

Use of Individual Identification Based on the Fingerprint of Things Recognition Technology

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Abstract

One of the key technologies of "NEC the WISE", the leading AI technologies of NEC Corporation, is a group of technologies known as the "Fingerprint of Things" recognition technology that can identify individual objects based on the fine patterns that appear on the surfaces of industrial products and parts during their production processes. It thereby enables the individual identification of various objects that do not access traditional processing such as the attaching of ID tags or laser markings. NEC started the provision of the individual ID function based on the Fingerprint of Things technology in October 2016 under the name of GAZIRU Individual Identification Service, which is currently available via on-premise implementation in the GAZIRU Individual Identification Engine. The present paper introduces actual cases that use the individual ID function.

Keywords



Fingerprint of Things, image recognition, individual identification, traceability, quality improvement

1. Introduction

Globalization of manufacturing and logistics of enterprises have increased the importance of optimum management and quality assurance of merchandise more than ever. NEC is promoting management based exclusively on products and parts themselves by using the "Fingerprint of Things" recognition technology¹⁾, without relying on other means such as the merchandise management barcodes, RFID tags or special processing. The present paper introduces the Individual ID information Management Solution that ably demonstrates traceability at the individual object level at manufacturing sites. Some examples of its use in the secondary distribution market are also introduced.

2. Individual ID Function of the Fingerprint of Things Recognition Technology

The Fingerprint of Things recognition technology identifies individual products and parts by capturing the image of individual object-specific surface patterns that are produced spontaneously in the air manufacturing

process (Fingerprint of Things) and by registering and matching the images. Each Fingerprint of Things has unique characteristics proper to the product or part, even with precision-cut machine parts or parts manufactured using the same mold (**Fig. 1**). As a result, even

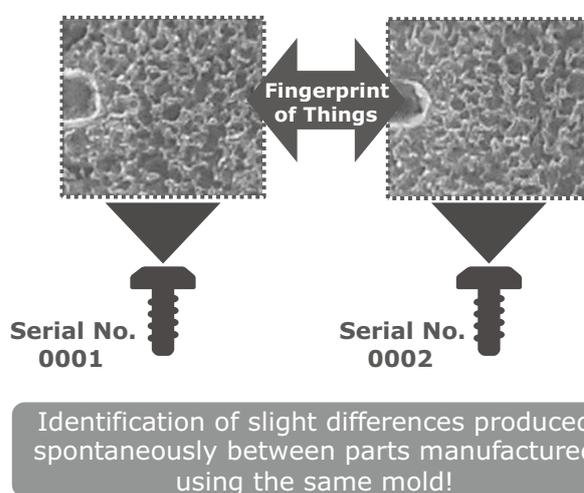


Fig. 1 Fingerprint of Things recognition technology.

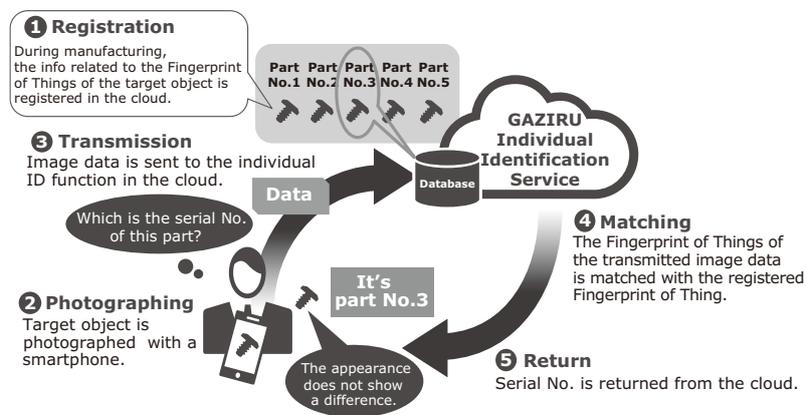


Fig. 2 Usage of individual ID function (example with a cloud service).

with parts that cannot be tagged or given the surface marking for identification, such as micro parts, capturing the images of their Fingerprint of Things with a camera under appropriate lighting conditions, it is possible to identify each individual part. (In NEC's verification environment for 1000 bolts manufactured using the same mold, it has been confirmed that $1,000 \times 1,000 =$ one million times of matching succeeded in achieving no matching mistakes).

This procedure is not limited to industrial objects such as metallic parts, the Fingerprint of Things technology is also capable of identifying individual printed matter and leather products provided that their shapes do not change much due to little aging.

NEC provides the individual identification function based on the Fingerprint of Things as the GAZIRU Individual Identification²⁾, which is available in two forms, the cloud-based individual identification service and the on-premise implemented individual identification engine. **Fig. 2** depicts an outline of usage of an individual ID function by taking the GAZIRU Individual Identification service as an example. The user can use the GAZIRU individual identification from a user-created application via the application interface (web API). The Fingerprint of Things of an object to be managed is photographed using a camera connected to a smartphone or computer running the application and the image is registered in the database in advance. It will then be possible to check later if an object of a similar type is already registered in the database by matching the image of the Fingerprint of Things of the object.

3. Examples of the Use of Individual ID Function

This section introduces examples of use of the individual ID function.

3.1 Individual ID information management solution for the manufacturing industry

(1) Background of development

Recently, critical incidents caused by the quality of products have been exerting serious effects on consumers as well as on enterprises. Quality management has now become a social requirement for any enterprise.

Consequently, many enterprises have begun efforts for subdividing the management and analyses of various data related to production as a measure to deal with quality issues. If an issue is found with a product, it is required to determine its cause by checking and analyzing the production data early on. In fact, however, even when the data is collected, it is often hard to link the data to the process causing the trouble. For example, when the quality is inspected by temporary stocking or sampling during the manufacturing process because of the characteristics of the production line, it is very difficult to track the production process of each individual article. If the production data management was possible only per lot, the cause of trouble would not be instantaneously determinable or the whole lot should be disposed of for safety, in which case the cost of cause determination would be huge or the productivity would deteriorate due to massive disposals.

Based on the background described above, NEC has developed the Individual Identification Information Solution that makes possible product management at the individual piece level.

(2) Traceability in the production process

The QR code, barcode or IC tag are usually used to manage products and parts at the individual level.

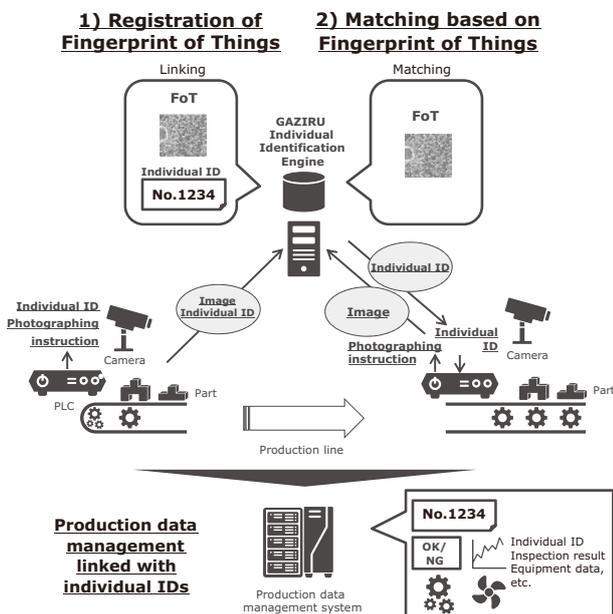


Fig. 3 Flow of Individual Identification Information Management Solution.

There are however cases in which attaching code or tag is difficult due to the size or shape of the part, or in which printing on the surface is impossible due to the characteristics of the product, or from the viewpoint of proper quality management.

As the Fingerprint of Things technology identifies individual items from their images, it is capable of identifying individual items whenever an image necessary for collecting the Fingerprint of Things can be obtained from even a small portion of a part. As a result, this technology offers some advantages including little restrictions on the selection of the identified position (which corresponds to the printing position of the barcode). There is no need of reevaluating the quality inspection process because the processing or contact are not necessary for individual identification.

The Individual Identification Information Solution manages individual IDs based on the Fingerprint of Things, thereby making it possible to store identified data into the core data management system together with production data and achieves traceability at the individual level. The flow of this solution is explained in the following figure (Fig. 3).

1) Registration of Fingerprint of Things

Interfacing with the production line uses the PLC (Programmable Logic Controller) that is generally introduced in the control of manufacturing equipment. When a part is set in the first production

process or in the specified position for starting the production management, the line issues the photographing instruction signal and the individual ID of the part to the PLC. The system of the solution then captures the image of the part by controlling the camera according to the photographing instruction and sends the individual ID received from the PLC and the photographed image to the GAZIRU Individual Identification Engine. Thus, it links the Fingerprint of Things information extracted from each image with the individual ID.

2) Matching based on Fingerprint of Things

At each of the matching points specified on the subsequent production and inspection process, the system receives the photographing instruction from the PLC and captures the image for matching by controlling the camera. The image is sent to the GAZIRU Individual Identification Engine for extracting the Fingerprint of Things information, which is matched with the registered Fingerprint of Things data to acquire the linked individual ID and writes it in the PLC. Because the individual ID is obtained by matching each part flowing in the line, the equipment data and the production data including the inspection results can be managed by linking the data with individual IDs. This applies even when a hard-to-trace process such as shuffling or stocking is included in the production.

(3) Effects

As this solution enables traceability at the individual level, it is expected to bring various improvements to manufacturing sites. An example of the effects is the possibility of an instantaneous search of the processing conditions and inspection results of the individual issues of concern. Also, in case variances in quality are observed during assembly because of an affinity problem, the assembly throughput rate can be improved using high-affinity parts selected after extracting the production process information of the parts of high-quality assembled products. It is also an effect that we can analyze and determine the cause of the affinity problem and select the appropriate combinations of high-affinity parts.

In the field of manufacturing, improvements in throughput and quality management by digital transformation of the whole supply chain is more important than ever. Applying this solution will contribute to enhancing the effects obtained by digital transformation of the production sites.

3.2 Cases of use in service linking the brand-name items and expert appraisals

(1) Background

The secondary distribution market of high-class brand-name items that includes the traditional BtoB and BtoC transactions, is expanding year on year thanks to the diversification of the distribution channels such as the CtoC transactions via the Internet. As a result, it is now required to prevent damage caused by the distribution of counterfeit products and to promote trade at optimum prices based on fair appraisals by experts.

The purchase of reused high-class brand-name articles is usually performed as shown in the **Table**. The quality status (scratch, dirt, deformation, smell, etc.) (3) is a factor deciding the value of each product and is as important as its authenticity (2), so its determination and evaluation (appraisals) are done by experts.

Reused articles are traded through several distribution channels such as owner -> buyer -> wholesaler -> dealer -> purchaser, for example. At present, the need for appraisal by a specialist at every purchase by the buyer makes any inadequacy of the expert labor force an issue. There is also the

issue by which, even if a certificate is issued to witness the results of an appraisal, replacement of the product or certificate and the counterfeiting of certificates makes it impossible to guarantee the correspondence of the product and certificate. This has resulted in the present status in which transactions based on appraisal certificates are not very diffuse.

(2) Problem solution by GAZIRU Individual Identification Service

One of the often-used approaches to deal with the issues above is the automation of steps (1) and (2) by using the image recognition and AI learning, and a service that adopts this approach has already been released. Nevertheless, as the counterfeiting techniques are increasing in sophistication year on year and step by step (3) necessitates judgments by experts and it is still unavoidable to rely on human appraisals. There is also the idea to identify the product by tagging an RFID. However this method is not applicable as the means of solving the replacement issue because the need to intervene with the product for tagging spoils the commodity value of the brand-name product.

As a solution for the issues, APRE Co., Ltd. has built the TAL Grading Report Issue Service. This is a new appraisal service using the GAZIRU Individual Identification Service (**Fig. 4**). This company handles purchase/sale of reused high-class articles including precious metals and brand-name products and conducts product appraisals using high technology for adopting scientific techniques.

When a reused article (a bag in the example in Fig. 4) is brought to the company, it appraises the authenticity and quality status based on the in-house criteria and issues the results in a certificate named the Grading Report. APRE manages this process by

Table Four steps in the purchase of reused articles

Step	Operation
(1)	Confirmation of article model
(2)	Determination of authenticity
(3)	Confirmation of quality status
(4)	Decision on price

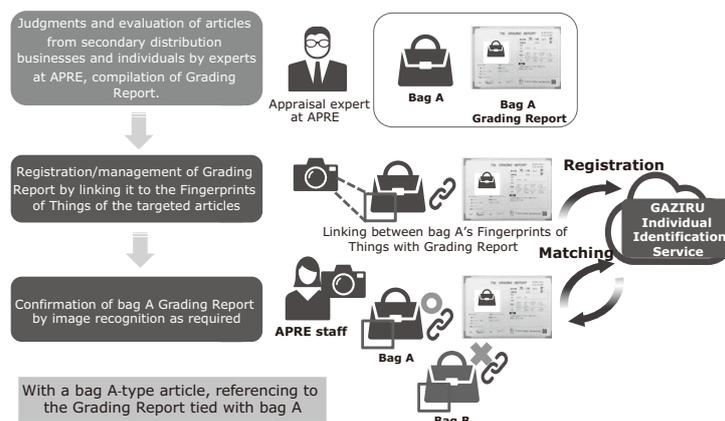


Fig. 4 Image of use.

photographing the Fingerprint of Things of the specific portions of the article and tying the obtained Fingerprint of Things with the Grading Report. This makes it possible to identify the registered reused articles by simply photographing and matching the images of specific portions as described above. There is no need for attaching special ID tags even to the same articles of the same brand as well as to refer the corresponding Grading Report based on the identification result. Even in a case of replacement of the article or Grading Report, matching using the GAZIRU Individual Identification Service can easily detect any unmatched items.

(3) Effects

The possibility of easy linkage of the Grading Report compiled by third-party experts to the actual articles described above makes possible reduction of labor by omitting or simplifying the expert appraisals that used to be performed at every transaction. Even when re-appraisal becomes necessary after a long time has elapsed after the issue of the Grading Report, steps (1) and (2) do not have to be performed again. In addition, reduction of the labor for re-appraisal is expected to occur because the Grading Report includes a detailed record of the quality status at the time of the last appraisal. Furthermore, in the CtoC transactions as well as the BtoB and BtoC ones, prevention and elimination of counterfeit and illegal articles and transactions at optimum prices can be promoted. Therefore a safe and fair trade environment to benefit both the sellers and purchasers and a sound development of the market may be expected.

4. Conclusion

The present paper introduces the individual ID function based on the Fingerprint of Things recognition technology and on cases of its use at the sites of manufacturing and in the secondary distribution market. The need for individual item management without using special ID tags is present in various domains including in the medical fields and in public institutions as well as in the examples of manufacturing sites and the distribution market described in the present paper. NEC will therefore promote the development of solutions, aiming at the expansion of the applicable domains.

* QR code is a registered trademark of DENSO WAVE INCORPORATED.

* All other company names and product names that appear in this paper are trademarks or registered trademarks of their respective companies.

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January 2020

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