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QArt - new Generation of Visual Appearing QR Code

Amit Kr Tiwari, Apurv Gupta
Under Graduate Student, CEO
Department of Computer Science and Engineering
WBUT, Flick2Know
amiit111tiwari@gmail.com ,
apurv@flick2know.com

Abstract:
We propose an approach to produce high quality, visually cognitive QR codes, which we call QArt – a new generation of QR codes that are machine-readable and visually perceivable by humans simultaneously. First, a pattern readability function is constructed wherein a probability distribution is learned which identifies replaceability of modules which are the collections of data inside QR code. Then, given a text tag, an input image is taken and based on the Grayscale label on that image, a high quality, visual appearing QR code is generated. A user just needs a phone with picture taking capability to extract the encoded data from these QR codes which may include URL, music, images, or a plethora of other digital content. Some advertisers use QR codes to promote their web presence since the smartphones can read and immediately access the URL encoded in it. As an instance of application of the technique proposed in this paper, such advertisers may generate a QR code on their company logo which contains the encoded URL, for advertising or promoting purpose.

Keywords: Quick Response(QR) Code, 2D BarCode, Mobile Learning, Digital Marketing.

1. Introduction :

In 1994, Denso Wave, a subsidiary of Toyota developed a code similar to barcode to identify cars during manufacturing process [1, 2, 3]. This code is called QR (Quick Response) code. Today, QR codes are seen everywhere, from newspapers to wrappers used for packaging of a commodity. QR code is a popular form of barcode pattern that is ubiquitously used to tag information to products or for linking advertisements. QR codes are versatile since a piece of long multilingual text, a linked URL, an automated SMS message, a business card or just about any digital information can be embedded into the two-dimensional barcode.

Fig.1 QR Code

Coupled with moderately equipped mobile devices, QR codes can connect the users to information quickly and easily. While, on one hand, it is essential to keep the patterns machine readable; on the other hand, even small changes to the patterns can easily render them unreadable. Hence, in absence of any computational support, such QR codes appear as random collections of black/white modules, and are often visually unpleasant. In this paper, we explore how a new generation of visual appearing QR code can be generated. The operations to retrieve or store QR codes are incredibly simple and quick [2, 3, 6], and combined with the capabilities of mobile devices, make them the ideal tool for not only Marketing purpose but also for education, learning and many other fields. We will first introduce the user characteristics of QR codes in Section 2, which will highlight the superiority of QR code over other one or two dimensional Bar Codes. In section 3, we will see the process of reading a document with QR Code. In Japan, QR codes are omnipresent and most people have mobile phone equipped with QR code readers.Although QR codes existed for over fifteen years, there were not many applications in this area [12, 14].Quick Response (QR) codes are creating progress into different western nations since their inception in 1994. However, there is an increasing interest in this technology, particularly in the marketing field. This is partly due to the fact that camera-equipped and software downloadable mobile phones are surging in recent years. In section 4, we will describe our approach to generate visually cognitive QR codes.

2. Understanding QR Codes:

In QR code, there are different sections which can different types of data.

1.Finder Pattern: The finder pattern contains three identical structures that are located in all corners of QR code except the bottom right one. Each pattern is based on 3*3 matrix of black modules surrounded by white modules that are again surrounded by black modules. The Finder Pattern enable the decode software to recognize the QR code and determine the correct orientation.

2. Separators: The white separators have a width of one pixel and improve the recognizability of the finder pattern as they separate them from actual data.

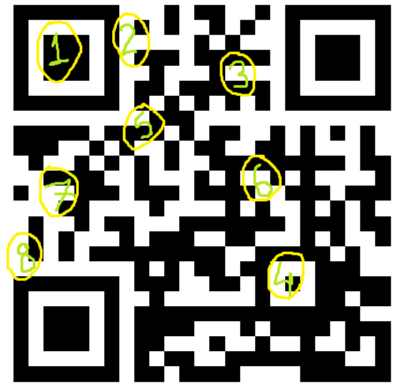

Fig.2 QR Code with different data fields

3. Timing Pattern: Alternating black and white modules in the Timing Pattern enable the decoder software to determine the width of a single module.

4. Alignment Patterns: Alignment Patterns support the decoder software in compensating for moderate image distortions. Version 1 QR code do not have alignment pattern. With growing size of the QR code more alignment patterns are added.

5. Format Information: The Format Information sections consists of 15 bits next to the separators and store information about the error correction level of the QR code and the selected masking pattern.

6.Data: Data is converted into a bit stream and then stored in 8 bits group (called code words) in the data section.

7.Error Correction: Similar to the data section, error correction codes are stored in 8 bit long code words in the error correction section.

8.Remainder Bits: This section consists of empty bits of data and error correction bits cannot be divided into 8 bit code words without remainder.

The capacity of a QR Code depends on several factors. Besides the version of the code that defines its size (number of modules), the chosen error correction level and the type of encoded data influence capacity.

Version: There are 40 different version in the QR Codes which differ in the number of modules. Version 1 consists of 21*21 modules, up to 133 (lowest error correction level) of which can be used for storing encoded data. The largest QR Code (version 40) has a size of 177*177 modules and can store up to 23,648 data modules.

Error Correction Level: Error Correction in QR Codes based on the Reed-Solomon Codes, a specific form of BCH error correction codes [7, 11]. There are four levels (Table 1) of error correction that can be chosen by the user at creation time.

L	7%
M	15%
Q	25%
H	30%

Table 1: Error Correction Levels

Higher error correction levels increase the percentage of code words used for error correction and therefore decrease the amount of data that can be stored inside the code.

Encoded Data: QR Code can use different data encodings. Their complexity influences the amount of actual characters that can be stored inside the code. For example, QR Code Version 2 with lowest error correction level can hold up to 77 numeric characters, but only 10 Kanji characters.

3. Process of Reading a document with QR Codes :

To prepare a document embedded with QR Codes, a simple way is for end users is to generate the specific codes using available standard code generator. These QR Codes can then be embedded into the document at appropriate places. If the Mobile device does not have any built-in QR Code Reader, the user needs to install the right decoder from the available QR Code Readers. The following steps illustrate the processes:

Step 1: To encode the required Text/SMS/URL/Contact Detail into a QR Code, User can make use of some available
Websites or the applications for generating QR Code.

Step 2: User can save the generated QR Code and embed it into, wherever it is required in the document.

Step 3: User needs to load the Mobile device with the right decoder. User can find many application Websites supplied the decoders for different mobile platforms.

Step 4: For the document with the embedded QR Code, the user can just slide the decoder over the area and the text will automatically be displayed in the device. If the text is URL, user can just click the link and QR Code reader (or decoder) will take you to the website of that URL. If the text is Contact record, the reader can save the record to the address book of the device with just one click.

4. Suggestions and Implementations of QR Code:

QR Code is a combination of three different types of data: Data Bytes, Pad Bytes and Error Correction Bytes. These are briefly explained as follows.

Data Bytes: These are the data which is provided by the users for that they want to generate QR Code. This may be URL, SMS, and Text etc.

Pad Bytes: These are data which is added with the Data Bytes to fulfill the requirements of the length of the data, if it is not already full. According to QR Code specifications [1, 4, 5], if the required length is not full with the user's provided data then QR Code generator algorithm should take care of the length and fill the remaining length with the Pad Bytes. There are two values which are considered as Pad Bytes as per the QR Code specifications[1,4,5] and those are: 236 and 17. In binary form:

1 1 1 0 1 1 0 0 (236)

00 0 10 0 0 1 (17)

Error Correction Bytes: Error Correction bytes (or code words), are the data bytes which is generated by Reed Solomon Error Correction

Method [7]. These are the data bytes which is used in QR Code Decoder algorithm to detect and correct errors in QR Codes. Error correction coding uses polynomial long division. To do that, two polynomials are needed. The first polynomial to use is called the message polynomial. The message polynomial uses the data code words from the input data as its coefficients. For example, if the data code words, converted to integers, were 25, 218 and 35, the message polynomial would be $25x^2 + 218x + 35$. In practice, real message polynomials for standard QR codes are much longer. The message polynomial will be divided by a generator polynomial. The generator polynomial is a polynomial that is created by multiplying $(x - a^0) \dots .(x - a^{n-1})$. Where n is the number of error correction code words.

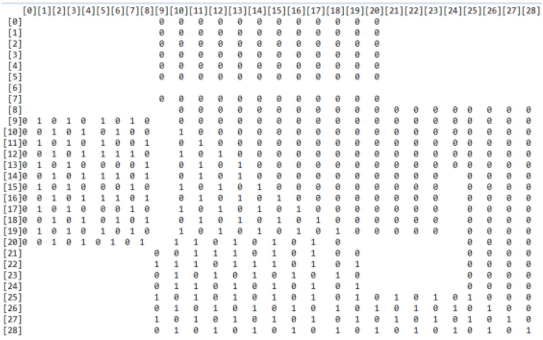

Fig.3 Pad Bytes distribution inside QR Code

When user provide the image, the first step of our approach is to binarize [15, 16, 17] the image and for that we are using Back Propagation Algorithm.

Binarization:

Let the pixel gray level be integer set [0,M] ⊂ GL (M: corresponding to the brightest pixel),N be an integer, and f: N X N be the image function of image N X N. The binarization is to find out the appropriate threshold value T ⊂ GL so that the visually satisfied result image can be obtained after blacking pixels which graylevels below the selected threshold T.

f: N X N B ⊂ [0, 1]

$$f\ (x,y) = \begin{cases} 1 & \text{if } GL > T \\ 0 & \text{otherwise} \end{cases}$$

Our proposed variation of QR code, "**QArt**" is novel in that it is based on the approach that the Pad Bytes as specified in the QR code can be avoided. In this approach, we provide users the facility to choose the images as per their choice and our algorithm will generate the QR code on that image. In this approach, a pattern readability function is constructed wherein a probability distribution is learned which identifies replacebility of modules (collections of pad bytes) inside the QR code.

After obtaining the histogram of original image, we further derive from H(j) to get the normalized histogram.

$$h(j) = H(j)/max(H(GL))(0 \le j \le N)$$

For the purpose of simplifying the teaching procedure, we enhanced the contrast of images used by the following linear transformation:

$$g(x,y) = \begin{cases} \frac{n-m}{b-a}(f(x,y) - a) + m & \text{if } a \le f(x,y) \le b \\ m & \text{if } f(x,y) < a \\ n & \text{if } f(x,y) > b \end{cases}$$

where a ≤ H[f(x,y)] ≤ b, m ≤ H[g(x,y)] ≤ n.

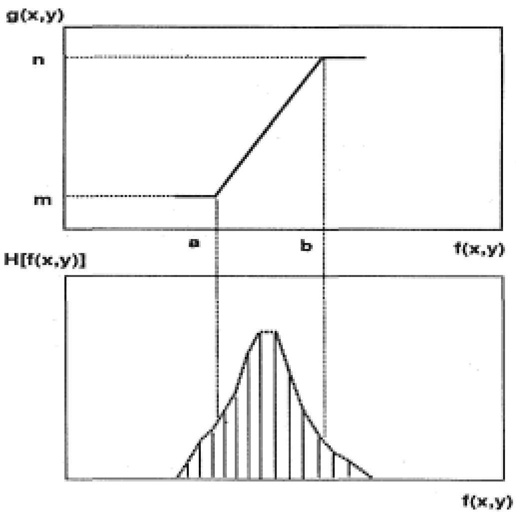

Fig.4: Transformation according to grayscale level

After getting the binarize value, our approach is to analyze the distribution of Pad bytes inside the QR Code. Pad Bytes are constant values which is either 236 or 17 or the combination of these values. So, we can easily identifies or analyze the distribution of these Pad Bytes inside the QR Code. After that, our focus is to replace the original Pad Bytes with the binarize value of image. So, by this approach we can generate a new generation of visual appearing QR Code which decrease the complexity of presently available QR Codes.

Input (Image + Data)

Output (QR Code)

Fig.5: QArt – new generation of visually appearing QR Code

This new generation of QR Code can be read by any standard QR Code Reader. Now, we are also on a process to remove all the dots from QR Codes for making it more reliable and visually more attractive. For that, we are looking for a machine learning approach by which, without breaking any rules or specification of the QR Code, we can achieve the goal which will not only decrease the complexity of the QR Code but it will also increase the applications of the QR Code in different fields like Marketing, Education, Industrial areas etc.

5. Conclusion:

In this paper, we have provided an approach to decrease the complexity of currently available QR Code so that we can increase the use of this exciting technology in different domains. Today, QR Codes doesn't have any security feature but adding such a feature is necessary keeping in mind the threads posed by QR Codes. So, we are also working on that part for removing the security issues from the QR Code. In general, we believe that QR Codes have great potential [8, 9, 10, 12, 13, 14] to make changes in different fields like Marketing, Education and Industrial areas. Some possibilities are demonstrated in this paper and there are many creative ideas waiting to be explore. Also, this paper can be served as the first step for the readers to investigate this exciting topic of Mobile Learning.

References:

1. Denso (2010a). QR Code Standardization. Retrieved June 21, 2010, from http://www.denso-wave.com/qrcode/qstandard-e.html.
2. Denso (2010b). About 2D Code. Retrieved June 21, 2010, from http://www.denso-wave.com/qrcode/aboutqr-e.html.
3. Denso (2009). Denso Wave Incorporated. Retrieved June 21, 2010, from http://www.denso-wave.com/en/index.html.
4. ISO 16022:2006. Data matrix bar code symbology specification. ISO, Geneva, Switzerland.
5. ISO 18004:2006. QR Code bar code symbology specification. ISO, Geneva, Switzerland.
6. S. Lisa and G. Piersantelli. Use of 2d barcode to access multimedia content and

the web from a mobile handset. In GLOBECOM, pages 5594-5596, 2008.

7. I. Reed and G. Solomon. Polynomial codes over certain finite fields. Journal of the society for Industrial and Applied Mathematics, 8(2):300-304, 1960.
8. M. Canadi, W. Hopken, and M. Fuchs. Application of QR codes in online travel distribution. In ENTER, pages 137-148, 2010.
9. J.Gao, V. Kulkarni, H. Ranavat, L. Chang and H. Mei. A 2d barcode-based mobile payment system. In MUE, pages 320-329, 2009.
10. 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 COMPSAC (2), pages 49-56, 2007.
11. R.Bose and D. Ray-Chaudhary. On a class of error correcting binary group's codes. Information and Control, 3(1):68-79, 1960
12. Y.-P. Huang, Y.-T. Chang and F.E. Sandnes. Ubiquitous information transfer across different platforms by QR codes. J. Mobile Multimedia, 6(1):3-14, 2010.
13. Elena (2009). Educational Qrcodes. Retrieved June 21, 2010, from http://www.qrcode.es/?p=350&language=en.
14. Liu, T., Tan, T. & Chu, Y. (2007). 2D Barcode and augmented Reality Supported English Learning System. Proceeding of the 6th IEEE/ACIS International Conference on Computer and Information Conference on Computer and Information Science (pp 5-10). IEEE Computer Society.
15. P.K. Sahoo, S.Soltani, A.K.C.Wong, and Y.C.Chen, A Survey of Thresolding techniques, Computer Vision, Graphics and Image Processing, 41(2)233-260, February 1988.
16. Tao Chen, Mikio Takagi. Image Binarization By Back Propagation Algorithm.
17. Pavlos Stathis. An Evaluation Technique for Binarization Algorithms. Journal of Universal Computer Science, vol.14, no. 18(2008), 3011-3030.