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Automated Management of Food Grain Warehouse Condition

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***Abstract*: The safety food storage is a significant issue concerning people's living quality and national quality development. In India, nearly 20% of food grains are going as waste due to storage losses. The food storage losses are accounted mainly due to the changing environmental conditions and improper infrastructure facilities. This project proposes an integrated system to monitor and control the environmental facilities like temperature, humidity and light illumination of food depots using wireless sensor network. The food products chosen are Rice and Wheat. The available method for food storage is cold storage. The problem with this method is its cost and consume more power. This project is intended to maintain the environment conditions inside the warehouse and its cost is also less and energy efficient. The wireless sensor networks are nowadays getting upper hand in the sector of control and monitoring applications where human interplay is really impossible or not feasible. In that way, wireless sensor networks could be used for monitoring and control of environment conditions inside the food storage warehouse. The NodeMCU model has been used to collect environment data from DHT22 sensor nodes inside the warehouse and monitored using the Arduino IDE software. The environment conditions are maintained for the respective food product. An automated aeration control strategy is used to provide aeration inside the warehouse to maintain the environment conditions to ensuring the food security. This project can be further improved by using thermal image sensor for detecting the pests inside the warehouse and detects the object in the night vision also based on the infrared emissions emitted by the objects. Arduino programming can be used for determining the pests which have better accuracy and has less computational cost.**

***Keywords*: Node MCU, Arduino IDE, DHT22 sensor, Thermal image sensor.**

1. Introduction

India, with more than 1.5 billion of population, make sure food security is much important. Production of the grain has been increasing steadily day by day due to advanced production technology but improper infrastructure facilities and unfavorable environmental conditions effects in storage losses of food grains. The environmental factors like temperature, moisture content, humidity, and light heavily influence on the storage of food grains. Also, the factors like time and purpose of storage, type of storage, preventive insecticide treatments and storage practices account for food storage losses. While storage, both quantitative and qualitative losses happens due to insect, pests, rodents, rats, fungi, micro-organisms and subsequent production of mycotoxins in storage. The occurrence and number of stored food insect pests are directly

To store a good quality of food for a long time cold storage is one of the best storage right now. In cold storage food can be store for very long time also the food quality will be good. In foreign countries for store the food grains they are using cold storage, problem is that in developing countries like India having cold storage, problem is that in developing countries like India having cold storage is very difficult. Agriculture is backbone of the nations. Around 70% of population depends on agriculture so providing the cold storage for them is very difficult because cold storage cost is very high. It is difficult to provide cold storage to the farmers by the economic crisis of India. The result is that we need to find an alternative solution for this problem.

The NodeMCU model has been used to collect environmental data from DHT22 sensor nodes inside the warehouse and monitored using the Arduino IDE software. The environmental conditions are maintained for the respective food product. An automated aeration control technique is used to provide aeration inside the warehouse to maintain the desired environmental condition to ensuring the food security.

Table 1
Moisture contents levels for different foods

S. No.	Food product	Maximum moisture content in %
1.	Rice	12.2 – 13.8
2.	Wheat	12.8 – 13.9

2. Description

This paper is framed as shown in the block diagram. The optimum temperature at which rice can be stored without any spoilage through grain storage and pest management was studied. NodeMCU is a processor which uses an open source platform and can be used to measure and store the data. DHT22 sensor is used to measure the ambience temperature and

humidity. Program was written for measuring the property of the grain storage condition and it is compiled on NodeMCU by using Arduino IDE. The DHT22 sensor is connected to the processor to measure the temperature and humidity.

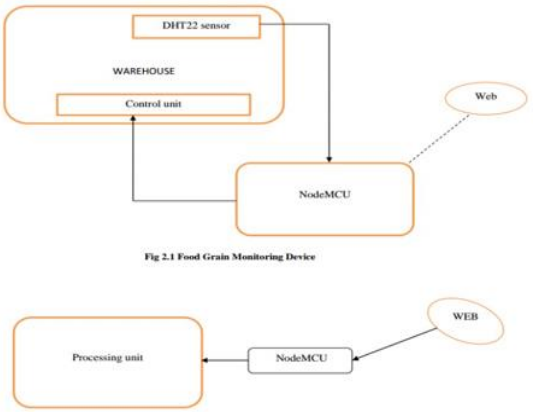

Fig. 1. Block diagram

The whole setup module is placed in the Rice bag. This DHT22 part of the setup system collects the information from the environment such as temperature and humidity, which is then sent and stored in NodeMCU. The measured data will be saved in the Google Data Sheet in order to monitor the fluctuation in the temperature and humidity which can be later used for analysis and give the proper feedback. The main advantage of Google data sheet is that it can be controlled with cell phones.

Trial and error method for creating the warehouse condition:

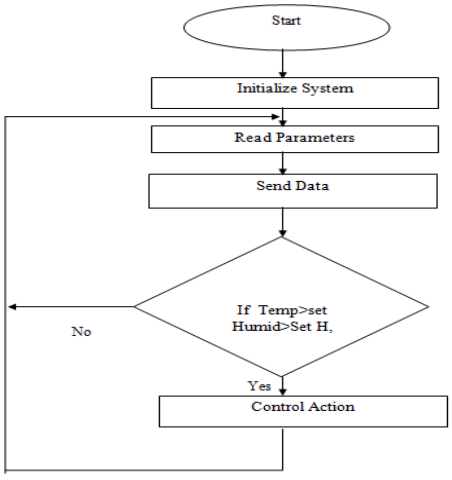

Fig. 2. Flowchart

A sample of rice has been taken, and a very small amount of water is sprayed to the sample for each four hours. The same process is repeated for few days. As the days passed, the rice slowly spoiled. The changes have been recorded. For controlled temperature and humidity, the rice will remain in good condition for longer days. The changes in temperature and humidity are sensed by sensor. The sensed data is stored in Google data sheet. This Google sheet is updated periodically. Hence the threshold value is found using this Trial and error method correspondingly program is written to maintain this temperature inside the food grain warehouse. This is done by triggering a suitable feedback system designed for automatic warehouse monitoring.

3. Hardware

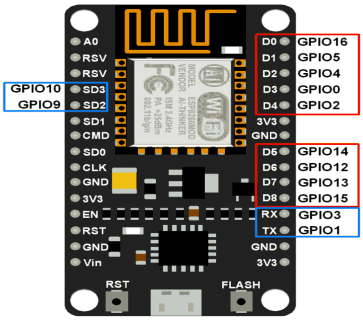

Fig. 3. NodeMCU

NodeMCU ESP8266 is an IoT platform and a microcontroller. Having a microcontroller means we can upload a program into the MCU to control the GPIO ports. Onboard NodeMCU consists of a CP2102 (works up to Windows-10) IC which provides USB to TTL functionality. The GPIO pins of NodeMCU are breadboard friendly and it comprises of a 3.3v regulator. The speciality of this is that it has Wi-Fi capability. Some of the GPIO pins include ADC0 pin is the one and only ADC pin of NodeMCU and accept a maximum value of 1V. Enable pin is the CH_PD chip enabled pin which is pulled high internally. Reset pin when pulled low reset the NodeMCU. When the GPIO0 pin is pulled low the Node MCU enters boot loader mode and the GPIO2 pin is used to detect boot mode and also an output to control blue LED. GPIO15 can be used as Output only and has an internal pull down resistor. GPIO16 pin is used to wake up Node MCU from deep sleep mode. The programming for Node MCU is done using the Arduino software installing a certain package. The installation can be done by following these steps. In the software opens File and go to preferences a dialog box appears where we need to copy and paste GSN link,

(http://arduino.esp8266.com/stable/package_esp8266com_index.json) then select OK. Now under Tools select Board click on Boards Manager and search for ESP8266. Locate the ESP8266 latest package and select it to install. This will install the arduino code for ESP8266 along with the required libraries. General specifications of NodeMCU:

- Voltage:3.3V
- Wi-Fi Direct (P2P), soft –AP
- Current consumption: 10µA~ 170mA
- Flash memory attachable: 16MB max (512K normal)
- Integrated TCP/ IP protocol stack

- Processor: Tensilica L106 32-bit
- Processor speed: 80~160 MHz
- RAM: 32K+80K
- GPIOs:17 (multiplexed with other functions)
- Analog to digital:1 input with 1024 step resolution
- Maximum concurrent TCP connection: 5

A. Relay

Fig. 4. Relay

A relay is an electrical switch. This electrical switch is operated by an electromagnet that opens and closes under the control of another electrical circuit. It is able to control an output circuit of higher power than the input circuit. Relays are used where it is necessary to control a circuit by a low-power signal or where several circuit must be controlled by one signal.

B. Fan

To maintain warehouse fans and air coolers should be used. It is used in our projects for cool the climate inside the warehouse. Fans are available in many sizes and capacities.

C. Hot air blower

Fig. 4. Air blower

To maintain warehouse hot air blower should be used. It is used in our project for cool the climate inside the warehouse. In our project hair dryer is used Type: NHP-8100

Rate voltage: AC220V

Rate frequency: 50Hz

Rate power: 120W

D. DHT – 22 sensor

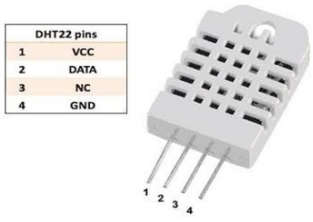

Fig. 5. DHT – 22 sensor

The DHT 22 sensor is a temperature and humidity sensor. It gives the digital output temperature and humidity in the digital format. It consist of capacitive humidity sensor and thermistor to measure the temperature and humidity of the surrounding environment and gives the corresponding value as a digital signal on the data pin. It uses a humidity sensing component, thermistor and an IC. Here humidity sensing components is used to measure humidity which consist of two electrodes with moisture holding substrate in between them. As the humidity changes, the conductivity of the substrate changes or may be the resistance between the electrode changes. This changes is measured and it is further processed by an IC. Here the thermistor is a variable resistor these resistance value changes according to the temperature. These sensors are manufactured by sintering of semiconductor materials like polymer or ceramic makes the sensors so sensitive, so far small changes it will gives the large changes.

Specification of DHT 22 sensor:

- Power supply: 3.3-6V
- Output signal: digital signal via single bus
- Sensing element: Polymer capacitor
- Operating range: Humidity 0-100% of RH and Temperature -40~80 Celsius
- Accuracy: Humidity + or -2% RH and Temperature<+-0.5 Celsius
- Sensing period: Average 2s

E. IoT devices

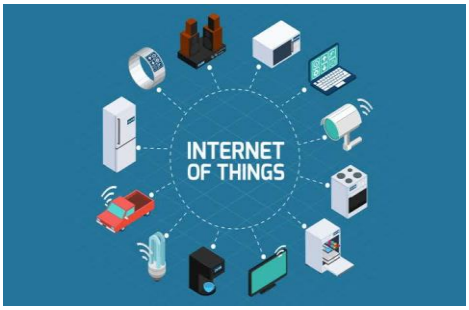

Fig. 6. IoT devices

The Internet of Things (IoT) is a giant network with connected devices. These devices gather and share data about how they are used and the environment which they are operated. It is all done using sensors and embedded in every physical device. It can be mobile phones, appliances, Pecos, barcodes, sensors, traffic lights and almost everything that you come across in day to day life. These sensors continuously emit data about the working state of the device. But the important question is how do they share huge amount of data and how do we put these data to our benefit. IOT provides a common platform for all these devices to dump these data and our common language for all the devices to communicate with each other. IoT is an extension of internet connectivity into physical devices and everyday objects. These devices can be communicate and interact with the others over the Internet, and

they can be remotely monitored and controlled.

In this project IoT is used to sense the humidity and temperature by the sensor and to store it in Google data sheet using NodeMCU.

4. Result and Conclusion

Fetching the environmental data inside the warehouse has been done using NodeMCU and DHT22 sensor. Arduino IDE is used for displaying the digital output of the sensor. The environmental data has been recorded.

The sensed data is given to NodeMCU for further processing and to generate control signal. The sensor output data will be stored in the Google data sheet. As the data changes the Google Data sheet will keep on updating. NodeMCU will controls the warehouse condition using Heater and cooler of the feedback control circuit.

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