Strength of Quick Response Barcodes and Design of Secure Data Sharing System

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***Abstract* - With the vast introduction of the wireless world, the exchanged information now is more prone to security attacks than ever. Barcodes are the information careers in the form of an image. Their various applications have been discussed in brief and also the structure, symbology and properties of barcodes. This paper aims to provide an approach which can share high security information over the network using QR barcodes. QR barcodes are explained in detail to get the rigged understanding on quick response technology. The design of data security model to share the data over the network is explained. This model aims to enable secure data share over the network. This model is a layered architecture and protects the data by transforming the structure of content. So barcodes are used to put tricks over the information rather than directly using it for its noble functionality.**

Keywords-QR Barcode; Quick response technology; Data Security; Information Security; Image processing; Data Sharing Architecture

I. INTRODUCTION

The emergence of diverse networked data sources has created new opportunities for the sharing and exchange of data. The use of information has become a persistent part of our daily life. Employees use information to perform elementary job functions; managers require significant amounts of it for planning, organizing and controlling; corporations leverage it for strategic advantage.

Since the application of computers in administrative information processing is also very important, computers have become a key instrument in the development of information processing. The rapid development of information technology (IT) has helped to firmly establish the general attitude that information systems are a powerful instrument for solving problems.

Utilizing these emerging technologies, however, is not without problems. People start considering their sensitive information when it is transmitted through open networks; they began worrying about using forged information for business; and corporations worry about customer and investor confidence if they fail to protect sensitive information. Protecting sensitive information has consequently become a top priority for organizations of all sizes.

The majority of existing systems focus on performance and precision of data retrieval and information management. A number of techniques are employed to protect information; however, in many cases, these techniques are proving inadequate. For example, while several information systems use the add-ons security features to provide information confidentiality (which allow users to share information from a data media while keeping their channel private), these security measures are insufficient.

Considering barcodes as an effective media to share information, at present, the black and white two dimensional barcode technology has developed more mature. American National Standards Institute (ANSI) developed the international standards of two-dimensional bar code, QR codes [1][2]. However, with the urge of increase in information, expanding the field of bar code applications is thought to be good idea. Barcodes are used to store the high capacity information in less space and thus, stands as a good ideate.

In the upcoming section, the structure, information capacity and other important properties of QR barcodes are explained. In section 3, a model is proposed with an algorithm. Finally in the last section, future work and conclusion for the model is proposed.

II. BARCODE APPLICATIONS

An effective and innovative call from Denso introduced the world with Barcodes which are so efficient in their work, especially in specific domains like automated storage systems and data hiding [3][4].

Barcodes finds good applications in inventory control systems like stock level maintenance, control on incoming goods and raw materials, etc. Also barcodes has production control applications like status on information of authentications of goods. They are also extensively used in industries and business sectors related to automotive, food processing, electronics, insurance, pharmaceutical, and so on [5].

As if now, author does not find barcodes to be used to secure data while transferring over the network. Before knowing the proposed work using barcodes, how barcodes are invented and what is the structure behind the creation of barcodes is discussed in next section.

III. RESEARCH ON QR BARCODES

The strength of QR Barcodes can be identified as they contain the forte of PDF 417 for its high data capacity, Data Matrix for its reduce space printing and MAXI Code for its high speed reading as presented in fig. 1.

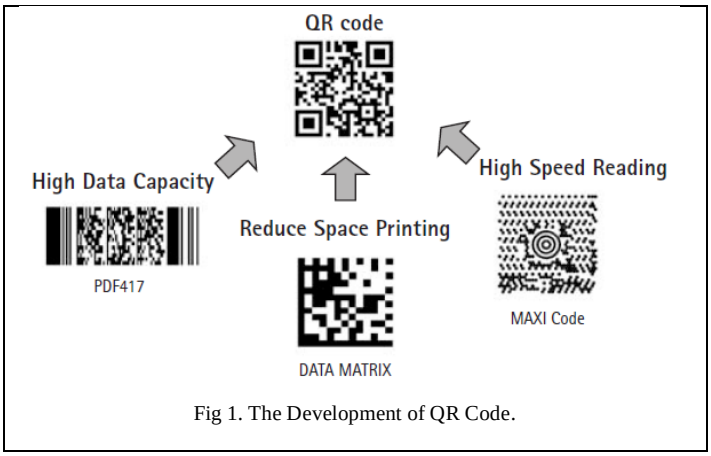

Fig 1. The Development of QR Code.

A. Generating Codes

QR codes can be generated online with various code sizes. For optimum readability we recommend a quiet zone area of 4 modules around the code. A module is the smallest pixel element of a QR Code. For most phones a smaller quiet zone of 2 modules will work, but 4 modules are required in the official documentation [8]. So we also recommend the module size to be 4 so that it captures the most information within and maximizes the capacity size. See fig. 2.

B. Encoding Process

There are three steps in the encoding process of colour bar code: encoding the data information, generating error correcting code, and generating symbol process [9]. Firstly, according to the data information encoding mode, the data is transformed into data stream. Meanwhile, the information of length of data stream is added into the head of data stream.

Then each four bits in the data stream form a code and the corresponding error-correcting code is generated through Reed-Solomon algorithm. The error-correcting code is added to the end of the data stream. Finally, all of the data codes will be transformed into symbols and the function images are added too as shown in fig. 3.

Fig. 2. QR Barcode Module.

C. Information Capacity

In the black and white two dimensional bar encoded method, the data is transformed into binary data stream [10]. Then these binary data value, 0 and 1, are presented with black and white symbols. Each module which can present 0 or 1, can express two kinds of different information. So in the black-and-white two-dimensional barcode with n symbol modules, the information capacity will be 2n.

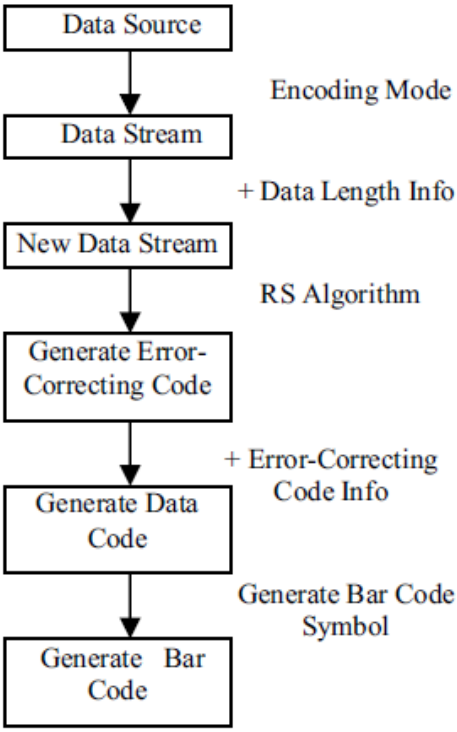

Fig. 3. The Encoding Process.

D. QR Barcode Structure

The QR barcode [6][7] is a two dimensional symbol developed by Denso Wave in 1994. The code contains information in both the x-axis and y-axis, whereas traditional barcodes contain data in one direction only. The main structure of the QR barcode is shown in fig. 4. The outer range is the quiet zone. The upper-left, upper-right, and left bottom square areas are used for position detection and pattern separators for positioning.

There are six smaller squares which are the alignment patterns. Additionally, the main area, which is colored grey, is the kernel area of data and error correction code. The QR code's size is decided by determining a symbol version based on data capacity, character type, numeric, alphanumeric, etc., and error correction level, and by setting a module size based on the target printer's or scanner's performance level. The placement of finder patterns and timing patterns can be seen in fig. 5.

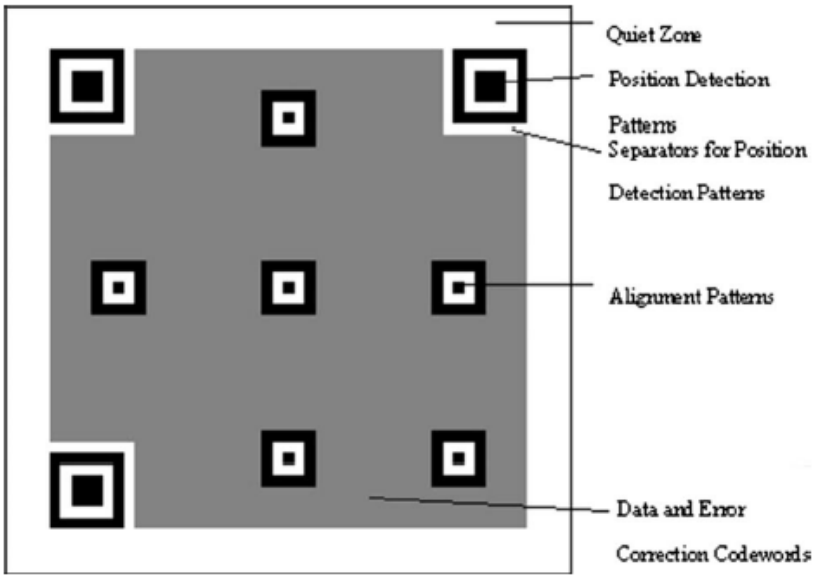

Fig. 4. The Structure of QR Barcodes.

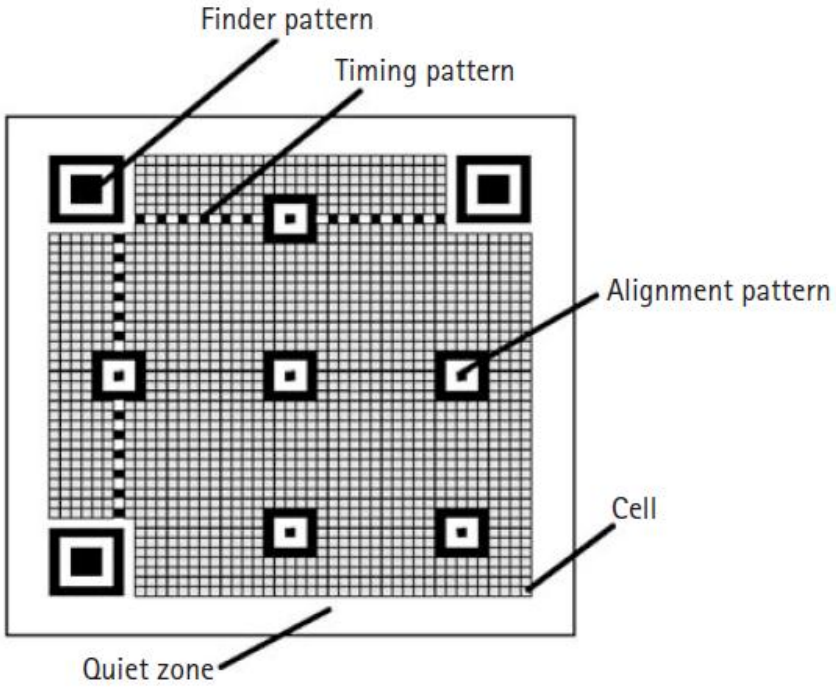

Fig. 5. The Finder and Timing Pattern of QR Barcode.

E. QR Code Structure in Detail

Fig. 6 shows an example of QR code symbol. The figure is version 1 (type 2) and the module is 21 X 21 cells, vertical 21 cells and horizontal 21 cells. This version is specified from 1 to 40, increased by 4 cells per one version up. The maximum version is 40 and the size is 177 X 177 modules. Fig. 6 is a case of the QR code version 1 modules that are arranged in a grid pattern of black and white squares. In this QR code symbol [11][12][13], there are three position detection patterns (Finder patterns) in the upper left corner, bottom left and top right corner. Then the timing pattern is placed between every one of these position detection patterns. Additionally, alignment patterns are introduced in the version 7 or higher. Then Table I shows the main specifications of the QR code. There are four modes available,

(1) number mode,

(2) alphanumeric mode,

(3) 8 bit byte mode and

(4) kanji and kana characters mode.

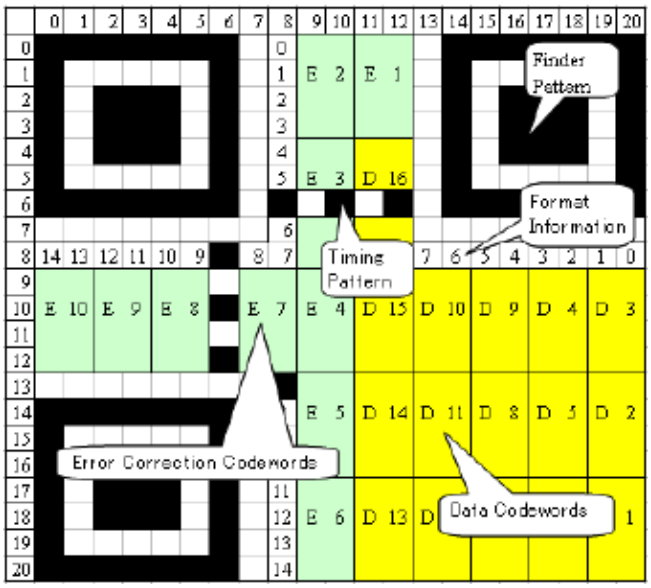

Fig. 6. Example Structure of QR Code.

It can also be combination of these modes. The RS (Reed Solomon) error correction code is used for recovering from symbol dirty or transmission error. There are four levels of error correction capability, Level L: about 7% recovery, Level M: about 15% error recovery, Level Q: about 20% error recovery and Level H: about 30% recovery.

IV. Proposed Algorithm

An algorithm is proposed here which secures the information while being shared on the network. The idea is to create a random number corresponding to the information saved in the database. The random number behaves as the key to the information in the database. Each random unique key point to the unique information placed in the database server.

Barcodes are used for the obvious reasons. They are acceptable worldwide. Various barcode readers are openly available on the internet and barcodes can be widely scanned in mobile devices.

For the random number created initially, a quick response barcode is created. QR barcode generators are widely available in the market. The preferable size of QR barcode in this algorithm is 800 length and 800 height to utilize more information space in barcodes.

The barcode created is now used to create two identical looking barcodes with minor differences in each which are not detectable by naked eyes. The identical image *one* is created by first detecting the black continuous series of pixel in barcode. Then the first black pixel from the series is formatted to white or base color. The process is repeated for all such black series of pixels in the image. This image is now named as the *False Image One*. False image one, on completion of formatting for each black series of pixel in the image, then looks identical to the original image.

Table I. Minimum QR Code Specifications.

Item	Specifications	
Error Correcting Code	RS Code	Data
	BCH Code	Format Information
		Version Information
Characters	Number	10 bit coding per 3 number digits
	Alphanumeric	11 bit coding per 2 characters
	8 bit byte	8 bit coding
	Kanji	13 bit coding per 2 characters
Version	1	21 x 21 modules
	2	25 x 25 modules
	40	177 x 177 modules
Error Correcting Level	L	about 7%
	M	about 15%
	Q	about 25%
	H	about 30%
Finder Pattern	1:1:3:1:1	3 co-centric squares
		7x7, 5x5, 3x3 modules
Alignment pattern	1:1:1:1:1	3 co-centric squares
		higher version 2
		5x5, 3x3, 1x1 modules

Now the second false image is created out of the original image. Same process as in creating false image one will be followed with a small difference. Black series of pixels are identified and then unlike *false image one*, this time the last black pixel from the series is formatted to white or base color instead of first black pixel in the series.

This is another identical looking image to the original barcode created and thus, called *False Image Two*.

As a result of steps described above, we get three images all identical to each other. But only one image which is original can be read by the *Barcode Readers*.

The false image one is then sent over the network to the destination. After a predefined scheduled time difference, false image two is also sent to the destination. The two images are scanned at the receiver's end and fed to the algorithm decoder.

Summarized Algorithm: (See fig. 7)

Step 1: Create a ***unique*** alpha numeric random number of length 1024 characters corresponding to the message to be secured.

This will allow 62^{1024} different combinations that are infinite.

Step 2: Of this random number, a QR Barcode (Quick Response) Image is generated of size 800 * 800.

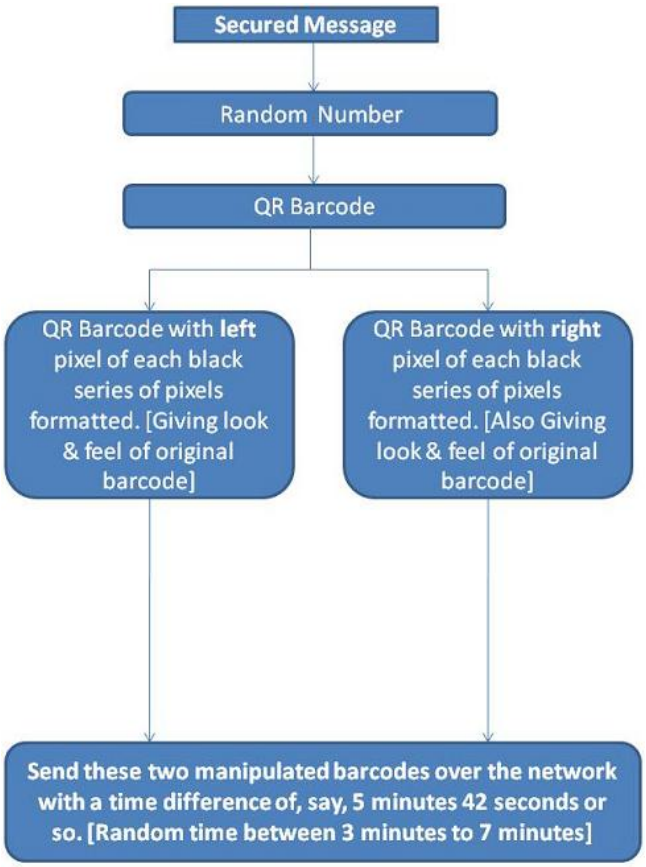

Fig. 7. Proposed Algorithm.

Step 3: Two Barcode images are created from the original barcode image each of size 800*800. One image will be manipulated by inverting one left most black pixel of each black continuous series of black pixels. Likewise, other image will be manipulated by inverting one right most black pixel of each black continuous series of black pixels. This will give the effect of three similar images.

Step 4: These two images are sent to the destination end with the time difference of 3 to 7 minutes (randomly created, on the fly) and the reverse process is followed at the destination to get the secured message.

V. Conclusion

Protection of sensitive information is a growing concern around the globe. Securing critical data in sectors like business, healthcare and military, has become the first priority of sensitive information management. Failing to protect this asset results in high costs, loss of customers and investor confidence and even *threaten national security*.

QR Codes are two dimensional barcodes that can contain any alphanumeric text. Quick Response (QR) codes are versatile. A piece of long multilingual text, a linked URL, an automated SMS message, a business card or just about any information can be embedded into the two-dimensional barcode. Barcodes are used to store the high capacity information in less space and thus, stands as a good ideate.

An algorithm is proposed in this paper which efficiently transfers the data with high security with the aim of able to protect sensitive information. This can be used for very high security data and its complexity makes it more efficient to secure the information. Thus, a competent and innovative way of utilizing the barcode technology is proposed. The system is efficient enough to handle the 1024 characters and leads to completely efficient and reliable results. Image processing makes the system's processing more complex but stands for its application purpose.

VI. Further Work in Progress

The implementation of the design of secure data exchange system is in progress. Also a real time application case study is in progress to its accomplishment. Also the capacity of the barcode can be increased by using color barcode.

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