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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:

Wood as casing material as it provides proper insulation.

Automated controlling mechanism

A storage container can have multiple raw food materials but only one material at a time not mixture of raw food.

Usage of two peltier modules for temperature as well as humidity control to save power

Weekly analysis reports as well as real time notifications through web application.

II. LITERATURE SURVEY

[1] This paper tells about the Iot framework for monitoring of the food such that it wouldn't get spoilt due to surrounding conditions while storage and transportation. Their proposed solution gives detailed information about analysis of the recorded values by the sensors, it analyses parameters like temperature, moisture and light as they affect the food's nutrition value. All the recorded value analysis can retrieved by the mobile application. As there is transportation factor involved the information of the location of the shipment will also be provided via the application. They use a web server for storage of the data values from the sensors in real time. And they even provide graphical representation the data values recorded which can help in further analysis. They aim to develop a platform such that user can interface with the third party stakeholders to get the information of the shipment and storage of the food.

[2] The rapid development of internet of things results in the application in the field of food quality and safety monitoring. In this paper, the architecture of the food quality and safety monitoring system based on internet of things is introduced. The characteristics, laered structure and key technologies are expressed. Application of internet of things to monitor food quality safety are bound to realize the functions of intelligent monitoring and controlling, accurate prediction and disposing food safety incidents efficiently. Throughout all the processes of production, logistics, consumption and tracing of food, the proposed architecture of quality and safety monitoring system based on IoT aimes to construct an unified platform. The proposed systematic platform operates on valid service contents and operational modes in case of data integration. The rapid development of internet of things has been providing comprehensive applications in the field of food quality and safety monitoring . On the basis of the advantages and features of internet of things technology, this paper has presented key innovation contents of internet of things applied in the modern intelligent food industry, which can realize the functions of intelligent monitoring and controlling, accurate prediction and disposing food safety incidents efficiently. The key technologies used here are the RFID technology and the cloud technology. The RFID tags are used to record the basic information of the source of raw materials together with other such as date of inspection, packaging date and batch number. The cloud technology is used to store databases which is parameters of the food materials for monitoring purposes with intelligent reasoning technologies.

[3] In this paper a prototype has been achieved where the the system is based on the designing monitoring and analyzing the information from the internet for safety of the food materials. This paper mentions some key technologies like web crawling which can collect timely information and related to the subject in question. It is based on the machine learning method. Here the internet information is to be analyzed according to the category and characteristics. This is in order to monitor and analyze the special internet information. The major key technologies here are Web page crawling, spam filtering and Information extraction and event warning. The topical crawling technology is used to classify the information on the internet, rapid collection of related content and disposing the unrelated information since collecting all of the information on Internet is unnecessary and not realistic. To ensure the accuracy of the information processing a method called spam filtering is required. After web crawling and spam filtering techniques are completed, it can be proceeded with the extraction of food safety incidents information and the working work. Therefore examining the key points of information extraction and the event warning are very necessary from the point of food safety. Here the technologies like topical web crawling, the deceptive spam filtering which is based on the method of machine learning and food safety information extraction based on ontology are put forward for the first time and these are the contributions of this paper.

[4] In this article, exploration of many methods of spoilage detection which is designed to prevent those consequences are shown. The effectiveness of each of these respective levels of methods are discussed in the paper. Furthermore there are several other approaches are discussed that is to contain the freshness by not regarding the detection. Spoilage of milk is indefinite and difficult to measure with accuracy which can cause the consumers and the manufactures. Ambiguous expiration dates on the milk cartons have mislead the consumers with uncertainty. These waste resources by disposal of unspoiled milk or consumers may be discomforted by drinking the spoiled milk. This behavior of the consumers have impacted negatively on the financial matters of milk producers. Many methods have been researched to detect milk spoilage with more accuracy which include indicators based on pH bacterial counts and gas sensor arrays. The methods mentioned in this article are as follows. i) Electrical methods for detection of bacteria. ii) Wireless detection and monitoring of milk spoilage. iii)Gas sensor arrays. iv) Infrared spectroscopy as spoilage indicator. And v) Protein and fat count detection. For simplicity, the pH and amperometric sensors are considered the most optional methods to detect spoilage of milk. A combination of more than one method is advised for increased reliability in this article.

[5] Food safety is a major public health issue. Incidents of illnesses arising from food poisoning. In order to monitor food spoilage, Australian government adopted HACCP systems to identify and manage potential food hazards. Agencies started exploring different places in Australia in order to monitor food safety. In this paper, the younger participants where initialized less amount of monitoring work compared to older participants. Usually food safety and quality monitoring is done using a monitoring index.

[6] In order to improve the control loops from bread and mill factory, a detailed process analysis and experimental tests have been done. Two solutions based on the Distributed Control System / Supervisory Control and Data Acquisition architecture are proposed. First structure using the digital controllers and the second one is using the compact data acquisition and control system. The solution proposed in this paper consists of four different levels, but in this paper we study only about three papers. This proposed solution for control system has been implemented in bread and mill factory.

[7] An intelligent monitoring and controlling system has been designed by using MSP430 for small and medium scale industries. Temperature, humidity and carbon dioxide are very important in order to control and monitor food. In this paper, in order to achieve automatic control system, deepfreeze process is used which sets the corresponding parameters based on the kind of food. In order to improve the efficiency we use fuzzy control prototype, it also enhances stability and reliability.

[8] In this paper we use wireless sensor network, which consists of sensor nodes which is equipped with integrated sensors, data processing capabilities, data gathering capability which helps in automatic monitoring system. In this paper we use ZigBee and RFID which are mainly used to detect and gather food supply information and upload it to monitoring system. This study proposed the food monitoring system that manages and checks the freshness of the food.

[9] Food poisoning may affect many factors such as temperature, humidity and monitoring them and storage is very important. In order to prevent these factors we use smarter RFID tag which helps in measuring the temperature and humidity. The measured information helps in handling temperature or humidity of food during transporting and storing. In this paper, once the food data is recorded it is sent to food poisoning index, then express food poisoning grade. The calculated grade is displayed in four different grade levels indicating the food poisoning level.

[10] This research paper presents three methodologies to identify the physical conditions which affect the food. It discusses how RFID sensor is introduced in safety of the food. The RFID which is the radio frequency identification is a system which has a tag and a reader in combination. It provides a cost effective way to identify objects. Even though RFID was discussed in many research paper, no paper had introduced it in food safety. The factors affecting the food physically needs to be identified and should be taken care of. This then requires the RFID system to be integrated with the WSN architecture. There are three methodologies involved and are discussed in this paper, which are as follows. i) Identifying the contamination of various food by physical factors such as Co2, room temperature and methane gas given by insects. These are identified using RFID bio-sensor which is newly fabricated. ii) Identifying the contamination by physical factors based on timer fixed by the RFID tag using RFID timer-sensor. And iii) Identifying the contamination by physical factors based on ambient environment. The need for food safety centre protecting the food from contamination is identified in this paper. Since contamination of food leads to health issues, the cost and time is saved by this new proposed system of RFID sensor. The results of physical factors affecting the food is shown for clear understanding.

[11] This paper is about the alternative solutions for cooling applications with the Peltier effect. This is effective because there is no fluids which leads to safer, reliable and eco-friendly operations. The above operations are driven by the DC power. Buck converter with customised design blocks are used to gain high performance. According to the carrier generation and recombination effects this occurs when current flows through different junctions which results in two junctions namely hot junction and cool junction. Peltier effect can be applied for both cooling and heating effects. Hence DC-DC buck converter with customised blocks was designed to meet the requirements.

[12] Peltier module's efficiency for cooling is limited by the FOM of the p and n-type semiconductors. this paper presents the maximum performance coefficient and temperature difference of the Peltier thermocouple. The difference between the p- and n-type semiconductors has been considered. Results are being compared with the measured values of the Peltier module. By using distributed Peltier effect can improve the efficiency of the thermocouples only if optimised thermoelectric properties are used. To successfully improve the characteristics of Peltier thermocouples we need an accurate development of thermoelectric materials namely p,p2,n and n2. Any deviations in the thermoelectric properties leads to better performance of the cooling device. Finally having a simple methods for manufacturing segmented thermoelements and their assemblance into the cooling device.

[13] Peltier module is a component which operate according to the Peltier effect. The effect creates a temperature difference by transferring heat between two electrical junctions. When the current flows through the junctions of the two conductors, heat is removed at one junction and cooling occurs at the other. Nowadays power consumption is the major issue. Semiconductors come into picture which can solve the power consumption problem. The issue of not using these semiconductors in a proper way makes it unpopular. Hence, we make the best use of Peltier module to reduce the power consumption. AC's power consumption is around 2000-3000 -watt power and cloth iron is around 750 watt power. Since we are using Peltier module AC takes around 200-watt power and cloth iron takes 50 -watt power. This paper discusses about the life and reliability of the device. Hence, we can use Peltier module in our daily life.

[14] The AC split device lacks the network connection. It can't be controlled through a network. Hence, paper tells us about the Node MCU which controls the conventional AC split device through Wi-Fi connection. This module has some inbuilt circuits which is called as IR module. This switches on the AC split device and can be controlled through wi-fi network. Here MCU has a connection with IR LED which transmits the infra-red command to help LDR to know about the power consumption of the split device. We use REST protocol for the purpose of communication to control the module through browser application. Controlling is successfully done to turn off the AC and for setting the temperature. The connection time and the receiving time depends on the network's quality.

III. 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 analysed using various sensors such as Digital humidity and temperature sensor (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 Arduino Nano microcontroller and node mcu microcontroller with Wi-Fi module embedded in it.

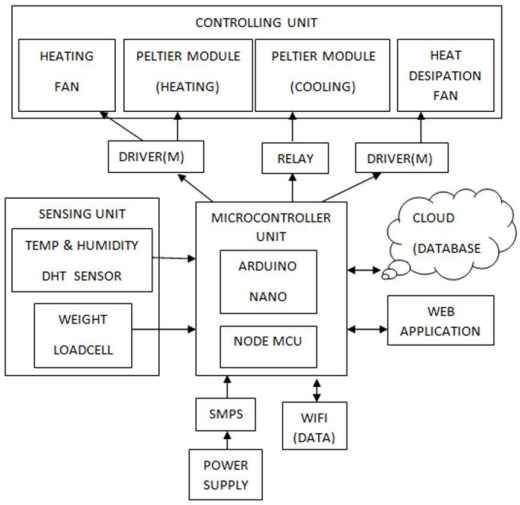


Fig 1: Block Diagram

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 favourable 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 thing speak plays an important role. Thing speak 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.

The user 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. 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.

IV. CONCLUSION

In this paper we have proposed a solution to the raw food product's hygiene by implementing a monitoring and control system using IoT. Now to control atmospheric parameters such as temperature and humidity, we need to have a heating and cooling device. Generally for cooling we may use peltier module and for heating we use induction circuit. Since induction circuit consumes a lot of power we may use a peltier module for heating as well. Therefore we use two peltier modules for hesting and cooling. The sensing unit are for monitoring purposes. This way by implementing a control and monitoring system we have a solution for food hygiene. The communication used is IoT technology having a ready database for the purpose of controlling.

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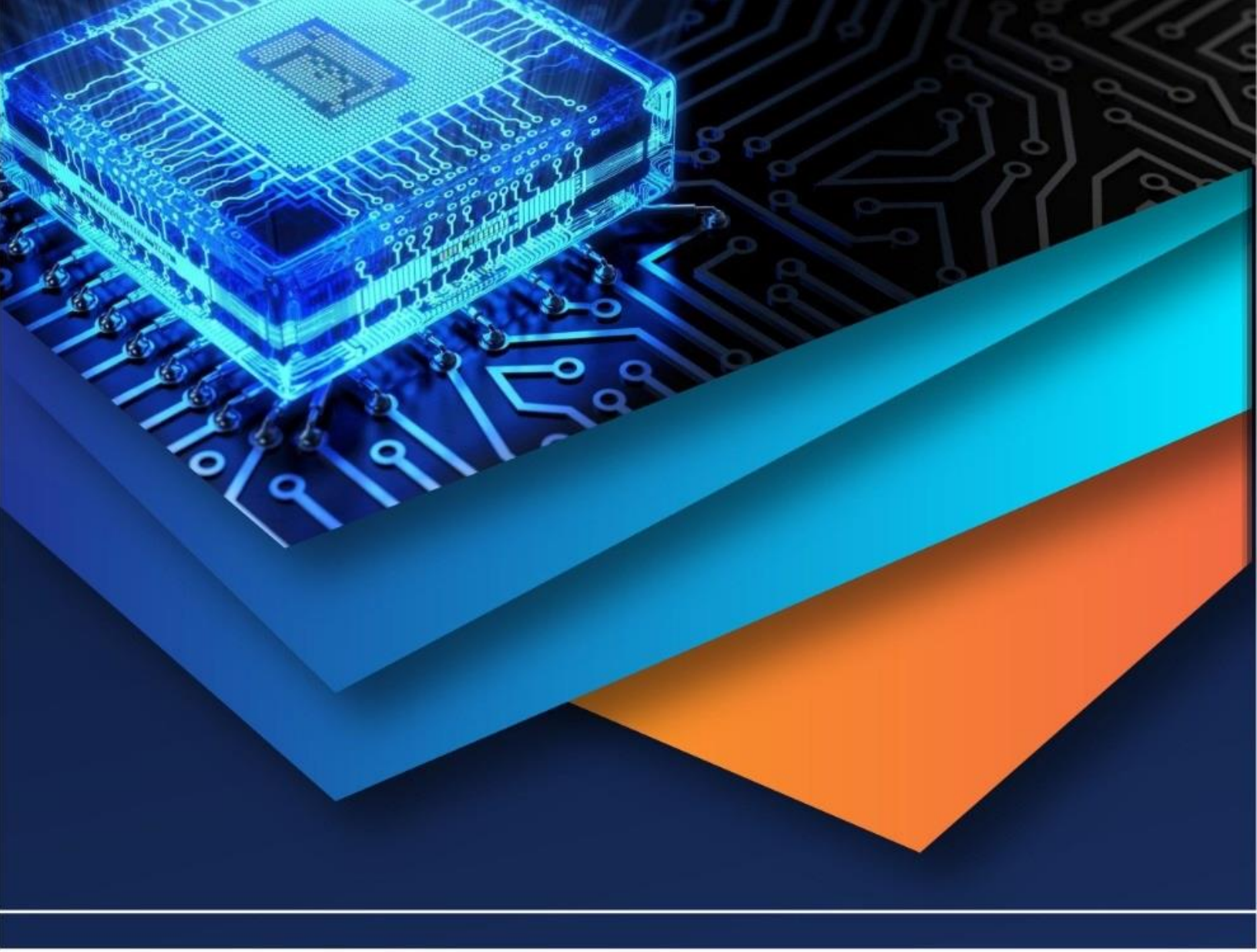
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