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Secured Message Transfer through QR Code Process for Document Authentication Systems

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***Abstract*— A phenomenal growth of data has been emerged due to the developments made by Information and Communication Technologies (ICT). Message transmission should be securely processed via Quick Response (QR) codes. QR code is a type of matrix barcode which is used for efficiently store and retrieve the data. Since, a tremendous volume of documents have been published by the organization. The process of securely transmitting those messages via public channel is a challenging task. In this paper, we have proposed a two-level QR code algorithm which transmits the messages via public channel without any adversary's interruption. The QR code holds two levels of storage, viz, storage at public level and storage at private level. The public level is focused on standard QR code process and private level presents the error correction capacity. An experimental results show a perfect restoration of private information. It also highlights the possibility of using this new rich QR code for document authentication.**

***Index Terms*— Information security, Quick Response (QR) code, Encoding, Decoding, Pattern recognition and Private message.**

I. INTRODUCTION

In the digital era, the documents are exchanged over the public channel. It makes the malevolent users to steal the sensitive data in easier way [1]. This insists to develop security model for secured transferring of messages over the internet. Authentication is the security process which engages message transfer between authorized sender and receiver. The message transfer should ensure that messages are not altered or modified. This means that any alteration of the document, however small, should be detectable during the extraction stage. Authentication processes may vary from simple password based authentication system to costly and computation intensified authentication systems [2]. They ensure our privacy, keeping our sensitive information secure. It enforces non repudiation, preventing us from later rejecting the validity of transactions authenticated with our passwords. The username identifies the intended receiver and intended sender and the password validate us. But passwords have some weaknesses: more than one person can possess its knowledge at one time [3]. Moreover, there is a constant threat of losing your password to someone else with venomous intent.

Quick Response (QR) code [4] is the recent technology used for secured communication process. It is a type of barcode matrix which was introduced by Japanese corporation Denso Wave. A barcode is an optical machine-readable data that relates to committed objects. It is linear and one-dimensional in expression. Later, they evolved into rectangles, dots, hexagons and other geometric patterns in two dimensions. Albeit 2D systems use a variety of symbols, they are in general referred to as barcodes as well. It has been used in several applications due to its merits like increase in capacity, reduced size, etc [5]. Combined with the diversity and extendibility offered, it makes the use of QR code more appealing than that of the barcodes. Statistically, QR codes are capable of symbolizing same amount of data in approximately one tenth the space of a traditional barcode. Information such as URL, SMS, contact information and plain text can be embedded into the two dimensional matrix. Moreover, with the explosive increment of the trend to use smartphones has also played an important role in the popularity of QR codes.

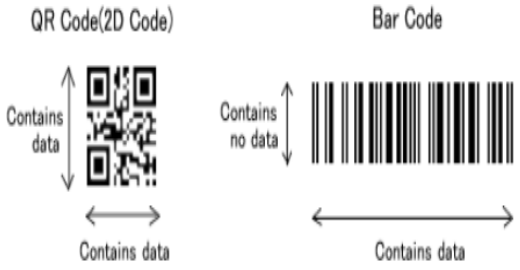

Fig.1. QR code [1]

QR Code is still a growing marketing tool that has not been fully accepted among marketers but with the right strategy it can increase a product's awareness and also drive the engagement between a company and its consumers. It can also assist in building customer database aiding customer relationship management (CRM) [6]. Lack of awareness and how to scan knowledge (application software) are limiting the benefits of QR codes [7]. The rest of the paper is organized as follows: Section II presents the related work; Section III presents the proposed work; Section IV presents the experimental analysis and concludes in Section V.

II. RELATED WORK

This section depicts the prior work carried out by other researchers.

A. *Features of QR code:*

Initially, QR code was introduced by Denso Wave for Japanese Automotive Industry. The unique feature is the formation of print size and high speed reading process. It is certified by International Organization of Standardization (ISO) [8]. At first, it converts the scanned information into binary form. Generally, Reed Solomon error correction code is employed for data encryption systems. 4 levels of error correction code have been deployed where first 2 levels depict the highest level and second 2 levels indicate the lowest level. The features of the QR code are discussed as follows:

- Version: The QR code consists of 40 versions with variant size of QR code where version 1 is 21 *21 modules and version 40 is 177 *177 modules. As the version increases, four times the modules increases.
- Structure of QR code: The QR code contains structures like position patterns, separators, timing patterns etc. Position pattern consists of 3 squares with different symbols. Separators contain white pixels which align to position pattern. Timing pattern contain white and black modules that are located between two position patterns. It tracks the time of incoming code [9].
- Alignment pattern: It assists to correct the distortion occurred during code capturing.
- Quiet Zone: It acts as margin space between 4 bits.
- Version information: It depicts the used version.

B. *Prior works:*

The author in [10] studied about robust image hashing schemes. Author studied and proposed under the name of contextual QR code. It relates to the static QR code information with a particular context. The authors developed a specific application, which takes into account the individual users parameters (time, device type, IP address, location) in order to personalize (add the name of a user, change the language) an output message and to transmit user information into a server database. The author in [11] discussed about the facial biometrics for 2D barcodes systems. A rich set of QR code data is used for enhancing storage capacity enhancements. In order to enhance the storage process, HCC2D code was developed for storage efficiency. It included both color and gray scaled QR code. The author in [12] discussed about the message hiding for QR code which enhanced the security aspects. The message length was devised for hiding the secret message of QR code. The maximum secret message length, mentioned in this paper, is equal to 1215 bytes for QR code V40. There are also some approaches that embed an invisible watermark into the QR code image.

The author in [13] depicts the tamper proofing methods for documents via hashing methods. It enhanced 2D barcode significantly improved the storage process of 2D code. They transmitted the QR code only the black-and-white (B&W) halftone printers and low resolution CDD-based scanners (up to 600 dpi) were used for their experiments. It was discovered that the rate of encoded version of multilevel 2D barcode is approximately 261 byte/cm2 at a bit error rate of 4×10^{-2} in comparison with the rate of Data Matrix approximately equals to 58 byte/cm2. The author in [14] discussed contextual QR code which takes ubiquitous computing into consideration. Context aware QR code is capable enough to help filter information so that the relevant information under the right time at the right place is extracted. QR codes are used for context aware navigation. QR code also acts as a location source in which the physical location of the QR code is encoded inside a uniform resource locator. Context based QR code can also consider proximity apart from location. Proximity based QR codes can be very useful if the location of the user is very difficult to find [15]. As far as private message sharing and document authentication is concerned contextual QR codes keeps a record of the various users attributes.

III. PROPOSED MODEL

This work concentrates over devising the standard QR code encoding capacity. The devised process is achieved by black modules of textured patterns. The aim of the study is to enhance the security of the information in both private and public use. The proposed algorithm is designed by two steps. The first level is about standard QR code reader and second level discusses the characteristics of initial QR code. The proposed step contains two processes, namely, Encoding and Decoding process.

A. *Encoding process:*

The encoding process consists of three steps, namely,

1) *Standard QR code generation:*

Initially, the conventional generation method is used for storing the public content. The traditional QR code process includes the following steps:

- Optimal mode is selected for examining the content of the message.
- The examined message is encoded using shortest string of bits.
- Then, Reed- Solomon code is applied for correcting the errors.
- The encoded data are aligned properly to scan the QR code for further process.
- The mask pattern is applied to read the QR code.
- The codewords are arranged in zigzag pattern of matrix structure.
- Atlast, the function patterns like position tags, alignment, timing, format and version patterns are added to the QR code.

2) *Private Message Encoding*

With the assistance of ECC (n, k), the private message is encoded. It is generally expressed in polynomial form. Secret key is generated for the codeword and then the private message is scrambled.

3) *Generation of 2LQR code*

In this process, the texture pattern is selected for encoded private message. The encoded message is then hided into the pattern using 2 LSB bit. Each encoded message is maintained with reference id. This reference id is also forwarded to the receiver, to easily recognize the authorized

users. These are then patterned into texture modules. Thus, final 2LQR code is generated.

B. *Decoding Process:*

Similarly, the decoding process has the following steps:

1) Authentication

It is the first step of the decoding process. Initially, the receiver enters their id and then matched to the encoder id. If the id gets matched, then encoded 2LQR code is forwarded to the receiver. Atlast, the traditional QR code and texture pattern is extracted.

2) Public message extraction

The public message is extracted at this stage. It is viewed by phone scanner or any scanning device.

3) Recognition

Pattern matching is performed in this step. Private message is extracted from the message hided texture pattern and reference pattern. Descrambling process is applied over the texture pattern to extract the original message.

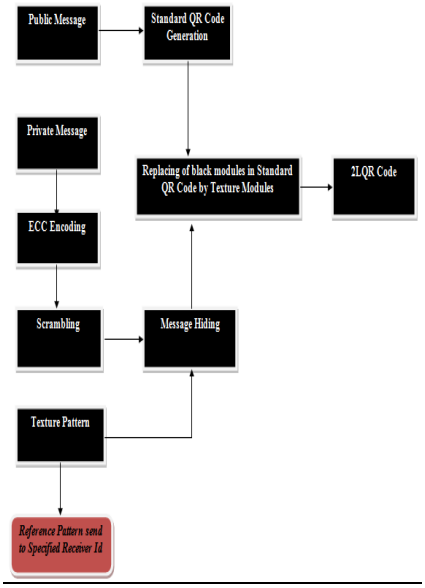

Fig. 2. Proposed Block Diagram for encoding

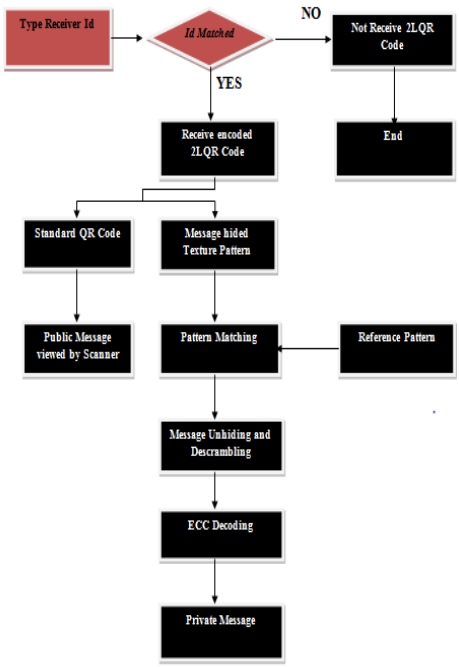

Fig. 3 Proposed block diagram for decoding process

IV. EXPERIMENTAL ANALYSIS AND RESULTS

This section depicts the experimental analysis of the proposed work.

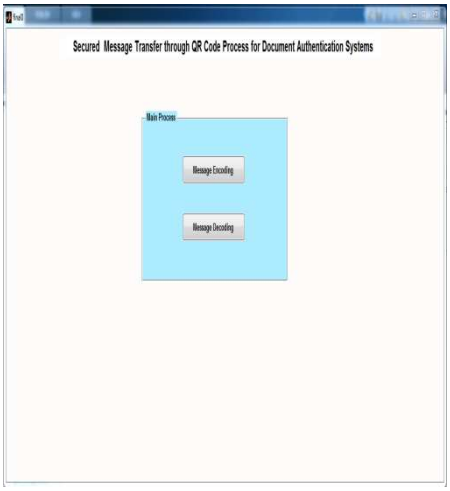

Fig.4. Main System process

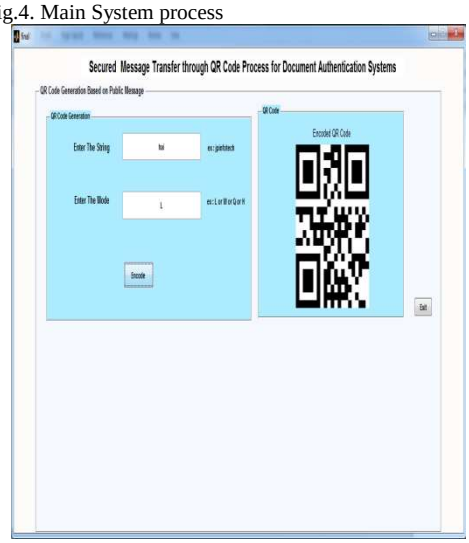

Fig. 5. Generation of QR code

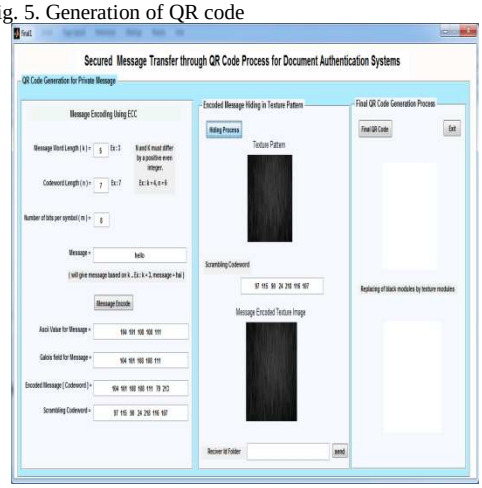

Fig.6. QR code generation for private message using ECC with its texture pattern

Fig.7. Reference id forward to the receiver id

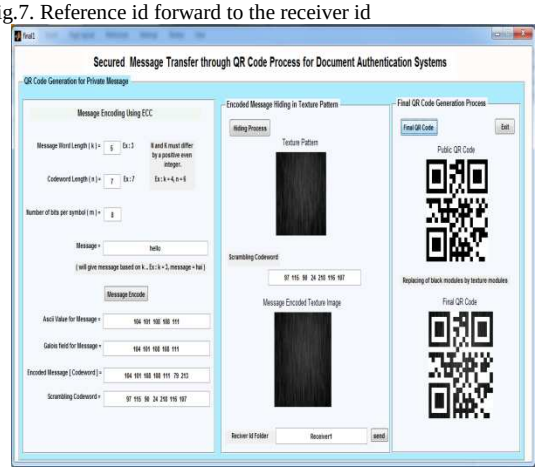

Fig. 8. Final QR code

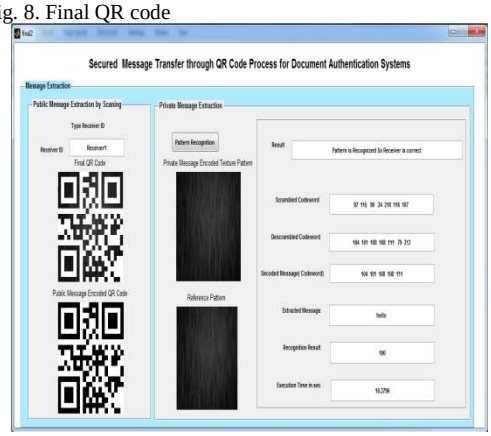

Fig.9. Scanning the public message for performing extraction process. And, the private message is also extracted using decoding process

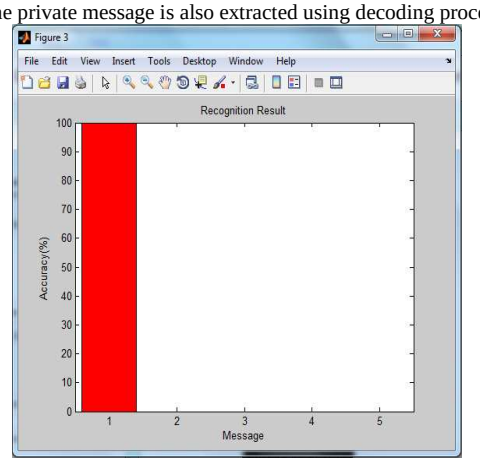

Fig. 10. Accuracy rate of the extracted message

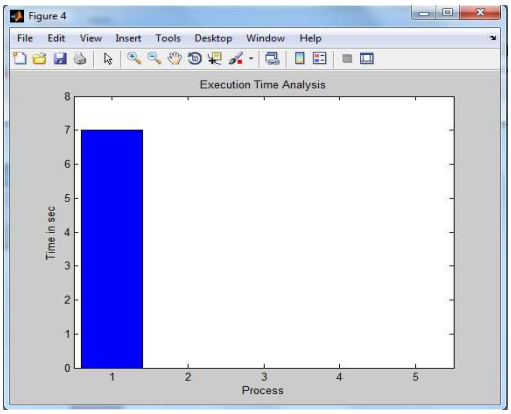

Fig.11. Time taken for message extraction process

V. CONCLUSION

The recent developments towards data computing technologies have enabled to focus on security concern. In this paper a new rich code called two levels QR (2LQR) Code is proposed. This 2LQR code has two levels: a public level and a private level. The public level can be read by any QR code reading application, while the private level needs a specific application with specific input information. This 2LQR code can be used for private message sharing or for authentication scenarios. The private level is created by replacing black modules. With specific textured patterns. These textured patterns are considered as black modules by standard QR code reader. Thus, the private level is invisible to standard QR code readers. In addition, the private level does not affect in anyway the reading process of the public level. The proposed 2LQR code increases the storage capacity of the classical QR code due to its supplementary reading level. Experimental results have shown the efficiency of our proposed model in terms of accuracy of the message extraction and time taken for extracting the messages.

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