The author Can BurakSisman and Selcuk ALBUT states that, it is difficult to improve the quality of stored grain but maintaining its initial quality can be done. When condition of stored grain starts degrading, it is usually the collective result of various management activitiesthat include initial condition of grain, temperature and moisture migration, aeration and monitoring grain condition.Grain store best if they are cool, dry and clean. Mold growth and insect activity are dependent on both temperature and grain moisture content. It is not easy to cool down grain from warmer atmosphere or summer storage temperatures. Keeping grain temperatures below 60º F as long as possible will help minimize insect activity and mold growth.Moisture content is one of the most important criteria effective on the spoilage during storage.

In this paper author had not mentioned the use of sensors for monitoring grain condition hence it will monitor it bi-weekly or according to seasonal requirement. So, there is not any actual correctness. By using sensors and microcontroller with help of various internet based applications and server, we can automatically monitor the system. Also use of cloud based services for storing, analyzing data will make thesystem more efficient and proper decision oriented.

2.3 Efficient Food Storage Using Sensors, Android and IoT [3]

The author of paper had proposed the food storage system based on IoT and different sensors for observing the temperature, humidity and other ecological conditions inside the food distribution center. The proposed method of author is a special case of introducing an android app using which the various environmental conditions like temperature, smoke, humidity, light can be sensed and can be stored in a database. DHT11 sensor monitors for any change in temperature and humidity within the go-down area, whereas MQ135 gas sensor is used to detect CO2 concentration emitting from decaying of grain. LDR sensors are placed at storage locations, since stored grain requires proper lighting. If the surrounding environment is changed, LDR sensors generate voltage ranges. These output voltages are provided to the pins of ADC unit of the microcontroller for the further processing.

3. System description and working principle

The proposed system of intelligent grain storage and management mainly includes the working of hardware comprises with the desktop system and blynk application.

The hardware part encompasses of microcontroller Node MCU ESP8266, the sensors which are DHT11, MQ135, MQ2 and PIR sensor. For the controlling actions the Buzzer, Relay Module and fan is used which will provide the alerting notification to the manager. The sensors will capture the data in the surrounding area and will send it as input to the ThingSpeak database over cloud. The data received will be input to the system for the next controlling actions. The API reference key generated over ThingSpeak act as interfacing medium between hardware and software.

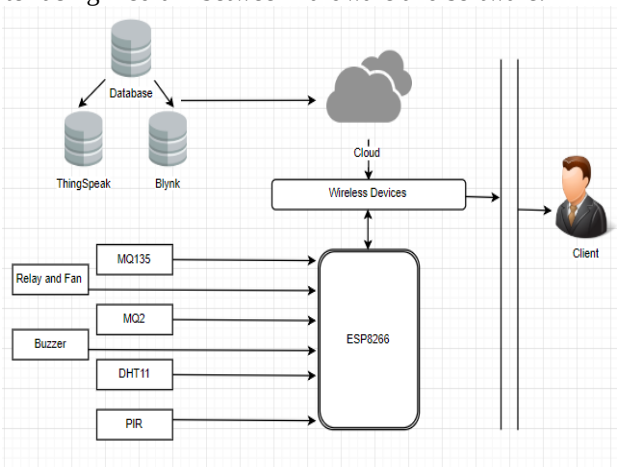

Figure 1: Architecture of Grain Storage Management System

As shown in architecture, the wireless devices are mainly comprises of the desktop system and blynk application. The desktop system is nothing but the overview of the go-down and its environmental conditions inside. The desktop system will provide the information regarding with captured data. The data will be in the format of graph or chart of table. The database used by the desktop system is ThingSpeak cloud and by blynk application is blynk cloud. The desktop system works for the monitoring the go-down through local area. If the manager of go-down goes to the remote area then the android application will serve the purpose of maintenance. The android application is developed with the use of Blynk technology. The regular notifications over the blynk application are sent through the Blynk cloud so that the manager will come to know about the recent situations in go- downs. So the software serves the important purpose of controlling actions.

4. Implementation

The intelligent grain storage management system consists of various sensors and microcontroller NodeMCU ESP8266.

The sensors used are DHT11 (Digital Humidity and Temperature), MQ135, MQ2 and PIR sensor [2]. For the controlling actions the buzzer will provide alerting alarms to the vendor. The notification over Blynk applications will be delivered regularly through Blynk cloud.

Hardware:

NodeMCU ESP8266: It is an open source IoT firmware used for number of various IoT applications. It includes 30 GPIO pins for the connection to the other hardware parts. It has inbuilt WiFi module for transmitting data over server.

DHT11: It is the sensor used to measure the atmospheric temperature and humidity. IT will sense the present condition and level of temperature and humidity in surrounding area and will display the data accordingly to the input. To store the grain safely, temperature is the key. When condition of stored grain goes beyond control, there is always an unusual increase in temperature. Hence, for the better maintenance of grain storage, temperature is the best indicator of grain quality [6].

MQ135: MQ gas sensor series is used to measure the amount of atmospheric gases in area. In particular, MQ135 specifically measures the amount of carbon dioxide in the surrounding. The amount of carbon dioxide is the main factor to investigate about the formation of insects or disease inside go-downs.

MQ2: MQ2 is the smoke detector. It measures the amount of fire gases in surrounding. If in case of emergency like fire, the sensor will observe the amount of smoke inside go-down [6].

PIR sensor: It is Infrared sensor, used to detect the movements inside the go-down. If certain animal such as mouse or rat enters inside the go-down, then those undesired movements will be counted by IR sensor and depending upon that the vendor will be informed.

Software:

ThingSpeak: ThingSpeak is an open source IoT application and API to store and retrieve data from things using the HTTP protocol over the Internet. The data captured from sensors is displayed on the window of ThingSpeak indicating the status of environment.

BlynkApplication: The blynk application is developed through the blynk platform by creating new project. The application will be updated regularly through the notifications sent over blynk cloud with certain time stamp.

The sensors MQ2, MQ135, DHT11 and PIR are connected to the NodeMCU, the buzzers and fans are provided for the controlling actions.

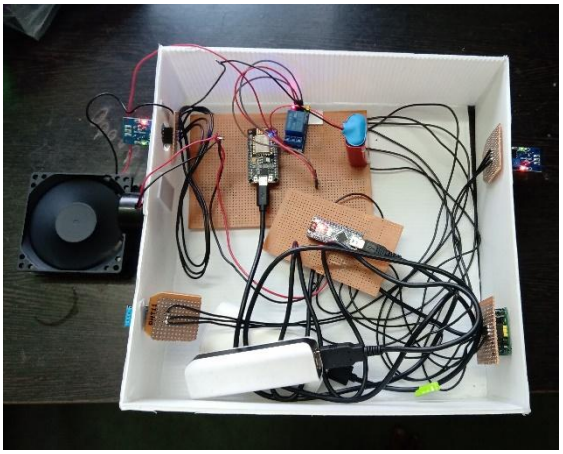

Figure 2: Setup of Grain Storage Management System

5. Result

The intelligent grain storage management system is developed on the raspberry pi processor and the output is displayed on the ThingSpeak interface and blynk application. When the DHT11, MQ2 and MQ135 sensors are connected to the raspberry pi board then their respective values of temperature, Humidity and carbon dioxide percentage is shown as below. Also the overview of blynk application shows the temperature and humidity content inside go-down. The output shown of desktop system and android application are in resemblance.

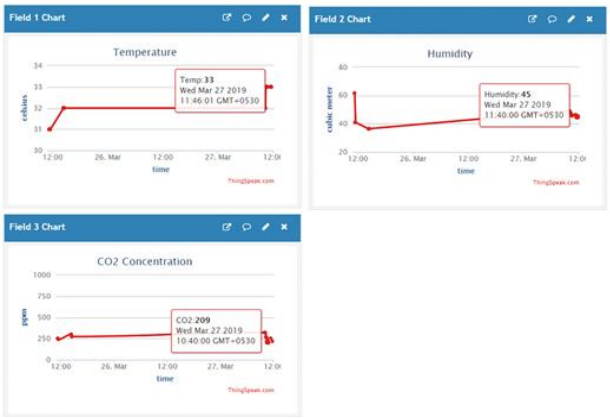

Figure 3: Output of DHT11, MQ135 and MQ2 sensor on ThingSpeak

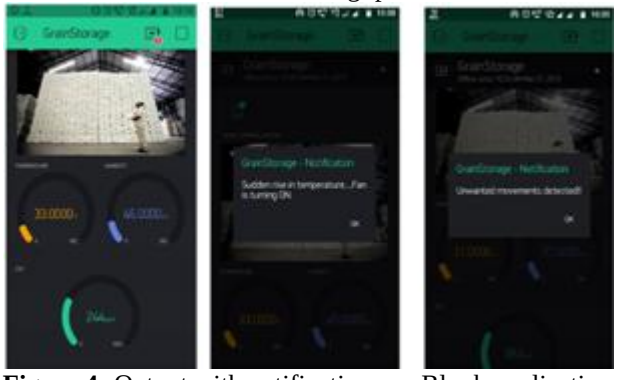

Figure 4: Output with notifications on Blynk application

According to the author Vinayaka and Roopa of Intelligent System for monitoring and controlling grain condition based on ARM7 processor, the data captured is displayed on the LPC2148 and if the values are greater than threshold then commands are given to the vendor. But the proposed

Intelligent grain storage system based on IoT not only captures the data but also takes the controlling actions over threshold conditions. And if the vendor is out of station then regular notifications will make him updated with the system continuously. The blynk application gives the snapshot of current situations regularly.

The methods are compared according to following parameters:

Table 1: Comparison between Method 1 and 2

Parameter	*Method 1*	*Method 2*
	Intelligent System for Monitoring and Controlling Grain Condition Based on ARM 7 Processor [1]	Intelligent Grain Storage Management System based on IoT.
1.Hardware	ARM7 processor, LPC2148, LCD, Temperature sensor, Humidity sensor, gas sensor, GSM/GPRS module.	NodeMCUESP8266, MQ2 sensor,MQ135 sensor, buzzer, PIR sensor,DHT11 sensor
2.Software	Embedded system, MS chart	ThingSpeak cloud, Blynk application, Arduino IDE
3.Display mechanism	LCD Display, Embedded application	Desktop System, Android application
4. Advantages	Immediate result and less cost	Multiple functionality using multiple sensors.
5.Disadvantage	CO2 concentration is not monitored while it being the important factor to preserve the quality of grain	Use of multiple sensors increases cost and complexity of programming.

6. Conclusion

The project Intelligent Grain storage system leads to the prototype and the effective solution over the problem of grain storage management and the wastage arises due to not taking the proper maintenance. Hence, at the end of the project the issues regarding with storage and management of grain will be removed to great extent and the system can be maintained at proper environmental condition and with high quality levels. And after completion of system, it can successfully reduce the stored grain losses upto 80%. Ultimately, the food availability to the people in drastic conditions and in case of natural calamities is the moto of government and this project will surely help to fulfil that moto with less manual efforts and with more efficiency.

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