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Food Monitoring and Control System using Internet of Things

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Abstract: ***Raw food product's hygiene is a scientific disciplinary mainly emphasizing with handling and storage. Storage of food under imprecise environmental condition will reduce the service life of the raw food material causing rotting and browning effect resulting in wastage of the food. This paper focuses on a system which controls and monitors the quality and quantity parameters such as temperature humidity and weight. The controlling unit is hinge on the databases of optimum parametric values for various raw food materials. This unit using the internet of things technology notifies the user about the intended parameters of the food continuously.***

Keywords: IoT, Quality and Quantity, food monitoring and control, temperature and humidity.

I. INTRODUCTION

One-third of the raw food produced over the world i.e.,1.3 billion tonnes is being wasted every year, according to resource Organization of the United Nations. In Singapore, the National Environment Agency (NEA) estimated that 790,000 tonnes of food was thrown in 2014. Such amount of wastage of resources ridicules the mankind. These wastage may be due to various reasons such as environmental conditions or buying excessive food, all these ambiguities can be reduced if the raw food materials stored will be properly monitored (to keep an eye on…). Parameters like temperature and humidity play a major role in maintaining the quality of the raw food material. The monitoring unit present in the system is done using various sensors to monitor relative humidity and temperature of the storage area where the raw food is stored, sensors continuously records the sensed values. Now the controlling unit makes sure that the parameters lie in the desired range of that particular raw food material, this is done with actuators, both actuators and sensors should go hand in hand i.e., based on the recorded values by the sensors the actuators must take an action to maintain the temperature and humidity in the desired range if it goes beyond or below the threshold range, all these help in maintain the quality of the raw food. Quantity is also an important factor to avoid wastage which is done by a sensor for continuously monitoring the weight of the raw food stored. The quantity of the food material is monitored continuously and a certain minimum threshold is set and if the quantity falls below the threshold minimum value set then the user is notified of the shortage of food. Since the presence of food is monitored there will be no excess food bought by the user and this avoids food wastage. Thus, to keep the user updated about these factors some or the other wireless communication is necessary. There are many technologies nowadays and each differ from other based on range, speed and reliable transmission. Therefore an communication system which is reliable, fast and by which user can have knowledge of data from anywhere would be suitable for this system. Here we use the Internet Of Things technology which keeps the user notified at all intervals of time.

The various features of our system:

1) Wood as casing material as it provides proper insulation.
2) Automated controlling mechanism
3) A storage container can have multiple raw food materials but only one material at a time not mixture of raw food.
4) Usage of two peltier modules for temperature as well as humidity control to save power
5) Weekly analysis reports as well as real time notifications through web application.

II. EXISTING SYSTEM

The requirement of maintaining the quality of food is very important aspect of health and hygiene. Accordingly monitoring the quantity avoid shortage and wastage of excess food materials. Although there are many ways to achieve them a collective system is not achieved. The existing system has analysis of internet information of food disposal, IoT framework for monitoring system, application of IoT to monitor food quality safety and implementation of control system. There is no system that helps in monitoring and controlling the quality of the food materials. Also no system has implemented quantity monitoring to avoid food wastage or shortage.

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III. PROBLEM STATEMENT

Quality of the food needs to be maintained to prevent the food from decaying. In order to do this we need to control the temperature and the humidity around the raw food material according to the desired values.

Quantity of the food needs to be monitored in order to avoid shortage. Continuous real time monitoring is required to keep the quantity of the food material in check. Automated control and monitoring of food sensed in real time is introduced to maintain the quality and quantity. Therefore there is no need of checking for the quality of the food and no manual monitoring of the quantity as well.

IV. METHODOLOGY

A food unit has various sensors, actuators and modules embedded in it such that it performs as intended and the necessary tasks can be accomplished. This unit has two different point of references or subjective attributes i.e., quality And quantity. This unit stores any raw food material, where monitoring and controlling can be done. Where monitoring is accomplished by using three measurable physical quantities which are temperature, relative humidity and weight, these quantities are monitored or analyzed using various sensors such as DHT11 module for temperature and relative humidity, load cell for weight. Controlling is accomplished by actuators i.e., two peltier modules with heat sink fan. One of the peltier module is used for controlling the temperature and relative humidity by cooling and the other one by heating. Sensors and actuators are interfaced with the help of ardiuno nano microcontroller and node mcu microcontroller with wifi module embedded in it.

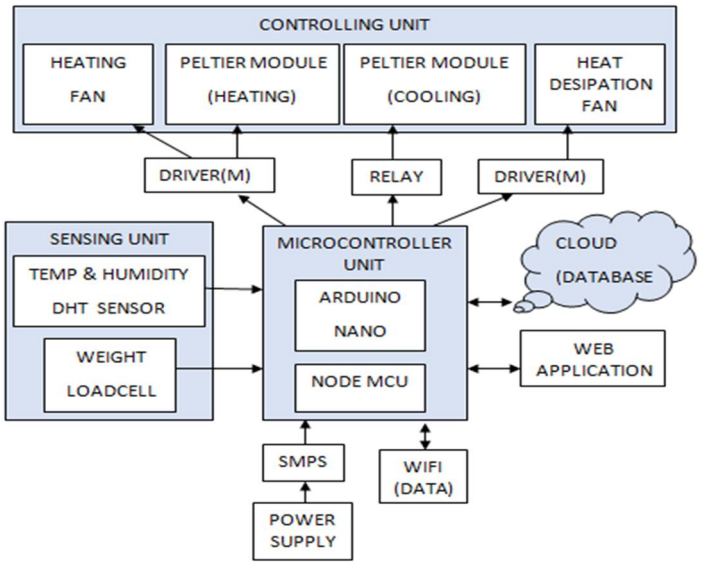

Fig 1 : Block Diagram

Raw food material's shelf life depends on the desirable range of certain parameters, each and every raw food material will have unique desirable values, For instance relative humidity of wheat is favorable to be between 45% to 55% for 28 Degree Celsius (approximately equal to room temperature). It can affect the health of the grains and cause increase in germination if the value of relative humidity is not in that range for 28 Degree Celsius room temperature. These desirable values (temperature, relative humidity and weight) of the respective food material is stored in the database (cloud), here Thingspeak plays an important role. Thingspeak is a platform or a channel which helps to post or retrieve the data to or from the cloud. A communication is established between the database and the microcontroller.

Here mosfet is used as a driver for various reasons such as the switching action of the peltier module or the fan, one of the main usage is that to maintain certain temperatures the speed of the fan must be varied which can be accomplished by the amount of current induced in the respective module which can be achieved by manipulating the duty cycle.

We enlighten the food material stored to the microcontroller through web application, the sensing unit continuously monitors. Whenever there's a deviation from the desired value, the microcontroller triggers the intended module and is commutated when the desired value is reached. the quantity attribute is taken care by setting the minimum threshold value, whenever the load cell value goes below the desired value a notification will be popped up on the web application indication the vacancy of that particular raw food material so that the user can get that food material.

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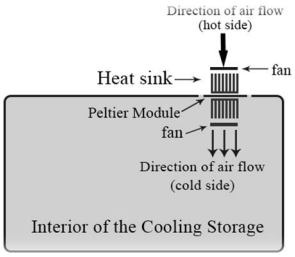

Fig 2 : Cooling System

The technology of internet of things is implemented using a Wi-Fi Module in the embedded system, the data can be sent to server using internet. This information can be accessed by any device which is interfaced with the server.

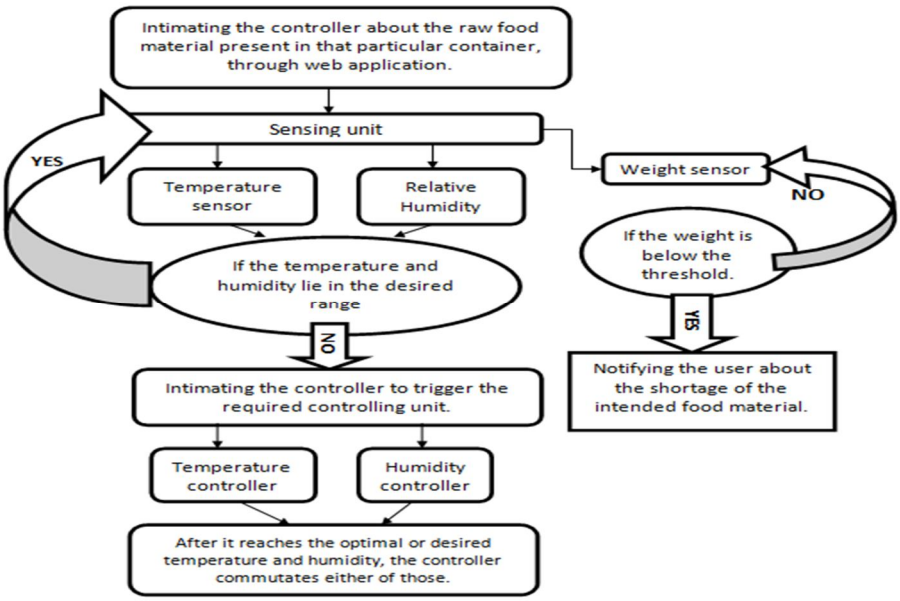

Fig 3 : Flowchart

A. Cooling Unit

The whole unit completely depends on the peltier module. Peltier module works on the principle of the peltier effect, whenever a current passes through the conductor the exchange of heat takes place from one region to the region. Whenever the peltier module is triggered, cold surface of the peltier module starts cooling then with the help of heat sink and the fan the cool air is circulated in the storage unit. At the same time the opposite surface gets heated up, to cool that down we use heat sink with fan placed outside the lid and the direction of the air flow is as shown. A Peltier module consumes power up to 24 watts. So to regulate the power consumption we have interfaced the Peltier module to a microcontroller. This Microcontroller is provided with temperature and relative humidity values inside the storage using temperature sensor Also threshold values (temperature and relative humidity values) are added to the program according to which the Peltier tile is switched on and off. This will reduce the total time for which the Peltier is switched on, Thus improvising the power consumption of the cooling unit.

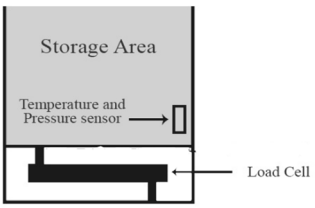

Fig 4 : Load cell and storage unit

B. Heating and Storage Unit

The same module as that of cooling unit is used for heating, its just the hot surface is faced inwards with heatsink as well as fan, where the direction of the airflow is faced towards the storage unit.

Load cell is used to measure the weight of the content in the container. A low threshold value regarding the minimum weight content of the container is fed to microcontroller. If the weight is reduced below the threshold due to repetitive use of the food material present in that storage, An user alert takes place to notify user regarding low amount of that particular food present in that particular storage. Further on user approval the microcontroller calculates the weight required to refill the compartment. This helps the user to make a list of refilling if multiple compartments are present. Due to this action easy refill of compartments take place and user will never run out of the food resources.

V. RESULTS

The project model showcased below in figure 5, 6 and 7 with hardware components including the wooden casing, the heating and cooling system, microcontroller unit, switch mode power supply and relays.

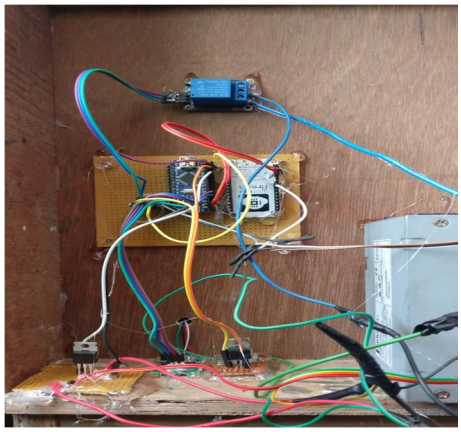

Fig 5 : Microcontroller unit, Relay and SMPS

Fig 6 : Wooden Unit

Fig 7 : Cooling and Heating unit

The storage system developed could store any number of raw food materials like vegetables, fruits and grains. Just by adding database of the temperature and humidity of that particular food material which is to be stored, we could store the newly added food material. Thus the system provided the flexibility of changing the type of the raw food material which could be stored. Different materials have different temperature and humidity which needs to be maintained. Here we have demonstrated up to 8 food materials with different atmospheric conditions and the control system proved to act according to the change in food materials and its conditions.

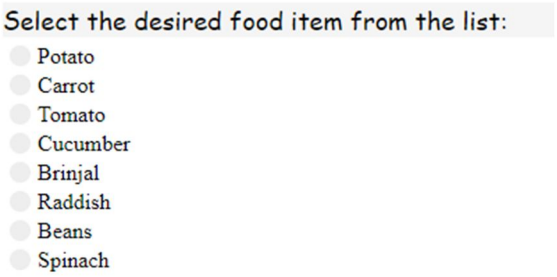

Fig : Selecting the food material

The load cell monitoring the quantity of the food stored worked precisely and was quick to notify the user if there was a shortage of food. The notification would expire if the shortage was full filled by the user. The threshold was set to 1 kilogram.

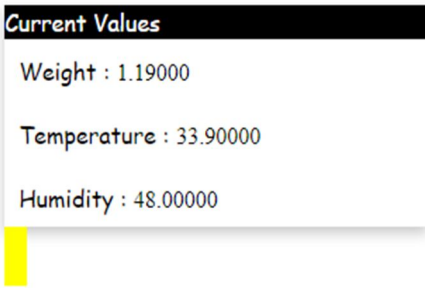

Fig : Current values and Notification absent if quantity is more than 1 kilogram

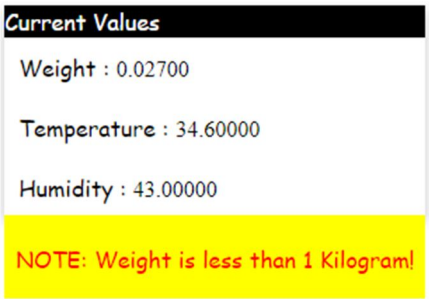

Fig: Current values and Notification given when the quantity is less than 1 kilogram

The real time variations in the Weight, Temperature and the humidity is continuously monitored as shown in the graphs below taken from the web application.

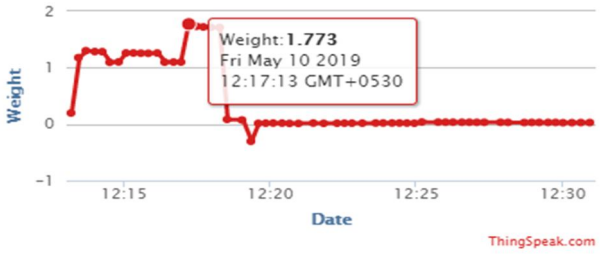

Fig : Weight Monitoring

Fig : Humidity Monitoring

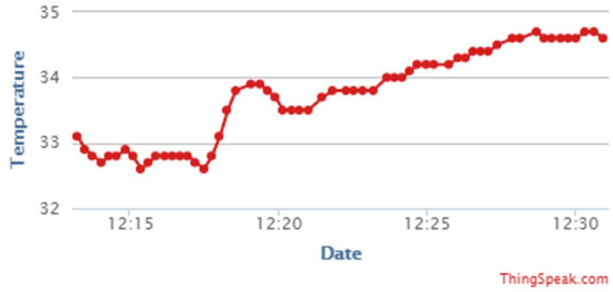

Fig : Temperature Monitoring

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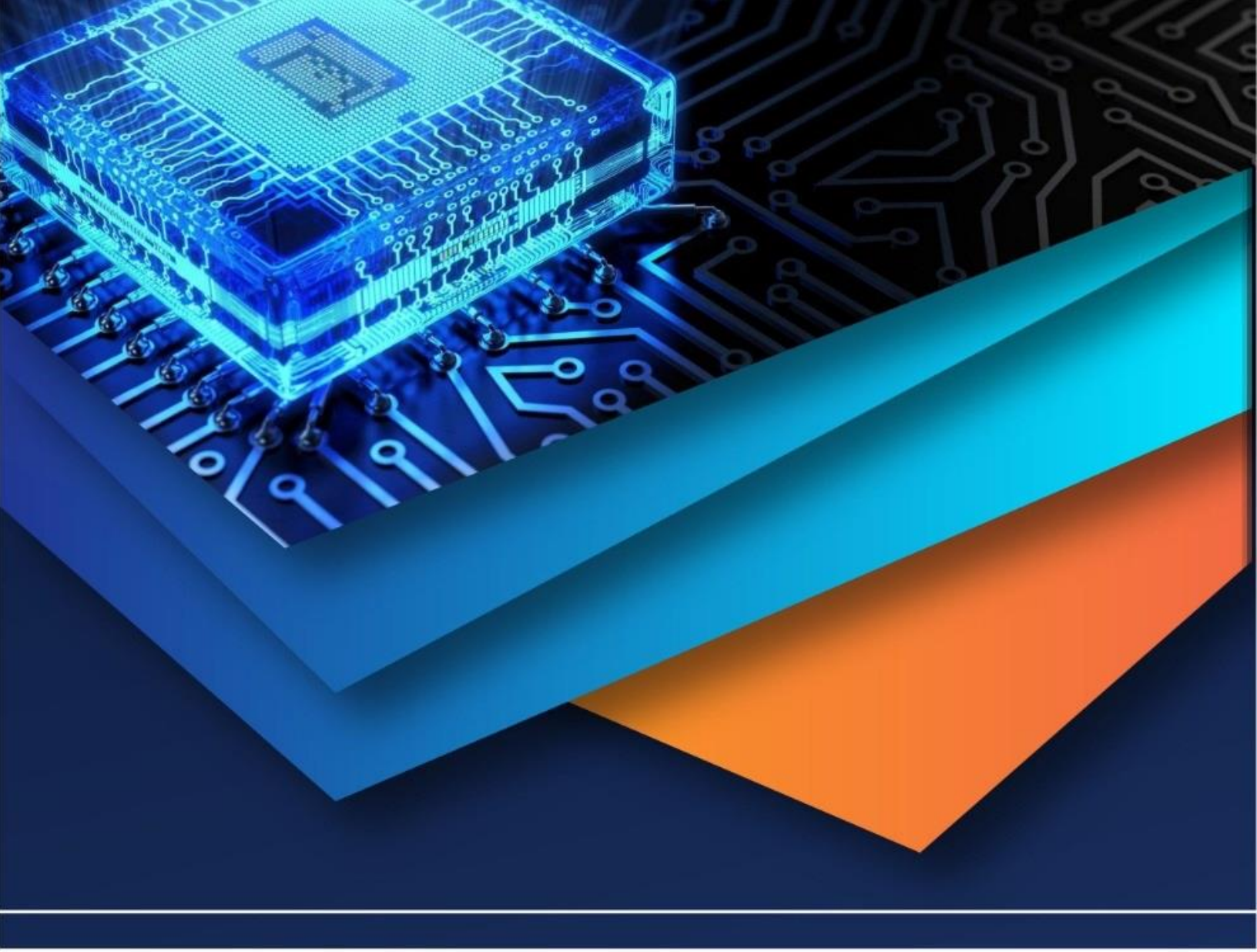

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