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Optimization of QR code readability in movement state using response surface methodology for implementing continuous chain traceability

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ABSTRACT

Logistics and storage is the main processing for agro-food supply chain. Because of disconnection information between the two processing, it is difficult to trace continuously. An intelligent conveyer belt provides an effective method to associate storage and logistics by QR code scanning and information recording. Improving the QR code readability in movement state is the core of implementing continuous chain traceability with this belt. In this paper, a intelligent conveyer belt including automatic conveyer unit, barcode scanning unit, fault remove unit and control display unit was designed. Four factors affected QR readability were selected and the value range was confirmed, which was reading distance, code size, coded characters and belt moving speed. Based on the belt, an Central Composite Inscribed (CCI) experiment of four factors with five levels was designed using Response Surface Methodology (RSM) to obtain the optimal reading parameters. The result shows that the main factors of reading distance, belt moving speed and the interaction between reading distance and code size have the significant effect on QR code readability. Under the optimization condition of 141.45 mm reading distance, 34.58 mm code size, 100 bytes coded characters and 2.98 m/min belt moving speed, the average value of QR code readability was 95%. With the optimization parameters, the intelligent conveyer belt was used in an apple marketing enterprise. The result shows that the continuous traceability between storage and logistic can be implemented with the extended breadth, deepened depth and improved precision.

1. Introduction

Traceability is an effective method to ensure food safety and quality and to reduce the costs associated with recalls (Regattieri et al., 2007; Yang et al., 2016). In the last three decades, some astounding events, such as the BSE crisis and the problems posed by foods ingredients from genetically modified (GM) crops, have strongly focused attention on the topic of agro-food traceability (Bertolini et al., 2006). The ISO 22005:2007 food traceability standard requires that each company knows both its suppliers and customers, based on the principle of one-up and one-down (International Organization for Standardization, 2007).

To achieve traceability, traceable unit identification and information record are very important. Identification technologies such as barcode and Radio Frequency Identification (RFID) as distinguishing traceable units method can be integrated into a supply chain system (Cunha et al., 2010; Ruiz-Garcia and Lunadei, 2011). Ampatzidis et al. (2009) evaluated using RFID and barcode technologies in manual fruit harvesting to improve traceability. A platform for livestock management was also formulated by deploying mobile computing, RFID technology and wireless/mobile networking (Voulodimos et al., 2010). With the development of mobile communication technology, the information collecting and uploading time using portable devices (mobile phone, PDA, tablet PC) has become an effective means for farming operation information collection (So-In et al., 2014; Qian et al., 2015). Steinberger et al. (2009) developed mobile farming information collection equipment that transmitted the information to the server through the internet.

Under the framework of from farm to table, it including many supply chain nodes, such as product, storage, logistic and sale. In the inner of supply chain enterprise, it is convenient to trace continuously through traceable unit identification and information record. For example, Qian et al. (2012) describe a study with a primary goal to develop a Wheat Flour Milling Traceability System

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