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Survey on Food Quality Monitoring System

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Abstract - *Food quality maintenance has become one of the major issues in the world. Recent surveys show that approximately half of food commodities produced is going waste due to inadequate maintenance of the environment where the food is stored. This calls for technologies that brings focus on this crisis and provide solutions for it. In this paper a food quality monitoring system (FQMS) for fruits and vegetables storage facilities has been discussed that has an Internet of things (IoT) system which can monitor stocks & control parameters such as temperature, humidity and light of the surrounding providing the ambient environment and at the same time alert the stakeholders when the food is spoiled or if any fire hazards. The above mentioned information will be communicated to the stakeholders via an app where they can keep track of the commodities safety and hygiene by making a profile.*

Key words: IoT systems, food quality monitoring, sensors, safety, adaptive technology, food engineering

1. INTRODUCTION

One of the many reasons that cause approximately a billion tons of food wastage yearly in the world is due to the poor management of food storage warehouses. In India the problem is not food availability but massive food wastage. As per FAO it was estimated that nearly 40% of the food commodities is wasted in India due to spoilage. It was already estimated that by 2050 the world would need 70% more food. However, the pandemic effect seems to be making the situation much more difficult in the coming years.

The storage facilities in the farm often lack adequate environment such as proper temperature and moisture which leads to damage by pests and insects which greatly affects the quality of stored items which in turn leads to wastage of the products. These damages happen due to lack of safe and scientific storage practices. The cleanliness of food storage warehouses has to be maintained as the food we consume is a major determinant of how we function in our daily lives. Improper food hygiene causes food poisoning sicknesses which include Listeriosis, Mycotoxicosis, Salmonellosis, E.coli, and Botulism. It is been surveyed and known that one out of ten people die because of food poisoning. Therefore it's important to maintain the quality of food we consume. An answer to this problem can be to maintain ambient condition in the food storage warehouses in order to control the spoilage rate. There are various factors that cause food decay, like humidity, moisture, pests, hygiene, light intensity and temperature. It's shown that if the temperature of the storage is between 4.44°C to 60°C, then bacteria double their number in every 20 minutes. Similarly, the humidity has to be maintained approximately 50-55% to keep the quality intact. Hence, food security needs to be treated as an extremely urgent issue.

In recent years studies have been conducted in order to estimate the original or remaining expiring date of the commodities, also systems have been developed to collect environmental data for evaluating and adjusting the shelf life. But the need in the current pandemic situation is a system that automates controlling of the parameters that affect the food spoilage & make it human interference free in order to increase the safety and hygiene of the storage facility.

Thus, in this paper an IoT based FQMS is being discussed that continuously monitor the amount of stock left in the warehouse and the parameters that have to be maintained in order to prevent food spoilage like temperature, humidity and light intensity are taken into consideration. These data after getting collected through different sensors is then compared to the required threshold values of parameters in the cloud; if it doesn't match the requirement then it is brought back to threshold values by activating or deactivating the cooling and lighting system. These activities along with the food spoilage alert are communicated to the stake holders via an app. This app will also have an emergency button for any fire hazard.

2. LITERATURE REVIEW

In this section, an overview of food quality monitoring system using various technologies is discussed.

2.1 Artificial Intelligence technology in Food quality monitoring system

To develop an intelligent system, artificial intelligence (AI) covers numerous techniques. Among several AI techniques, fuzzy logic is a technique which is used to handle the fuzzy information and rule based inference so as to construct decision support in real-life applications. Fuzzy set theory is applied to estimate the expiry of food commodities [1].

2.2 Machine Learning technology in Food quality monitoring system

Machine learning (ML) is a process that uses sample data to train the model in order to make decisions.

The proposed system in [8] uses ML systems such as GPR and SVR to calculate the age of fruit and decide the edibility of the fruit.

In [20] the food spoilage is determined using PCA and KNN algorithms of machine learning. The information from MQ gas sensors is fed to PCA to reduce the data. It also uses KNN for classification of food.

2.3 Deep Learning Technology in Food quality monitoring system

Deep learning helps the machine to behave similar to human brain by extracting features automatically by neural network and then training them to make decisions.

In [5] the system has been proposed that takes food colour as a major factor of decomposition. It is applicable only for cooked product. It uses a trained back propagation neural network as a distinguisher. This system is being applied to numerous food products and has given accurate results.

In [18] the proposed system uses CNN as a method to detect the fruit type and quality.

2.4 IoT technology in Food quality monitoring system

IoT is an emerging concept for connecting objects or things with the internet using sensors, actuators and other identification and sensing technologies so as to achieve smart recognitions, positioning, tracing, monitoring and administration. The IoT sensing system combines the features of intelligent sensor, wireless communication and radio frequency identification (RFID) technology. Therefore, Internet of things is feasible in establishing a visibility and traceability system in handling perishable food.

In [2]-[4], [9]-[10], [12], [14]-[16] and [19] basic sensors such as temperature, humidity and light sensor are used to monitor different parameters that causes food spoilage and then the data is sent to the cloud. The user is notified about the quality changes using IoT technology and can control the spoilage of food manually or automatically.

[11] Proposes a system using Bluetooth Low Energy and IoT technology, to trace the food quality throughout the circulation by using an electronic tag.

[13] Uses an IoT system that has an infrared camera to capture images of leafy food in the field. The data is then sent to an Arduino processor via a Wifi module and a decision is made based on the data.

[17] On the basis of the advantages and features of the IoT technology, this paper has presented key innovation contents of IoT applied in the stream of modern intelligent food industry such as cloud technology, RFID technology and intelligent reasoning technology which can understand the functions of intelligent monitoring and controlling, accurate prediction and disposing food safety incidents efficiently.

3. METHODOLOGY

The IoT based FQMS for fruits and vegetables warehouses has three basic functions and the block diagram of FQMS is shown in Fig .1–

3.1 Monitoring

The physical parameters like light intensity, humidity and temperature are constantly monitored in real time using sensors.

3.2 Controlling

The real time value from the sensor is compared to the threshold values and brought back to the required value. List of fruits and vegetable with their ambient requirements is given in table 1.

3.3 Tracking

The above two functions can be tracked using an app, which will also notify the user when the food gets spoiled, when the stock is over and if there is any fire hazard.

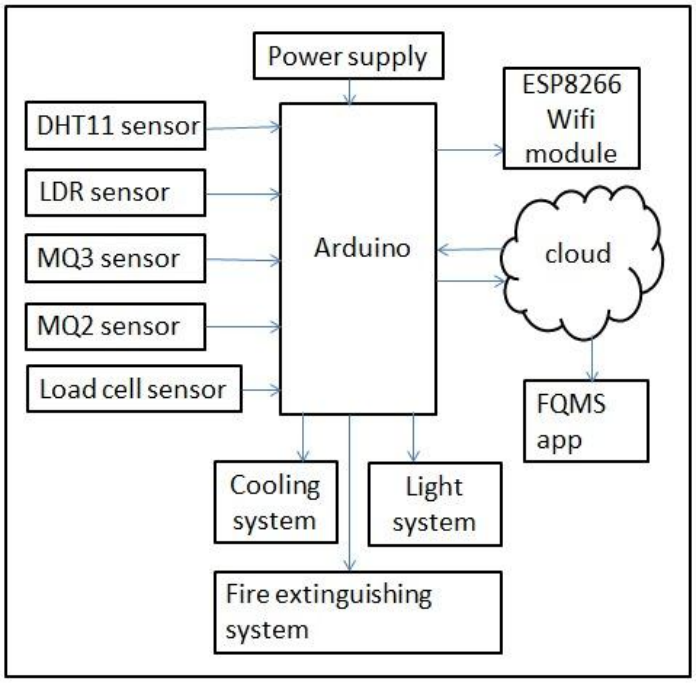

Fig -1: Block diagram of FQMS

Table -1: fruits and vegetables with their ambient values of temperature, humidity and light intensity

Fruits or vegetables	Temperature required (°C)	Humidity required (%)	Light intensity required
Tomato	55-60	85-90	neutral
Potato	38-40	85-90	high
Spinach	32	90-95	low
Onion	32	70-75	high
Cluster beans	45-50	85-90	low
Watermelon	50-55	85-90	high
Apples	30-35	90-95	high
Pear	29-31	90	low

4. SYSTEM REQUIREMENTS

To implement the FQMS following are the requirements:

4.1 Hardware needed

1) Arduino Uno board: This board has ATmega328P microcontroller which has 14 GPIO pins, 6 PWM pins, 6 analog input pins and is programmable with the Arduino IDE. It can run on USB power. This board allows many different external peripheral connections like Wi-Fi, Bluetooth and Ethernet.

Fig -2: Arduino UNO board

2) DHT11 Sensor: This sensor mainly consists of two parts a capacitive humidity sensor and thermistor. It converts the analog data to digital signal which indicates the humidity and temperature.

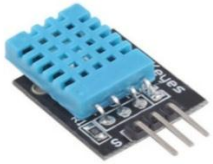

Fig -3: DHT11 Sensor

3) LDR Sensor: It is a light intensity sensing sensor. The resistance of the sensing material changes based on the light intensity. The change of resistance causes change in voltage, which is used to determine the light intensity.

Fig -4: LDR Sensor

4) MQ3 Sensor: It is used to sense the presence of alcohol using SnO2 as the sensitive material. The concentration of alcohol gas in the environment increases the conductivity of the sensing material, using which the alcohol presence in the environment can be determined.

Fig -5: MQ3 Sensor

5) MQ2 Sensor: MQ2 Sensor is used to detect the presence of gas or smoke. It detects it by the change of resistance in sensing material when there is a presence of smoke in the surrounding.

Fig -6: MQ2 Sensor

6) Load cell Sensor: It is a transducer that converts force into an electrical signal. Any change in the force causes a change in the output electrical signal.

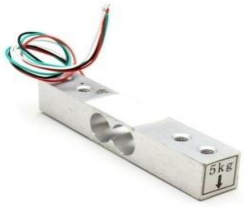

Fig -7: Load cell Sensor

7) ESP8266 Wifi Module: It is a system on chip (SoC) module that is pre-programmed with TCP/IP protocol stack which gives an access for the microcontroller to a Wifi network. It is mostly used for various IoT applications.

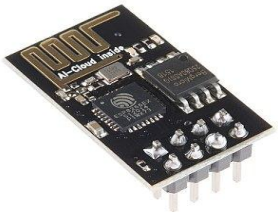

Fig -8: ESP8266 Wifi Module

4.2 Software needed

1) Arduino IDE: It is free source Arduino software that helps to write codes and program Arduino board. This software is compatible with any type of Arduino board.

4.3 Web platforms needed

1) Thingspeak: It is a free source that uses HTTP protocol to store or retrieve data from things. The information can be used for further analysis in IoT application.

2) MIT app inventor: It is a web application that allows the developer to create application software for operating systems. It is easy to build fully functional apps as it uses block- based programming.

5. CONCLUSION

Food wastage is one of the crucial crises in the world. One of the main reasons of food wastage is improper warehouse management and this is a solvable problem to an extent with the current technological advancement. Over referring to different researches and solutions to this problem, we have come to a realization that the field of IoT can provide a very efficient solution to this problem. Therefore, we have discussed a food quality monitoring system based on IoT that will control different environmental factors such as light intensity, humidity and temperature that are necessary to be maintained at a threshold value to prevent the food from spoilage. It also provides a user interface through an app where they can monitor the light intensity se parameters and at the same time get alerts when the food is spoiled or if there is a fire hazard.

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