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Auto Climate Monitoring System

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Abstract: Warehouse is used in almost every nation worldwide mainly for the storage of perishable food items and food grains. In India, Central Warehouse Corporation is the sole authority that is managing the task of storing agricultural products, finished goods and variety of perishable and hygroscopic items and the problem faced by the Central Warehouse Corporation is storage loss of food grains and other perishable food items due to sudden changes in environmental conditions. It seems that the current granary management systems are not efficient enough to keep the food products safe. To make the management work easier and to reduce the loss, a smart warehouse is implemented which is enabled with several sensors and technologies.

This project aims to provide a low cost IT solution to this problem with the use of Internet of the things (IoT) sensor and IoT data integration to existing application software. The idea is to capture real time information regarding temperature, moisture and fire using sensors and send alerts using IoT technology Sensors are used to record the atmospheric moisture and temperature (automatically) inside the warehouse. Based on the readings so obtained, the software performs appropriate data analytics and sends timely alert to concern officials of CWC for mitigation and remedial actions arising due to moisture and temperature inside the warehouse. Not just that, IoT sensor also captures fire/gas and alerts the respective nearest authority like Fire Station, Hospital, Police besides alerting CWC officials for mitigation.

Keywords: Fluctuation, IoT, Microcontroller, Mitigation, Real-Time.

Introduction: In India, more than 52% people are involved in agriculture. Crops are grown seasonally and after harvesting, grains are stored for short or long periods as food reserves, and as seeds for next season. But apparently poor food grain storage facility and food wastage has been a persistent problem in India. Storage plays a vital role in the food supply chain, and several studies reported that maximum losses happen during this operation. In most of the places, every year we face considerably huge loss of harvested grains just because of inefficient storage techniques. Thus, every year we lose tons of food grains. Despite producing more than sufficient food grains for a year's requirement India faces the problem of food scarcity. So in order to bring down India's problem of food grain loss and hence the problem of food scarcity we need to enhance the food grain storage system. And for that we need to look properly for the root cause. Apparently fluctuation in the weather pattern is the major cause of damage to the stored grains. Also sudden fire outbreaks are adding considerably to the problem. And currently we use manual ways of warehouse management that are not efficient enough to serve the purpose. We have humans in particular serving as watchman for the warehouse and it is very much certain that a humanly guard cannot look after the warehouse for long as he/she will need to have breaks for personal reasons. Also it takes much time for humans to realize the situations like fire outbreak and that is also a reason for the damage of food grains. Currently we need to check the fire outbreak and climatic fluctuations all together.

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Hence we need a system that can efficiently manage the storage of food grains and perishable goods through quality control practices by tracking parameters like moisture, temperature and fire/gas. We need a solution capable of handling this situation smartly and efficiently.
So, as a solution to the above stated problem, we have an IoT based system.
This system has two parts:

1. Hardware
2. Software

Both software and hardware are connected to each other and play a very crucial role. Hardware is installed inside the warehouse and software is installed in the computer or mobile with internet connection. Hardware collects the real-time data from the warehouse and the Software comprehends it and takes appropriate steps as per the data feedback.

Related Works: Most of the works and projects in this field do not prioritize data storage. But our project stores all the data so obtained from the sensors. This is done to implement certain other techniques like Machine Learning & Data Analysis in the coming future for the purpose of predicting the forthcoming events based upon previous records. Also, for instant actions and better safety we have added the feature of sending direct alarm to the owner in case of fire. Being cost effective is one of the key feature of the proposed project. Also this system uses just one sensor to track both temperature and humidity; it is called DHT sensor.

Requirements:

1. **Hardware:** It comprises of several smaller devices as follows:

   a. **Arduino-Uno Board**
   The Arduino Uno is an open source microcontroller board. It is based upon the Microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog input/output (I/O) pins. Arduino has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9volt battery. Also it accepts voltages between 7 and 20 volts. The Arduino Uno board plays a vital role in uniting all the sensors together and enables them to upload the real time data that is obtained from the environment. In other words, it can be said that Arduino Board handles every sensor used in the system and it is the most typical microcontroller capable of dealing with the input modules such as the sensors transferring the real time data.

Fig.1. Arduino Uno Board

   b. **Gas Sensor (MQ2)**

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Gas Sensor(MQ2) module is a very useful and reliable electronic device in case of detection of gas leakage or smoke (that indicates fire) (home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible.

Fig.2. MQ2

c. **Temperature & Humidity Sensor (DHT)**

DHT11 is an electronic device that is capable enough to record real time value of both temperature and humidity. Its integration with a high-performance 8-bit microcontroller makes it special. It is highly reliable and excellent in terms of long-term stability. This sensor uses a resistive element and a sensor for wet NTC temperature measuring devices. It ensures fast response, anti-interference ability and excellent quality. DHT11 sensors feature extremely accurate calibration of humidity calibration chamber. They are of small size, low power and possess signal transmission up to a distance of 20 meters.

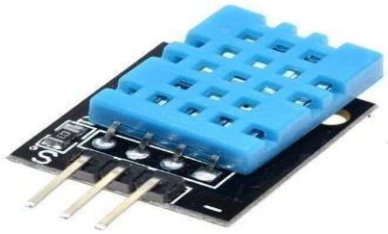

Fig.3. DHT11

d. **Wi-Fi Module (ESP8266 module)**

ESP8266 module is low cost, small size and easy to operate wireless transceiver that is used for end-point IoT developments. Its capability to support both TCP/IP and Serial Protocol makes it the most widely used WiFi module. Generally it runs at an operating voltage of 3V but can handle voltage upto 3.6 V. ESP8266 WiFi module can easily be interfaced with microcontrollers board via Serial Port.

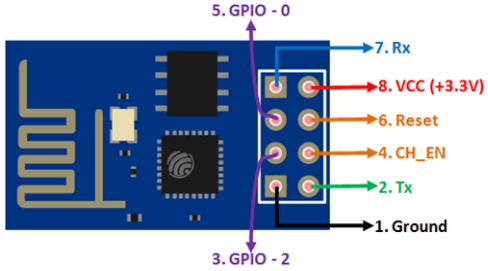

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Fig.4. ESP8266 Module

e. **Breadboard**

A Breadboard is used to design temporary circuits for testing or to try out an idea. It does not require any soldering which makes it easy to change connections and replace components. Parts are not damaged and can be re-used afterwards.

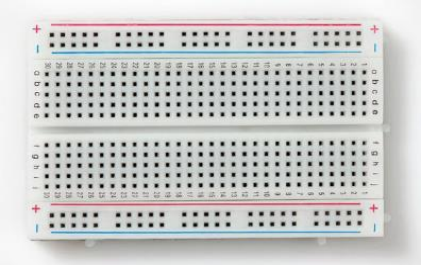

Fig.5. Breadboard

f. **Jumper Wires**

Jumper wires are simple wires having connector pins at each end, allowing them to connect two points in a circuit without soldering. Jumper wires are generally used with breadboards and other prototyping tools. Male jumpers plug securely into the holes in a breadboard whereas female jumpers connect male header posts and pin terminals on components.

Fig.6. Jumper Wires

g. **Display (16×2 LCD)**

LCD modules are commonly used in embedded projects. It is cost effective, easily available and programmer friendly. 16×2 LCD has 16 Columns and 2 Rows. So, it can have (16×2=32) 32 characters with each character made of 5×8 Pixel Dots.

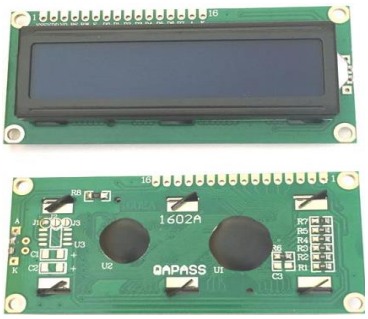

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Fig.7. 16*2 LCD

h. **Buzzer**

A buzzer is a small and efficient electronic component for the purpose of adding sound features to project/system. It is a cost effective and compact 2-pin structure which makes it easy to be used on breadboard, Perf Board and even on PCBs.

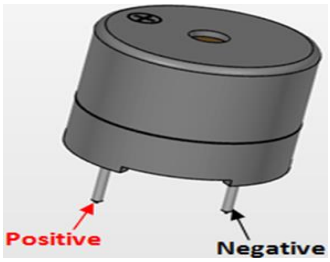

Fig.8. Buzzer

i. **LED Bulbs**

LEDs are semi-conductor light producing devices used in small scale projects or appliances. It stands for light emitting diode.

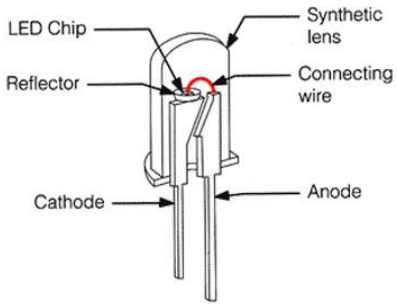

Fig.9. LED Bulb

j. **Power Supply**

We can supply power to the system using appropriate batteries or other suitable sources.

2. **Software:**

a. Mobile Application
b. DBMS
c. Cloud

3. **Dependencies:**

a. Structured Warehouse
b. Hardware Availability
c. Internet Connectivity

Work Plan: The entire work plan is divided into two categories:

1. **Hardware Working:**

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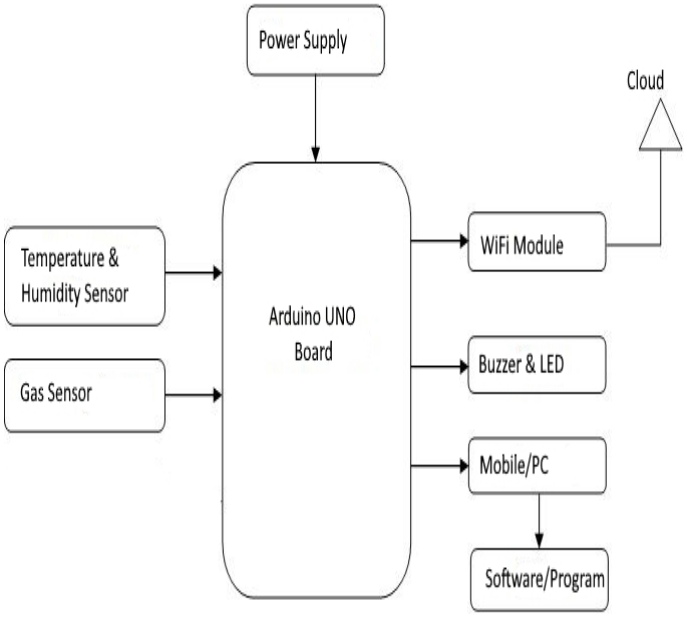

Fig.10. Hardware Setup

Hardware setup includes many sensing devices connected together with the help of Arduino-Uno board. Arduino board unites DHT11 module, MQ2 module, Wifi Module and other supporting devices like a backbone. Further the Arduino board is connected to the Mobile App through Wi-Fi Module. Microcontroller located at the center of the block diagram is the control unit for each node. It helps sensors to collect data from the environment and upload it to the cloud. A web application is created which receives all data through cloud. Here we have a login system for the manager wherein he can view and monitor the environmental conditions of warehouse as shown in flow chart below. The software checks if there is any change in temperature and humidity within the warehouse or cold storage facility and controls the air conditioning as per the need. Also it checks for smoke/fire and then as per the analysis it generates alarms and notifications.

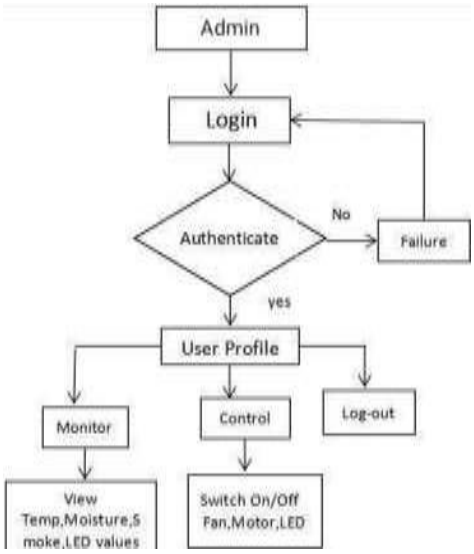

Fig.11. Activity Diagram for Software

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2. Software Working:

Hardware part needs command and direction to act together. This purpose is served by the Software part. Software part is for collecting the data from sensors and uploading it to the cloud. This application is open source and so programmed that it will check the data immediately. This data will be compared with the warehouse's min-max tolerable value. If the real time data crosses the min-max limit set by the warehouse, the alarms will be turned ON immediately. For example, if maximum temperature allowed is 40C, and the real time value of temperature is 41C, the alarm will be turned ON and also the air conditioning will be adjusted automatically by the system. The alarm is turned OFF once the situation is taken care of. One can have this software downloaded in the smartphone and simply login to the software. Login to the system using valid ID and password. After getting into the system one can track the real time data related to the physical factors of the warehouse and control the system. One can also track and compare the readings of the past few hours. This application gives you a proper graphical view of the readings. After you are done, do not forget to logout of the system.

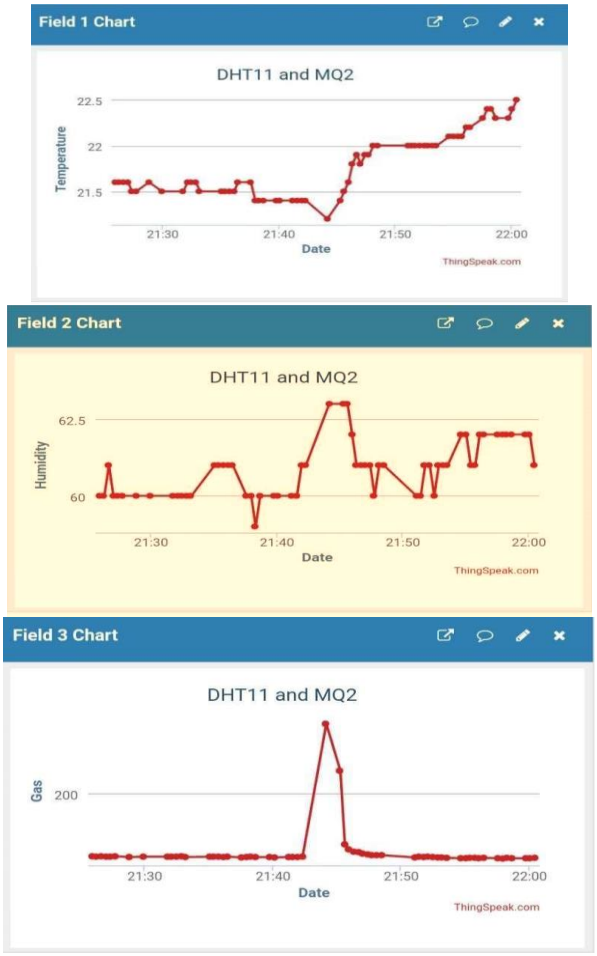

Fig.12. Graphs

Expected Result: Through this paper we tend to present an IoT based simple and cost effective system designed to keep track of real time atmospheric events inside the warehouse and take appropriate actions in perfect competence. This system works as 24x7 guard for the warehouses and that too without any lunch break or any vacation. It controls the humidity and temperature on its own with respect to the real time atmospheric conditions of the warehouse. In case fire breaks out, the

system generates alarm and sends direct message to the owner and fire brigade. Thus this system has the potential to cut down the food grain wastage by 80% and help solve the problem of food scarcity in our country.

Future Scopes: With cost effective design, this project possesses enormous potential and can be used in various other ways. Not only in food storage grains but also it can be used in other agriculture related storage and management. Currently this project is totally IoT based and uses real time data and takes decision based upon certain conditions only. But in the coming future, in addition to the current architecture, implementing Artificial Intelligence and Machine Learning along with data analytics may help to predict the events or the atmospheric changes inside the warehouse. Thus providing the authorities sufficient time for mitigations against predicted threats.

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