Review on Color Qr Codes:Decoding Challenges and Security Issues

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Abstract:**A 2D color barcode can hold much more information than a binary barcode. While a color barcode can hold more information, it makes this vision task unusually challenging because of the varying color balancing in different cameras, poor quality of images taken with current cell phone cameras and webcams, varying lighting conditions, arbitrary rotation of the barcodes in images. They are frequently used in advertising to provide customers with scannable URLs to product websites. In pursuit of increased barcode capacity, novel schemes using color have been proposed.**

Encoding data independently in cyan, magenta, and yellow (CMY) print colorant channels with detection in complementary Red, green, and blue (RGB) image capture channels offers an attractive framework for extending monochrome barcodes to color with increased data rates. The undesired absorption of colorants in regions of spectral sensitivity of the no complementary capture channels, however, gives rise to cross-channel color interference that significantly deteriorates the performance of the color barcode system. This provides a better decoding of data along with higher data rates.The paper provides an overall look on QR codes.

Keywords:2-D barcodes,QRcodes,Color QR Codes,Interference Cancellation.

I. INTRODUCTION

As in [1-6] Barcodes are optical machine-readable representations of data, capable of storing digital information about the physical object to which they are attached. Due to their reading speed, accuracy, and functional characteristics, barcodes have become ubiquitous in many applications, including their usage in department stores and retail chains to price goods, to track items and to identify customers through membership cards; in tracking item shipment and movement, such as express mail, rental cars, airline luggage; in patient identification in hospitals; in document management systems; in ticketing for sports events, cinemas, theatres and transportation. Barcodes in broad has two dimensions. The first one referred to as one-dimensional (1D) barcodes; represent data by varying the widths and spacings of parallel lines. The amount of digital information stored in 1D barcodes is limited and could be simply increased by increasing the number of barcode digits or by laying out multiple barcodes. This approach has many negative effects, however, such as enlarged barcode areas, more complex reading operations, and increased printing costs. Again if one or bars in the code is lost whole barcode becomes unreadable. For this reason, the barcode technology has been deploying geometric patterns in two dimensions: such barcodes are referred to as bi-dimensional (2D) codes. Note that 2D codes increase the data space available by storing information in two dimensions, whereas 1D code contains data in one dimension only.

Figure 1.1 shows examples of 1D and 2D barcodes. Available 2D codes span from repeating a single 1D barcode over multiple rows to exploiting bi- dimensional shapes in order to represent data. Figure 1.2 illustrates the evolution of 2Dbarcode technology. In particular, Figure 1.2 (a) shows a multiple barcode layout: the main disadvantage related to this simple 2D layout is the need of multiple scans in order to get all the information contained in the barcode. Figure 1.2 (b) illustrates a stacked barcode layout: in this case one single scan is enough to obtain the stored information but the scanning equipment must be carefully aligned with the barcode orientation. Finally, in Figure 1.2 (c) a matrix barcode layout is presented: this layout enables to acquire information with one single scan and does not require the accurate alignment of the scanning equipment.

This completes a brief introduction about barcodes. Now we will have a look on details about 2D barcodes.

1.1 Examples of 1D and 2D barcodes

1.2 Evolution of barcodes: (a) multiple barcode layout, (b) stacked barcode layout, and (c) matrix barcode layout.

II. 2D BARCODES

There are a lot of varieties of 2d barcodes available[5]. They can be widely divided into two: Database 2D Barcodes and Index-Based Barcodes. The database 2D barcodes were initially invented to improve data capacity for industrial applications .QR Code, VSCode, and Data Matrix belonged to this type. The working of these codes can be integrated into mobile phones with built-in cameras that can scan and decode data, allowing these 2D barcodes to operate as portable databases, letting users access information anytime, anywhere, regardless of network connectivity. The VS code that uses encrypted format of data makes the mobile applications secure and useful in biometric applications. But again the absence or presence of a very small quiet zone makes the decoding inefficient. In the case of data matrix this is solved by the use of two types of border but again distortions within the image cannot be handled. The compression of data for compaction makes its decoding complex.

The other type index-based 2D barcodes take into account the reading limitations of these built-in cameras. The Visual Code, Shot Code, and ColorCode belonging to this take into account the reading limitations of these built-in cameras. They have a much lower data capacity than database 2D barcodes, but they offer robust and reliable barcode reading. Each barcode basically works as an index that links the digital world to the real world, so these barcodes require network connectivity. Going to the case of Visual codes they have a good detection capability with structure but the data capacity is very less(max 83 bits). Shot Code has an aesthetic round shape but this again makes decoding bit complex and understandable. Colour Codes use set of colour and work on it. This has a good data capacity but the problems caused by illuminations are still a challenge.

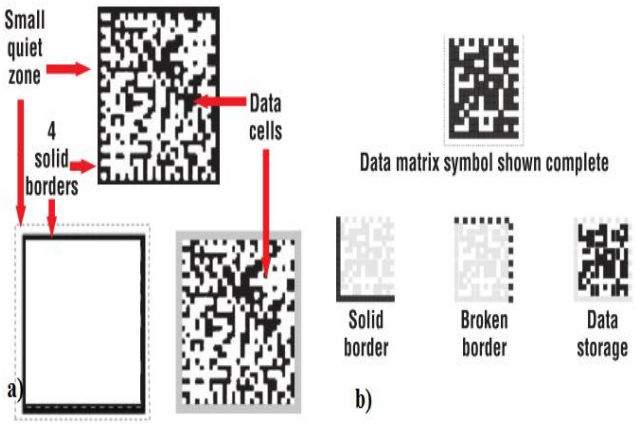

Fig 2.1 Different types Of Database Barcodes-a)VS Code b) Data Matrix

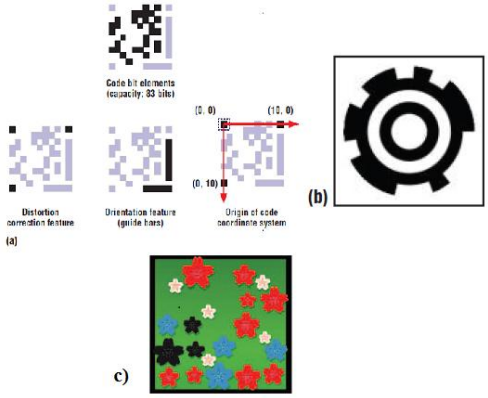

Fig 2.2 Index Based 2D barcodes a)Visual Code b) Shot Code c) Color Code

2.1 QR Codes

The most prominent and popular 2D barcode is QR codes[1]. The "QR" stands for "quick response", a reference to the speed at which the large amounts of information they contain can be decoded by scanners.
They were invented in 1994 in Japan by Denso-Wave and initially used for tracking shipping. Now QR Code is seen and used everyday everywhere for the following reasons:
. Several characteristics superior to linear bar codes: much higher data density, support Kanji/Chinese character, etc.
. It can be used by anybody free of charge as Denso has released the patent into the public domain.
. Data structure standard is not prerequisite for current usages.
. Most mobile phones in Japan equipped with cameras that enable reading of QR Codes can access Internet addresses automatically by simply reading a URL encoded in the QRCode.

QR codes adopt an arrangement of black and white squares for all the required functions. In particular, each module represents a single bit following a simple rule: black squares store 1 and white squares store 0(fig 2.3).The features like high capacity encoding of data, small printout size, data linking functionality, data restoration functionality, readability from 360 degrees masking availability and confidentiality makes it more powerful. The basic structure of QR code is already known and standardized [1].

The finder patterns, alignment patterns and the timing patterns make QR codes easily detectable as well as decodable. The information to be encoded is then included in the other parts. The encoding type is first identified for the given data and then encoding is done based on that. Inorder to be resistant to errors and distortion up to a certain level, error correction code words corresponding to encoded words is made based on Reed-Solomon error correction. Now this codewords and error correction codewords are combined together and are placed within qr code. The binarised data is then given level color, black or white, and placed in a zig-zag manner. The reverse process is done in decoding to get the data back.

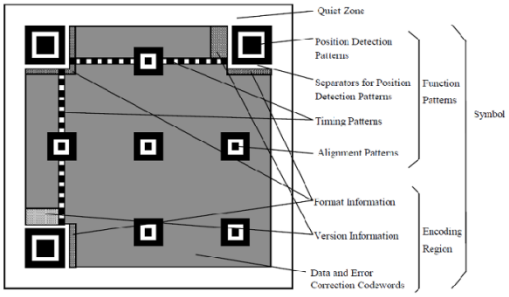

Fig 2.3 QR Codes

QR code thus created can be enhanced by the application of color.The issues of which how colors should be selected and the color of border begin used is discussed in [7-8] .Data encoding is same as per the standards while instead of black and white we go for using the colors. This is also handled in [9-12]

2.2 Issues in using colors

Using colors, not only increases the data density but as well as increases the challenges for proper decoding. The problems of correct and reliable color identification, color deblurring, correct detection of finder pattern can be some of the superior issues. Once an image of color barcode is taken data retrieval consists of following phases:

A. *Preprocessing*:

The image acquired using the camera is tobe processed to reduce the distortions and make the QR code clear within the image. Initially, QR code should be localized from the given image. For this basically the encoding idea is used. That is the idea of locating the finder pattern encoded with black: white: black: white: black in the ratio 1:1:3:1:1is being used [13-18]. Once the finder pattern is found , we have three sides with us. Fourth can be found with the help of basic structure. The method using alignment patterns can be also used [13]. But this is something tedious due to its structure. The color image will be thresholded to give black and white image for detection. Either local or global thresholding methods discussed in [19-22] can be used. Thresholding can also be performed on each color band separately by providing separate color thresholds for each colour.The same idea is being discussed on [9-12].

The image might be taken in different orientation for more clarity by the user and may have a lot other illumination problems[23-26]. The image should be thus geometrically corrected to get the image. [25] suggests a second order moment calculation in order to identify candidates for orientation bars among the regions found. But the idea can't be used due to its complexity itself. A more easier and efficient approach was proposed by Y.Liu[16] for the same. It's based on the feature of QR code that it can be read from any direction from 360 degree. The rotated symbol is oriented commonly by sine and cosine transformation, for example the reference algorithm of national standard [1]. Rotate the symbol first, then implement interpolation operation. This is widely used and implemented.

B. Color Image Processing:

In the case of color image processing the different methods aim to reduce the color challenges. Here we intend to handle the problems with color interference. The papers [9-11] handles this issue that provides an EM approach or pilot block approach for estimating the printing colors and hence the values, from image considering the interference. The barcode thus collected can then be fed to a QR code reader and the data can be decoded with the steps in reverse that used in encoding.

III. RECENTDEVELOPMENTS

Several studies are being performed in the area of color QR codes (fig 3.1). The latest among them is encoding the data in printing colors and decoding them back with vision colors [9]. This solves the issues with data recovery that can arise due to printing vision colors. Since the colors used are the same used for printing, this improves the quality. But the estimation of printing colors from vision is not simple since we look on practical issues. This can be solved by the method of probabilistic estimation of colors in given position.

Fig 3.1 Color QR Codes.

Even though it is solved security of QR codes is still a question. Private QR codes cannot be made since all are decodable in a basic QR code reader.

IV. CONCLUSION

QR codes are the most popular barcodes that are most useful in all the cases. The paper has gone through different available two dimensional barcodes and has seen that QR codes perform the best. Now the advantages of colours are incorporated with qr code to improve its efficiency. Using colors will increase the data rate as well as complexity in its decoding. Although, bit error rates and therefore information capacities vary across the three resulting channels, the error rates are in ranges that are readily handled by the error correction coding options available for monochrome barcodes. Efficient methods can be adopted for its decoding. The security issues are still a question. The QR code accessible in a LAN network can cause privacy issues. The solution is in its developing section. We can go for the classical encryption techniques for solving this. Denso wave co. has introduced a secure method in recent times but its details are still to be known.

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