A Novel Approach For Detect Counterfeit Product Using Color QR Code

B.Prabhu Shankar, Dr.R.Jayavadivel, T.Viswanath Kani

Abstract: Counterfeiting is one of the biggest challenges to the authenticity of the original product. Counterfeit goods generate 15-20% revenue loss on average businesses. To combat this situation, product manufacturers use holograms and barcodes. Therefore, customers cannot guarantee the reliability of a product. Therefore, with the growing trends in mobile and wireless technology, rapid response (QR) codes provide a robust mechanism for counterfeit products. QR codes and color QR codes are primarily used in security and proprietary applications. Many mobile applications use QR codes for secure login and receive product information. Our proposed approach uses QR codes based on 2 Dimensional color QR codes to recognize the originality and reliability of a product.

Index Terms: Bar code, Color QR codes, Color model, Error correcting

1 INTRODUCTION

According to the Global Brand Counterfeit Report, the global losses due to counterfeiting. Government and state-owned organization are taking steps to prevent this. The counterfeit market can affect a country's growth. Counterfeiting is the practice of deceiving individuals into believing that they are following something real, stealing, destroying or replacing it. Counterfeit products are fake or unauthorized copies of actual products. Counterfeit goods are often manufactured with the intention of taking advantage of the higher value of the product. A counterfeit word describes fraud. Counterfeit products contain the company's logos and brands (as a result of patent or trademark infringement), which may be of poor quality (and sometimes not working) and may be toxic. Modern technologies that use barcode and QR code provide the perfect solution against counterfeit. Customers view their mobile app as a solution that helps companies and customers identify the viability of the product. Barcodes enable automated work processes without human intervention, and are widely used because they are fast and accurate, eliminate many errors and often save time and money. [1-4] Barcodes are the optical machine readable representations of data that are capable of representing the data clearly and efficiently. Because of their readability, accuracy, and operational characteristics, barcodes are ubiquitous in many applications, tracking prices in their stores and retail chains, tracking products and identifying customers with membership cards; the amount of digital information stored in 1D barcodes is limited, and these bars have fewer errors. The data rate can be increased simply by increasing the number of barcode digits or by setting multiple barcodes. This approach has many negative consequences, however, with expanded barcode areas, more complex reading operations, and increased printing costs. If one or more bars are lost in the code, the entire barcode cannot be read again.

For this reason, barcode technology uses geometric shapes in two dimensions: such barcodes are represented as two-dimensional (2D) symbols. Note that 2D codes increase the amount of available data space by storing information in two dimensions, whereas 1D code only contains data in one dimension. Figure 1 shows examples of a one-dimensional bar code and Figure 2. Shows examples of a two-dimensional bar code (QR code) 2D codes range from repeating a single 1D barcode to multiple 1-rows to exploit 2D shapes to represent the data [5].

![Fig. 1. Model of 1D bar code](Image 395x377 to 493x440)

![Fig. 2. Model of 2D bar code (QR Code)](Image 408x285 to 480x344)

We now have a brief literature review of this research. Then the secure color QR code method will be proposed and the results will be discussed.

2 QR CODE AND COLOR MODEL

A Quick Response (QR) Code is a popular type of a 2D barcode. It encodes alphanumeric information. The main difference is barcode represents the data in horizontal axis, and QR code represents the data in horizontal axis.

The salient features of QR code are as follows:
- High Capacity Data Encoding system: QR code having more capacity as compared to 1-D barcodes, because the data is stored in two dimensions order.
- Small Printing Size: In small square print area stored more information about the product.
- Dirt and Damage Resistant: Error correction technique such as Reed–Solomon codes ensures the reliability of QR codes
Easy Decoding system: QR code is read from a view of 3600 and decoded using mobile phone application.
Readable from any direction: QR Code is capable of read 3600 and its support high speed reading.

Nowadays, the Quick Response Code (QCR) has become one of the most reliable data storage tools by joining the enormous growth of e-commerce and mobile phone Market. QRC is particularly robust and combines cost and effectiveness. Since then, this has become increasingly widespread Demand for different fields like product labelling and product tracking [6-7]. Through QR scanner or mobile camera read the QR code, it is giving their corresponding information. The use of augmented reality of QR codes [8] refers to the extracted information in QR codes in 3D form. The effectiveness of QR code depends on the amount of information stored and the following factors:

- Version of QR code
- Coded data type
- Error correction status

There are different versions of QR codes, and the efficiency of QR codes increases with version number. There are four data types supported by QR codes: numeric, alphanumeric, kanji and byte. The Reed-Solomon algorithm combines zeros at the end of polynomial and data terms and is equated with the highest power in the generator polynomial. The decimal representation of the residuals is used to create error in correcting the index words. Error correction code using Reed-Solomon technique to [9, 10] restores partially lost data in QR code.

A. Structure of QR Code
It is well known that there is no formally established standard of a QR code. However, any decoding program maintains the most popular formats.
A QR code consists of some obligatory elements:

- Version information
- Timing patterns
- Format information
- Alignment patterns
- Data and error correction keys

1. Positions of patterns are placed in every corners of the QR Code image, except the bottom left. They provide an opportunity for any scanning device to scan the QR code image and obtain the location of the code and start the scan and authentication process.
2. Format Area is intended to store information about the format and coding, which is involved in transcription.
3. Version is pattern of the image contains the encoded information about the version of the code.
4. Timing patterns are situated between the three position patterns and look like a line of alternating dark and light squares. QR code generator,

B. Error correcting in QR Code
QR code is the Error Correcting for reading data between black and white. There is an error in correcting methods are classified into four levels. Error correcting method able to retrieve data even the QR code contain damage or scratch. The portion of damage is calculated in term of percentage ratio to the area of the QR code must under the error correcting level in order to restore data. However, since it contains essential information pertaining to the decoding process, the damage should not affect the shape or design area of the specific area. If the detection system or design area is damaged, the decoding process stops[11].

C. Color Model
Color QR code generator using random number generator to determine the unique color of each element of the QR code. This allows you to change the shape of the elements between the square and the round or use both format. RGB - Is used for radiant media like computer screens and television it is made up of three basic colours: red green and blue. If all colours are not used (switched off) you have a black screen. As you add more of each colour it becomes lighter. Adding 100% of each colour will then give as result a white screen. Thus the more colour, the lighter it shows.

CMYK - Used for reflective media, like white paper. It is made up of four basic colours with one (Black) being an interesting one. Here no colours (or ink) means a white sheet of paper, and the more of a colour you add the darker it becomes. It is thus the exact opposite of radiant media. Using Cyan + Magenta + Yellow should give us black, but instead it turns into a very dirty bark brown, and costs a lot of ink from each colour to achieve this. So black is added as fourth colour to ensure a solid black colour and minimize the amount of colour ink(s) needed to achieve this.

Fig.3. Structure of QR Code
Fig.4. The damaged QR Code
Fig.5. RGB Color Model and QR Code
HSV - HSV (hue, concentration, value) [12]. The purpose of HSV is to make it easier to use color than standard RGB, since the model is developed as an alternative shown in figures 7. HSV will provide better definition for different colors. For example, in the case of yellow, it is difficult to distinguish a group of yellows. In the art design view it is pale yellow, dark yellow and brown, which is considered a yellow base. Concentration and hue are different in those colors. These values represent simple differences in color. HSV breaks down into three values.

\[
\begin{align*}
H &= \begin{cases} 
0^\circ & \Delta = 0 \\
60^\circ \times \left( \frac{G'-R'}{\Delta} \right) & , C_{\text{max}} = R' \\
60^\circ \times \left( \frac{B'-R'}{\Delta} + 2 \right) & , C_{\text{max}} = G' \\
60^\circ \times \left( \frac{R'-G'}{\Delta} + 4 \right) & , C_{\text{max}} = B' 
\end{cases}
\]
\]

The R, G, B values are divided by 255 to change the range from 0...255 to 0...1

\[
R' = \frac{R}{255} \\
G' = \frac{G}{255} \\
B' = \frac{B}{255} \\
C_{\text{max}} = \max(R', G', B') \\
C_{\text{min}} = \min(R', G', B') \\
\Delta = C_{\text{max}} - C_{\text{min}}
\]

V (value) is the brightness of the color values from 0 to 100, increasing the brightness of the image, thus increasing the value. For any value of dye with a concentration of 0 and a value of 100 (brightness), a white is indicated. Any configuration with a value of 0 (brightness) will be black. Suppose Hue is yellow, with a concentration of 100 indicating yellow with a maximum brightness, where the minimum brightness value is still black.

Value calculation: \( V = C_{\text{max}} \)

The advantages of using the HSV model are the minimal variability with the light beam. The value of HSV is very familiar to man; therefore, it is appropriate to use the QR code of this research.

3. RELATED WORK

The QR code thus created can be improved by the use of color. Issues such as how to select colors and how to start using border color are discussed in [13-14]. Data encryption is equivalent to standards, while we are going to use colors instead of black and white. This is handled in [15-18]. The use of colors in QR code now improves its functionality. Using a color scheme can further improve the data rate in 2D barcodes. But this can also cause a few problems. The image of the QR code is taken by a simple cell phone camera, which can suffer from all the imaging problems and therefore needs to be handled with care. The use of colors adds more complexity. You need to identify the right color for the right decoding. The interference between the layers of color makes it very complicated. It can handle problems with the processing of images better. First you need to pre-process the image to remove any dullness and noise and make it suitable for color estimation. A lot of methods have been proposed in this area [18-26]. The achieved image can be filtered using average or any filtered filters to adjust the image. Once the image is fixed, the image is then examined for functional forms. The most important operating system-level detection method is coded for this easy detection. The image is searched in the same format. Once this is discovered we are with three sides of the QR code. Finding the fourth corner, therefore, the total QR index is discussed in [18-25]. The localized image can be tilted or flipped during image acquisition. Thus the image must be geometrically adjusted to decode correctly. This is discussed in [18-26]. The image is now processed for color detection. Color detection here may be through the use of simple probability methods or specific methods such as those used in high-efficiency color barcodes [13-16]. But again, probability methods are always true or false, so accuracy is limited. But if data, such as passport or hospital data, is important, you cannot buy the wrong read. When considering the case of reference colors, it is important to consider the quality of the camera, such as its printed ink. The cost of resources makes it inaccessible. So we can't really trust such methods. Once the color is detected, it can be decoded according to the standards. Now let's move on to safer color QR codes.

4. THE PROPOSE METHODOLOGY

QR code is not only capable of handling a wide variety of data types, but also has larger data storage than some other types of 2D barcodes. However, their maximum data size may not be sufficient for the need for more data space. Therefore, this research should propose the design concept for color QR code using the following coding algorithm.

A. Color QR Code Encoding

The QR code symbol has a code area and functional forms, as shown in the figure 8. The inventor, separator, timing modes, and alignment methods had functional forms. Functional forms are not used for coding data. Inventor shapes located at all three corners of the code, the QR code encoding process consists of the following steps to facilitate easy positioning of
its position, size and gradient[27].

Encryption: Data is encrypted here before encoding. While classical and powerful encryption techniques are available, here we need to stick to simple encryption. The topic will be discussed later. The data is diffused even before encrypting. Now this data encryption stream created by key. The encryption stream is generated by a random generator within the range of the key value [5].

Encoding: Now we go to encoding to generate QR codes with encrypted data. The black and white QR codes are generated according to ISO / IEC standards. Now in each QR code black is replaced with cyan, magenta and yellow respectively. As a result, color QR codes are combined together to produce color QR codes. Due to the structure, the color detection patterns of the color QR codes can be seen in black and white. It now increases the data rate by three factors with improved security [5].

Color Processing: After encoding process the bit streams are divided into coded words. Then the code words are divided into volumes. All these coded words are placed in a matrix. Finally functional forms are added to the QR symbol [27]. A QR code icon is generated. Encoding the input data for the color QR code is described below.

![Fig.8. Block Diagram (Encoding)](image)

<table>
<thead>
<tr>
<th>H = 100</th>
<th>L = 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tl/n</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 9. Color Table**

Where
H=Higher Range
L=Lower Range
Tl = Total length
n = GrayColor Level

Color blocks H = 100, Lower blocks L = 0 and the centre of the range of values are calculated by subtracting the lowest (0) from the highest value (100). Divide the number of shades of gray (n). In figure 9, showing the calculated value range, this research uses 2 shade gray and color blocks H = 100, L = 100 and dye as the centre of the calculated dye range by subtracting from the highest dye value (0).

![CMYK/HVS Process](image)

**Fig. 10. Converting binary input data to color code**

So a hexadecimal digit can have 16 different values (0 to 15 in decimal), and two hexadecimal digits together (called "bytes") can produce $16 \times 16 = 256$ different positions. Each of the three colors can have values from 0 to 255 (256 possible values), including:

$256 \times 256 \times 256 = 2563$ Gives16,777,216 possible color combinations. Approximately 16 million colors.

For generating and acquiring color QR code. The color QR code encoder was understood with the help of Zxing ("zebra crossing") open-source Java library for encoding data in standard QR code symbols.

B. Color QR Code Decoding

The color QR code decoding process is similar to standards QR code decoding process. However, reading color has difference that is standards QR code transfer image color to grey but color QR code reads image color then transfer to hexadecimal and binary data respectively for decoding (Described in encoding process in previous section) and next step will be the same standard QR code process. The decoder was built with the help of Zxing open source Java library and mobile or android based project for improving the processing of QR code [27].

![Decoding Block Diagram](image)

**Fig. 11. Block Diagram (Decoding)**

CMYK/HVS Process: Camera images taken for processing are often in jpeg format, it has already been compressed. The data is lost their itself. Now again the different combinations of C, M, and Y occur while creating and must be decoded from the blurred image. This requires processing the image and then passing it through the color estimation method. Binarization: When we come up with color-adjusted QR codes we need to binaryize it. Binarization results in a black and white QR code in which decoding can be performed.

Decoding: Once validated using the C, M, Y threshold, the image is irregularly processed to obtain QR codes in cyan, magenta and yellow [5]. Now it has doubled to generate black and white QR codes. QR codes are then decoded according to ISO / IEC standards. Any missing data can be retrieved using the Reed-Solomon error correction technique implemented for encryption.

Decrypting: Decoding results in encrypted data. It must be encrypted for information retrieval. This decryption is used, which is the reverse of encryption. Incorporating data results into our valuable data.

5. SIMULATION RESULTS AND DISCUSSION

This research developed a prototype that enables encoding (developed in PC, Java or C#) and decoding (developed in Android and PC, Java / C#) for color QR code. Specifically, we implemented two different applications, the encoder in PC and the decoder in Mobile Application, while performing some performance tests using our prototype.
Simulation parameters Software used: NetBeans Version 8.2
Ultimate Platform: NetBeans
Programming language: Java
Library used: Open Source QR Code
Mobile platform used: Android 4.4.2
Android app used: QR code reader
Screen outputs

Fig. 12. Scanning of original QR code using an Android phone with QR Reader application

Fig. 13. QR code scanned for the first time

After scanning the QR code the Mobile application decoded it, shown in figure 13. The decoder gives error free product data the mobile application display "GENUINE PRODUCT". Customer wants product information Click the button to link to the product webpage.

Fig. 14. Scanning of photocopied QR code using an Android phone with QR Reader application

Illustrates the scanning of QR code for the second time, shown in figure 14. The QR code is copied from the genuine product or the product is not authentic. The Mobile App displays the message: “Not Genuine Product” shown in figure 15.

Fig. 15. QR code scanned for the Second time

The experimental and analysis results gives 92% success rate for the above product authentication system. Many of the images taken using Nokia, Samsung, MI and different phones and the results remained the same. Reflecting from bright color is a challenge in low light conditions and strong illumination that increases the success rate up to 98%.

6. CONCLUSION AND FUTURE WORK

This research created the new QR code (color QR code) to increase the efficiency of QR codes and also better understand the counterfeit product identification. It has been found that different colors enhance the capacity and readability of QR codes. As future extension, we may consider expanding the enhanced security of encryption in QR codes. In addition, a slight change in the QR codes is proposed so that the mobile device can easily differentiate the original QR code and the photocopied QR code. This system can be very helpful for customers to buy a good product.

7 REFERENCES


