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Encoding and Decoding of High Capacity Color Qr Codes For Mobile Applications

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Abstract: *The use of color in QR codes brings extra capacity, but also inflicts tremendous challenges on the decoding process due to chromatic distortion cross-channel color interference and illumination variation. Particularly, we further discover a new type of chromatic distortion bin high density color QR codes cross module color interference caused by the high density which also makes the geometric distortion correction more challenging .To address these problems ,we propose two approaches ,LSVM-CMI and QDA-CMI, which jointly model these different types of chromatic distortion. Furthermore, a robust geometric transformation method and several pipeline refinements are proposed to boost the decoding performance for mobile application.*

I. Introduction

As the significant increase of mobile device users, more wireless information services and mobile commerce applications are needed. In the past decade, various barcodes have been used as a very effective means in many traditional e-commerce systems, supply chain management, retail sale-and-buy, as well as tracking and monitoring of products and goods.

Today, many people believe digital barcodes provides an effective means for mobile commerce application systems due to the following reasons: By Using digital barcodes provides a simple and inexpensive method to present diverse commerce data in electronic commerce and m-commerce, including product id and the detailed product information, advertisements, and purchasing and payment information.

As more mobile digital cameras are deployed on mobile devices, using digital barcodes is becoming an effective way to reduce the mobile inputs from mobile users. Therefore, mobile user experience can be improved and enriched. To meet the increasing needs of mobile-based barcode applications in m-commerce, more research work and technology study are needed to understand 2D-Barcodes, required supporting technologies, standards, and applications in m-commerce mobile and services.

DIGITAL BARCODE:

More design and experience reports are also needed to help engineers to create effective 2D-Barcode enabled mobile applications. Although there are a number of recent publications discussing various 2D barcodes, and related technology and algorithms

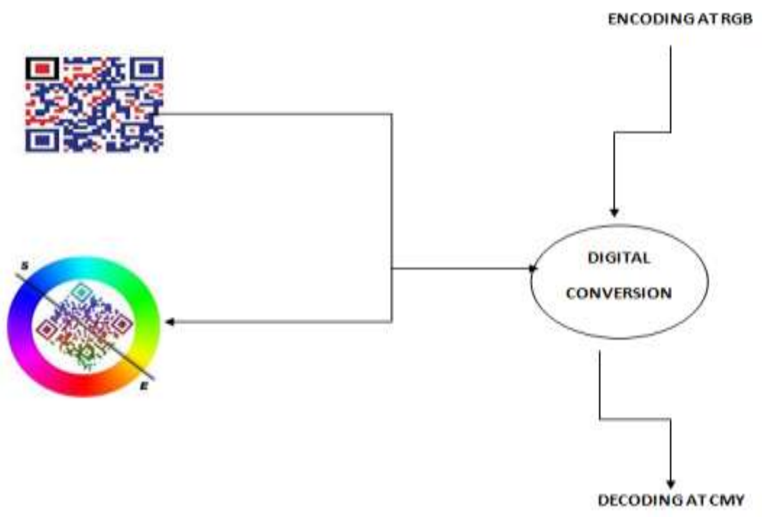


Figure 1.1: QR Conversion

Linear Barcode

A linear barcode refers a way of encoding numbers and letters in a sequence of varying width bars and spaces so that it can be read, retrieved, processed, and validated using a computer. Using barcodes provides a simple and inexpensive method of encoding text information that is easily read using electronic readers.

Barcode Symbology

The barcode symbology refers to the protocol that defines a standard for arranging the bars and spaces that comprise a particular type of barcode, such as UPC-A and EAN. It defines the technical details of a particular barcode type, including the width of bars, character set, method of encoding, checksum specifications, etc. Since the earlier forms of linear barcodes were not capable of encoding letters, 2-D barcodes were invented to meet the needs of encoding alphanumeric data, including letters, numbers, and punctuation marks.

At the end of 1980s, two dimensional (2D) barcodes appeared. With a much larger data capacity, 2D barcodes become popularly used in different areas. PDF417, Micro PDF417, and Data Matrix are typical examples. In general, there are two types of 2D barcodes: a) stacked 2D barcodes, such as Code 49 and PDF417, and b) Matrix 2D barcodes, such as Data Matrix and QR Code. Some examples of common 2D barcodes are listed below. Compared with 1D barcodes which hold vary limited information data, 2D barcodes has a much larger capacity to hold more information data. As shown in table 2, a QR code can holds up to 7,089 digits, 4296 letters, and 2953 binary data. Selecting and using 2D barcodes must consider the following factors:
a) The Application Usage,
b) Standard,
c) Implementation,
d) The Data You Need To Encode In Barcodes, And
e) How You Wish To Print The Barcode.

2D BARCODE APPLICATIONS IN M-COMMERCE

As pointed out by H. Kato and K. T. Tan [2], 2D barcodes were designed to carry significantly more data than its ID counterpart. Mobile phones have evolved from just a mobile voice communication device to what is now a mobile multimedia computing platform. Recent technology development and integration of these two make more interesting and diverse applications of 2D barcodes in mobile application systems and mcommerce services. Figure 1 shows different interactions between a 2D barcode and a mobile phone.
Therefore, the major challenge in M-commerce is where to find an effective interface technology to support the simple and efficient interactions between mobile customers and M-commerce systems without mobile keyboard data entry. Barcodes provide a simple and effective solution to cope with this issue due to their advantages over linear barcodes in data capacity and visual representation size.

Until recently, people are gradually realized the importance of 2D barcode and its great application value in M-Commerce because of the followings:
• 2D barcodes provide a new effective input channel for mobile customers carrying mobile devices with inbuilt cameras.
• 2D barcode is becoming a popular approach to present semantic mobile data with standard formats.
• 2D barcodes support a new interactive and efficient approach between mobile customers and wireless application systems.
• 2D barcode technology can be and are being used in diverse applications in mobile commerce.

As the fast advance of 2D barcode enabling technology, people have found its great value and diverse applications in M-commerce. Wireless advertising and marketing – 2D barcode becomes one of best cost-effective advertising and marketing tool for advertisers and manufactures. Using a mobile camera phone, a customer can easily input a 2D barcode on a product advertisement (posted everyone), found more product information from the barcode. When the customer likes the product, only a very few clicks can lead to a trading transaction with the backbone M-commerce application system. Clear mobile 2D barcode ads on mobile devices are transaction-oriented ads, which allow mobile customers to purchase products as long as they see their ads at anywhere and anytime.

Wireless trading (pre-sale/sale-and-buy/ post-sale)

Using 2D Barcodes on products and goods, merchants and manufactures allow mobile customers to find more detailed product information. For example, NTT DoCoMo, in Japan, is developing a system using 2D barcodes for food consumers. Using mobile camera phones, consumers can easily input a 2D barcode of a product by scanning product barcodes in the store, and found more detailed information about each product, including producers, harvest date, shipping date, and agricultural chemicals in each found.

In addition, 2D barcodes are also very useful in post-sale, including product tracking, shipping, and delivery. Furthermore, they can be used as very effective tool to prevent the frauds in luxury goods, such as paintings. Johnston and Yap in [16] considers the feasibility of transmitting EDI shipping information using PDF417 2D barcodes in terms of organization, technical and practical feasibilities. Their results indicate that there is no risk using 2D barcodes in EDI-based applications.

To facilitate the needs of a barcode enabled mobile payment system, we enhanced our encoding and decoding processing solution for 2D Data matrix barcodes by providing a multiple information encoding and decoding feature. With this feature, a user can easily perform the following two tasks:

- Encode multiple data information into one Data matrix code
- Decode one (or more) selected data information from a given multi-segment Data matrix code.

Since a typical payment transaction record must includes four types of data:
a) Customer information,
b) Product information,
c) Payment information, and
d) Security information.

Hence, we tested this feature with a simple payment transaction data. The encoding result and selected decoded result.

SIGNAL-RICH-ART CODE IMAGE GENERATION

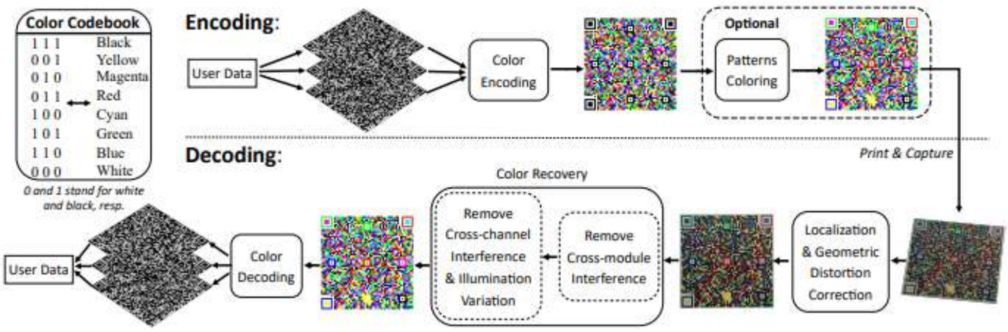


Figure 3.1. Three phases of proposed method.

The proposed method includes two main phases of works as illustrated in Fig. 3: 1) signal-rich-art code image generation; and 2) message extraction. In the first phase, given a target image IT and a message M, a signal-rich-art code image IC is created by four major steps:

Step 1.1 － transform message M into a bit stream B of codes;

Step 1.2 － transform every three bits of B into four bits and represent them by a binary pattern block, resulting in a pattern image IP;

Step 1.3 － modulate each pattern block Ti of IP by two representative values calculated from the Y-channel values of the corresponding block Bi of target image IT, yielding a modulated pattern image IP';

Step 1.4 － replace the Y-channel of target image IT with IP' to get a signal-rich-art code image IC as the output. In the second phase, given a camera-captured version IC' of a paper or display copy of the signal-rich-art code image IC, a message M', which is supposed to be identical to M, is extracted from IC' by four major steps:

Step 2.1 － localize the region IC'' of the original part of the signal-rich-art code image IC in IC';

Step 2.2 －correct the geometric distortion in IC'' incurred in the image acquisition process, yielding a corrected image IC''';

Step 2.3 － identify the unit blocks in IC''' automatically and divide IC''' accordingly into pattern blocks, each with 2×2 unit blocks;

Step 2.4 － binarize each pattern block of IC''', recognize the result to extract the bits embedded in it, compose all the extracted bits to form a bit stream B, and transform B reversely to get a message M'.

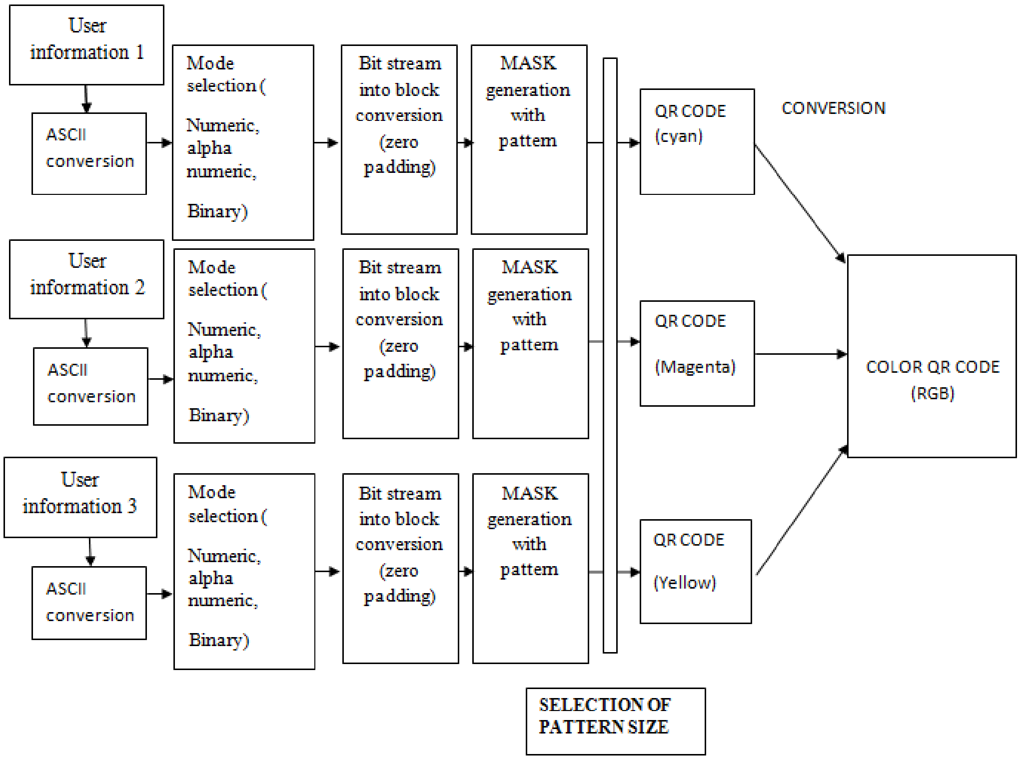


Figure 3.1: Code Generation

The mathematics of calculating extended parity bits (sometimes called Cyclic redundancy check) involves treating data as the coefficients of a polynomial rather than a series of numbers and, from this technology, emerged a way to repair damaged data. First look at how some extended parity schemes are actually calculated.

The polynomials are of the form:

$$\mathbf{a_n x^n + a_{n-1} x^{n-1} + \ldots + a_2 x^2 + a_1 x + a_0}$$

The Galois arithmetic operations for GF(256) must be implemented as follows: The **ADDITION** and **SUBTRACTION** of two numbers are both implemented by the bitwise exclusive-or of the two numbers. N.B.In Galo is arithmetic A-B is the same as A+B.

e.g.

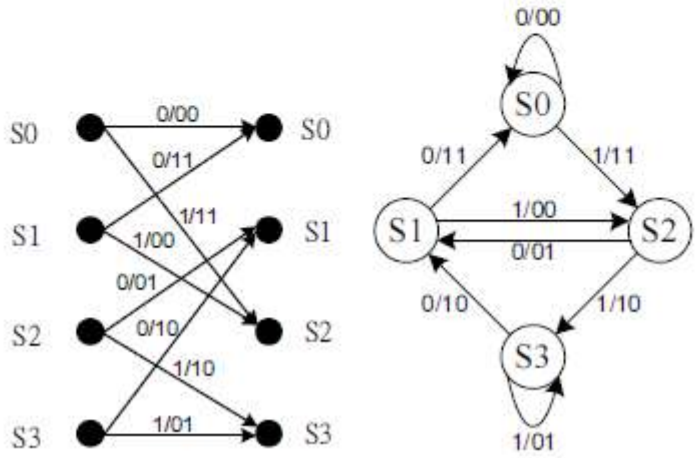
Given that $A=15_{10} = 00001111_2$

and $B=6_{10} = 00000110_2$

then $A + B = A - B = 00001001_2 = 9_{10}$

```
function addition(a,b:byte):byte;
begin
result:=a xor b;
end;
function subtraction(a,b:byte):byte;
begin
result:=a xor b;
end;
```

Trellis diagram:



Now that we have the two basic components of the convolutional encoder (flip-flops comprising the shift register and exclusive-or gates comprising the associated modulo-two adders) defined, let's look at a picture of a convolutional encoder for a rate 1/2, K = 3, m = 2 code:

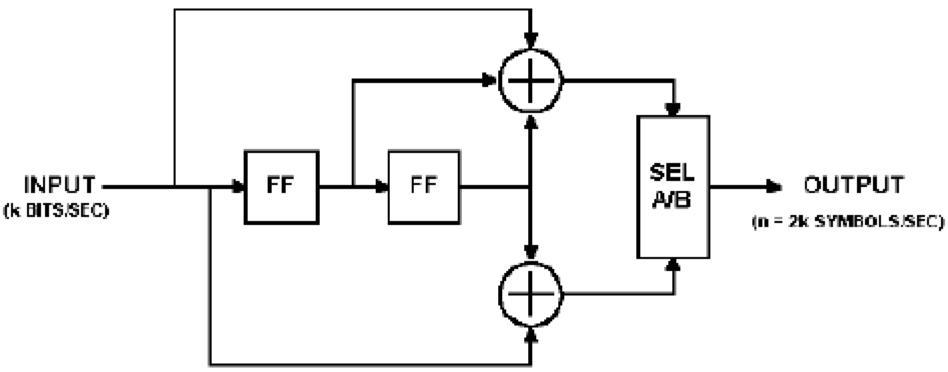


Figure 3.7: Convolutional Encoder

	Next State, if	
Current State	Input = 0:	Input = 1:
00	00	10
01	00	10
10	01	11
11	01	11

Figure 3.11: State Transition Table (I)

II. Conclusion

Here we analyzed the performance of type of signal-rich-QR image for applications of data transfer, called signal-rich-art code image which act as a carrier of a given message. The target image is kept in the created image, achieving the signal-rich-art effect. Here we use configurable color set selection with QR code pattern design, unit block segmentation are proposed for message data extraction. The output image visual appearance of pre-selected target image and acquired versions of the with screen blurring is proved with MATLAB simulation.