A Secure and Optimal QR Code

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ABSTRACT

Barcode are used for storing the different type of data. Today different type of barcode is used for different purpose. In market lots of barcode are available. There are three type of barcode i.e. one dimensional barcode (1D), two dimensional barcode (2D) and three dimensional barcode (3D). In this paper we provide a secure and optimal approach for implementing quick response code in two dimensional barcode.

Keywords: AES, comparison 1D barcode, 2D barcode, QR code, encryption algorithm.

1. INTRODUCTION

A barcode is simply a series of stripes (usually black) on a light back ground (usually white) barcode scanner or in other language representation of the data that is readable by a machine not human being.

Barcode are of three types one – dimensional (1D), two, A barcode is a dimensional barcode (2 D) and three dimensional barcode (3D) [1]. One dimensional barcode store the information in only one direction i.e. horizontal direction. While two dimensional barcode stores the data in two directions. i.e. horizontal and vertical direction.

3D barcode do not use any barcode labels. They are embossed or engraved directly on the product during the manufacturing process [1].

The main advantage of choosing the two dimensional barcode is that it stores more data as compare to the one dimensional barcode. As a result, the data capacity is 100 times more than the 1D barcode [2].

As barcode become popular and their convenience universally recognized, the market began to call for codes capable of storing more information, more character type and that could be printed in a smaller space however these improvement also caused problem such as enlarging the bar code area, complicating reading operation, and increasing printing cost. 2D code emerged in response to these need and problem [3].

This paper presents a brief description of different type of barcode such as one dimensional and two dimensional and type of two dimensional such as stacked barcode and matrix barcode and main focus

is given on QR code then we discuss the related work and proposed approach and conclusion.

In this paper we proposed an approach that provides a secure and optimal approach to generate a quick response code. This algorithm is generally divided in to two steps. The following step is involved:-

Step1- Convert the data into QR code
- When the data is too large then compress the data using compression algorithm.
- For security we encrypt the compressed data.
- After that QR code generated.

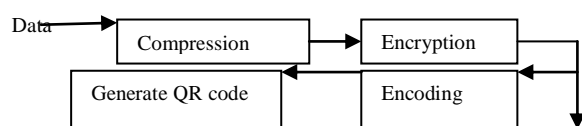These steps are easily understood by flow chart in figure 1.

Fig. 1 Process of creating QR code

Step2- Convert the QR code into data
- After getting the QR code we decrypt the data using decryption algorithm.
- Then decompressed the data.
- After that we get original data.

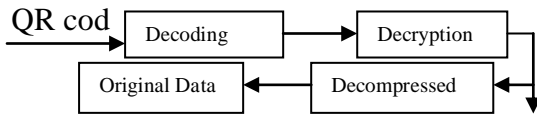These step is easily understand by flow chart in figure 2.

Fig. 2 Process of creating data

2. ONE DIMESIONAL BARCODE

A barcode systematically represent data by varying the width and spacing of parallel lines is known as one dimensional barcode. A linear barcode encode the number and letters in the parallel lines as shown in figure 3. Today linear barcode are used everywhere, such as manufacturing product transportation, retail business, health care and automotive business [4].

Fig. 3 Structure of barcode

2.1 TYPES OF 1D BARCODE

There is different type of 1D barcode. Some of them are given below:-
Universal Product Code (U.P.C), European articles numbering (E.A.N), code 39, code 128[5]

2.2 ADVANTAGE OF 1D BARCODE

1. It is cheap due to the printing cost.
2. It is more reliable because of very low error.
3. It captures the data fast.

2.3 DISADVANTAGE OF 1D BARCODE

The main disadvantage of the one dimensional barcode is that it stores less data as compared to the 2D barcode.

3. TWO DIMESIONAL BARCODE

2D barcode are more powerful as compared to the 1D barcode because it stores the more information as compared to the 1D barcode. Information stored in two direction i.e horizontal as well as vertical. Some other advantage of two dimensional barcode is that the data can be read easily and write correctly. 2D barcode is very popular for communication, public relation and security point of view [6]. The durability of 2D barcode is much high as compared to the ID barcode.

3.1 TYPES OF 2D BARCODE

There are two types of 2D barcode such as stacked 2D barcode and matrix 2D barcode. Stacked 2D barcode are further divided in two category such as code 49 and PDF 417. Matrix 2D barcode are further divided in Data matrix and Quick response code.

3.1.1 STACKED 2D BARCODE
3.1.1.1 CODE 49

The code 49 is a type of stacked 2D barcode as shown in figure 4.and other name of code 49 is USS-49. David Allais developed code 49 for the Intermec Corporation in 1987. It is defined in USS standard. So it is called USS- 49. In code 49 the input can consist of any ASCII data. It is capable to encode full ASCII 128 character set. It is used to encode the lengthy data into a symbol. Each symbol consists of 2 to 8 rows. Each row is consisted of an area of start pattern four data characters encoding eight characters with the last one as a check symbol and as a stop pattern [7]. The minimum height of the code 49 is 0.54 inch.

Fig. 4 Code 49

3.1.1.2 PDF 417

PDF 417 is a stacked two dimensional barcode that is used in different application such as healthcare centre[5], identification card, Manufacturing product, railways and different other system. The full form of PDF is Portable data file. The meaning of 417 is that it consists of 4 bars and space and each symbol is of 17 bit long. It is invented by Dr.Ynjiun P. Wang in 1991. It is also used to encode the large data into a symbol. It is represented in 15438 ISO Standard. There are lot of feature that define what is actual PDF 417. Some of them are given below:-

- There are more symbols that is attached to other symbol which are read in a sequence and more data are stored in PDF 417.
- User decide the length of the row (vertical) and narrowest bar.
- The person can implement easily without any license.

The PDF 417 has a number of rows such as 3 to 90 each of have a linear barcode. Each row has a small area that shows the start of the PDF 417 barcode. A row left codeword identifies the information about the row. A right row codeword store the more information as compared to the row left codeword and then the PDF 417 barcode stop the pattern. It is used a PDF encoding base 929 i.e. 0 to 928. The codeword are just like that the small pieces of small black and white symbol [7]. The diagram of PDF 417 is as shown in figure 5.
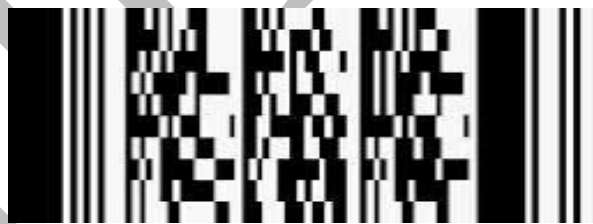

Fig. 5 Structure of PDF417

3.1.2. MATRIX 2D BARCODE
3.2.2.1 DATA MATRIX BARCODE

Data matrix is an example of matrix of 2D barcode as shown in figure 6. It was developed by company RVSI Acuity Chi Matrix [7]. It encodes the data or information into a picture has a small white and black rectangular or square cell. The other name of the data matrix code is sema code. Data size is from a few bytes to 1.5 KB. When more number of cells is these in matrix code, then the length of the original data is large. The length of the data depends on the cell in the code. Error correction code is also used to correct the code if there is some problem. But it is used only when the error is minimized. Even if one or more cells are damaged then the information is not useful.

A data matrix symbol store up to 2355 alphanumeric character , 3116 numbers, 1556 binary and 778 kanji characters. It is mainly used to encode the large amount of data. It is two dimensional matrix codes with very high density. Symbol size varies from version to version such as 9*9 and 49*49 in the old version Error correction code (ECC), ECC 000-140 and 10*10 to 144*144 in the new version ECC 200. The comparison between the different standard of ECC is as shown in Table 1.

Table 1 Comparison of ECC 000-140 AND   ECC 200

S. no	ECC 000-140	ECC 200
1.	Oldest version	Newer version
2.	Ex: ECC 000, ECC 050 , ECC 080, ECC140	Ex: ECC 200
3.	Symbol has odd no. of rows and column such as 9*9 to 49*49.	Symbol has even no. of rows and column such as 10*10 to 144*144.

Data matrix uses the ISO/IEC 16022:2006 standard.

Fig. 6 Data matrix barcode

APPLICATION OF DATA MATRIX
It is used in-
1. Encoding the large amount of data.
2. Aerospace, Electronic, and Automotive Industry.
3. Medical and Health Industry.
4. Mobile Marketing.
5. Logistic Purpose.

3.1.2.2 QUICK RESPONSE CODE
QR stands for Quick Response code. It is a two dimensional Matrix barcode. It was developed by the Japanese Corporation Denso Wave in September in 1994. Firstly QR code is generally used in automotive industry but now days it is used for fast readability and stores the large data. In the QR code the data store in both the direction horizontal and vertical. It stores the 100 times greater information as compared to traditional barcode.

In QR code, data is accessed by capturing a photo of the code using a special device such as barcode reader and processing the image to get a data [8].

A QR code is capable of holding the more data such as 7089 numeric character, 4296 alphanumeric character, and 2953 binary bytes, 1817 Kanji or Chinese character or mixture of all character [9]. It can read

in any direction such as 360. It can encode the information, image or sound. In past years QR codes generally used in china in ticketing system. A capacity of QR code is shown in Table 2.

It is increased by more than 20% than the other two dimensional barcode on the efficiency of the character representation. It has following extra feature such as ultra fast response, portable offline application database, letter, character, images etc. The completed standard of the QR code is ISO/IEC 18004.

Table 2 character of QR code

S. no.	Character name	Character number
1.	Numeric character	7089
2.	Alpha numeric character	4296
3.	Binary	2953
4.	Kanji	1817

The figure 7 of the QR code is given below [8]:-

Fig.7 Image of QR code

STRUCTURE OF QR CODE

QR code consists of black and white cell, the white cell is background and black cell is also known as module. These cells are arranged in square or rectangle. QR code has five fields such as finder pattern, alignment pattern, timing pattern, Quiet zone and data area. Figure 8 shows the structure of QR code [10].
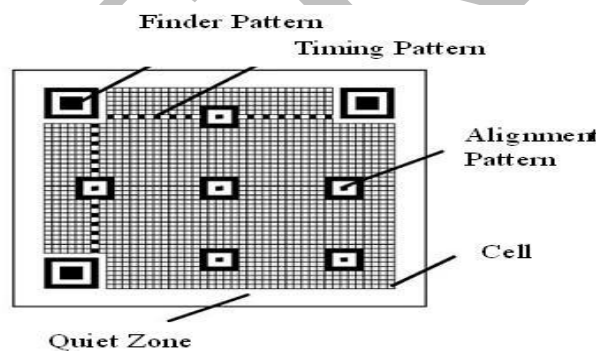

Fig. 8 Structure of QR code

Every field has of great importance. Each QR code symbol has mainly two features such as encoding region and function pattern. A function pattern has following three pattern such as finder pattern, timing pattern, and alignment pattern. These three patterns does not encode the data. The size of the QR code depends on the information to information 21*21 cells to 177*177 cells increments in both directions [11].

1. Finder pattern: It consists of three square matrix that are located in upper right, upper left and lower left. Each pattern is based on 3*3 matrixes. 7*7 matrixes, 9*9 matrixes. The position can be used for detecting the position, size and angle of the QR code.

2. <u>Alignment pattern:</u> Previous version do not have alignment pattern. But when the size of the information is increased then the alignment pattern are added. The pattern is actually used for correcting the distortion of the symbols.
3. <u>Timing pattern</u>: It is arranged in both the direction such as horizontal and vertical. A pattern for identifying the central point of each cell in the QR code.
4. <u>Quiet zone</u>: The margin space necessary to read the accurately barcode. Generally four cells are
5. <u>Data area</u>: QR code encodes the data in terms of 0 and 1 in form of black and white cells and is arranged in various encoding algorithm.

The capacity of the QR code that depends on several factors QR code generally stores more information as compared to other traditional barcode such as PDF 417 and data matrix.

ADVANTAGE OF 2D BARCODE
- High density information
- Store large information
- Store information in both direction
- Allow error correction

DISADVANTAGE OF 2D BARCODE
If we need to read the information that are stored in QR code its more difficult because it use some special type of scanner.

APPLICATION OF QR CODE
It is used in various fields such as
- Storing URLs
- Business cards
- Public transport vehicle
- Signature
- Logistic management
- Ticketing system
- Authentication
- Catering orders
- Security application etc.

4. COMPARSION BETWEEN PDF417, DATA MATRIX AND QR CODE
 There is a various type of the 2D barcode such as PDF 417, data matrix and quick response code. There is various differences in these three type of two dimensional barcode. But in these three two dimensional barcodes, Quick response barcode are more beneficial to store the information in two direction horizontal and vertical.

The difference in these three type of barcode are given in Table 3.

The main focus on this paper is generate a quick response code because quick response code store the 7089 numeric character , 4296 alphanumeric character , 2953 binary bytes , 1817 kanji or Chinese character or mixture of these character.

While the other code such as data matrix store the 3116 numeric character , 2355 alphanumeric character , 1556 Binary bytes and 778 Kanji characters and other two dimensional barcode such as stacked PDF417 barcode store the data 2710 numeric character, 1850 alpha numeric character , 1018 binary bytes and 554 Kanji character .

5. COMPARSION BETWEEN ONE DIMESIONAL BARCODE AND TWO DIMESIONAL BARCODE
There is a various type of barcode such as 1D, 2D and 3D. These codes are used for different purpose in market. The difference in 1D and 2D are given in Table 4.

6. RELATED WORK

In past few years, new types of two dimensional barcode are developed such as quick response code. Quick response code is used in ticketing the train of china and India in 2009. The QR Forest is two dimensional barcode which user can change the position shape [11]. Previously we use a barcode for authentication purpose. But now a day's QR application use in smart phones to store the data, first we capture the data or image then store, after that we display it. Generally 2D barcodes are not useful for security purpose, because smart phone has a feature that directly scan the QR code and get data.

Table 3 Comparison between various barcode

S.No	Feature	PDF 417	Data Matrix	QR Code
1.	Design	Stacked	Matrix	Matrix
2.	Direction	Upward or downward	Full direction	Full direction
3.	Photo electrical Sensor	Japan or US	Japan	China
4.	Max. Capacity	1KB	1.5 KB	3 KB
5.	Type	1D	2D	2D
6.	Source	USA	USA	Japan
7.	Advantage	High capacity	High capacity, small size	High capacity, small size and error correction
8.	Application	Office	Plant and Medical Industry	All Industry
9.	Standard	AIML,ISO	AIML,ISO	AIML,ISO
10.	Image			

Table 4 Comparison between 1D and 2D

S.no.	Feature	1D BARCODE	2D BARCODE
1.	Other Name	Linear Barcode	Two Dimension
2.	Pattern store information	Horizontal	Horizontal and vertical
3.	Store Information	Small	Big
4.	Density	Low	High
5.	Information type	Number & English	Number, Chinese, English, Pictures e.t.c
6.	Dependence database	Yes	No
6.	Correction function	No	Yes

So everyone can read the information. When we talk about Credit card detail such as username, password for an account that is vulnerable to theft. So we need to hide this information . So before the generate of the QR code first we encrypt the various data, that data is not directly read by special scanner if read then user is not able to understand it. There is various type of encryption algorithm such as Data Encryption Standard (DES), Triple Data Encryption Standard (TDES), Advanced Encryption Standard (AES), etc. There are

various sites that directly generate the data but that data is not secure because any one can read it. So our main purpose to generate a QR code after encrypting the data.

7. PROPOSED APPROACH

We proposed an approach to generate a secure `and optimal QR code. When the data is too large then we need to first compress the data using various compression algorithms such as lossy and lossless algorithm. But we use the lossless algorithm because in lossless algorithm there are no losses of any kind of information after compression.

When we compress the data then we need to provide a secure QR code. So for this purpose we use encryption algorithm such as DES, AES, and TDES etc. We need to encrypt the compressed data using this algorithm.

But we used the AES because it provides the more security as compared to other algorithm.

In encryption we can use the AES algorithm because of several reasons-

DES is an old way to encrypt the data, the information is easily read by the people who intercepting the traffic. So DES is replaced by AES because AES used the symmetric key in both end so its broken is more difficult as compared to DES.

We use the lossless compression algorithm because when we use lossless compression then decompressed data is exactly received but when we use lossy compression algorithm there is no guarantee decompressed data that allow the exact data.

8. CONCLUSION

In this paper we proposed an approach that generates a quick response code using various algorithms. 1st we compressed the data 2nd encrypt the compressed data and 3rd encode it and 4th we generate a Quick response code. And if we get a original data first data are decrypted and then decompressed using various algorithm.

We will consider I-Card System for a private secret agency as a real case scenario for the implementation of our work.

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