# Application of Quick Response (QR) Codes in Mobile Tagging System for Retrieving Information about Genetically Modified Food

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*Abstract:* - The purpose of this paper is to introduce an integrated mobile tagging system, which can be used by consumers to retrieve product information about Genetically Modified Food (GMF) products in the market. In the proposed mobile tagging system, 2 dimensional Quick Response (QR) codes are adopted as the tag for identification purpose. Consumers can use the camera on their mobile phone to capture the image of the QR codes and send to the server for decoding. Subsequently, the server sends back the details of the GMF product in the form of Multimedia Message Service (MMS). This paper reviews and discusses various available tagging techniques, and thus justifies the appropriateness of QR codes to be used in the proposed system. Additionally, the paper presents the overall system architecture and system design of the proposed mobile tagging system.

*Key-Words:* - Mobile tagging, Quick response (QR) codes, 2D codes, Genetically Modified Food

## 1 Introduction

In the recent years, mobile phones with integrated digital cameras and capability to send data through General Packet Radio Service (GPRS) are prevalent and available to the wide range of users. In relevant to this, mobile tagging technologies have subject to ever increasing growth. Generally speaking, mobile tagging is the process of scanning or capturing the tag or barcode with the camera of a mobile device, subsequently decoding, interpreting, and use the content embedded in the barcode or tag. Due to the convenience, user friendliness, multiple fields of application, customer-driven information provided by mobile tagging, it has become the key technology for mobile surfing. The primary usage of mobile tagging is to use 2D codes to embed URL and works as a hyperlink to request further or relevant information.

At the same time, genetically modified food (GMF) has attracted much attention in the past decade as well. The terms GMF applies to foods, which contain genetically modified ingredients or to food additives or processing aids produced using genetic technology. Genetic technology uses recombinant DNA techniques to alter the heritable genetic material of living cells or organisms. In recent years, gene technology has been used in the agricultural industry to genetically modify crops.

Populations in developing countries are gradually aware of controversial issues related to GMF and paying greater attention toward the product information of GMF in the market. Nevertheless, it is common that the basic product information provided in the product label is not adequate for consumers to make purchase decision. Some consumers might require more details information about the product (such as location of plantation, and pesticide used), which are not available from the package label. Additionally, majority of consumers are lacking of proficiency to accurately or objectively interpret the product label of GMF products. The interpretation of the label might be influenced by perception of society or influences of mass media. These situations imply that consumers are lacking of information to make due purchase decision, thus a mechanism which able to provide adequate, accurate, and customizable information is much appreciated.

Hence, the purpose of this paper is to introduce a mobile tagging system which provides the consumers the access to accurate and adequate information of a GMF product. Consumers capture the 2D barcodes on the product packaging and send to the system for decoding, subsequently the system will retrieve information stored in the central database server and send to the requestor in a Multimedia Messaging Service (MMS) format. The information retrieved can be customized according to consumer's preference and need. Additionally, an URL is attached to enable consumers to use their phone browser to access more detailed information. On the

system backend, the construction of database in the proposed mobile tagging system requires collaboration across the crop producers, retailers, and related government agencies to provide independent, accurate, and sufficient information on the GMF products. In the rest of this paper, the proposed mobile tagging system for GMF label is coined as "Tagpreneur".

The next section reviews and compares the various technologies which possible to be applied to the Tagpreneur. Section 3 introduces the architecture and system design of the proposed mobile tagging system for genetically modified food.

## 2 Literature Review

This section represents the fundamental technologies and research which form the foundation of the research background and justification for the selection of identification techniques or technologies.

### 2.1 Identification Methods

As a part of the mobile tagging system, identification technique is one of the core functionalities to make captured image readable by the application or system. However, there are various identification techniques available. This section provides the justification of the techniques selection based on the comparison on the features of different identification techniques. The 1D barcode is not being considered because the capacity of 1D barcode is not sufficient to embed information such as URL address in this case [1].

Table 1 provides the comparison between 2D barcode and other automatic identification technologies such as magnetic card and Radio Frequency Identification (RFID). Compared to other methods, 2D barcode shows its superior performance in terms of identification speed, bit error rate, and printing cost [2]. In the food label tagging, 2D barcode is the more appropriate identification method compared to others in the comparisons. The single most important reason is the low printing cost, as the margin of food product is not wide, thus high printing cost method such as RFID is impractical. Hence, the selection of identification method is narrowed down to 2D codes.

Next step takes the comparison down to the various 2D codes, namely Data Matrix, Quick Response (QR), PDF417, and GM as shown in Table 2. Among the 2D codes, QR codes have the appropriateness to be applied in the GMT-MT system, given its content capacity, camera readability, and cost [3]. Furthermore, the QR format's specification is available royalty-free [4]. The owner has promised not to exert patent right on it. Additionally, QR codes house 3 KB of data, which provide the scalability to embed other information or media in future.

### 2.2 Quick Response (QR) Code

The Quick Response (QR) Code is a 2-dimensional symbol invented by Denso Wave in 1994. Denso Wave is a division of Denso Corporation and one of the major Toyota group companies. Another advantage of using the QR Code is that the camera does not have to be lined-up in a specific manner in order to read a barcode. Although the user's hand needs to be stable, a good QR Code reader comes with the ability to sharpen up and correct a 'shaky' scanned QR Code and read it. QR code indirectly enables the ubiquitous computing; allow user to access the information at anywhere and anytime. QR code is commonly adopted by companies for advertising purposes.

The Quick Response (QR) Code is capable of high-speed reading in all directions (360°) from three corners implemented with the finder patterns to

Table 1 Comparison between 2D barcode and other automatic identification technologies

| Information media | Magnetic card | OCR identification | Biological identification | RFID | 2D barcode |
|---|---|---|---|---|---|
| **Identification speed** | 0.3－2s | 4－8s | 1－5s | 0.3－0.5s | 0.3－1s |
| **Bit error rate** | Up to life of magnetic media | 1/ 1,000 | 1/300 | Up to noise and angle | 1/1,000,000 |
| **Technical advantage** | Portable and data rewritable | Quick in image and symbol operation | Non-counterfeitable | Quick and batch processing | Quick and accurate |
| **Print cost** | Intermediate | Low | High | Very high | Very low (only ink cost) |
| **Sample** |  |  |  |  |  |

(Source: Denso Wave Incorporated, 2009)

Table 2 Comparison between Quick Response (QR) and other 2D barcodes

| 2D barcode | **Data Matrix** | **QR** | **PDF417** | **GM** |
|---|---|---|---|---|
| Layout | Matrix | Matrix | Layers (1D layout) | Matrix |
| Max capacity | 1.5KB | 3 KB | 1 KB | 2 KB |
| Readable direction | Full direction | Full direction | Upward/downward | 360o full direction |
| Image "dead point" | Yes (no tarnishing for positioning image) | Yes (no tarnishing for positioning image) | Yes (no tarnishing for positioning image) | No |
| Chinese encoding efficiency | Bad (16bit) | Bad (16bit) | Bad (16bit) | Good (13bit) |
| Photoelectrical sensor (core part of a reader) | Made in Japan or US | Made in Japan | Made in Japan or US | Made in China |
| Intellectual property rights | US | Japan | US | China |
| Sample picture |  |  |  |  |

(Source: Denso Wave Incorporated, 2009)

notify the position of the code. The black and white ratio of the code among the scan line is 1:1:3:1:1 through the finder patterns from any direction 360° surrounding the code [5]. Through this ratio, the position of the Quick Response (QR) Code can be detected in a short period of time through the finder pattern captured by the sensor.

QR codes are resistant to distortion. The barcode is attached onto a curved surface resulting in a distorted code image and causing difficulties for the scanner to decode the barcode. The alignment pattern in the Quick Response (QR) Code is arranged at a regular interval in the code to resolve this distortion. The center position of the alignment pattern from the outer shape of the code and the alignment pattern of the actual center position of the code is calculated. The calculated variance is used to map the adjusted position of the code for identifying the centre position alignment pattern of each cell. This will make the distorted code readable.

The error correction function of the Quick Response (QR) code adopts the high resistance to bursts of errors from the Reed-Solomon code, overcoming the smudges or damages on each code. Reed-Solomon codes are implemented in the Quick Response (QR) Code data area. The error correction levels of the Quick Response (QR) Code are 7%, 15%, 25%, and 30% per code area [4]. Within the error correction level, the code can still be decoded correctly although they are smudged or damaged through this error correction function. For codes which are susceptible to damages or smudges, it is recommended that a correction level of until 30% can be adopted.

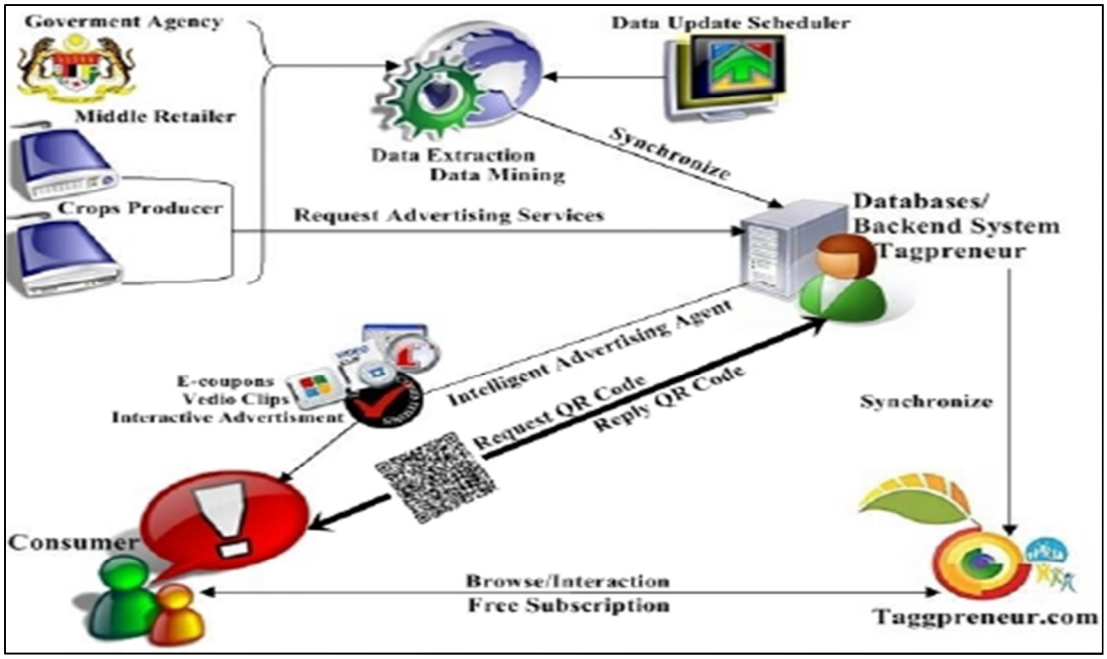
A single Quick Response (QR) Code can be divided into several portions of code through the linking function. A single code can be divided into 16 portions of code at maximum. The entire data will be compiled and sent to the computer despite the sequence of the code read by the scanner. If the printing surface area is limited, the Quick Response (QR) Code still can be printed through this linking function.

The Quick Response (QR) Code can be encrypted by linking the relationship of the specified data storage to the types of characters for unique usage. The confidential Quick Response (QR) Code cannot be decoded until the permission of conversion between the specify data storage and the type of character is deciphered. This function can be used to boost the security of high value corporate information.

## 3 QR Code Mobile Tagging for Genetically Modified Food

This section introduces the proposed mobile tagging system which uses QR code to tag GMF product. The proposed system is named as "Tagpreneur" in the rest of this paper.

Fig. 1 Comparison between 2D barcode and other automatic identification technologies




## 3.1 Overall Architecture

Fig. 1 illustrates the system overview of the Genetically Modified Food Mobile Tagging Services. The system acts as an informediary between the consumer, the crop producer and the middle retailer. Tagpreneur will define the mobile tag for those crop producers and middle retailers who agree to let Tagpreneur to tag their product. The information in the mobile tag is customized according to the customer preferences.

Tagpreneur is offering a free 2-Dimensional Quick Response (QR) code reply to consumers requesting information about the genetically modified product tagged with a 2-Dimensional Quick Response (QR) code. Tagpreneur will decode the 2-Dimensional Quick Response (QR) code into text form via the SMS and reply to the consumer complete with a link to the Tagpreneur's web site in the replied text message. Consumers can access the link and browse the web site via their personal mobile device.

Tagpreneur provides the necessary feedback and its comment function to enable consumers to interact with other consumers virtually. These comments are capitulated back to Tagpreneur's backend system to generate a customized profile of each customer who opts for the services. Through the data extraction and data mining technique, customized marketing messages will be delivered to the targeted customer.

As an additional service, Tagpreneur rewards the loyal customers with e-coupons, e-vouchers, and redeemed points to keep the loyal customer and attract new customer to adopt the service. Crop producers and middle retailers can advertise through Tagpreneur to the targeted consumer. The customer can use the e-coupons, e-vouchers, and redeemed points to get discount rate from the crop producer and middle retailer who advertise through Tagpreneur.

## 3.2 System Design

The main font end functionality of the system is to allow user to retrieve information about particular GMF product, the steps of the interaction between the user and system are described as:

1. Point the mobile phone camera to the product.
2. Take a picture of the 2-Dimensional QR code with the camera hand phone
3. Send the code to the message centre
4. Wait for a while for the decoding
5. Replied product information in text message from message center
6. Customers can link to Tagpreneur's website for further browsing activity

The replied message comes with a list of information about the product. The figure in Fig. 2 illustrates the prototype user interface which showing the product information of a particular GMF product. The replied message consist of the details description of the product will lead a positive perception on consumer in the purchasing process. The details of the description include:

1. The suitability of planting site
2. Transition period from conventional to organic system of production
3. Pesticide residue and heavy metal
4. Crop buffer and buffer zone distance
5. Soil fertility management
6. Good water management

7. Use of seed and plant material
8. Use of fertilizers
9. Soil conditioners
10. Pest and disease control materials
11. Management of weeds, pests and diseases,
12. Packaging, storage and transport of farm products

Fig. 2 Sample Interface of Product Details


The detail description lead better convince on consumer to make procurement. Consumers can browse through the Tagpreneur's website via the direct link at the bottom of the replied message for further information.

Through the data mining technique, the intelligent advertisement software in Tagpreneur's back-end system has the ability to provide content and services tailored to an individual's preference and behavior. This highly personalized service is available to each targeted consumer. The information obtained from the customer's transactional history enables the company to construct individual profiles containing facts about that particular customer and redefine the rules describing customers' behavior.

Fig. 3 illustrate the customized advertisement contents delivered to targeted consumers who have the potential to buy the product based on that particular consumer's purchase history. Richer media content can be implemented in the advertisement such as spokesperson recommendation for the product, product tutorial videos, and e-books. In addition, Fig. 3 on the right illustrates the interface which shows details of advertisement message.

Fig. 3 Sample Interface of Customizable Advertisements


# 4 Conclusion

With the wide availability of camera phone and increasing awareness of toward GMF products, the proposed system is technically and financially practical to be implemented. The proposed system has the potential to change the existing way of retrieving shopping information and advertising.

Nonetheless, the major challenge of implementing this system is the need of collaboration across various parties in the supply chain and government agencies as well. Thus, it is important to ensure the system will grow to incorporate more sophisticate functions and introducing attractive revenue stream to the participants of the system. In terms of academic and research, this paper proposed an application of mobile tagging technology in the genetically modified food, which is an emerging trend, especially in developing country. This study provide a foundation for future study to propose more comprehensive application and solution in application area of genetically modified food tagging, which is much neglected in the computer science study.

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