Radio-Frequency pH-Sensing Model to Analyze the Quality of Food Material

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Abstract: Food safety is the first parameter needed to achieve the global health goal. So it is very essential that the quality of food material must be maintained. This research presents a new method, suitable for food quality control by monitoring pH level changes in various food with a flexible pH sensor which is embedded in a radio-frequency (RF) transponder. The pH sensing system is designed to achieve convenient, long-term, and on-demand monitoring of food quality, especially for large-quantity applications and continuous monitoring from place of production to retail stores. This model is used to compare and analyze different food material which is beneficial to maintain the quality of material.

Index terms : Food quality, pH Sensor, Radio frequency (RF)

1. Introduction

Food quality is an important manufacturing requirement for consumer to maintain the safety of the food material. Current methods to monitor the quality of food during the transit and storage process are to use temperature sensors, enzyme sensors, or gas sensors. However, these sensors have unavoidable drawbacks, such as low sensing accuracy in moist environments, high operating temperatures, complicated designing processes, and several design issues, which prohibit a wireless integration. These factors reduce the cost-effectiveness and feasibility of their use in commercial applications.

An alternative technique is used to manage food quality, which monitors the change of pH levels of the food products. pH is essentially the measurement of the hydrogen ion concentration and is usually expressed in the logarithmic scale. A pH sensor consists of two electrodes which provide a linear potential response over a wide range of pH values. During the food spoilage process, the pH value changes due to the growth of microbes and metabolic activities.
actions of microbes [1]. The pH level can therefore provide an accurate indication of the freshness of the product. This device has three main components, which will include the pH sensor, two resonator circuits, and the transceiver. The wireless sensor tag includes a flexible pH sensor based on miniature iridium oxide and silver chloride (AgCl) sensing electrodes integrated on a deformable substrate, and wireless communication circuit.[1]

2. Objective of Research

The objective of this project has been design and fabricate a pH sensing device which can be embedded into packaged material. The research work is carried out to design the model to study the various condition of sample food material and analyze the different performance parameter of the material under testing. This work is used to achieve the quality testing by monitoring the sample food material.

3. Experimental Setup

In this research, the pH sensor system is developed that provides a direct and convenient means to monitor food quality, to address food safety and waste issues of the food material. The pH sensor is connected with microcontroller, which record the signals from system sensor. The sensing device is placed in the food material to sense the pH level. The pH value of food material under test is recorded and sent through zigbee transceiver to the computer based system. The database of the pH value of the testing material is created which is useful for assessing quality of food, which may be used by various manufacture.

The display unit display the pH value of food material under test.

Fig1: Block diagram of Basic pH sensing system

3.1 System Configuration

The pH sensing device operates in a rage of 4-7 pH and have a ± 0.3 pH accuracy which
may vary depending on the sample food material. To determine the accuracy, the output pH value of the sensor will be compared with commercial pH sensor. The device is designed using pH detector, two controlling circuits, and a transceiver and receiver.

### 3.1.1 Transmitter Section

The device is magnetically coupled to an external source, where the desired frequency of one of the resonator circuits is proportional to the pH of the material. The change of pH values varies the potential across a set of electrodes integrated into the resonator circuit. The response of the device is measured by a network analyzer.

The hardware setup is designed by using measurement panel, sensing panel, and control panel and display unit.

A pH measurement loop is designed using the pH sensor, which includes a measuring electrode, a temperature sensor and reference electrode; a preamplifier; and transmitter.

The reference electrode is used to provides a stable potential against which the measuring electrode can be compared.

The humidity sensor is made of a film usually made of either glass or ceramics. The material which is generally insulator absorbs the water is made out of a polymer which takes in and releases water based on the relative humidity of the given area. This phenomenon is used to changes the level of charge in the capacitor on board electrical circuit. These modules convert the relative humidity to the output voltage.

![Fig 2: Transmitter Section](image)

![Fig 3: Experimental Setup](image)

### 3.2. Experimental Setup

### 3.3. Experimental Result

**Table 1:** pH Value (by Experimental Setup)
### Table 2: pH Value (comparative pH value)

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Products</th>
<th>pH Value (by meter)</th>
<th>pH Value (std)</th>
<th>pH Value (by project)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Curd</td>
<td>43</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Milk</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Jaljira</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Rasna</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Coke</td>
<td>3</td>
<td>3.4</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Water</td>
<td>7</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>Mixture of Dhokla</td>
<td>4</td>
<td>4.6</td>
<td>4</td>
</tr>
</tbody>
</table>

**5. Research highlights**

1. Detection of infection in food material is the emerging need of the society.

2. This research analyze the different form of food material like solid, liquid and in the powder form also.

3. Performance parameters like temperature and humidity of the sample change at the different span of time of day.

4. Depending on the life time of material, there is regeneration of infection can occurs.

5. Detection and extraction of impurities of testing material is analyzed.

**6. Conclusion**

The Radio-Frequency pH-Sensing Tag for Food-Quality Monitoring overcome the disadvantage by using zigbee module which is use for serial communication of data obtained by testing of food and organized acquisition of data and their meaningful display.

This research work is used to design the system to study the sample food material.
The sample food material is checked under the different atmospheric condition. The impurity is added in the testing material is analyze at the different interval of time of a day by the monitoring pH value. The variation in the performance parameters like temperature and humidity is recorded.

7. Future Scope

As the food safety is prime requirement of society, so portable and cheaper system is require to test the quality of food material.

8. References