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Smart Plate for the Detection of Quality of Food

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Abstract— Extensive research to tackle the issue of food poisoning and reduce the damage to unwary consumers has given rise to innovative devices. The use of chemical, optical and electrical sensors to determine the staleness of food has proven to be a boon to consumers of packaged foods. In this project, we attempt to develop a smart sensor plate that can detect the freshness of household food items like dairy, meat and cooked items.

Keywords— *pH sensor, Optical sensor, Moisture sensor*

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I. INTRODUCTION

Food poisoning has been the source of innumerable diseases and illnesses over the years. Unwary consumption of stale food results in ill health. In a country like India, where majority of the population struggles for their daily bread, efficient preservation of existing food resources is critical. The great amount of money spent on diagnosis and treatment of diseases is also a cause for concern. The need of the hour is to develop an efficient method to reduce the consumption of spoilt food. Extensive research to tackle the issue of food poisoning and reduce the damage to unwary consumers has given rise to innovative devices. The use of chemical, optical and electrical sensors to determine the staleness of food has proved to be a boon to consumers of packaged foods. In this project, we attempt to develop a smart sensor plate that can detect the freshness of household food items like dairy, meat and cooked items. Smart Plateis a flat plate consisting of a variety of sensors that are activated depending on the food item. This plate can be placed in any utensil and a panel can be used to select the type of food item. Further functionalities can be implemented into this device with the integration with smart phones. A mobile app can be designed specifically to receive data from the Smart Plate to generate advance warnings regarding the status of the food item.

In today's world, we see a number of individuals suffering from food borne illnesses due to the consumption of stale food. The labels found on packaged food and other food materials with the expiry date of the food printed on it does not serve as an accurate method to identify the quality of food.

Sometimes, the food remains fresh even after the expiry date if it is maintained and controlled effectively. Thus, by proper maintenance and monitoring the shelf life is improved. Other times, the food can lose its freshness before the mentioned expiry date. This leads to the consumption of stale food which poses a threat to human health.

Accounting for the above mentioned factors, we aim to design a smart plate with sensors that detect the freshness of everyday food. The smart plate can be fit into any household utensil and can sense and detect the quality of the food placed in the utensil.

Very encouraging results have been obtained in the past in the area of food quality management by using sensors to detect spoilage. The application of an LC sensor for monitoring the moisture content inside packaged cereals has been demonstrated efficiently [7]. A wireless pH sensing system was tested for in situ monitoring of the spoilage processes in fish meats continuously for over 18hours [6]. A quality assessment to food and beverages that included determination of freshness and identification of spoilage, polluted, contaminated, unhygienic or adulteration in the food was made with the application of electronic noses [3]. The implementation of Quartz Crystal Microbalance (QCM) based biosensor for the detection of various analysts in food systems has been successfully carried out [1]. Quantitative color information from the release of spoilage products, typically amines, was detected by a colorimetric sensor to determine the quality of the food [8].

In this paper, we make use of a Moisture sensor to detect the humidity level of the food item, a pH sensor to monitor the change of pH level in dairy products and an optical sensor to detect the amount of biochemical such as amines released by meat based products.

II. METHODOLOGY

The parameters to be analyzed are pH, Moisture and amount of Amines present in the food item. For dairy items like milk and cream, pH is the most crucial parameter that determines freshness. Sour milk or cream displays a lower pH value than fresh good-quality milk or cream. The amount of moisture in the air can be used to determine the freshness of fried and baked items like chips and biscuits. When the moisture content increases, it is indicative of stale food. Meats items like chicken and fish release complex amines when spoilt. The level of amines can determine the freshness of meat.

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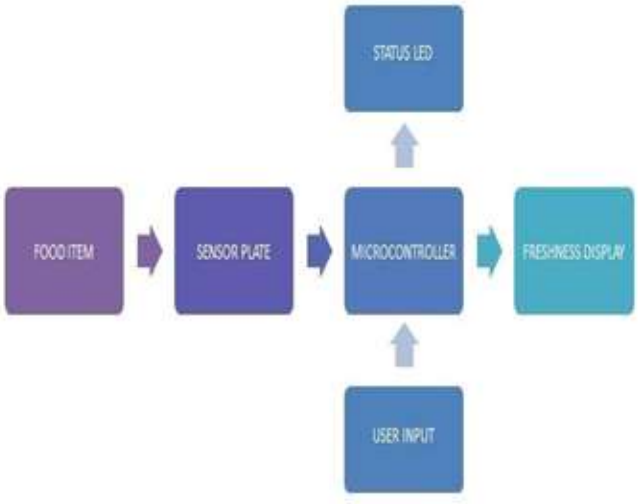

Figure 1. Block diagram for the Smart Plate for Detection of food quality.

The food item to be analyzed is placed in a utensil. The Smart Plate can be placed inside the vessel after making the required settings. The sensor plate contains an array of sensors that are activated depending on the food item. The sensors determine the quality of the food item.

The user input is a keypad or a java-based android application that can be used to turn on the Smart Plate and specify the food item. It also starts a timer that contributes in the overall decision making process. The app is used to provide connectivity with the smart plate via Bluetooth and is used to select the type of food item whose quality needs to be checked. Depending on the food item selected, the smart plate activates the particular sensor for testing.

The microcontroller receives the user input which specifies the type of food to be tested. It also receives the input from the sensor plate and determines the freshness or staleness level of the food based on a pre-defined algorithm.

Red and green LEDs indicate when the food is good and when it is bad. The freshness level of the food item is indicated using a user friendly display. Through this information, the consumer can determine whether it is fit for consumption.

III. SENSORS USED

A. pH Sensor

The pH of a solution indicates how acidic or basic (alkaline) it is. The pH term translates the values of the hydrogen ion concentration, which ordinarily ranges between about 1 and 10 x -14 gram-equivalents per litre - into numbers between 0 and 14. A pH measurement loop is made up of three components, the pH sensor, which includes a measuring electrode, a reference electrode, and a temperature sensor; a preamplifier; and an analyzer or transmitter. A pH measurement loop is essentially a battery where the positive terminal is the measuring electrode and the negative terminal is the reference electrode. The measuring electrode, which is sensitive to the hydrogen ion, develops a potential (voltage) directly related to the hydrogen ion concentration of the solution. The reference electrode provides a stable potential against which the measuring electrode can be compared.

B. Moisture Sensor

Most moisture sensors are designed to estimate volumetric water content based on the dielectric constant of air. The dielectric constant can be thought of as the air's ability to transmit electricity. The dielectric constant of air increases as the water content of the air increases. This response is due to the fact that the dielectric constant of water is much larger than air. Thus, measurement of the dielectric constant gives a predictable estimation of water content.

C. Optical Sensor

Several techniques exist to detect the amount of amines in a substance. Biosensors, electrochemical sensors and piezo crystal sensors are widely used for the detection of gaseous amines. For the detection of amines in food items however, optical sensors [8] are the best option. Optical sensors are based on the pH indicator Bromocresol green, adsorbed onto a silica sphere matrix. When the amines adsorb onto the matrix, the colour changes from orange to blue. The colour change is detected with a fiber optic spectrometer.

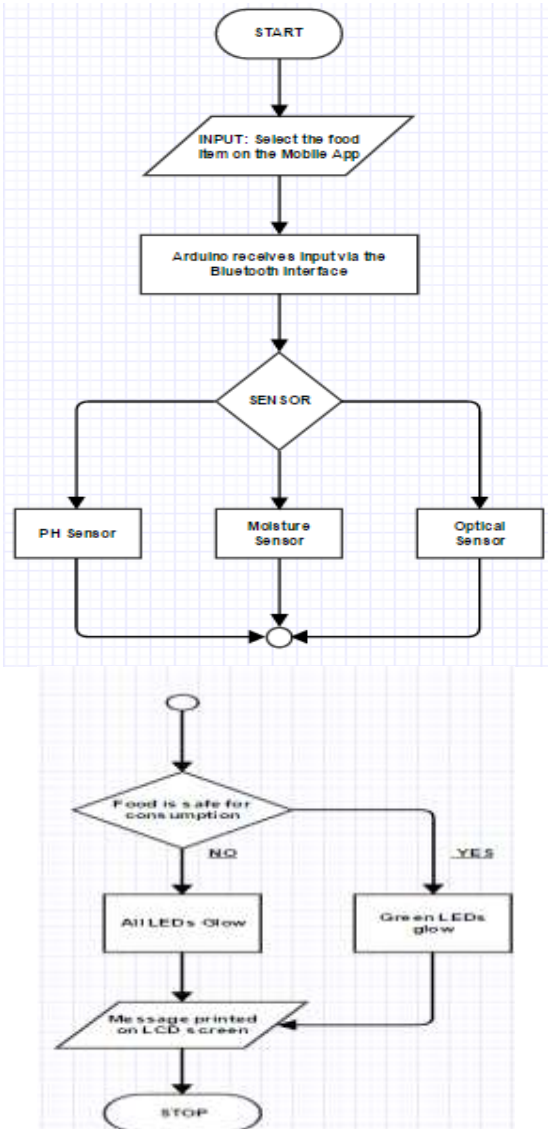

Figure 2. Flow chart for the process of food detection using Smart Plate

IV. RESULTS

Smart Plate for the detection of food quality is designed to ensure quality of the food used by the consumers, and improve their health.

The sensor plate is able to detect spoilage of common household items like dairy, meats and fried items. The display system accurately displays the freshness level of the food, enabling consumers to be well aware of the quality of food. This design is simple, effective, feasible and cost effective.

V. CONCLUSION

The rising cases of food poisoning calls for an effective technique to alert unwary consumers of spoilt or stale food items. This ultimately leads to lesser ailments and low expenditure in terms of diagnosis and treatments. The Smart Plate provides a direct and convenient means to monitor produce/food quality to address food safety and waste issues. The Smart Plate is designed such that it can be fitted into any common household utensil, hence increasing its feasibility. It also consists of an array of sensors, enabling it to be used for multiple food items. The system ultimately alerts consumers regarding the status of their food item accurately and conveniently. The integration of a specially developed mobile app enables users to track the status of food items at their homes wirelessly. The design is compact and can be built efficiently using low cost components. A cheap and efficient design enables the Smart Plate to be affordable for all sections of the society.

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