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Improving continuous traceability of food stuff by using barcode-RFID bidirectional transformation equipment: Two field experiments

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ABSTRACT

Radio frequency identification (RFID) and quick response (QR) codes are an effective way to identify traceable resource units (TRUs) and are widely applied in traceability systems. TRU transformation is common for things such as beef segmentation and wheat-flour packaging. The present study describes the development and testing of equipment for barcode-RFID bidirectional transformation to improve traceability by conserving identification association and information correspondence while transforming barcodes to RFID and vice versa. The framework of traceable bidirectional identification labels is based on comparing the features of RFID and barcodes and on analyzing TRU transformation. The proposed equipment includes a tactile industrial controller, a RFID-reader module, an embedded printing module, and a barcode scanning module. Furthermore, we develop the main functions of RFID-barcode conversion, bar-code-RFID conversion, and condition monitoring. The system is tested in field experiments based on two typical scenarios: beef segmentation and wheat-flour packaging. The average conversion success rate in RFID-barcode processing is 97%, and in barcode-RFID processing is 93.48%. The proposed equipment is more rapid than the reference method: 3.2 versus 8.7 s for RFID-barcode transformation and 10.5 versus 13.3 s for barcode-RFID transformation. In addition, the proposed equipment is less expensive than the conventional equipment. Test results indicate that continuous traceability is improved because identification association and information correspondence are conserved after TRU transformation.

With ever more attention being devoted to food safety, traceability is looked to as an effective method to ensure food safety and quality and to reduce the costs associated with recalls (Regattieri, Gamberi, & Manzini, 2007). Traceability is defined in international standards, legislation, and even in dictionaries (Badia-Melis, Mishra, & Ruiz-García, 2015). The ISO 22005:2007 food traceability standard requires that every company knows both its suppliers and customers, as per the one-up, one-down principle (International Organization for Standardization, 2006). The General Food Law, i.e., Regulation (EC) 178 of the European Parliament and the Council published on 28 January 2002, outlines the general principles and requirements of food law, establishes the European Food Safety Authority, and provides procedures in matter of food safety (e.g., the implementation traceability systems in the food and feed supply chains in Europe) (Stranieri, Cavaliere, & Banterle, 2017).

As the foundation to implement a traceability system, traceable resource units (TRUs) must be defined (Dabbene & Gay, 2011). A TRU must be uniquely identifiable and consistent with information on record, which follows every TRU along the supply chain (Olsen & Borit, 2013). Generally, three types of TRUs exist: batch, trade unit, and logistical unit (Aung & Chang, 2014). A batch is a quantity that goes through the same processes. A trade unit is a unit sent from one company to the next in a supply chain. A logistical unit is a type of trade unit and designates the grouping created by a business before transportation or storage (Karlsen, Donnelly, & Olsen, 2011). To distinguish different TRUs, different identification technologies exist, such as barcode and radio frequency identification (RFID) (Cunha et al., 2010; Ruiz-Garcia & Lunadei, 2011). Due to their low cost and ease of use, barcodes are have become widely used in retail in the last 30 years to facilitate inventory control, stock recording, and checkout (Ghaani, Cozzolino, Castelli, & Farris, 2016). With data transfer moving to wireless electromagnetic systems, RFID has been increasingly adopted

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