# PICODE: A NEW PICTURE-EMBEDDING 2D BARCODE

[1]Prof. Akshay Agrawal, [2]Pravin R. Unde, [3]Omkar K. Patil, [4]Dinesh R. Devkule

*[1]Asst. Professor, [2,3,4]BE Student Computer Engg. Dept. SSJCET, Asangaon, India.*

*[1]akshay1661@gmail.com, [2]krishnaunde0@gmail.com, [3]patil.omkar280@gmail.com, [4]dineshdeokule@gmail.com*

**Abstract— Nowadays, 2D barcodes are commonly used as an interface to connect customers and advertisement contents of companies. However, the pattern of a 2D barcode is more obtrusive for integration into an advertisement. Besides, human readable content is provided after successfully decoding of barcode takes place. Proposed System is a new picture-embedding 2D barcode also called as a PiCode, which overcomes these two limitations by providing a scannable 2D barcode with a picturesque appearance. PiCode is designed with careful consideration 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 of the embedded image, and maintains a better trade-off between image quality and decoding robustness in various application conditions. PiCode has been implemented in Matlab on a PC and a few key building blocks have also been ported to iOS and Android platforms. Its practicality for real-world applications have been demonstrated successfully.**

**Keywords—2D barcode, embedded picture, perceptual quality, decoding robustness.**

## I. INTRODUCTION

Nowadays, 2D barcodes are commonly used in the advertisement of a business as a bridge to link the offline and online contents. In these applications, a 2D barcode is encoded with a promotion link of a product is attached to an advertisement to connect customer and their mobile phone with increase in computational power and image capability is employed as a 2D barcode capturing and decoding device. Potential customers can conveniently retrieve further information about an advertisement by scanning the barcode with their mobile phones. This process simply involves an appropriate barcode scanning mobile application software and pointing the phone camera towards barcode.

However, the traditional 2D barcodes, such as QR code and Data Matrix code are not originally designed for mobile barcode applications. Firstly, they are of binary appearance which is not perceptually attractive and are too obtrusive to be integrated with colorful and aesthetic advertisement contents. Secondly, no visual hint about the encoded information content is provided before a successful decoding accomplished. These two issues limit the Potential customer`s interest in scanning the barcode and lowering the chance of successful customer engagement.

A recent report shows that the scanning volume of a picture-embedding QR code is three times more than that of the traditional QR code. Therefore, designing of the image-embedding 2D barcode with the customer engaging application is a problem of practical significance. Proposed system is a novel picture-embedding 2D barcode, called PiCode, with corresponding decoding algorithm.

## II. LITERATURE SURVEY

### *A. Barcode readers using the camera device*

This paper shows new implementations and the algorithms of image reorganization for QR barcodes in cell phones. The mobile phone system used here consists of a camera, digital signal processor, mobile application processor, and display device, and the source image is captured by the camera device. The introduced algorithm is based on the spiral scanning for 1D barcode and code area found by four corners detection for 2D barcode using the embedded Digital Signal Processor This algorithm is robust for practical situations and the DSP has god enough performance for the real-time recognition of the codes.

### *B. QR images: optimized image embedding in QR codes*

Optimized image embedding in QR code is an automatic method to embed QR codes into color images with bounded probability of detection error. These embedding are compatible with standard decoding application and can be applied to any color image with full area coverage. QR information bits are encoded into the luminance values of the image. To mitigate the visual distortion of the QR image, the algorithm utilizes halftoning mask for the selection of modified pixels and nonlinear programming techniques to optimize luminance levels locally. A tractable model for the probability of error is develop and models of the human visual system are considered in the quality metric used to optimize the luminance levels of the QR image.

 

### *C. Two-dimensional barcode decoration based on real-coded genetic algorithm*

This paper proposes a system for decorating 2-dimensional barcode with some illustrations inside the code without detract machine-readability and stored information. The proposed system formulates the task of finding appropriate positions, scales, and angles of illustration, and solves the task by using real-coded genetic algorithm, also uses multiple barcode decoder with the aim of improving decode feasibility of the decorated barcode. Experiments have show that the real-coded genetic algorithm can decorate barcodes with three illustrations, and that using more than one decoder can improve decoding feasibility of the decorated barcodes.

### *D. Appearance-based QR code beautifier*

QR (Quick Response) code is a widely used matrix barcode with the increasing population of smart phones. However, QR code usually consists of random textures which are not suitable for incorporating with other visual designs. In order to overcome the shortcomings of noise-like looks of QR codes, This paper propose a systematic QR code beautification framework where the visual appearance of QR code is composed of visually meaningful pattern selected by user, and more importantly, the correctness of message decoding is kept intact. It makes QR code from machine decodable only (standardized random texture) to a personalized form with human visual pleasing appearance.

## III. COMPARATIVE STUDY

Table 1: Comparative Study

| *SR. NO.* | *PAPER TITLE* | *AUTHOR'S NAME* | *PROBLEM* | *SOLUTION* |
|---|---|---|---|---|
| 1. | QR code(2005)-Barcode | Technical Corrigendum | Its Black and White pattern is non-attractive | Embedding of image is the Solution to overcome this. |
| 2. | Optimized Image Embedding in QR Codes | Gonzalo J. Garateguy, Gonzalo R. Arce and Daniel L. Lau | Leads to degradation in the decoding performance . | Embedding Image over DataMatrix code |
| 3. | Halftone QR Codes | Hung-Kuo Chu, Chia-Sheng Chang and Ruen-Rone Lee | Introduces dark or bright dot-like patterns in the embedded images | Simply lowering the contrast or size of dot-like pattern |
| 4. | Two-Dimensional Barcode Decoration Based on Real-Coded Genetic Algorithm | Satoshi Ono,Kensuke Morinaga and Shigeru Nakayama | Due to inappropriate location of images barcode decoding is quite Complicated | Appropriate embedding of image over the barcode reduces decoding time |
| 5 | Visually Significant QR codes by Image Blending | Zachi Baharavv and Ramakrishna Kakarala | It looks like transparent Image on black and white dots which is no more attractive | Sets the intensity of the central patch of image pixels to a dark or bright level according to the encoded bit value. |

## IV. PROPOSED SYSTEM

The proposed PiCode system is described with the novel aspects of the encoding and decoding algorithms. For the encoding part, the details of the modulation scheme will be presented to show how PiCode preserves the perceptual quality of the embedded image while minimizing the interference of the latter incurred on the modulation waveform. For the decoding part, the algorithms for performing detection of corners, module alignment and demodulation.

### *A. PiCode Encoding*

The process of PiCode encoding can be divide in two parts: input processing and PiCode generation. In the first part, the input message is converted into a bit stream with source coding and channel coding to improve the efficiency and robustness of the encoded message. The input image is then divided into a 2D grid of image blocks according to the user's input on the number of modules per dimension. Each module contains k x k pixels. In the PiCode generation part, the pixels in each image block are modified by the proposed adaptive modulation scheme so that each image block conveys a bit '0' or '1'. Finally, a layer of finder pattern of one module wide is added to the exterior of the modulated 2D grid of image blocks to form the PiCode.

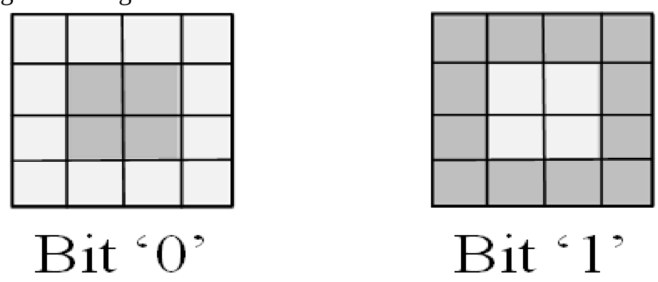


 

**Fig 1. Image block of bit '0' & '1'**

The proposed modulation scheme divides a module into a block of bi-level pixels. For illustration purpose, the module size is set as 4 x 4 pixels which is the minimum printed/displayed size per module to guarantee theoretical readability. The actual module size is adaptive to the resolution of the embedded image and the number of barcode modules per dimension. The pixels of a module are separated into the inner and outer parts, and the inner part is of size 2 x 2 pixels. If the inner part has a higher intensity, bit '1' is encoded. Otherwise, bit '0' is encoded.

### *B. PiCode Decoding*

First, the captured PiCode image is converted to grayscale and is binarized to facilitate the search for the potential barcode regions which are then checked against the detection criteria. If the check is passed, the four corners are obtained; otherwise, the image will be rejected and the decoding process will be reinitiated with another image frame. Based on the barcode corner locations, the perspective distortion is then estimated and compensated on the gray level image. For the module alignment step, the region for each PiCode module is obtained based on broken line parts of the finder patterns. The following demodulation process is the reverse of the modulation process by inspecting the intensity differences between the inner and outer parts of each module. The modulated bit in each module is retrieved by the demodulation operation. Finally, the message is obtained by applying channel and source decoding to the demodulated bits. : In the demodulation step, each received module resulted from the module alignment step is analysed to retrieve the data bit. The picode demodulation scheme is designed according to the modulation scheme.

## V. ALGORITHM

- Proposed System involves both Encoding and Decoding Algorithm for PiCode.
- The finder pattern of PiCode is similar to that of the Data Matrix code.

### *PICODE ENCODING*

The PiCode encoding process can be divided into two parts:

- Input processing :

1) The input message is converted into a bit stream with source coding and channel coding
2) The input image is then divided into a 2D grid of image blocks according to the user's input on the number of modules per dimension.

- PiCode generation:

1) Divide a module into a block of bi-level pixels.
2) the module size is set as 4 x 4 pixels which is the minimum displayed size per module
3) The pixels of a module are separated into the inner and outer parts, and the inner part is of size 2 x 2 pixels.
4) If the inner part has a higher intensity, bit '1' is encoded. Otherwise, bit '0' is encoded.
5) The image contrast C of an input image block $I_0$ at pixel location (i; j) is calculated.
6) The adaptive intensity parameter $\Delta_I$ is then computed with image contrast C and quality parameter $\lambda$.
7) The embedded intensity $I_e(i,j)$ is computed accordingly with $\Delta_I, I_0(i,j)$ and corresponding bit value B$(i,j)$.
8) The modulation in the pixel intensity is then calculate.
9) Color component of embedded image modified with the least perceptual differences when compared with the original colors.
10) Perform the modulation operation in the YUV color space which treats the chrominance and luminance components independently.
11) A layer of finder pattern is added to the exterior of the modulated 2D grid of image blocks to form the PiCode.

### *PICODE DECODING*

1) PiCode image is converted to grayscale image.
2) Converted grayscaled image is then Binarized.
3) Search for the potential barcode regions which are checked against the detection criterion.
4) If the check is passed, the four corners are obtained else, the image will be rejected.
5) Based on the barcode corner locations, the perspective distortion is then estimated and compensated on the graylevel image.
6) The region for each PiCode module is obtained based on broken line parts of the finder patterns.
7) Inspect the intensity differences between the inner and outer parts of each module.
8) Retrieve the Demodulated data bit from each module.
9) Finally,the Message is obtained by applying channel and source decoding to the demodulated bits.

## VI. MATHEMATICAL MODEL

1)The Calculation of Adaptive Intensity Parameter can be formulated as:

$$\Delta_I = \left[\frac{C+\eta}{\lambda}\right].\lambda + \epsilon_O$$

for inner pixels

$$= \left[\frac{C+\eta}{\lambda}\right].\lambda + \epsilon_I$$

for outer pixels

Where,

$\Delta_I$=Adaptive Intensity Parameter
$C$ =Image Contrast
λ =Quality Parameter(by default 25)
η =Small Constant(set as 0.1)

1)The Contrast based demodulation operation is formulated as

$$\hat{B}(m,n) = sgn[\overline{\mathcal{M}_I}^{(m,n)} - \overline{\mathcal{M}_O}^{(m,n)}]$$

Where,

 

$(m, n)$=Indices of the targeted Module

$\hat{B}(m, n)$= Demodulated bit

$\mathcal{M}_I^{(m,n)}, \mathcal{M}_O^{(m,n)}$=Inner and outer pixel

$sgn()$=Extract the sign of operand

$\overline{\mathcal{M}_I}^{(m,n)}, \overline{\mathcal{M}_O}^{(m,n)}$= Average Intensities of pixels

## VII. SYSTEM ARCHITECTURE

### PiCode Encoding

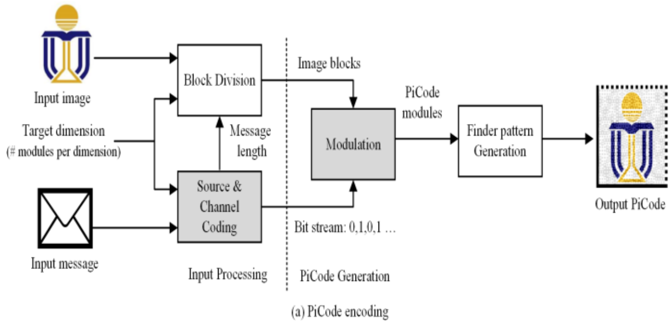


**Fig 2. System Architecture of PiCode Encoding**

Above Figure shows the block diagram of the PiCode encoding procedure. Generally speaking, the PiCode encoding process can be divided into two parts: the input processing and the PiCode generation. In the first part, the input message is converted into a bit stream with source coding and channel coding to improve the efficiency and robustness of the encoded message. The input image is then divided into a 2D grid of image blocks according to the user's input on the number of modules per dimension. Each module contains k x k pixels. In the PiCode generation part, the pixels in each image block are modified by the proposed adaptive modulation scheme so that each image block conveys a bit '0' or '1'. Finally, a layer of finder pattern of one module wide is added to the exterior of the modulated 2D grid of image blocks to form the PiCode.

### PiCode Decoding

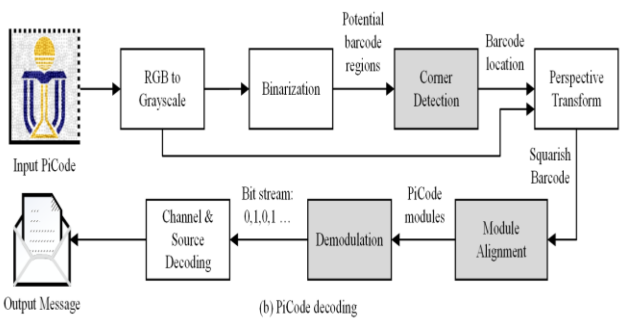


**Fig 3. System Architecture of PiCode Decoding**

The demodulation process is the reverse of the modulation process by inspecting the intensity differences between the inner and outer parts of each module. The modulated bit in each module is retrieved by the demodulation operation. Finally, the message is obtained by applying channel and source decoding to the demodulated bits. This part mainly cover the corner detection, module alignment and demodulation steps which reflect major contributions. Finally Using Channel and Source coding to obtain the output message.

## VIII. SCREENSHOTS

### PiCode Encoding

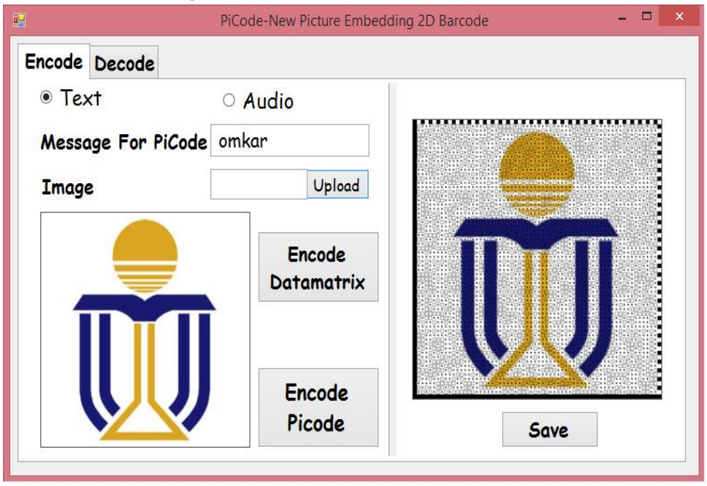


**Fig 4. Screenshot of PiCode Encoding**

Enter the text in textbox or upload audio in an application and then upload image for generating a Picode then click Encode button after which the result is displayed on the screen. Firstly it takes text or audio as a input and convert it into data matrix code, then the image is taken as a input and convert it in the picode. Then user can save the image and can be decode in any machine having PiCode decoding application.

### PiCode Decoding

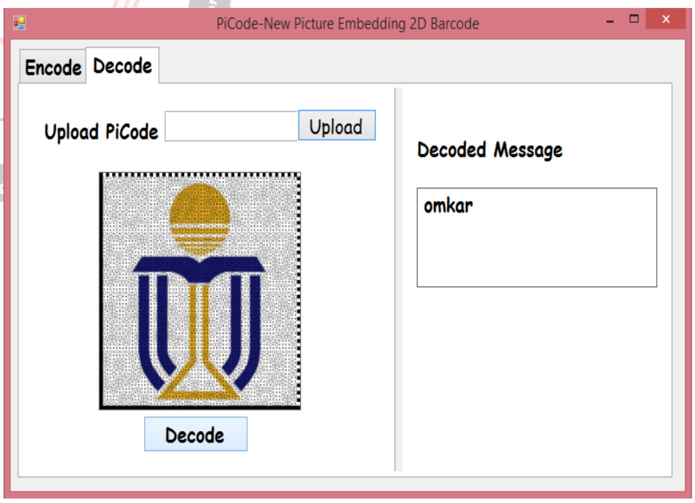


**Fig 5. Screenshot of PiCode Decoding**

For decoding, upload a picode image and click on Decode button after which encoded text or audio is successfully displayed. Firstly we can upload the encoded image in decoding section. Then it will automatically calculated if the encoded image is for text or image. Output window of decoding section changes as per calculation. For text it only shows the region for displaying the message. And for audio there are two options one is for playing the audio and another is for saving that audio. Then after decoding process the encoded data is display on screen.

 

## IX. CONCLUSION

We have tried to implement the paper "Changsheng Chen, Wenjian Huang", "PiCode: A new picture-embedding 2D barcode", IEEE Trans. on Image Process., May 2016 And according to implementation the conclusion is, PiCode is a novel picturesque 2D barcode. Comparing with existing beautified QR codes, it provides one of the best perceptual quality while maintaining the good appearance of the embedded image, while maintaining the decoding robustness. It is achieved by the design of barcode pattern and better decoding algorithms. The PiCode is designed with less part of fixed patterns to completely avoid distortions on the embedded image, and a modulation scheme which represent the data bit value adaptive with the intensity of the embedded image. The decoding process also been developed to guarantee decoding robustness including coarse-fine corner detection, module alignment with barcode structural information and demodulation with information from all pixels in each module. Comparisons with the existing beautified QR codes by experimental results show that PiCode has maintained a better trade-off between the perceptual quality and the decoding robustness.

## REFERENCES

[1] W. Huang and W. H. Mow, "PiCode: 2D Barcode with Embedded Picture and ViCode: 3D Barcode with Embedded Video," in Proceedings of the International Conference on Mobile Computing and Networking, ser. MobiCom '13, 2013, pp. 139–142.

[2] E. Ohbuchi, H. Hanaizumi, and L. Hock, "Barcode readers using the camera device in mobile phones," in International Conference cyberworld, Nov 2004, pp. 260–265.

[3] J. McCune, A. Perrig, and M. Reiter, "Seeing-is-believing: using camera phones for human-verifiable authentication," in IEEE Symposium on Security and Privacy, May 2005, pp. 110–124.

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

[5] G. Garateguy, G. Arce, D. Lau, and O. Villarreal, "QR Images: Optimized Image Embedding in QR Codes," IEEE Transactions on Image Processing, vol. 23, no. 7, pp. 2842–2853, July 2014.

[6] S. Ono, K. Morinaga, and S. Nakayama, "Two-dimensional barcode decoration based on real-coded genetic algorithm," in IEEE Congress on Evolutionary Computation, June 2008, pp. 1068–1073.

[7] D. Samretwit and T. Wakahara, "Measurement of Reading Characteristics of Multiplexed Image in QR Code," in International Conference on Intelligent Networking and Collaborative Systems (INCoS), Nov 2011, pp. 552–557.

[8] T. Wakahara and N. Yamamoto, "Image Processing of 2-Dimensional Barcode," in International Conference on Network-Based Information Systems (NBiS), Sept 2011, pp. 484–490.

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

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

[11] Z. Baharav and R. Kakarala, "Visually significant QR codes: Image blending and statistical analysis," in IEEE International Conference on Multimedia and Expo, July 2013, pp. 1–6.

[12] "ZXing, Multi-format 1D/2D barcode image processing library," Available at https://github.com/zxing/zxing/.

 