

Message Security with QR Code

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ABSTRACT

A QR Code is a specific matrix barcode (or two-dimensional code), readable by dedicated QR barcode readers and camera phones. The code consists of black modules arranged in a square pattern on a white background. The information encoded can be text, URL or other data.

Common in Japan, where it was created by Toyota subsidiary Denso-Wave in 1994, the QR code is one of the most popular types of two-dimensional barcodes. QR is the abbreviation for Quick Response, as the creator intended the code to allow its contents to be decoded at high speed.

QR codes were originally made to track parts in vehicle manufacturing. QR codes are free to anyone who wants to make them or use them for any kind of tracking or promotional service. QR codes contain embedded information that can only be read by QR code readers that are usually downloaded by smart phones. The purpose of QR codes is to give a consumer additional information about the product, an event, or even a promotion. It is widely used in daily life because it has high capacity encoding of data, damage resistance, fast decoding. QR code technique can be used for Steganography which leads to many problems, so to recover or retrieve the hidden secret information, the Reed Solomon and list decoding scheme being used. QR code technique also used in cryptography, as it has mainly used to convey or store message because they have large storage capacity than conventional barcode. Here the information being send (which is in an encrypted format) securely and safely to authorized party. The focus of this paper is to explore and analysis the compilation of data and research regarding the current digital functionalities, benefits, limitations and future expectations of QR code in digital technology.

Keywords

Standard QR code, Two Level QR code technique, cryptography, Steganography, document authentication

1. INTRODUCTION

Barcodes have been used since the 1970s. Barcodes have advanced the way data is stored, shared and interpreted. Barcodes were originally invented because grocery stores did not have any form of an automated checkout with pricing. Barcodes would prove to be a great organizational tool that more than just grocery stores would be able to take advantage

Barcodes are optical machine-readable representation of data, capable of storing digital information. Due to their reading speed, accuracy and functional characteristics, barcode have been used in many applications. They have limited storage for digital information to be stored. To enlarge barcode areas, need to increase the length of the barcode lines, which causes more complex reading operations and increased printing costs. For this reason, the barcode technology has to implement geometric patterns in two dimensions, such barcode referred to as 2D barcode. Note that 2D codes increase the data space

available by storing information in 2 dimensions whereas 1D barcode data is available in one dimension. There are more than 20 types of conventional 2D codes. These barcodes differ each other by the size of the data storage. The matrix barcode is also named as Quick Response (QR) code. This is the technology evolving recently and being replaced barcode technology.

The quick response (QR) code was designed for storage information and high-speed reading applications. QR codes are read by mobile phones that have a QR code reader application whereas in barcode, the code is read by separate scanner machines. The popularity of QR code is mainly due to the following features: they are robust to the copying process, easy to read by any device and any user, they have a high encoding capacity enhanced by error correction facilities, they have a small size and are robust to geometrical distortions. However, those undeniable advantages also have their counterparts:

- 1) Information encoded in a QR code is always accessible to everyone, even if it is ciphered and therefore is only legible to authorized users (the difference between “see” and “understand”).
- 2) It is impossible to distinguish an originally printed QR code from its copy due to their insensitivity to the Print-and-Scan (P&S) process.

In this report, we propose analytical study on standard QR code, two level QR code and 3D QR code on security basis.

2. LITERATURE SURVEY

Today, graphical codes, such as EAN-13 barcode [1], Data Matrix [2], Quick Response (QR) code, PDF417 [3], are frequently used in our daily lives. These codes have a huge number of applications including: information storage (advertising, museum art description), redirection to web sites, track and trace (for transportation tickets or brands), identification (flight passenger information, supermarket products) etc. A traditional barcode is 1-dimension (1D) barcode which only contains data by one side. Quick Response (QR) code is a type of 2-dimension (2D) barcode developed in 1994 by Denso Wave Corporation. In order to improve the reading speed of 2D-barcode, thus got the name by QR code. It contains data for both vertical and horizontal dimensions. Due to this reason, QR code has greater volume of information. It can store various kinds of content such as text, web link, number, and multimedia data. The decoding speed of the QR Code can be 20 times faster than that of other 2D symbols [4]. In recent years, QR code is becoming popular in business via QR readers and mobile devices. Since QR code is so popular, some secret information could be transferred via it. In this study, its analyzed the properties of each QR code before embedding it into this one. If they want to embed a secret message into QR code, they will encode it first. After that, they exploit the structure of QR code which code they want to use.

In this report, we present two level QR code (2LQR) technology which contains two levels: one is the public level which acts like standard QR code, therefore it can be readable by standard QR application and second is the private level in which the information is being stored and accessible only by authorized party [5]. 2LQR code technology, the private level is constructed by replacing the black modules by specific textured patterns. It consists of information encoded using q-ary code with an error correction capacity. This allows us not only to increase the storage capacity of the QR code, but also to distinguish the original document from a copy. This authentication is due to the sensitivity of the used patterns to the print-and-scan (P&S) process. The pattern recognition method that we use to read the second-level information can be used both in a private message sharing and in an authentication scenario. It is based on maximizing the correlation values between P&S degraded patterns and reference patterns. The storage capacity can be significantly improved by increasing the code alphabet q or by increasing the textured pattern size.

The availability of high quality copy machines, the duplicate of document can be made easily. This is a major problem for document authentication, to solve copy detection, printed document authentication system based on sensitivity of a new two level QR (2LQR) code to copying process. This 2LQR code contains specific textured patterns, which are sensitive to printing and copying processes. Therefore, it can be used to detect unauthorized document duplication [6].

QR code technique is used in cryptography, here the message is encrypted with password. This password will generate a secret code, which will be added to each digit or alphabet in the numbers or text entered in the message (which is needed to be encrypted) and generate the first phase of encryption. That newly generated encrypted message will again be encrypted using various other methods to generate the final encrypted message [7]. Recently, there has been a dramatic increase in the usage of QR codes. However, the relatively low capacity of existing QR codes has limited their applicability, e.g. in protecting the authenticity of a QR code [8]. To increase the data capacity of QR codes, leveraging color is probably the most natural and inexpensive approach.

Transferring highly confidential information is a real challenge, here the combination of steganography and cryptography technique is implemented together to best results on security basis [9], [10].

3. QUICK RESPONSE (QR) CODE TECHNIQUE

Traditionally barcode technology is used as an optical machine-readable representation of data, capable of storing digital information about the physical object to which they are attached. They are ubiquitous in many applications such as used in departmental stores, to track items etc. As barcode is referred as 1D dimensional in which the amount of digital information storage is limited [1,2,3]. For this reason, the barcode technology replaced by matrix barcode layout which is referred as Quick Response (QR) code technology which enables to acquire information with one single scan and does not require the accurate alignment of the scanning equipment. QR code is able to store more than 7,000 decimal digits.

The QR code was originally invented to track vehicles during manufacturing. However, QR codes are now extended to be used in commercial settings. Many mobile

users have used QR codes to send texts, open a Uniform Resource Locator (URL), or to send e-mail or text messages. The technology has since become one of the most commonly used two-dimensional (2D) barcodes. The current design of QR code is made up of black and white squares and it can store variable sized data. A Version 1 QR Code is a 21×21 array of data elements and can hold up to 25 alphanumeric data with the array increasing in size by 4 modules (25×25 for Version 2) for each increase in version number. The largest standard QR Code is a Version 40 symbol that is 177×177 modules in size and can hold up to 4296 characters of alphanumeric data.



Fig 1 Example of QR code

3.1 Feature of QR Code

- A simple scan captures the desired information.
- The Decoded data can be stored in the server and can be viewed by the cashier.
- High accuracy in image capturing.
- Customer can easily detect the QR code image, via his Android mobile itself.
- High capacity encoding of data
- Small printout size
- Kanji and kana capability
- Dirt and damage resistant
- Readable from any direction in 360 degree
- Structured appending feature
- High capacity encoding of data

4. TECHNOLOGIES OF QR CODE

4.1 Data Exchange via Multiplexed Color QR Codes on Mobile Devices

A new way of exchanging data such as images and text files via mobile devices in the absence of existing wireless technologies, namely Wi-Fi and Cellular Data Network in a personal area network. It does not incur the overhead of Bluetooth pairing and discovery. This application, ColorQR, sends data through the manipulation of colors into multiplexed QR codes. Data is encoded into Red-, Blue- and Green- color QR codes and are multiplexed to form multiple multi-color QR codes that will be flashed on the screen of the sender's device. The receiver, in the form of a camera of a mobile device, will record the flashing images and convert the images into RGB channels using grayscale conversion. Thus, one image will be split into 3 sets of black and white QR codes.

Results show that ColorQR is highly feasible and it can transmit data of varying sizes without limitation.

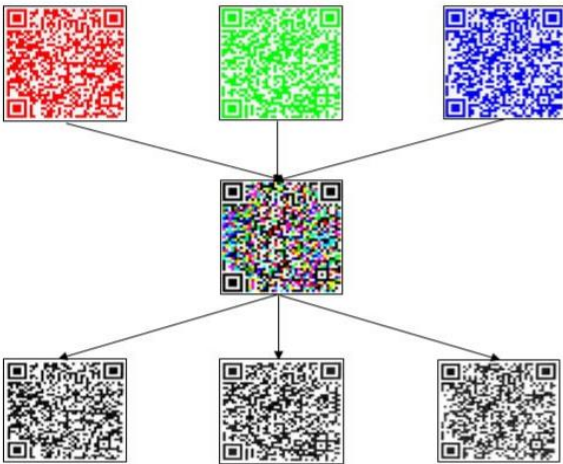


Fig. 2 Multiplexing and Demultiplexing of QR codes

The 3 Colored QR codes are multiplexed into a single QR code during the encoding at the sender. The single multiplexed QR code is color inverted and demultiplexed during the decoding at the receiver.

4.2 Two Level Quick Response (2LQR) Code Technique

Two Level Quick Response Code is a new rich QR code that has two storage levels and can be used for document authentication. This new rich QR code, named two-level QR code, has public and private storage levels. The public level is the same as the standard QR code storage level; therefore, it is readable by any classical QR code application. The private level is constructed by replacing the black modules by specific textured patterns. It consists of information encoded using q-ary code with an error correction capacity. This allows us not only to increase the storage capacity of the QR code, but also to distinguish the original document from a copy. This authentication is due to the sensitivity of the used patterns to the print-and-scan (P&S) process. The pattern recognition method that we use to read the second-level information can be used both in a private message sharing and in an authentication scenario. It is based on maximizing the correlation values between P&S degraded patterns and reference patterns. The storage capacity can be significantly improved by increasing the code alphabet q or by increasing the textured pattern size. The experimental results show a perfect restoration of private information. It also highlights the possibility of using this new rich QR code for document authentication [5].

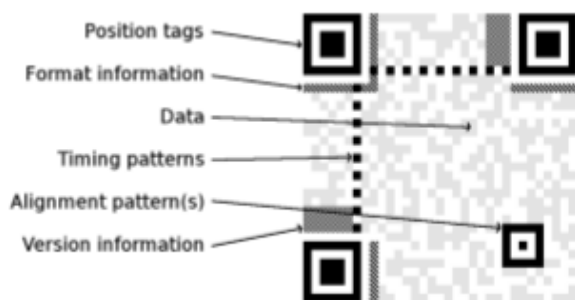


Fig. 3 Structural pattern of QR Code

4.3 Rich QR Code with public and private levels

The 2LQR code has two storage levels. In the first level, the information is stored in a standard way [5]. The second (private) storage level is created by replacing the black modules with specific textured patterns. The generation process of this 2LQR code is described in figure 4.

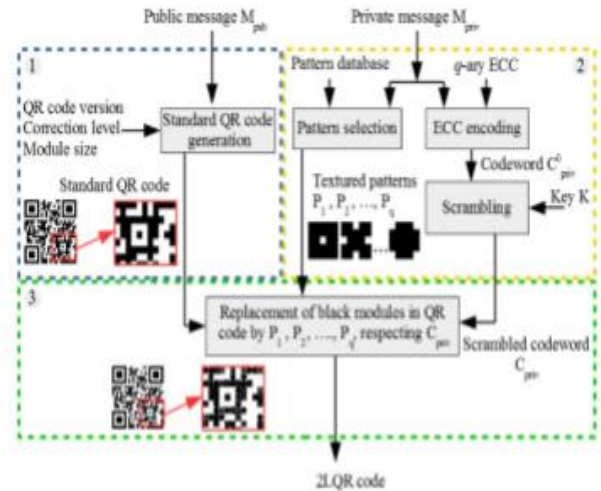


Fig 4 Overview of 2LQR generation process of code

This process consists of 1) a public message storage in standard QRcode, 2) a choice of specific textured patterns, 3) a private message encoding using an Error Correction Code (ECC), 4) the encoded message (codeword) scrambling process and, 5) a replacement of black modules with textured patterns respecting the codeword. In the referenced paper, the authors [6] suggest to choose textured patterns that can be detected after the impact of P&S process, since the main idea is to increase the storage capacity of QR code. The document authentication of our approach is based on the sensitivity of the textured patterns to the P&S process. Thus, we propose a new method for selecting a textured pattern combination that ensures this sensitivity to P&S process.

4.4 Document Authentication

The document authentication of our approach is based on the sensitivity of the textured patterns to the P&S process. Thus, propose a new method for selecting a textured pattern combination that ensures this sensitivity to P&S process [6].

A copy attack is production chain that implies two successive P&S processes. The modifications induced on the document are cumulative. The authentication step aims at evaluating the pattern degradation in order to acknowledge for successive P&S functions applied to the original pattern. We propose to use the Pearson correlation coefficients for measuring the degradation.

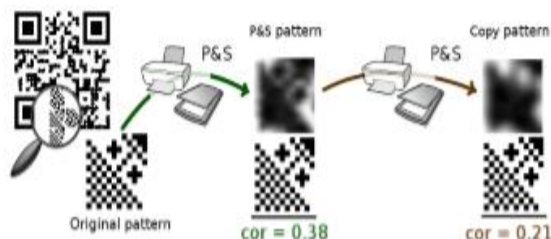


Fig 5 Textured pattern changes during copying process

Authentication process dedicated to printed documents that use a two level QR code. The 2LQR code has two levels of information storage: the public level, where information is stored in standard way, and the private level, where the black modules are replaced by specific textured patterns, that are sensitive to copying process. Thanks to characteristics of textured patterns, the private level of 2LQR code cannot be read into overprinted document copy. The authentication test, that we propose, aims at verifying the printed document authenticity. If the maximal correlation values between P&S textured patterns and original numerical patterns are smaller than a predetermined authentication threshold, the printed document is considered as being counterfeited [4].

One important feature of the textured patterns used is their sensitivity to the P&S process. To take advantage of this sensitivity, we use a pattern recognition method based on maximization of correlation values among the P&S degraded versions and characterization patterns. We have tried three different types of characterization patterns: mean patterns, median patterns (for the private message sharing scenario) and original patterns (for the document authentication scenario). The mean and median characterization patterns give almost the same results of pattern detection. Therefore, either of them can be used in the private message sharing scenario. The best pattern recognition results were obtained, when the original patterns are used as characterization patterns. The original patterns can be also used for the private message sharing scenario, but in this case the blind method for pattern detection cannot be performed. The suggested textured patterns can be distinguished only after one P&S process. Therefore, we can use the detection method with original patterns in order to ensure good document authentication results [5].

5. ENHANCED SECURITY IN STEGANOGRAPHY USING ENCRYPTION AND QUICK RESPONSE (QR) CODE

Due to advancements in communicating technologies and proliferation of internet facilities, it is a necessity to build a system for transferring confidential data securely over a network. Steganography involves concealing messages in the images which are referred as cover images. These cover images are then transferred across the network securely. The hidden messages are overlooked and cannot be retrieved without knowing the exact Steganography cover technique. Cryptography includes modifying the message format by applying various techniques and finally rendering a distorted message which is not intelligible. Both the techniques have their own pros and cons. By combining both the techniques, a secure and more sophisticated system can be built.

Quick Response codes, also known as two-dimensional barcodes are used for increased encoding space. In this paper, a secure information model is presented by combining cryptography and Steganography. QR codes are employed for encoding the encrypted message. A nested image steganography is performed with QR codes on a suitable cover image. The author [9] proposed approach has a potential to be employed in communicating confidential information.

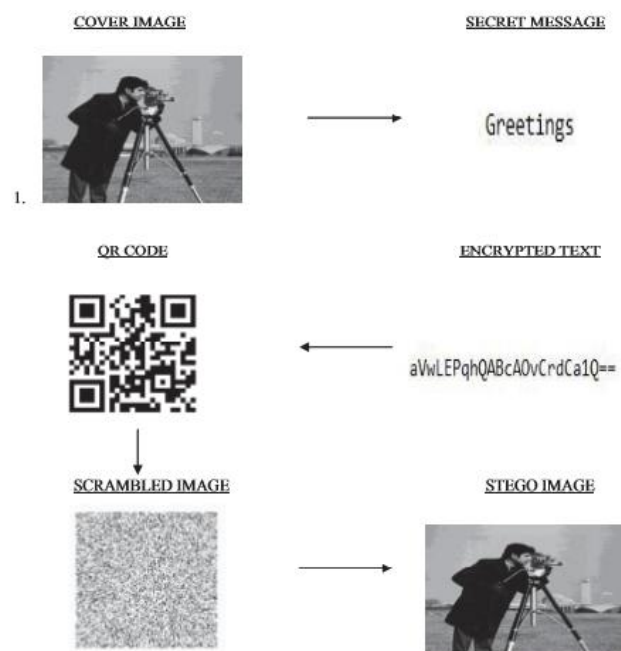


Fig 6 Stages involving in Encryption

An encryption technique is employed to encrypt a secret message before encoding it in to a QR code. The encoded image is scrambled to achieve another security level. The scrambled QR code is finally embedded in a suitable cover image, which is then transferred securely to deliver the secret information. At the receiver's side the secret information is retrieved through the decoding process. Thus, a combination of strong encrypting algorithm and Steganography technique to make the communication of confidential information safe, secure and extremely hard to decode.

6. FUTURE SCOPE

Till now we have seen how QR Code has been evolved over these years and hence has helped in providing enhanced and secure communication. QR codes are a great way to minimize the number of documents that people need to carry during travelling long distances or during any emergencies. The day-to-day required information such as Aadhar Card information, Driving License and Insurance Papers need not to be carried every time we travel. The required and relevant information can be encrypted and stored securely in the QR codes. It is a smart way to reduce the unnecessary load of hefty documents. It also avoids the chances of theft or burglary and minimizes the number of documents that need to be carried. With the help of Enhanced Encryption and Decryption Techniques QR Codes can prove the future of Smart and Compact Data Transmission.

7. CONCLUSION

In this report, a new authentication process dedicated to the printed document for detecting the duplicate copy of original document, that uses the two-level quick response code

technique has been proposed. In 2LQR code, there are 2 levels of information storage, the public level where information is stored in standard way and the private level, where the black modules are replaced by specific textured pattern which are sensitive to copying process. Feature of two level QR code is that, they can't read overprinted document copy. Because of authentication test, the document authenticity is verified properly and efficiently. The combination of steganography and cryptography uses QR code, confidential data transferring can be done securely and without distortion.

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