

A Survey on PiCode: Picture-Embedding 2D Barcode

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Abstract: In this Review paper discusses about the last few years, conventional Two-Dimensional (2D) barcodes and some existing beautified QR codes. Quick Response (QR) code is widely used in many applications such as marketing, for industrial applications, retail applications, health care applications, manufacturing, and product tracking etc. This paper explains the basic concept of QR images, i.e. a recently proposed beautified QR code. We focus on revising preprocessing methods by proposing block division and source & channel coding methods. In the traditional decoding procedure decoding steps consist of image binarization, corner detection, perspective transformation and error correction. So the existing barcodes have some limitations, so the new picture-embedding 2D barcode system: PiCode proposed. PiCode technology improves the aesthetic value of the picture embedded barcode. To preserve both the perceptual quality of the embedded image and the decoding robustness of the encoded message PiCode is designed with careful considerations. Advantage of using PiCode in advertisement business to link customers in a more interactive, interesting, and unique way. So the PiCode enable pictures/logo to be integrated with a 2D barcode to achieve enhanced visual appearance and high decoding reliability.

Keywords: 2D barcode, beautified QR code, Halftone QR code.

I. INTRODUCTION

Nowadays to improve the performance, productivity and profitability the combination of barcode technology with computer and application software are widely used. Barcode encode information in a visual pattern that a machine can read. Barcode technology is also known as an automatic identification technology. Barcode is a represented in the format of dark bars and white spaces. Barcode allows real-time data to be collected accurately and rapidly. Recently beautified QR code, called QR image concept proposed. The current 2D barcodes, such as Quick Response (QR) codes, is being utilized for this purpose by overwriting a central region of the barcode by a small picture. The proposed beautified QR code is used in more visual-pleasant mobile multimedia applications.

Advertisers are taking advantage of barcodes by using them to reach out to customers in a more interactive, interesting, and unique way. This invention aims at developing PiCode, a human readable 2D barcode technology that enables almost ideal picture-barcode integration. Distinguished from common binary 2D barcodes which do not convey meaningful visual information to users, PiCode combines the attractive appearance of a picture and the decoding reliability of barcode.

It offers a superior solution for mobile advertisement, media and marketing. Users can directly scan the PiCode for accessing information, while the advertiser would not have

to stress over the valuable advertisement space occupied by the traditional 2D barcodes any more.

II. LITERATURE SURVEY

A. QR code

Two-dimensional (2D) barcodes uses symbol types of matrix and stacking to represent data. 2D barcodes consist of QR code, Data Matrix, PDF417, Maxi Code etc. 2D Barcodes is having more advantages than 1D Barcodes. 2D barcodes provides data security, and readability. 2D barcodes hold more amount of information and take up less space than one dimensional barcode.

QR code is an invention of Denso Wave used to encode information like numbers, letters, and binary codes. QR code is in black and white pattern. Fig 1 shows the basic structure of QR code contains position, alignment and timing patterns. QR code uses Reed Solomon code for the error correction and it consist of 4 types of error correction levels L, M, Q, H that allow correction up to 7%, 15%, 20%, and 30% of codeword's in error respectively. QR codes are used for storing addresses and URLs present in magazines, business cards, buses.

B. Beautified QR Codes

In the literature, recent review on QR Images also known as beautified QR Codes. To improve the visual appearance of QR codes, QR images are proposed.

1) QR code beautifier techniques

In this paper, a two-stage QR code beautifier proposed using module based binary image and pixel-based binary image which is used to ensure visual semantics of the embedded content and decodability. To improve visual quality rendering mechanism is used which takes original image and pixel based binary image [2]. In this paper an optimization based approach used to embed color images into QR codes. To avoid the visual distortion of the QR image, the algorithm utilizes halftoning techniques based on halftone mask [3]. This paper presents how the saliency of the embedding image is considered in QR code beautification by considering some perceptual features. Simulated annealing (SA) optimization is chosen, to achieve the goal of generating visual pleasant QR codes [4].

2) Halftone QR Code

In QR code challenges are visual quality and machine readability so that a new approach halftone QR codes are proposed to produce high quality visual QR codes. Halftone QR code encodes module’s appearance using a set of binary patterns. To maximize readability based on pattern reliability a pattern assignment optimization method used [5].

3) Binarization scheme

In this paper for the binarization of the barcode images captured by mobile phones a novel adaptive thresholding technique used. The proposed method have several advantages like of high flexibility to different barcodes, text and sketches, good preservation of weak edges and fine details, effective in tackling uneven illumination and objects of different sizes [6].

4) Embedding QR code Techniques

In this paper, embeds an image into a barcode using real-coded genetic algorithm to find an appropriate position. The replacement region is selected by finding the appropriate scale, angle and position parameters using an optimization approach [7].

5) Image Quality assessment technique

In this paper, Digital images are subject to a wide variety of distortions during acquisition, processing, compression, storage, transmission and reproduction, any of which may result in a degradation of visual quality. The goal of research in objective image quality assessment is to develop quantitative measures that can automatically predict perceived image quality. In the proposed system, developed a measure of structural similarity (SSIM) that compares local patterns of pixel intensities that have been normalized for luminance and contrast [8].

6) Error correction Technique

In this paper, Reed Solomon Encoder and Decoder falls in the category of forward error correction encoders and it is optimized for burst errors rather than bit errors. Reed Solomon code is based on the Galois Field Arithmetic all two-dimensional bar codes such as PDF-417, Maxi Code, Data matrix, QR Code, and Aztec Code use Reed–Solomon error correction to allow correct reading even if a portion of the bar code is damaged[9].

III. COMPARISONS

	QR Code	PiCode
Modulation Technique	Binary Modulation Scheme Disadv:Distortion of image	Adaptive Modulation Scheme Adv:Reduces the image distortion introduced by the data modulation operation
Fixed Pattern Impact	For the high capacity QR code there are more fixed patterns located in the interior region of barcode. Adv: Fixed patterns can be utilized to improve Module alignment. Dis: Degrades the appearance of the embedded image.	In the case of High capacity versions, no fixed pattern is inserted in the interior area of Picode. Adv:No additional distortion due to such patterns is incurred to the embedded image.
Demodulation Technique	Binarization Technique	Coarse Fine Corner detection algorithm

Table I Comparison between QR code and PiCode

IV. PROPOSED SYSTEM

A novel approach picture-embedding 2D barcode, called PiCode system proposed. PiCode system mainly emphasis on the new kind encoding and decoding algorithms. The PiCode encoding process divided into two parts: the input processing and the PiCode generation. Input processing method contains, Source Coding - Code data to more efficiently represent the information and Channel Coding - Code data for transmission over a noisy communication channel. PiCode generation part image blocks of $k * k$ pixels are modified using adaptive modulation scheme.

PiCode decoding process contains key three steps coarse fine corner detection, module alignment and demodulation will be described. The corner detection algorithm locates four extreme corners of the barcode from the captured image. To achieve higher accuracy, the proposed coarse-fine corner detection scheme exploits the prior information of the barcode structure in refining the corner locations. The module alignment step slices the barcode region into image blocks with reference to the black and white alternations in the ‘_’-shape pattern. Demodulation scheme will be used to

retrieve the data bit resulted from module alignment step. Three demodulation schemes are proposed: contrast-based demodulation, matched filter-based operation, gradient-based operation. In the proposed work the decoding performance comparison is evaluated in terms of demodulation bit error probability (BEP) for three demodulation techniques

V. DISCUSSION

To study the perceptual quality and the decoding robustness of PiCode as well as existing beautified QR codes experiments have been conducted. The multi-scale structural similarity (MS-SSIM) metric which aims to design quality measures that can automatically predict perceived image quality. The experiments are conducted with quality parameter $\lambda = 25$ have highest MS-SSIM scores across all images. For the high capacity case, a quality improvement can be achieved by PiCode because module size gets smaller and the modulation waveform becomes less obtrusive to the overall image.

Module size Image	Low Capacity(29×29)			High Capacity(65×65)		
	Halftone QR	QR Image	PiCode	Halftone QR	QR Image	PiCode
HKUST Logo	0.33	0.52	0.58	0.38	0.44	0.63
Academic building	0.25	0.58	0.56	0.24	0.46	0.63
Lincoln	0.20	0.39	0.46	0.24	0.47	0.61
Great Wall	0.11	0.29	0.53	0.13	0.35	0.65
Mona Lisa	0.15	0.31	0.53	0.16	0.31	0.63
WWF Logo	0.36	0.42	0.46	0.43	0.46	0.61

Table II Perceptual quality comparison of existing Halftone QR code, QR image and PiCode

VI. CONCLUSION

This review paper mainly focuses on the research exertion with an eye of improving security for the data in various levels by utilizing QR code. The recent advancements in modulation and demodulation of QR codes are also reviewed in literature survey. Also comparative study between existing techniques such as beautified QR code, Halftone QR code and various image embedding techniques are studied. PiCode technology improves the aesthetic value of the picture embedded barcode. Advantage of using PiCode in advertisement business to link customers in a more interactive, interesting, and unique way.

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