Traceability of Agricultural Products Based on Individual Identification Using Image Recognition

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Abstract

One of the methods used to identify individual articles of product for implementing traceability is to use barcodes or IC tags, but this method is accompanied by problems related to costs, misrepresentations and the difficulty in attaching tags to certain kinds of products. This paper introduces an image recognition technique that can identify individual articles using a single picture of products with a slight difference between individual articles, such as agricultural products. For example, the stripe patterns of individual muskmelons are different even when the breed is identical, so that when a picture of each melon is taken before shipment, the place of origin and sorting results of each muskmelon can be identified by collating them with the picture shot in the distribution stage. As this method can match actual articles of product without using tags, it is also expected to become a countermeasure against misrepresentation and replacement with fake products.

Keywords

individual identification, traceability, tag-free, image recognition, agricultural product
FAR (False Acceptance Rate), FRR (False Reject Rate)

1. Introduction

The most important action for the management of product quality from production to storage and distribution and for the improvement of management efficiency is to record the history of individual articles of product to enable surveys, i.e. to establish the traceability of products.

One of the most generally used methods for identifying individual products is to attach a barcode or IC tag to each article of product. However, this method involves many problems including the cost of the tags and the work attaching them, the presence of certain products that are hard to attach tags to due to their material, design or sanitary considerations and the risks of misrepresentation and replacement with fake products. There are also some products to which tagging-based management is hard to apply. To enable management of products which are unsuitable for tagging with ICT (Information and Communication Technology), we are studying an individual identification solution applying image recognition technology.

1.1 Individual Identification for Traceability

With industrial products that can be marked easily with serial number stamping, it is a matter of course to record the history of individual articles and use this history as the basic data for dealing with complaints and improving production efficiency and quality. Meanwhile, management of agricultural products at an individual level is not advanced in spite of serial risks to safety.

Previously, consumers did not have a strong will or consciousness about confirming the nature of marketed agricultural products. In addition, since agricultural products are mass-produced at relatively low cost, the burden of the management costs incurred by tagging was significant for the producers. Due to these issues, dissemination of strict traceability has been delayed among agricultural products except for those prescribed by law, such as beef, and certain branded products. However, the establishment of traceability for agricultural products is now strongly requested due to repeated food accidents, revelations of serious food frauds, expansion of exports and the rise in consumers' consciousness of quality.

1.2 Tag–free Individual Identification Using Image Recognition

To disseminate and expand the traceability of agricultural products, it is desirable to use an individual identification

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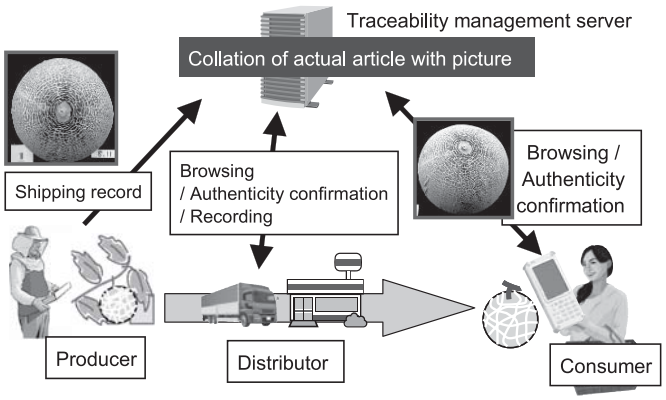

Fig. 1 Agricultural product traceability system based on individual identification using images.

technique that enables easy confirmation of the history and authenticity of articles at low cost. This paper introduces an image recognition technique that can identify an individual article from a single picture of the external appearance (skin pattern) of an agricultural product. For instance, the stripe pattern of a muskmelon varies between individual articles even when they are of the same breed. If a cloud service that takes a picture of each article before shipment and collates this with the distribution process can be provided as shown in **Fig. 1** , it is possible to confirm the place of origin and sorting result of the article regardless of the person who buys it or the place where it is sold. At this time, the picture is collated with the actual article so that misrepresentation and replacement with fake products can be prevented without using excessive counter-fraud tags. When individual identification becomes possible with a camera of the class used in popular mobile phones, it will be possible for ordinary consumers to confirm articles themselves. This is expected to bring marketing effects for producers because it can improve consumers' confidence in a product's appeal while adding value to the product.

2. Individual Identification Experiment on Nearly 1,800 Muskmelons

We evaluated the identification performance of the proposed technique. As shown in Fig. 1, the experiment assumed that the muskmelon farmer registered a picture of each muskmelon before shipping and that the consumer collated a picture shot with his or her mobile phone with the registered picture. Since camera-holding poses vary at the time of registration and collation, and also a certain period will have passed between registration and collation for transportation, etc., the collation is executed by considering possible changes in the appearance of the muskmelon.

In this experiment, we prepared 1,776 muskmelons, shot their registration images with a digital camera, shot collation images with the built-in camera of a mobile phone a few days later and compiled separate databases for each kind of image. In each case there was a difference in pose of about 20 degrees between the registered and collated images.

Individual identification performance can be evaluated using a pair of evaluation values: the FAR (False Accept Rate: the rate of falsely judging pictures of two different individuals to be those of a single individual) and the FRR (False Reject Rate: the rate of falsely judging the pictures of a single individual to be those of different individuals). The FAR can be regarded as an evaluation scale related to the prevention of misrepresentation and the number of identifiable individual articles and the FRR as an evaluation scale related to convenience. Increasing the severity of judgment reduces the FAR (or the probability of overlooking misrepresentations) but increases the FRR (or the probability of judging an authentic article to be a misrepresented article). The FAR and FRR are in a trade-off relationship as shown here and it is important to reduce both of them at the same time.

In this experiment, the technique newly developed by us achieved an extremely high identification performance with an FRR (the rate of authentication failures) of 0.2% even when misrepresentations and frauds are prevented powerfully with a FAR (the probability of overlooking misrepresentations and false articles) of 0.0001%.

3. Conclusion

This paper has introduced a tag-free individual identification technique using image recognition as a technique for the management of products to which it is hard to attach tags for the individual identification required for traceability. As an example of its application, we also summarized a technique for individually identifying fruits based on their skin patterns. This technique can be used to implement a low-cost, highly convenient traceability system that can identify individual articles by simply taking a picture of each article. Collation of the actual products is also expected to prevent frauds such as misrepresentation of tags or replacement with fake products.

Since the shipping inspection of fruits (sorting by sugar

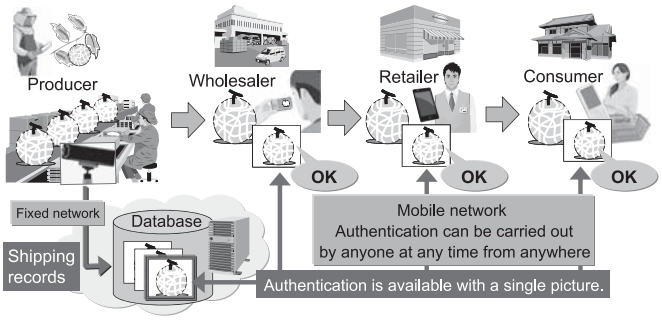

Fig. 2 Individual identification solution using an M2M network.

content, grading, etc.) has already been automated using optical sensors, it will be easy to take pictures of shipped fruits automatically. With an M2M cloud-based service for enabling collation of the pictures shot in the distribution process with the original pictures, users can collate the fruits easily using the built-in cameras of their mobile phones regardless of the destinations to which the shipped fruits are distributed (**Fig. 2**). Such a service is expected to contribute to improving the added values of agricultural products by preventing frauds in the entire market and implementing safe, reliable traceability. In fact, it demonstrated an extremely high identification performance in an experiment using nearly 1,800 muskmelons.

In the future, we will advance efforts toward the practical implementation and expansion of applications of individual identification using recognition by conducting demonstrative experiments involving larger scales of data and developing techniques applicable to other kinds of products.

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