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Grain Storage Management at Distribution

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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 and methane concentrations 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 independently for contributing to their effective storage. The approach of grain storage system at real-time designed by using some sensors like, DHT11, CO2 sensor, Methane sensor HC05 and Bluetooth module. These experimental results shows that the grain storage management system proposed, helps to check the nutrition levels of the grains that are being stored. This improves the rate of distribution of the grains at governmental distribution centre. The Grain storage management system gives the effective solution over the problem while distributing the grains. Hence at the end of this project the issues regarding distribution are eliminated at certain extent. 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.*

Keywords: Arduino Uno, Temperature, Humidity senser, CO_2 sensor, Methane sensor and Bluetooth module

I. INTRODUCTION

India is an agricultural country where 70% of its population depends on farming. The storage of grains plays an important role in national economy. The storage of these grains is the top priority task for restoring and reusing of them. In this process temperature, humidity and carbon dioxide concentration are the major ecological factors that influence directly on the quality of the grains. In India, 25% of the grains are lost during pre-gather and 30% of grains are lost after the reap due to rodents. Grains are kept in storage to prevent quality loss from storage to consumption. Grains should not be stored in bulk in bags for long-term storage. The increasing moisture level in food grains encourages the formation of mold and fungus, which harms the stored grains. Government organizations like the Food Corporation of India (FCI) buy grains in bulk from farmers and store them in enormous go downs. Maintaining threshold temperature, proper humidity and relative carbon dioxide content and other gases that are produced 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 fungal growth, insect activities. In agricultural produce, fungi are responsible for two distinct issues: (i) fungal growth that leads to spoilage; and (ii) the production of mycotoxins, which include aflatoxins, fusariotoxins, ochratoxins, fumonisins, trichothecenes, deoxynivalenol zearalenone, citrinin, patulin, Alternaria toxins, and moniliformin. The most significant mycotoxin-producing fungus connected to food and feed are Aspergillus, Penicillium, and Fusarium. Mycotoxins can be ingested, inhaled, or absorbed via the skin in both humans and animals. These mycotoxins can be transmitted to people and animals by direct contact with contaminated grain storage facilities during drying, handling, processing, and even through cooked and processed foods. These activities release CO2 gas and methane gas in the stored grain. Hence, CO2 concentration and methane concentration are the effective factor to determine the early spoilage stage of stored grains. The main components are Arduino UNO interfaced with several sensors like temperature sensor, humidity sensor, CO2 sensor, methane sensor. The overall operation is to measure the temperature, humidity, CO2 and methane concentration of the grain. The data collected by the sensors with respect to the grains is communicated to the user by Bluetooth module through mobile app.

II. LITERATURE SURVEY

In paper [1] the Author in this paper has mentioned that maintaining the threshold temperature, proper humidity and relative carbon dioxide concentration in storage environment are the problems faced in the go-downs. The fluctuations in seasonal and daily environment influence the quality of grain and these are reasons to increase mould growth, insect activities. Hence to overcome these problems the author has developed the prototype using some sensors and a microcontroller that will reflect the data automatically on the desktop. And 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 up to 80%.

In paper [2] the author states that, Grain loss occurs by adverse environmental conditions and from the activities of insects and microorganisms. Temperature and moisture content of the stored grain environment are the most important factors that can influence stored-product mould growth, insect activity and subsequent production of mycotoxins in storage facility. Maintaining optimum temperature, relative humidity and proper moisture content in the storage facility are the challenges faced in Grain acquisition. Seasonal and daily climate fluctuations influence quality of Grain to the greater extent results in mould growth, insect activities. The optimum temperature range for mould growth inside the depot is around 25-30°C, and temperatures above 15°C (Celsius) are ideal for insect growth and reproduction. These activities release CO_2 in Grain depot so CO_2 concentration can be effectively used to monitor early detection of spoilage during storage.

In paper [3] around 25% of aggregate sustenance grain is lost in pre-gather and around 30% in present reap due to rodents. In this paper we propose a method to characterize the images of rodents using feature extraction. The algorithm used in this paper is compiled in MATLAB R2013b environment and tested with 200 images using a predefined image as a base image. This work presents an efficient method for detecting the rodent in large scale storage of grains such as in warehouses or in go-downs. Using Feature Extraction Methods, we can find a rodent in warehouses where grains are stored. Each image is compared with predefined image of rodent and client gets the information whether Rodent is found or not.

In paper [4] the Gray Level Co-occurrence Matrix (GLCM) method is a way of extracting second order statistical texture features. The approach has been used in a number of applications, Third and higher order textures consider the relationships among three or more pixels. These are theoretically possible but not commonly implemented due to calculation time and interpretation difficulty. The Gray Level Co-occurrence Matrix (GLCM) method is used for extracting four Statistical Texture Parameters i.e., Entropy, Inverse Difference Moment, Angular Second Moment and Correlation. By extracting the features of an image by GLCM approach, the image compression time can be greatly reduced in the process of converting RGB to Gray level image.

In paper [5] the primary goal of this project is to protect food grains from rats invading storage facilities and threats to stored crops being destroyed by changes in temperature, excessive humidity, fire, theft, rain, flooding, etc. in order to supply food grains when needed from storage. IoT and sensors have been used by the author in this article to increase the effectiveness of food preservation in the warehouse. The author of this research has proposed that the project be enhanced further, for example, by making it easier to distinguish between people, animals, and rodents. The gadget should automatically switch on the air conditioner or modify the air conditioner's settings if the temperature exceeds the threshold value. When fire has been detected automatically the fire extinguisher should turn on.

In paper [6] this paper states that monitoring and controlling of the Food grains based on the various temperature level conditions is done using IoT sensors and IoT data integration to existing software. This system helps to keep the room at desired levels. Real time information of the room’s level will be displayed in web browser. Intelligent sensors placed at the rooms which notify about the temperature, humidity content in the bins. The web application can also be operated using any devices. This system is adaptive and hence can adapt to various new technologies. This process reduces cost and resource optimization. Improves quality and effective usage of rooms. The author in this paper suggests further enhancement like, keeping parameters at nominal level by an Automatic system irrespective of condition.

In paper [7] In order to assess carbon dioxide sensors for monitoring grain deterioration before it is detected by more conventional techniques like visual inspections and temperature cables, field tests were carried out in storage silos. The presence of stored-product insects, moulds, and mycotoxin levels in the stored grain were connected with the monitoring of carbon dioxide concentrations in the storage silo for up to eight months. According to the results, grain storage was safe at CO2 levels between 400 and 500 ppm. Higher CO2 levels made it obvious that there was insect activity or mould rotting inside the grain storage silo. Carbon dioxide levels between 500 and 1200 ppm showed the beginning of a mould infection, but levels between 1500 and 4000 ppm and beyond definitely indicated a serious mould infection or an insect infestation in stored goods.

In paper [8] the buildup of deoxynivalenol in infected plants was dramatically boosted by an increasing ambient CO2 concentration of 1000 ppm CO2. Furthermore, both wheat and maize accumulated the most pathogen biomass and toxin during growth at cold temperatures, 20 °C/18 °C day and night, respectively. With reductions of up to 99 percent in maize, warm temperatures of 25 °C during the day and 23 °C at night, respectively, inhibited pathogen development and toxin buildup. In wheat, the fungal pathogen was more active with more disease damage and toxin synthesis per unit biomass, despite lower pathogen biomass and toxin accumulation at warm temperatures.

In paper [9] elevated (eCO_2) increases wheat grain production while decreasing the content of nitrogen (N) and protein. In order to perform the analysis, it was necessary to I derive response functions to evaluate the gradual change in element concentration with increasing CO_2 concentration, (ii) conduct a meta-analysis to evaluate the average magnitude and significance of observed effects, and (iii) link the effects of CO_2 on minerals to those of N and grain yield.

III. METHODOLOGY

The block diagram of the Grain Storage Management System is shown in the figure 4.1. The arduino uno is interfaced with sensors like temperature, humidity, CO_2 and methane gas sensors. The temperature and humidity sensor that is DHT11 sensor has 3 pins. The data pin of this sensor is connected to pin number 7 of the arduino uno board. The Vcc and GND pins if the DHT11 sensor is connected to +5V and ground respectively. The temperature and humidity content of the grains are sensed in terms of temperature and percentage respectively. MQ135 and MQ4 are the gas sensors that are interfaced with the arduino uno board.MQ135 is a gas sensor that senses the CO_2 concentrations of the stored grains. This sensor has 3 pins. The data pin of this sensor is connected to the analog pin that is A0 of the arduino uno board. The Vcc and GND of this sensor is connected to +5V and ground respectively. CO_2 is the gas that is produced in high levels when grains are infected by the fungi.

The other gas sensor used here is MQ4 gas sensor. This sensor is used to detect the methane gas which is produced by the stored grains when infected by molds. The MQ4 sensor has 4 pins. The analog pin of this sensor is connected to analog pin that is A1 of arduino uno board. The digital pin of this sensor is connected to pin number 8 of the arduino uno board. The Vcc and GND of the sensor is connected to +5V and ground respectively. Certain threshold will be set for the sensors to decide whether the grains are eligible to distribute are not. If the value that are sensed by the sensors satisfies the specified conditions, then they are distributed for the people. If the value is beyond the set threshold levels then they are distributed. All the data from these components are communicated to the user by Bluetooth module that HC-05. This plays an important role in this project.

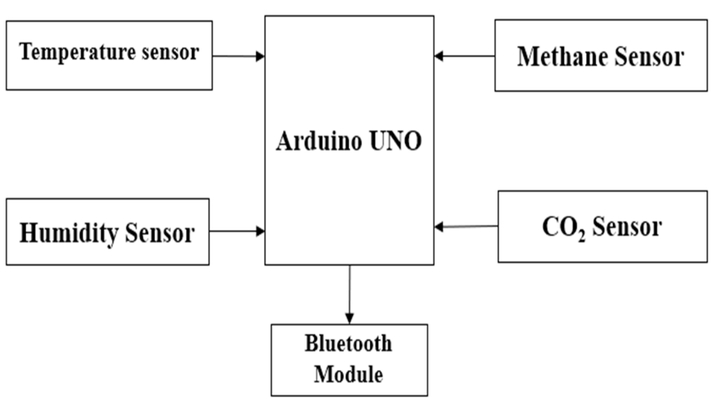

Fig. 1. Block diagram of grain storage management at distribution

The HC-05 bluetooth module has 6 pins in which only 4 pins are used. The receiver pin of the bluetooth is connected to the transmitter of the arduino uno board. The transmitter of the bluetooth is connected to the receiver of the arduino uno board. And as usual the Vcc and GND of the bluetooth module is connected to +5V and ground respectively. All the data that are collected by the sensors are displayed on the bluetooth app that is been used. Ultimately, by this model the concerned authority will get to the know the condition if the grains. Based on the condition of the grains the authority may distribute the grains to the people. The ecological conditions like temperature, humidity, CO_2 and methane gases are sensed using DHT11 and MQ135 and MQ4 sensors respectively. The data collected by the sensors are sent as trigger pulse to the Arduino UNO. The Arduino UNO sends the commands to Bluetooth module to communicate with the mobile app. If any of these parameters are beyond the threshold values then the concerned authority is not allowed to distribute the grains. Initially, the data from the sensors are collected and sent to the arduino uno. The temperature and the humidity of the grains are sensed by the sensors and are sent to the arduino uno. The Bluetooth module helps to display the temperature and humidity on the Bluetooth app. The concentration of gases like CO_2 and methane are sensed by the respective sensors and are sent to arduino uno board. A threshold is set to decide whether the stored grains are safe to distribute are not. If the conditions are satisfied then the grains are of good quality and are safe to distribute. If the concentration of the gases is beyond the set value, then the grains are not distributed.

IV. SOFTWARE IMPLEMENTATION

Flowchart of the system in Fig. 2 represents the flow of the steps that has been implemented in the system.

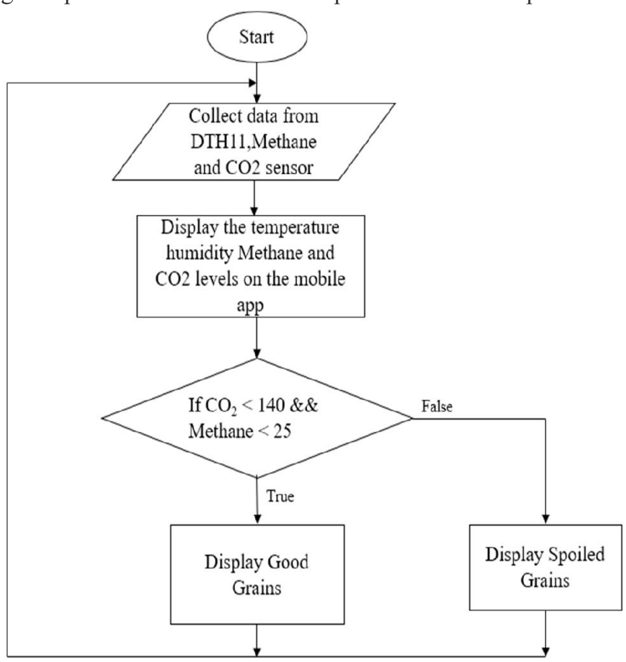

Fig. 2. Flowchart of the system

Initially, the data from the sensors are collected and sent to the Arduino uno. The temperature and the humidity of the grains are sensed by the sensors and are sent to the Arduino uno. The Bluetooth module helps to display the temperature and humidity on the Bluetooth app. The concentration of gases like CO_2 and methane are sensed by the respective sensors and are sent to Arduino uno board. A threshold is set to decide whether the stored grains are safe to distribute are not. If the conditions are satisfied then the grains are of good quality and are safe to distribute. If the concentration of the gases is beyond the set value, then the grains are not distributed.

V. ADVANTAGES/APPLICATIONS

Benefits of this system include its ability to detect the gases which are produced by the grains when affected by the fungal infections when stored in the large quantities. Therefore, this system can determine the quality of the grains.

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This project helps to maintain the health and well-being of the people who consume the grains by detecting the CO_2 and methane concentration of the grains.

VI. RESULTS AND DISCUSSION

The first version of the system was used for check the conditions inside the storage area. The interconnections were made with wire strips, The connectors were used for the connection between the sensors, Bluetooth module and the Arduino uno module. After assembling the electrical connections and wiring, the software was implemented via the Arduino IDE. The source code was written for each module separately and an attempt was made to calibrate them. Optimal values were assigned to their corresponding variables in each code part. The Arduino development board and the battery will be inserted in the inside storage area and the temperature and humidity sensor, carbon dioxide sensor, methane sensor will be fixed inside it, so that they can measure the all parameters like temperature, humidity, carbon dioxide concentration, methane concentration. In this project, all sensors are fixed to the Arduino uno board including Bluetooth module. Firstly, when we put the sensors inside the storage area, sensors will sensor the conditions inside the area like DHT11 sensor sense the temperature and humidity inside the stored area, MQ135 sensor senses carbon dioxide concentration, MQ4 sensor senses methane concentration. that can be monitored and noted with the help of the circuit. The mobile application has the major role in this project. This application has to be connected with the mobile Bluetooth option and after connecting with Bluetooth option the application gets started. Since the hardware is connected with the temperature sensor, humidity sensor, carbon dioxide sensor, methane sensor, so that the temperature, humidity, carbon dioxide and methane concentration will be automatically detected and displayed in the application. After that the sensors sense continuously but when the concentration levels of the gases exceed beyond the threshold it displays bad condition otherwise it displays good condition.

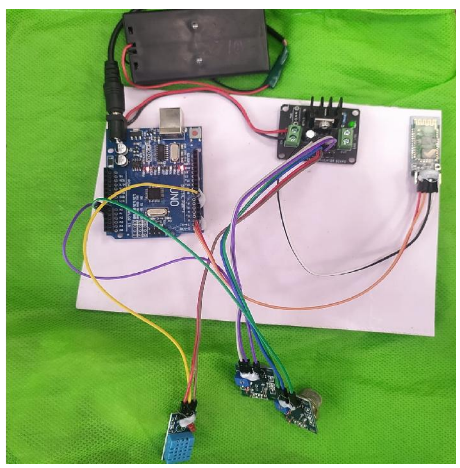

Figure 3: Output of the proposed system

Gases that are released by grains when stored	Good Quality grains Concentration levels (in ppm)	Spoiled Grains Concentration levels (in ppm)
CO_2	<140	>140
Methane	<25	>25

Figure 4: Results of the implemented system

The grains which were considered are wheat and rice which were taken as two samples each. The first sample was good grains and the second sample was kept in contact with moisture content for 50 days. When the gases like CO_2 and methane are sensed, the concentration of the gases are displayed on the screen. Since this is the continuous process an average value of the gas is concentration is considered to decide whether the grains are in good condition or not. When the concentrations of CO_2 and methane is displayed above 140 ppm and 25ppm respectively, then the grains are said to be the affected one. If the concentrations of CO_2 and methane gases are below the specified value then the grains are said to be good grains.

VII. CONCLUSION

The "grains storage management at distribution" project will include the ability to maintain grains in good condition using temperature, humidity, carbon dioxide, and methane sensors. It will also monitor temperature, humidity, carbon dioxide, and methane concentrations in mobile devices with the aid of circuit design. This system is small in size and simple to operate. It is also lightweight and simple to operate. We can easily monitor and maintain the grains inside the storage area by using this technique. The sensor will measure the grain concentration before sending the information to an Arduino Uno and a Bluetooth module. It will be possible to view grain concentration using a Bluetooth electronic app. The state of the grains will indicate whether they are in good or bad shape. Identification of the gas created during storage is one of the project's obstacles. Due to the fact that grains release various gases depending on their environment. This project produces a working prototype that addresses the issue of managing grain storage and the wastage that results from improper maintenance. As a result, at the project's conclusion, there will be much less of a problem with grain storage and management, and the system may be kept in good environmental condition and with high levels of quality. And once the system is complete, it can successfully cut down on grain losses by up to 80%. The ultimate goal of the government is to ensure that the people have access to food in terrible situations and in the event of natural disasters, and this project will undoubtedly help to achieve that goal more effectively and with less physical labour-intensive task.

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