Fruit Quality Monitoring System Using the Smart RFID Tag

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Abstract. Difficult to outwardly judge the state of the fruit, it is directly related to consumer health. Therefore, the consumer can monitor the status of the fruit that is very important. So we monitor the status of the fruit by the loss of Vitamin C, and temperature is the most important in prolonging the shelf life of the products. Therefore, monitoring temperature variability during transport and storage is very important. In this paper, we propose the fruit quality monitoring system using the smart RFID tag. The proposed system consists of server, reader, RFID tag, sensor interface, temperature sensor. In order to verify the effectiveness of the proposed system, we performed experiments on the strawberry juice. Strawberry may be considered among the fruit most rich in Vitamin C. The temperature is taken by the sensor and reported through MFC software. The experimental results show that was confirmed the performance of the fruit quality monitoring system.

Keywords: Smart RFID tag, Temperature Sensor, MFC, Fruit Quality Monitoring.

1 Introduction

Fruit is delivered to the end customer in an excellent and fresh condition is really important. The required system should control and monitor the fruit conditions in order to ensure quality for consumers and to comply with all legal requirements. Each group of consumers requires different status such as in retail or institution, hospital, school, etc. Among environmental parameters during transport and storage, temperature is the most important factor in prolonging the shelf life of the fruit. Radio Frequency Identification (RFID) has resulted in a wide variety of applications in food industry [1].

In this paper, we propose the fruit quality monitoring system using the smart RFID tag, in order to consumer health. This system consists of server, reader, RFID tag, sensor interface, temperature sensor. In order to verify the effectiveness of the proposed system, we performed experiments on the strawberry juice. Strawberry may be considered among the fruit most rich in Vitamin C. The proposed system, temperature is taken by sensor connect to RFID tag, it is read by Speedway Revolution UHF RFID reader. Kinetic modeling method is applied in order to verify

status of vitamin C left, five fruit statuses are reported on server computer by MFC software.

2 Proposed Fruit Monitoring System

2.1 System Overview

The system consist of smart RFID tag and reader connected to server computer, each part of fruit is attached temperature sensor, it was read by reader 900Mhz Speedway R420. Five fruit statuses are very bad, bad, normal, good and very good reported on server computer through MFC software. Operator can know percentage vitamin C left and fruit status, therefore warehouse can make delivery plan to consumer. The system overview is shown in Fig. 1.

Fig. 1. Fruit monitoring system overview

2.2 Built Sensor Tags and RFID Reader

The RFID sensor tag block diagram is shown Fig. 2. An antenna 900 MHz and impedance matching circuit precede the analog front end. The power harvester block rectifies incoming RF into DC voltage to supply for the system. The demodulator follows the envelope of the RF carrier wave to extract Amplitude Shift Keyed (ASK) [2]. It is read by MSP430 microcontroller (MCU) to receive downlink data from the reader. Uplink data is sent through modulator circuit (FSK) [3], detail of fabricated RFID tag is shown in Fig. 3.

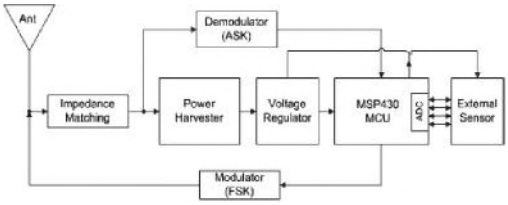

Fig. 2. RFID sensor tag block diagram

Fig. 3. Fabricated RFID sensor tag

The reader Speedway revolution UHF RFID reader used in the monitoring. By running Speedway connect on the reader and configuring it to export tag reads over TCP/IP port [4].

2.3 Proposed Kinetic Modeling Method

The Kinetic modeling method is applied in order to verify Vitamin C left in food. Vitamin C loss was found to be described by the equation (1).

$$= 0^{-} \quad (1)$$

Where C and C_0 are the concentration of vitamin C at time t and zero. k is the apparent reaction rate of vitamin C loss.
The reaction rate is affected by temperature follow equation (2) below

$$= \exp[- \quad \sim^{1} - {}_{1} \quad \sim] \quad (2)$$

Where is the reaction rate of the vitamin C oxidation at a reference temperature , Ea is the activation energy of the chemical reaction and R is the universal gas constant [5].

In order to verify kinetic modeling method, data of strawberry juice stored at different temperature is referenced [6]. Degradation parameters of vitamin C are shown in Table 1.

Table 1. Degradation parameters of vitamin C obtained by Weibullian model

Temperature	b($^{-1}$)	r
5	0.0278	0.993
10	0.0480	0.994
25	0.1982	0.981

2.4 MFC Interface Design

Interface software based on Microsoft Foundation Classes (MFC), temperature average is calculate in set time period, vitamin lose percentage is measured by kinetic method. The software flowchart is shown in Fig. 4. Interface is designed for convenient operation, in main screen, temperature value, food status and vitamin C percentage left is displayed like Fig. 5. Five fruit conditions are inputted by other tab on interface screen.

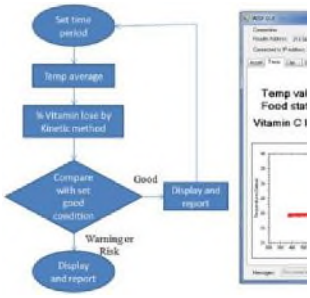

Fig. 4. Interface software flowchart

Fig. 5. The main screen

monitoring system

3 Experiment and Discussion

In order to verify proposed system, strawberry juice was used as fruit juice object, the system was set up Fig. 6. The experiment had been implemented for 15 days.

Basic temperature was kept at 5°C. The 3rd day temperature had changed to 25°C for 24 hours. The 8th day temperature had changed to 10°C, and 14th day temperature was 25°C. Result is shown at Fig. 7, when temperature increase the percentage vitamin C left decrease rapidly, at 4th day C/Co decrease about 16%, the monitoring system change from very good status to good status only. At 12th day status from normal to warning bad, 14th day temperature reach 25°C strawberry juice became very bad, risk report at the monitoring system.

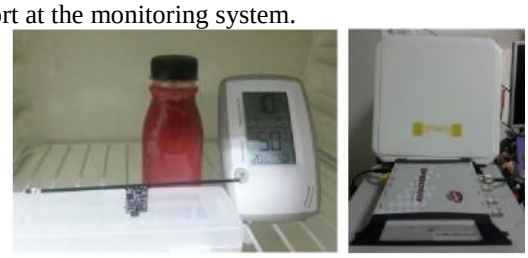

Fig. 6. System implementation

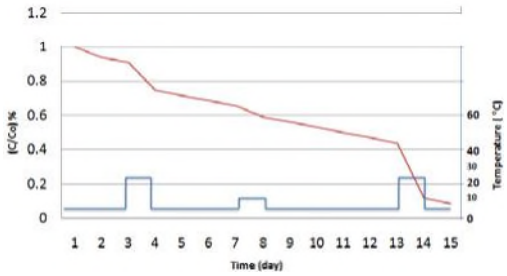

Fig. 7. Percentage vitamin left depend on temperature and time

4 Conclusion

We proposed smart RFID fruit monitoring system in order to provide safe and high quality fruit. Current temperature and fruit vitamin C left are measured and reported to monitoring center. Therefore, warehouse can control temperature suitably and make delivery plan to reach individual customer requirements.

In order to verify effectiveness of the proposed system, we performed experiments on the strawberry juice. The strawberry juice had been tested for 15 days in case of temperature changing from 5°C to 25°C. The temperature was transmitted to server well, percentage vitamin left was calculated by kinetic method, and the strawberry status was display on server PC. The proposed system confirmed usefulness through experiments. This system can apply for any fruit or food. We used strawberry as the object for experiment because of strawberry juice database from other food paper.

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