Implementation of PiCode Using Embedded 2D Barcode System for Ecom application

Nikita Katakwar

Student, CSE, SSPACE, Wardha, MS(India)

Email-nikitakatakwar05@gmail.com

ABSTRACT

A 2D barcodes have been widely used as an interface to connect potential customers. However, appearance of 2D bar code is often too noticeable for integrating into an aesthetically designed advertisement. It is impossible to get any information regarding that 2D bar code until not decoded. This paper is proposed a new picture-embedding 2D bar code. picture-embedding 2D bar code is designed with careful considerations on both the perceptual quality of the embedded image and the decoding robustness of the encoded message. This system contain two part, one is bar code encoding and other is bar code decoding. it provides one of the best perceptual quality in preserving the aesthetic appearance of the embedded image, while maintains the decoding robustness. Comparisons with the existing beautified 2D barcodes show that picture-embedding 2D bar code achieves one of the best perceptual qualities for the embedded image, and maintains a better trade-off between image quality and decoding robustness in various application conditions.

Index Terms—**2D Barcode Detection, embedded picture, perceptual quality.**

1. INTRODUCTION

A barcode is an optical, machine-readable and used it for representation of data; the data usually describes some information about the object that carries the barcode. Barcodes is represent data by varying the widths and spacing of parallel lines, and it may be referred to as one-dimensional bar code. After few years two-dimensional (2D) codes were developed, using rectangles, dots, hexagons and other geometric patterns represent in two dimensions, usually called 2D barcodes. Barcodes originally were scanned by special optical scanners. Later applications software became available for devices that could read images [1]. 2D Barcodes became commercially successful when they were used to automate supermarket systems, a task for which they have become almost universal. Their use has spread to many other tasks that are generically referred to as automatic identification and data capture (AIDC). The very first scanning of the now ubiquitous Universal Product Code (UPC) barcode was on a pack of Wrigley Company chewing gum in June 1974.

QR code (Quick Response Code) is the trademark for a type of matrix barcode first designed for the automotive industry in Japan. A QR code uses four standardized encoding modes to efficiently store data; extensions may also be used. The QR code system became popular outside the automotive industry due to its fast readability and greater storage capacity compared to standard UPC barcodes. Applications include product tracking, item identification, time tracking and general marketing.

A QR code consists of black squares arranged in a square grid on a white background, which can be read by an imaging device such as a camera, and processed using Reed–Solomon error correction until the image can be appropriately interpreted [2]. Then required data is extracted from patterns that are present in both horizontal and vertical components of the image. QR codes storing addresses and URLs may appear in magazines, on signs, on buses, on business cards, or on almost any object about which users might want information. Users with a camera phone equipped with the correct reader application can scan the image of the QR code to display text, contact information, connect to a wireless network, or open a web page in the telephone's browser. QR codes also may be linked to a location to track where a code has been scanned. Either the application that scans the QR code retrieves the geo information by using GPS and cell tower triangulation (aGPS) or the URL encoded in the QR code itself is associated with a location.

Traditionally designed 2D bar code such as QR code or Data matric are not designed for mobile application. Firstly, they are of binary appearance which is not perceptually attractive and are too obtrusive to be integrated with colourful and aesthetic advertisement contents. Secondly, there is no visual hint about whatever encoded data content is provided before a successful decoding is accomplished. These two issues limit the customer interest in using 2D bar code and reduce the chances 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 [3]. Therefore, designing a superior picture-embedding 2D barcode for the customer engaging applications is a problem of practical significance.

2. Literature Review of Beautified QR Code

This section gives review on previously made conventional 2D bar code system, QR code system and some of existing beautify QR code system, some of which are currently in practical usage.

BARCODE is a representation of digital data that are encoded in it and can be read using an optical machine. Due to its advantage over human performance in accuracy, speed and so on, barcode technology is used extensively. Once the traditional 1D barcode was developed, people started to think of developing 2D barcodes[4]. 2D barcodes can be formed using simple geometrical shapes such as square, circle, hexagon, triangle and so on, rather than using adjacent parallel lines. Moreover, the need to maximize data capacity of the barcode, led to the development of 2D barcodes such as Quick response (QR) codes and color barcodes. A QR code is a graphical representation of data in vertical and horizontal positions over a fixed space. For example, the Microsoft's High Capacity Color Barcode (HCCB) or the tag barcode. has the data density of 16,000 bits per square inch which is three times larger than data density in QR barcodes[5]. Nowadays, application of QR code can be seen in airport boarding pass, retail shops, company logo and so on.

QR Images: Optimized Image Embedding in QR Codes introduces the concept of QR images [6], an automatic method to embed QR codes into colour images with bounded probability of detection error. These embedding are compatible with standard decoding applications and can be applied to any colour image with full area coverage. The QR information bits are encoded into the luminance values of the image, taking advantage of the immunity of QR readers against local luminance disturbances. To mitigate the visual distortion of the QR image, the algorithm utilizes halftoning masks for the selection of modified pixels and nonlinear programming techniques to locally optimize luminance levels. A tractable model for the probability of error is developed and models of the human visual system are considered in the quality metric used to optimize the luminance levels of the QR image. To minimize the processing time, the optimization techniques proposed to consider the mechanics of a common binarization method and are designed to be amenable for parallel implementations.

Visually significant QR codes: Image blending and statistical analysis in this paper QR codes are widely used as a means of conveying textual information [7], such as emails, hyperlinks, or phone numbers, through images that are interpreted using a smartphone camera. The codes take up valuable space in print media. The random appearance of QR codes not only detracts from the production values of the advertisement in which they appear, but the codes are also visually insignificant in the sense that a human cannot discern the vendor, brand, or purpose of the code just by looking at it, without the aid of scanning software. Though neither the aesthetics nor the visual significance of the code matter for scanning purposes, they do matter for advertising layout and, more importantly, can provide valuable brand distinction. In this paper, we show how the visually significant QR codes may be obtained by image blending. Unlike various ad-hoc methods that have been proposed by others, our method leaves completely intact the error correction budget of the code.

As 2D barcodes become more and more popular, their new applications, like mobile marketing, give a strong motivation for embedding visual information in them. Information stored on a 2D barcode, being printed on paper or shown on a display device, can be delivered to people via a camera phone with suitable decoding software. The barcoding system can be viewed as a communication system with key functional modules, including channel coding, modulation, channel estimation, demodulation and channel decoding. By applying advanced communications principles, a way to integrate a picture into a 2D barcode (called PiCode) is developed [8]. By extending the idea, a way to integrate a video clip into a series of 2D barcodes (called ViCode) is also developed. To realize PiCode and ViCode, new modulation and demodulation schemes are designed. Based on our channel estimation technique, a new decoding scheme for low-density parity-check codes is devised to provide more robust error rate performance than traditional 2D barcodes.

In general, the second approach is more favourable for two reasons. First, the perceptual quality of the embedded image is better since it introduces less image distortion [9]. Second, the error correction capability of a barcode is not largely compromised as compared to the first approach. However, we observe that the existing customized modulation schemes are not optimized in achieving the trade-off between perceptual quality and decoding robustness for the following reasons:

The modulation of the beautified QR codes using the second approach introduces dark or bright dot-like patterns in the embedded images. However, to achieve better perceptual quality by simply lowering the contrast or size of such dot-like patterns increases the probability of demodulation error, as also pointed out in [10]. A less “impulsive” or dot-like modulation pattern is potentially less obtrusive and may achieve a superior trade-off. The demodulation performance heavily depends on the binarization algorithm which is designed based on the assumption that there exist the same amount of black and white pixels in every local window of a selected size. While this assumption is adopted in many stateof-the-art binarization algorithms[11], it may often be invalidated by the content of the embedded image, which is not restricted.

Given the aforementioned limitations in the existing beautified QR codes, a new picture-embedding 2D barcode achieving a better trade-off between the perceptual qualities and decoding robustness is needed. This is also what motivate us to propose the PiCode scheme.

3.THE PROPOSED PICODE SYSTEM

The proposed PiCode system is described with an emphasis on the novel aspects of the encoding and decoding algorithms. For the encoding part, the details of the modulation scheme will be presented to illustrate 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 corner detection, module alignment and demodulation will be described.

This paper has designed a novel picturesque 2D barcode, named the PiCode. Comparing with existing beautified QR codes, it provides one of the best perceptual quality in preserving the aesthetic appearance of the embedded image, while maintains the decoding robustness. It is achieved by the design of barcode pattern and better decoding algorithms. The PiCode is designed with less obtrusive fixed patterns to avoid distortions on the embedded image, and a modulation scheme which represents the data bit value adaptively with the embedded image intensity. On the other hand, some key steps of the decoding process have also been developed to guarantee the decoding robustness including the coarse-fine corner detection, module alignment with barcode structural information and demodulation with information from all pixels in each module [12].

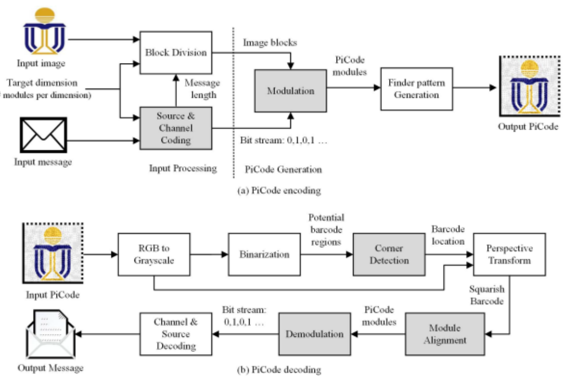

Fig.1.The block diagrams of the PiCode encoding and decoding procedures. The contributions of this work are focused on the shaded blocks.

PiCode Encoding

Fig. 1(a).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 block consists of $k \times k$ 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. In the following, we describe the channel coding and the modulation schemes which are essential in balancing the decoding robustness and perceptual quality[8]. The goal of channel coding is to protect the information bits against errors after the demodulation step. In PiCode, a Reed-Solomon (RS) code over the finite field GF*(*28*)* is adopted. The code rate3 is adaptive to the message length (or the number of information bits). The shorter the input message, the smaller the code rate (and hence the stronger error correction capability), and vice versa. This is designed to maximize the error correction capability under a given pattern size and message length (Unlike QR code has four present error correction levels to guarantee the robustness under different operation conditions). To ensure decoding robustness, the maximum code rate is set as 5*/*6 which ensures that the code is capable of correcting one erroneous byte out of every 12 bytes. For the modulation scheme, the aim is to represent a message, e.g., bit '0' or '1', by varying some physical parameter (e.g. intensity) of the modulation waveform. In this part, we present a modulation scheme with considerations on the trade-off between decoding robustness and perceptual quality[12]. For the color components of the embedded image, they should be modified with the least perceptual differences when compared with the original colors. We perform the modulation operation in the YUV color space which treats the chrominance and luminance components independently. During color rendering, the two chrominance components, U and V, should be kept the same as the original ones so that the perceptual difference between the original and modulated colors are minimized, while the luminance component (Y) is modified according to the proposed modulation scheme represented by Eq. (1).

Ie(i, j)= {I0(i, j)−(−1)B(i,j)· I, for inner pixels
{ I0(i, j)+(−1)B(i,j)· I R , for outer pixels

PiCode Decoding

Fig. 1. (billustrates the steps for PiCode decoding process. 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 criterion. If the check is passed, the four corners are obtained; otherwise, the image will be rejected and the decoding process will be re-initiated with another image frame. Based on the barcode corner locations, the perspective distortion is then estimated and compensated on the graylevel 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, then message is obtained by applying channel and source decoding to the demodulated bits[13]. In this part, we mainly cover thecorner detection, module alignment and demodulation steps which reflect our major contributions.

Coarse-Fine Corner Detection: The corner detection algorithm locates four extreme corners of the barcode from the captured image. This is a non-trivial task due to various image distortions, such as uneven illumination, perspective distortion, blurriness and complex background structures.

Module Alignment*:*The module alignment step slices the barcode region into image blocks with reference to the black and white alternations in the '_'-shape pattern is illustrated . Each block corresponds to one module which is then input to the succeeding demodulation step. The accuracy of the module alignment step is therefore critical to the decoding performance. The slicing operation depends on the broken line'_'-shape pattern, as also used in the Data Matrix code.

Demodulation: In the demodulation step, each received module resulted from the module alignment step is analyzed to retrieve the data bit. The demodulation scheme is designed according to the modulation scheme described. Before the demodulation operation, each module is first resampled with the bilinear interpolation into 8 × 8 pixels since it is the minimum size required for our demodulation algorithm, luminance change, e.g., a sharp edge and a corner.

To demonstrate the practicality of the proposed PiCode, we have implemented our algorithm in PC. With an unoptimized Matlab implementation on a PC with Intel i5 CPU and 8 GB ram, a PiCode with embedded image of size 512 × 512 pixels can be encoded within 1 second. It costs ∼1.4 seconds to decode a low capacity PiCode image captured with a resolution of 720×720 pixels, while the decoding time takes ∼2.1 seconds for the high capacity version.

4.CONCLUSION

This paper has designed a novel picturesque 2D barcode, named the PiCode. It is achieved by the design of barcode pattern and better decoding algorithms. The PiCode is designed with less obtrusive fixed patterns to avoid distortions on the embedded image, and a modulation scheme which represents the data bit value adaptively with the embedded image intensity. On the other hand, some key steps of the decoding process have also been developed to guarantee the decoding robustness including the coarse-fine corner detection, module alignment with barcode structural information and demodulation with information from all pixels in each module. To evaluate its practicality, the PiCode system has been implemented in Matlab on a PC. The perceptual quality and the decoding robustness of the PiCode system have been successfully demonstrated. In the future, the unobtrusive pilot symbols will be embedded into the PiCode center to serve as center alignment pattern and training symbols for the camera response function. Hopefully, a lower BEP in the demodulation process can be achieved.

REFERENCES

[1] W. Huang and W. H. Mow, "*PiCode: 2D barcode with embedded picture and ViCode: 3D barcode with embedded video*," in Proc. Int. Conf. Mobile Compute. Netw., 2013, pp. 139–141.

[2] C. Chen and W. H. Mow, "*Poster: A coarse-fine corner detection approach for two-dimensional barcode decoding*," in Proc. Int. Conf. Mobile Comput. Netw., 2014, pp. 351–354.

[3] E. Ohbuchi, H. Hanaizumi, and L. A. Hock, "*Barcode readers using the camera device in mobile phones*," in Proc. Int. Conf. Cyberworlds, Nov. 2004, pp. 260–265.

[4] J. M. McCune, A. Perrig, and M. K. Reiter, "*Seeing-is-believing: Using camera phones for human-verifiable authentication*," in Proc. IEEE Symp. Secur. Privacy, May 2005, pp. 110–124.

[5] T.-Y. Liu, T.-H. Tan, and Y.-L. Chu, "*2D barcode and augmented reality supported english learning system*," in Proc. Int. Conf. Comput. Inf. Sci., Jul. 2007, pp. 5–10.

[6] J. Z. Gao, L. Prakash, and R. Jagatesan, "*Understanding 2D-barcode technology and applications in M-commerce—Design and implementation of a 2D barcode processing solution*," in Proc. 31st Int. Comput. Softw. Appl. Conf., vol. 2. Jul. 2007, pp. 49–56.

[7] H. Kato and K. T. Tan, "*2D barcodes for mobile phones*," in Proc. 2nd Int. Conf. Mobile Technol., Appl., Syst., Nov. 2005, p. 8.

[8] 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.

[9] G. J. Garateguy, G. R. Arce, D. L. Lau, and O. P. Villarreal, "*QR images: Optimized image embedding in QR*

codes," IEEE Trans. Image Process., vol. 23, no. 7, pp. 2842–2853, Jul. 2014.

[10] H.Bagherinia, R.Manduchi, "*A Novel Approach For Color Barcode Decoding Using Smart Phones*", -2014

[11] A.Motahar, M.Adjouadi "*Barcode Modulation Method for Data Transmission in Mobile Devices.*" – Jan 2015

[12] Rinju Alice John and Kaamran Raahemifar "*Designing A 2D Color Barcode*." – May 2015

[13] Clement Creusot, Asim Munawar " *Low-Computation Egocentric Barcode Detector For The Blind.*" -2016

