INTERNATIONAL JOURNAL OF ADVANCE RESEARCH AND DEVELOPMENT

(Volume2, Issue5)

Available online at www.ijarnd.com

Removing Blurness in Picode Using Enhanced Modulation

Greeshma G. S[1], Dr. Noble Marie Juliet .A[2]

[1] *Final Year Student of M.Tech Computer Science and Engineering, Department of Computer Science and Engineering, Jawaharlal College of Engineering and Technology, Lakkidi, Kerala, India*

[2]*Professor and Head of the Department, Department of Computer Science and Engineering, Jawaharlal College of Engineering and technology, Lakkidi, Kerala, India*

ABSTRACT

The appearance of a conventional 2D barcode pattern is often too obtrusive for integrating into an aesthetically designed advertisement. This is because of the fact that they didn't provide perceptual quality and decoding robustness of the encoded images. Besides, no human readable information is provided before the barcode is successfully decoded. There proposes a new picture-embedding 2D barcode, called PiCode, which mitigates these two limitations by equipping a scannable 2D barcode with a picturesque appearance. PiCode is designed with careful considerations on both the perceptual quality of the embedded image and the decoding robustness of the encoded message. Comparisons with existing beautified 2D barcodes show that PiCode achieves one of the best perceptual quality for the embedded image, and maintains a better trade-off between image quality and decoding robustness in various application conditions. The generation of PiCode thus enhances the customers to scan the code using their mobile phones in order to retrieve the data that carries behind them

.

Keywords: 2D barcode, PiCode, Perceptual Quality, Decoding Robustness.

I. INTRODUCTION

The barcode is an optical machine-readable representation of data that are relating to the object to which it is committed. Primitively the barcodes represented data by varying the widths and spacing of parallel lines and is referred to as linear or one-dimensional. Later these are evolved into rectangles, dots, hexagons and other geometric patterns in two dimensions. Although 2D systems use a variety of symbols, they are in general referred to as barcodes. A QR code stands for Quick Response Code, which is the trademark for the type of the matrix barcode that was invented by the Japanese corporation Denso-Wave. A QR code has a number of features such as high capacity data encoding and damage resistant, high-speed reading, little print out the size, providing 360-degree reading and structural flexibility of an application. QR codes have already taken the popularity of classical barcode in different areas because of some advantages like high capacity, small size, etc. Combined with diversity and extensibility offered, it allows the use of the QR code more appealing than that of barcodes. QR codes are capable of symbolizing the same amount of data in one-tenth the space of traditional barcode. The information such as URLs, SMS, contact information's and plain texts can be embedded into two-dimensional matrix.

In order to rectify the problems in existing barcodes, a new picture-embedding 2D barcode, called PiCode is used, which mitigates the limitations by equipping a scan-able 2D barcode with a picture like an appearance. A PiCode is designed with some careful considerations on the perceptual quality of embedded image and decoding robustness of the encoded message. Comparisons with existing 2D barcodes the PiCode achieves one of the best perceptual qualities and maintains a better trade-off between image quality and decoding robustness in different application conditions. Scanning volume of a picture embedding QR code is three times higher than that of a traditional QR code.

The key aspects of the PiCode system, compared with the existing 2D barcode are summarized as follows.
1) Major encoding enhancements for maintaining greater perceptual quality for the embedded image:

a) An adaptive modulation scheme that adapts modulation energy to local image intensity will be used. As compared with binary modulation scheme in conventional 2D barcodes, the adaptive modulation scheme reduces the image distortion that was introduced by the data modulation operation.

b) Unlike a QR code and a Data Matrix code, no fixed pattern is inserted in the interior region of a PiCode in order to avoid the degraded pattern that degrades the appearance of an embedded image.

2) Major decoding enhancements for achieving higher decoding robustness in the presence of embedded image:

a) Under the absence of some fixed patterns in the interior region of a PiCode, the module alignment accuracy will be sensitive to the performance of the corner detection scenario, which aims to locate four corners of barcode image that make use of some fixed patterns in the exterior region of the barcode. Here uses a coarse-fine corner detection algorithm and also a module alignment scheme that exploits the previous information on a PiCode structure that accurately locate each and every module for demodulation.

b) The conventional demodulation algorithm initially binarizes the barcode image and samples the central pixel of all binarized module to obtain a demodulated bit decision. There proposes a demodulation scheme which utilizes the intensity of all pixels of each module for demodulation decision.

This paper also tries to reduce the blurriness of existing PiCode. This can be achieved by adding Quadrature Phase Shift Keying - Orthogonal Frequency Division Multiplexing (QPSK)-OFDM) modulation along with adaptive modulation. The output obtained from the source and channel coding result bit stream of data. These data are taken as input to QPSK-OFDM [9] modulator. In this type of modulation, the input message is reshaped for Modulation. Then QPSK modulated data is created. Inverse Fast Fourier Transform (IFFT) of four subcarriers is created. IFFT is used to convert frequency domain data into the time domain. Then appends a prefix to each subcarrier. Finally, generates OFDM signal to be transmitted. This is given as message input needed for adaptive modulation. Further steps are preceded as in normal adaptive modulation scheme to generate PiCode. At last comparisons are performed depending on the MS-SSIM value difference while using these two modulation techniques.

2. LITERATURE REVIEW

A QR Code is a Matrix-like code and was developed in Japan by Denso Wave to help for tracking automobile parts throughout production. The QR code [6] technology has been around for over a decade but has become popular as a medium for marketers to reach in smartphone users. Quick Response Codes (QR Codes) are nothing new. The security [8] of a one-dimensional (1D) barcodes is smaller than that of 2D barcodes. 1D barcodes are easy to read by scanning lines and the spaces. 2D barcodes are not easy to read by human eyes. With regard to readability, 1D barcodes should scan along in a single direction. If the angle of scan lines will not fit within a range, the data would not read correctly. However, 2D barcodes must get wider ranges of angles for scanning. The difference between the two is in the amount of data they can hold.

Bar codes are one-dimensional codes and can only hold nearly 20 numerical digits, whereas QR codes are 2D matrix barcodes that can hold 7,089 numeric characters and 4,296 alphanumeric characters, and 1,817 Japanese (kanji) characters. Their ability will hold more information and ease of use makes them practical for shorter businesses. When we scan or read a QR code with our iPhone, Android or other camera-enabled smartphones, we can link to digital content on the web and activate a number of phone functions such as email, instant messages, and SMS and connect the mobile device to a web browser. Any of these functions are easily achieved by creating our QR code. It is a simple process of entering an appropriate data into QR code generators. It can be read by using the camera of smartphones, and it may instantly redirect them user to a web page. QR Codes are machine readable. This means that the human looking to the code is unable to determine the contents behind it. QR Codes are used in a variety of ways to market business, to provide some information's on a product or a service by encoding general texts, URLs, phone numbers etc.

Barcodes become widely popular because of their reading speed, accuracy, and functionality characteristics and their convenience universally recognized. As a result, different efforts were made to increase the amount of information stored by the bar codes, such as increasing the number of barcode layout. This improvement also causes problems such as enlarging the area of the bar code, complicating the reading operations, and increasing the printing cost. A 2D Code emerges in response to these needs and the problems. The QR code can be formed from multiple barcodes. QR Code is a kind of 2D (two-dimensional) code that primary aim of being a symbol that is interpreted by a scanner equipment. QR Code contains information in both the vertical and horizontal directions, whereas a bar code normally contains the data in one direction only. QR Code holds a greater volume of information than that of a bar code.

With increasing popularity of smartphones, the Quick Response Code become a popular form for acquiring information of specific object or event in our daily life and some numerous applications are built based on the QR codes. An original framework of QR code aims to embed a machine- readable messages with tolerance in error, and the appearance of a resulting 2D matrix looks like a random pattern. Since the QR codes are encoded using a Reed-Solomon (RS) error-correcting codes, the QR scanner does not see every pixel accurately while decoding its contents. This error correction mechanism enables it possible to generate few errors and it enables the QR code designer to change the QR code appearance to some extent. In the past years, the designers have tried to beautify the QR code by adding the elements or recognizable visual contents [11]. Generally, the designers target on two kinds of variants in order to make the original QR code visually pleasant. This means the changing the shape or color of modules and embedding the picture into the QR code. Embedding a picture into QR code [10] will easily convey the characteristics of QR code owner and would impress the viewer highly. For example, if a QR code is generated for accessing our personal homepage, then embedding our own portrait into it will make the QR code visually unique and also representative. A two-stage QR code beautifier not only ensures the decode ability but also preserves the most visual semantics of an embedded content in the near real-time.

With an increase in the number of smartphones is the reason behind the popularity of QR code [2]. The smartphones are being capable of decoding and accessing the online resources as well as it has a high storage capacity and almost high speed of decoding. The QR codes are hence used in various applications, such as accessing websites, initiating phone calls, reproducing videos or open text documents. A big problem of QR codes is it looks like noisy. To improve some appearance of a QR code and to reduce the noisy black and white random texture that has generated a great interest for algorithms that are capable of embedding the QR codes into images without losing the decoding robustness. There are many efforts in order to improve the appearance of those embeddings. The main challenge of the embedding method is that the embedded result should be decodable by a standard application.

A suitable color barcode framework for mobile phone application is used by exploiting a spectral diversity afforded by cyan (C), magenta (M), and yellow (Y) print colorant channels that commonly used for color printing and a complementary red (R), green (G), and blue (B) channels respectively, that are used for capturing the color images [3]. A color is a common image property that was frequently leveraged in order to increase the information density and 2-D color barcode designs. The majority of color barcodes provide an increased data rates as compared to 2D monochrome barcode by encoding the data in a color of small shapes such as triangles or rectangles. Data are independently encoded in three monochrome bar codes those are then combined as cyan (C), magenta (M), and yellow (Y) colorant channels within a single print leading to a three-fold increasing data rate as compared with the corresponding monochrome barcode. The data in C, M, Y colorant channels are decoded from corresponding complementary red (R), green (G), and blue (B) sensor channels. To overcome the s effects of unavoidable inter-colorant interference, there uses a model-based interference cancellation procedure which is computationally inexpensive and thus provides an improvement in significant performance.

There is the difficulty that lies indirectly apply an existing binarization approaches to the barcode images that are captured by mobile device due to their low quality [5]. A new scheme used for the binarization of such images can be used. The barcode and background regions are differentiated by a number of edge pixels in the search window. Unlike an existing approach that center the pixels to be binarized with a fixed size window, there uses a shift on the window center to the nearest edge pixel so that the balance on the number of objects and background pixels can be achieved. The window size is thus adaptive either to the minimum distance to edges or to the minimum element width in the barcode. The threshold is calculated by using the window statistics. This method uses its capability in handling the non-uniform illumination problem and the variation of size in objects. It is very difficult to use a single threshold in order to binaries the barcode images that are captured by mobile devices under uncontrolled lighting conditions.

Data Matrix is a matrix (2D or two-dimensional) barcode [7] which are printed as a square or rectangular symbol made up of individual dots or squares. This representation is an ordered grid of dark and light dots bordered by a finder pattern. The finder pattern is partly used for specifying the orientation and structure of the symbol. The data are encoded using a series of dark or light dots based upon a predetermined size. The minimum size of these dots is known as the dimension X. 2D barcode consists of white and black geometric modules that alternately arrange in vertical and horizontal directions according to certain rules and it is a symbol with a larger capacity for storing some information. As the 2D bar code with the smallest size in the world, data matrix codes are widely applied to electronic product components. Camera-based readers are the newest type of code readers. This type of readers uses a small video camera for capturing an image of the code.

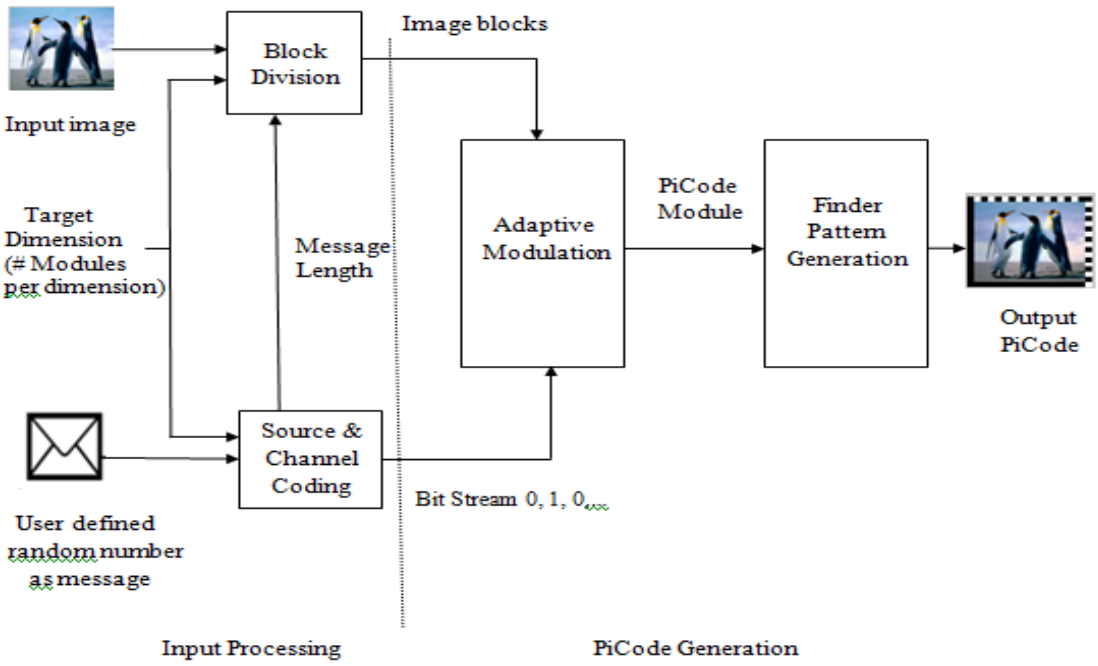
Digital image processing techniques are then used to decode the code. However 2D barcodes are not sufficient for scanning because of less perceptual quality and lack of visual content in it. QR code is a popular form of barcode pattern which is ubiquitously used to tag the information of products or for linking advertisements. While it is essential to keep the patterns that are machine readable; on the other hand, even smaller changes to the patterns can easily render them unreadable. Hence, in the absence of any computational support, such QR codes appear as random collections of black or white modules and are often visually unpleasant. An approach to producing high-quality visual QR code is called halftone QR code that combines the halftone images with QR codes. Since the QR codes often take up a non-negligible display area, there will be a growing demand for producing visually appealing QR codes. Such codes will incorporate high-level visual features such as colors, letters, illustrations, or logos that are referred to as visual QR codes. However, by creating a visually interesting QR code without compromising its readability being non-trivial. A key challenge arises due to the lack of proper understanding or by analytical formulations that capture the stability, this means, and the validity of QR codes under variations in lighting and under camera specifications. In the Halftone QR code [4], a set of binary halftone patterns is used in order to replace the original black-and-white modulation of QR code pattern.

An automatic method is to embed the QR codes into color images with a bounded probability of detection error. These embeddings are then compatible with a standard decoding application and also can be applied to any color image with full coverage area. The QR information bits are hence encoded into the luminance values of an image, taking the advantage of the immunity of QR readers against local luminance disturbances. To mitigate the visual distortion of this QR image [2], the algorithm utilizes the halftoning masks for the selection of some modified pixels and nonlinear programming techniques for locally optimizing luminance levels [2].

3. MODULE DESCRIPTION

The proposed PiCode scheme mainly consists of three modules. They are PiCode encoding, PiCode decoding and enhanced PiCode modulation.

a. PiCode Encoding using Adaptive Modulation.



PiCode encoding procedure is divided into two parts: the input processing and PiCode generation. In the first part, an input message is converted into a bit stream with source coding and channel coding. This ensures better efficiency and robustness of the encoded message. For that, the message is taken as a randomly generated numbers. Again we take an input image and are divided into a 2D grid of image blocks depends on the user's input on the number of each module per dimension. Each block consists of k x k pixels. Block division can be

done by dividing the source image into 16 X 8 blocks and perform the fusion. For taking the input, initially, all files with extension .jpg are taken out. Then an image is read from that specified location and is stored in a particular variable. For simplicity, the input image is resized into a particular dimension such as of dimension 64 X 64. After that, the image is converted to grayscale if the image is true color. The conversion is done for processing the image more fastly. In PiCode generation part, the pixels containing in each image blocks are modified by an adaptive modulation scheme. Thus each image block will convey a bit '0' or '1'. Finally, finder pattern layer of one module wide is added into the exterior region of modulated 2D grid of image blocks will form the PiCode. The following describes the channel coding and the modulation schemes that are essential in balancing the decoding robustness and the perceptual quality. The goal of channel coding is to protect information bits against errors after demodulation step. In PiCode, the Reed-Solomon (RS) code over a finite field Galois Field, GF is used. The code rate will be adaptive to the message length or on the number of information bits. If the input message is shorter, the code rate will be smaller and hence the stronger error correction capability, and vice versa. This is done to maximize the error correction capability under a specified pattern size and on a message length. The PiCode encoding is shown in figure 1.

b. PiCode Decoding

In PiCode decoding stage, initially, the captured PiCode image will be converted to a grayscale one and is then binarized to facilitate the search for potential barcode regions that are then checked against detection criterion. If the check is passed, there obtain the four corners. Otherwise, the image should be rejected and the decoding process should be re-initiated with another image frame. Based on barcode corner locations, the perspective distortion is then estimated and compensated on the gray level image.

For module alignment step, the region for each and every PiCode module is obtained based on the broken line parts of the finder patterns. The demodulation process is the reverse of the modulation process by checking the intensity differences between inner and outer parts of each module. The modulated bit in each module can be retrieved by demodulation operation. Finally, the message can be obtained by applying and source and channel decoding to the demodulated bits. The following figure 2 shows the complete decoding process.

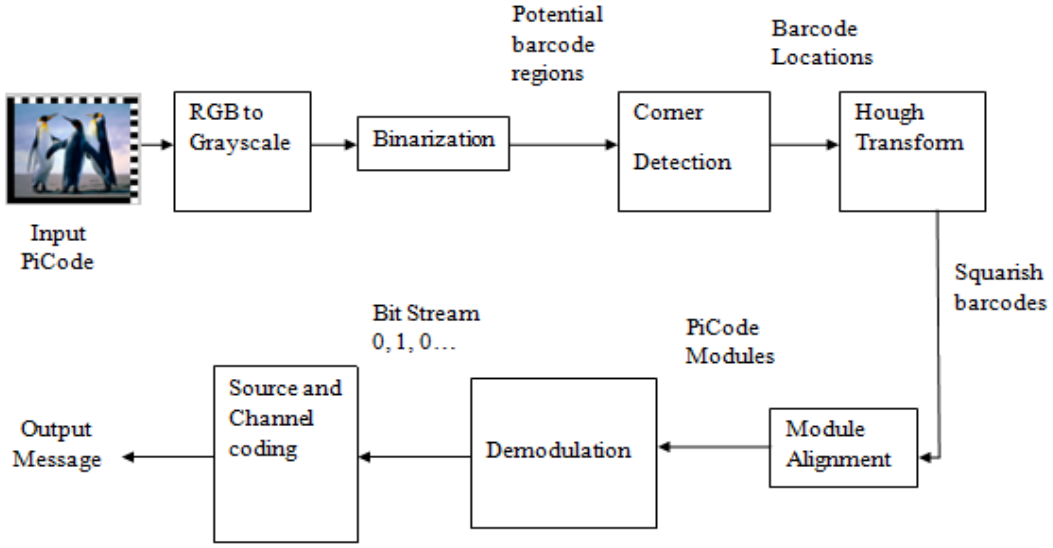


Fig-2: PiCode decoding

In this part, there mainly cover the corner detection, module alignment and demodulation steps that reflect the major contributions.

1) Coarse-Fine Corner Detection scenario: The corner detection algorithm will locate the four extreme corners of the barcode from the captured image.
2) Module Alignment step: This step slices the barcode region into blocks of images with reference to white and black alternations in 'q'-shape pattern.
3) Demodulation: In demodulation step, each module that is received from module alignment step is first analyzed in order to retrieve the data bit.

c. Enhanced PiCode Modulation

There is a slight variation that was used in adaptive modulation enables to increase the MS-SSIM value of new PiCode. This can be achieved by adding Differential Phase Shift Keying (DPSK) modulation along with

adaptive modulation shown in figure 3. For that, after Reed-Solomon encodes the eight packets, The encoded packets are reshaped for easier conversion of decimal data to the binary form. Left MSB data are taken and are doubled for using it in adaptive modulation technique. After executing the code, it seems that the MS-SSIM value of PiCode generated using enhanced adaptive modulation is better than that of MS-SSIM value of PiCode generated using normal adaptive modulation.

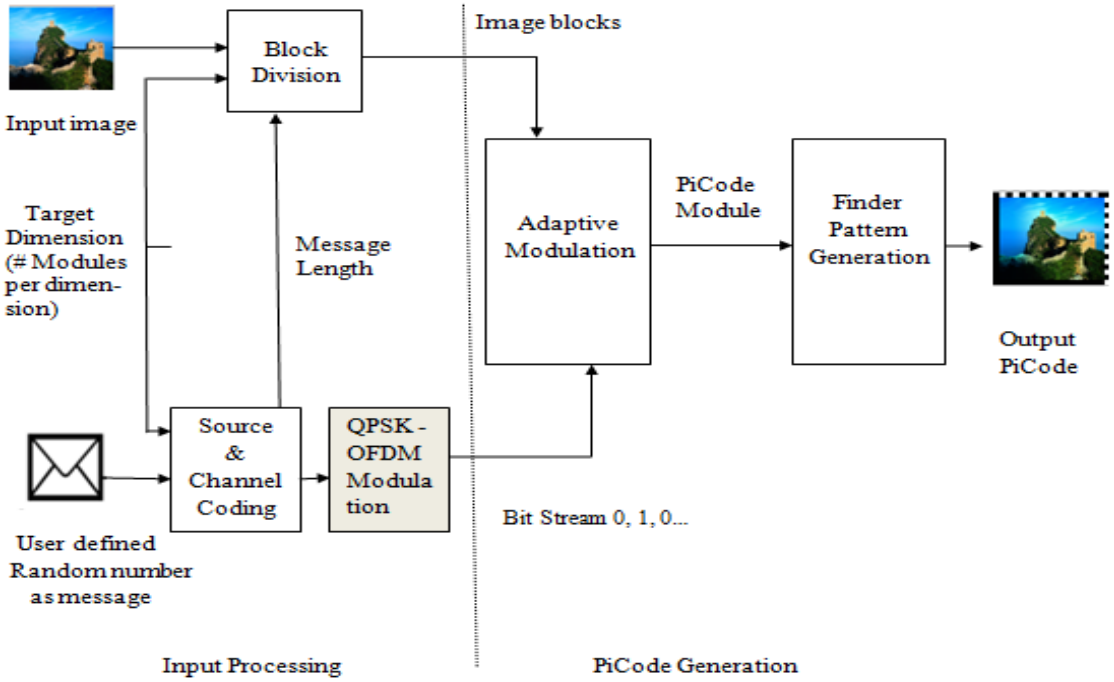


Fig-3: Enhanced PiCode Modulation

The following table shows that the MS-SSIM values of PiCode generated using enhanced adaptive modulation is higher than that of normal adaptive modulation.

Table -1: Comparing MS-SSIM values of PiCodes generated using both Modulations

Image	MS-SSIM value (Adaptive Modulation)	MS-SSIM value (Enhanced Modulation)
1. Dr. Kalam	0.9923	0.9956
2. Mandril_gamlo	0.9255	0.9319
3. Great wall	0.9118	0.9374
4. Lincoln	0.9755	0.9757
5. Red rose	0.8720	0.9397
6. Desert	0.9723	0.9850
7. Panda	0.2814	0.2821

4. CONCLUSION

A novel picturesque 2D barcode is named as the PiCode. Comparing with existing beautified QR codes, it provides one of the best perceptual quality in preserving the aesthetic appearance of embedded image, while maintains the decoding robustness of the encoded images. Here no fixed patterns are inserted in the interior region of PiCode. This enables to reduce the images distortion. It is achieved by the design of barcode pattern and better decoding algorithms. The PiCode is thus designed with less obtrusive fixed patterns in order to avoid the distortions on the embedded image and a modulation scheme which represents the data bit value adaptively with the intensity of embedded image. There uses an adaptive modulation scheme for the encoding process. The DPSK reduces blurriness highly in QR code. So by using QPSK-OFDM along with adaptive increases the MS-SSIM value of PiCode, Hence the perceptual quality can be further improved. This ensures that the scanning volume of PiCode from the customer is highly improved.

5. REFERENCES

[1] **Changsheng Chen, Wenjian Huang, Baojian Zhou, Chenchen Liu, and Wai Ho Mow** (2016), PiCode: a New Picture-Embedding 2D Barcode", *IEEE Transactions on Image Processing*, DOI 10.1109/TIP.

[2] **G. Garateguy, G. Arce, D. Lau, and O. Villarreal** (2014), "QR images: optimized image embedding in QR codes," *IEEE transactions on image processing*, Vol. 23, no. 7, pp. 2842–285.

[3] **H. Blasinski, O. Bulan, and G. Sharma** (2013), "Per-colorant-channel color barcodes for mobile applications: An interference cancellation framework," *IEEE Transactions on Image Processing*, vol. 22, no. 4, pp. 1498–1511.

[4] **H.K. Chu, C.S. Chang, R.R. Lee, and N. J. Mitra** (2013), "Halftone QR Codes," *ACM Trans. Graph*., vol. 32, no. 6, pp. 217:1–217:8.

[5] **H. Yang, A. Kot, and X. Jiang** (2012), "Binarization of Low-Quality Barcode Images Captured by Mobile Phones Using Local Window of Adaptive Location and Size," *IEEE Transactions on Image Processing*, vol. 21, no. 1, pp. 418–425

[6] **Kinjal H. Pandya1, Hiren J. Galiyawala** (2014), "A Survey on QR Codes: in the context of Research and Application," *International Journal of Emerging Technology and Advanced Engineering*, Volume 4, Issue 3.

[7] **L.S.Khedekar, Dr.A.S.Alvi** (2013), "An Effective Technique to Protecting Sensitive Information Using 2d Data Matrix," International *Journal of Scientific and Research Publications*, Vol. 3, Issue 1.

[8] **Sankara Narayanan A** (2012), "QR Codes and Security Solutions," *International Journal of Computer Science and Telecommunications*, Vol 3, Issue 7.

[9] **Shwetarani R. Kurhade, Panchal J.R** (2016), "QR code transmission using QPSK-OFDM," *Proceedings of 26th IRF International Conference*.

[10] **Swapnil Mahajan, Nisha Wankhade** (2013), "Image Embedding in QR Code," I*nternational Journal of Science and Research (IJSR)*, Index Copernicus Value.

[11] **Y.H. Lin, Y.P. Chang, and J.L. Wu** (2013), "Appearance-Based QR Code Beautifier," *IEEE Transactions on Multimedia*, vol. 15, no. 8, pp. 2198–2207.

