Digital 3D Barcode Image as a Container for Data Hiding Using Steganography

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Abstract-Steganography is a technique of concealing private information in a cover medium in such a way that it becomes impossible for the third person to come to know that some confidential information is contained in the cover envelope. In today's era with the inception of new emerging technologies, barcodes has become one of the most popular methods to provide a mechanism for protecting sensitive information.3D barcodes are used to accommodate high data rates by making use of third dimension as a color. 3D barcodes serves as the most reliable technique to hide data because they do not make use of any error correction levels due to the reason that it is very difficult to alter the encoded information. This paper introduces the concept of data hiding in barcodes by using color as third dimension. The process is classified into different categories and performance is evaluated by using various statistical parameters.

Keywords - Steganography; Quick Response code; Cover channel; Stego channel; PSNR; MSE.

I. INTRODUCTION TO STEGANOGRAPHY

With the inception of new communication ways, the need for providing security to the confidential data on the internet is going on increasing day by day. There exists a number of information hiding applications like watermarking, fingerprinting, copyright protection for digital media and steganography. Steganography provides a means for covered writing. [1]Combining steganography with cryptography results into a higher level of information privacy and security. Digital images serves as the most popular information carries for embedding encrypted information because of their increased usage on the internet. [2]

A. Framework of Steganography

The basic process of steganography is hiding encoded secret information in a cover channel in such a way that potential intruder cannot suspect the existence of confidential information. The Cover envelope or channel can be an image, audio, video or text file. [3]

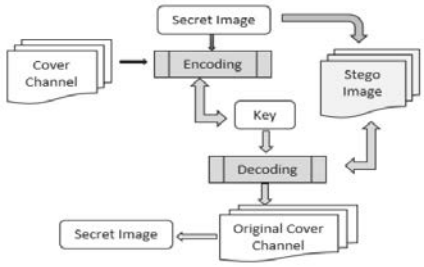


Figure 1. Steganography Process

Cover envelope + Secret data + Secret Key =Stego envelope

II. INTRODUCTION TO 3D BARCODES

3D Barcodes looks like an ordinary barcodes. In these barcodes, bars and squares are prominence.3D barcodes have the same structure as that of 2D QR (Quick Response barcodes) but these barcodes use color as third dimensions.

3D barcodes are scanned with the help of special type of scanners that read height as a function of time the laser light takes to travel to the code section and projects back. [3]

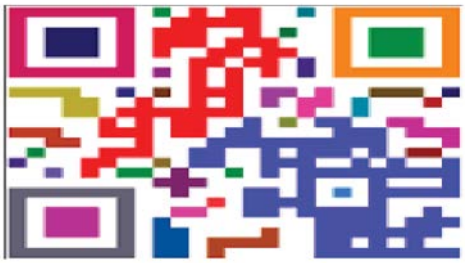


Figure 2. 3D barcode

Pros of 3D Barcodes:

- 3D Barcodes do not make use of any error corrections levels because it is very difficult to modify the encoded information. [4]
- These codes have high data embedding capacity.
- These codes provide a means for security in manufacturing industry, in diamonds, in jewelry, in pharmaceutical products.
- 3D barcodes can encode Picture, song format directly.
- 3D barcodes are high temperature resistant.

Cons of 3D Barcode

- 3D barcodes are costly to generate.
- These barcodes need special type of scanners for extracting information.
- The generation of these color barcodes require proper knowledge of color modes and programming languages. [5]

A. Classification of 3D Barcodes

3D Barcodes are mainly categorized into three types

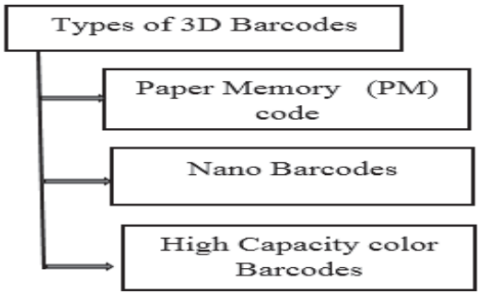


Figure 3 Classification of 3D barcodes

1. Paper Memory Code

PM codes were introduced by a Japanese company named "Content Idea of Asia" in year 2006. This code is similar to QR code but it has color as third dimension. The main advantage of using PM code is that you can embed a picture directly into QR Code. [15] The data embedding capacity of QR code ranges from 0.6mb to the impressive 1.8mb. In PM codes we are able to embed song frames, video frames as well as images directly.

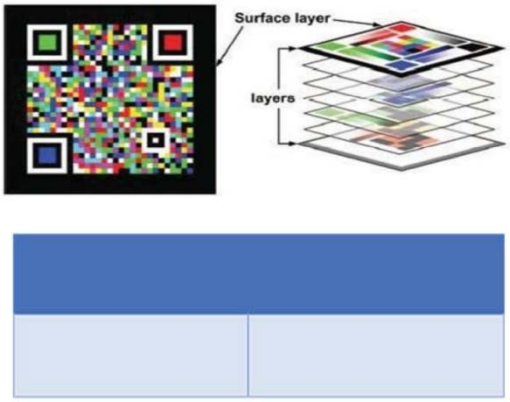


Figure 4 Paper Memory code

Nano Barcodes

These barcodes have resemblance similar to a QR Code. These barcodes have been created by National Physical Laboratory. Nano barcodes have the length equal to the length of a single skin cell. Device which is capable to make 90,000 squares into a cube each having information is stored in the stored in the space between black and white lines.

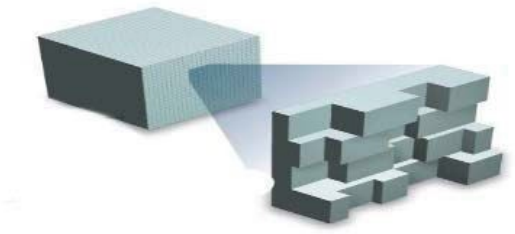


Figure 5. Nano Barcode

High Capacity Color Barcodes

In 2007 a company named Microsoft introduced a new type of 3D barcodes called high capacity color barcode. These barcodes have large data storage capacity than traditional 2D barcodes. HCCB barcodes are different in the sense that eight different RGB colors are used to print these barcodes. The eight colors then make a number of color patterns. [5]

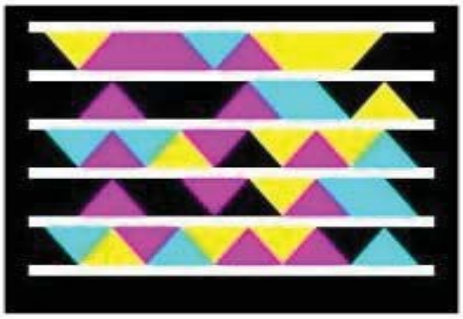


Figure 6. High Capacity color barcode

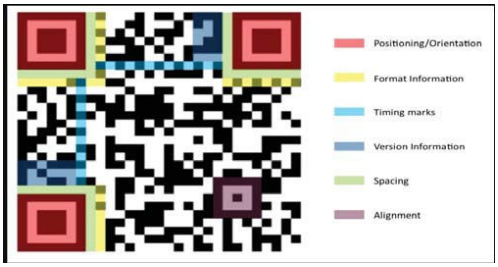


Figure 7. Structure of QR Code

1. *Specification of QR code*

QR code is made up of small black and white squares called modules, timing patterns, format information, position recognition patterns, error correction functions, data area. [7]

Specification	value	
Smallest Symbol Size	21 X 21 modules	
Largest Symbol Size	177 x 177 modules	
Maximum Data Payload	Numeric character	7089
	Alphanumeric character	4296
	Kanji character	1817

Figure 8. Specification of QR code

1. Alignment Pattern: It is used when there is a deformation due to displacement of modules.

2. Position Pattern: The three corners of QR codes are used for detecting position. The ratio of black and

white module is used to specify the edge and displacement of code.

3. Error correction information: It is used when part of QR code is absent.

The rate has four different levels of error correction function.

Error correction Section	Damage area to entire code function
L	7%
M	15%
Q	25%
H	30%

Figure 9: Error Correction Levels

4. Margin: The black area around the QR Code is called margin.

5. Timing Pattern: Modules are used to determine the coordinates which are arranged alternatively.

6. Format Information: It includes the error correction code rate and mask pattern.

2.) *3D Barcode Scanner*

Special type of scanner called direct product mark (DPM) issued to read 3D Bar codes. This scanner makes use of laser light that:

•Passes over the whole bar code.

•There corded information is then converted into binary form.

•A digital processing unit is applied on the binary for min order to interpret the image

•These scanners can be found in hand held versions.3DBarcodesin today's modern era have considerably large effects on the savings and manufacturing costs of industries[12].

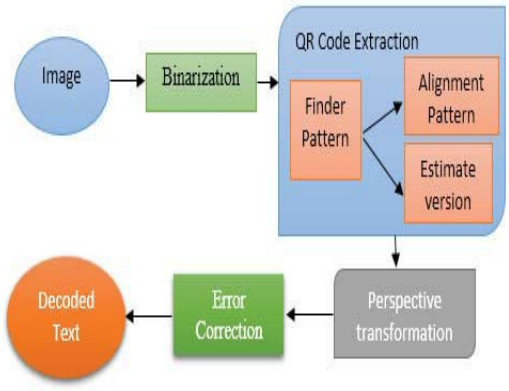


Figure 10: Decoding Process of Barcode

III. METHODOLOGY

In today 'world of network communication, forthe need of greater security, data can be concealed in 3D Barcode images. 3D barcodes are usually represented by using color as a third dimension.

A. 3D Barcode generation and embedding phase

We proposed a framework for generating a 3D colored barcode from monochrome barcode and then hiding the secret information in the least significant bits of the generated barcode.

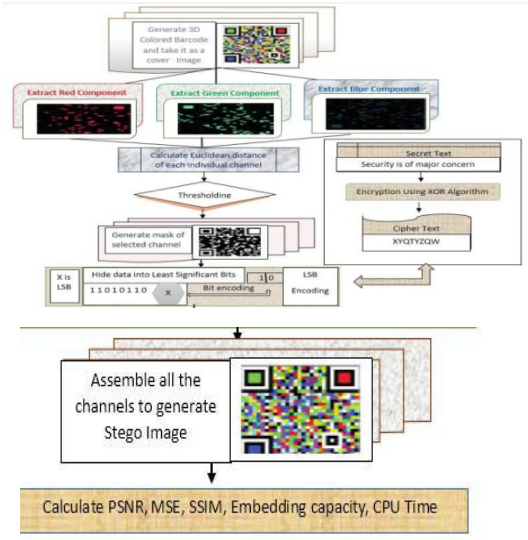


Figure 1: Block Diagram of Embedding Process

Step1: Generate a colored barcode by using three colors barcodes images Red, green, blue with each image individually encoded with information.

Step2: Take the generated barcode image as the cover image. Based on some random key Extract red, green, blue component. Step3: Calculate the Euclidean distance of each individual channel using formula:

$$dr = ||XR' - R||$$

$$dg = ||XG' - G||$$

$$db = ||XB' - B||$$

XR',XG',XB' is the extracted red, green, blue channel based on

key value and R ,G ,B is the original red, green, blue component of the image. Calculate overall distance from RGB color:

$$d = dr .^ 2 + dr .^ 2 + dr .^ 2;$$

Step 4: choose some threshold value. For d <100

Generate the mask of the cover image.

Step5: Hide data into the least significant bits of the mask. Step6: Finally combine all the segments to generate the stego image.

Step 7: Calculate PSNR, MSE, RMSE, and SSIM

MSE = 1 / m*n [S (x,y) – ST (x,y)] all square

PSNR = 10 log 10(255 square / MSE)

SSIM=sum(sum(origimg.*origimg) /

sum(sum(distimg.*distimg))

3D Barcode extraction phase

At receiver side, following steps are used to extract the embedded secret message and source image from the stego image.

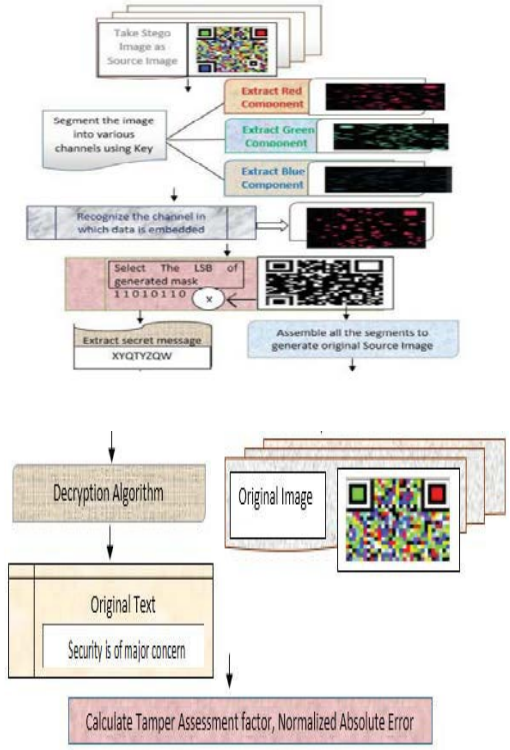


Figure 2: Block diagram of extraction phase

Step 1.Take stego Image as an input. The stego image is the image generated after concealing secret message in the cover image.

Step 2: In this step, the image is segmented into a number of segments.

Step 3: Then we have to recognize the segment in which the sensitive information or secret message is hidden.

Step 4: After recognizing the segment in which the data is hidden, we have to identify the least significant bits in which data is embedded.

Step 5: In this step, by using the same key as used in the embedding phase we can decrypt the secret message.

Step 6: All the segments are then assembled

4.3 GENERATION OF 3D COLORED BARCODE

We proposed a procedure for creating 3D Barcode. The procedure includes the generation of colored barcode from three red green, blue color barcodes with some encrypted information in them Equation

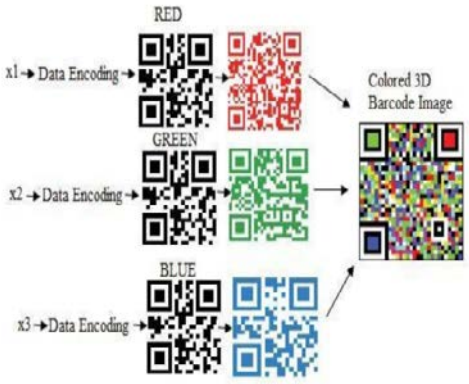


Figure 1: Generation of 3D colored Barcode image

D. *Simulation*

S. No	Original Image	Mask Of Channel	Extracted Component	Stego Image	PSNR	MSE	SSIM	Embedding capacity	CPU time
1.					87.9320 7290	1.046 825e -04	0.99 999	25 bits	5.56 923
2.					85.9133 4	1.666 27202 e-04	0.99 9999	25 bits	3.15 122 020
3.					86.5337 95	1.444 444e- 04	0.99 999	25 bits	4.22 762 710
4.					91.1470 650	4.993 14128 e-05	0.99 999	25 bits	5.94 363 80
5.					95.8150 7	1.704 40710 e-05	0.99 999	25 bits	10.8 264 69

IV. EVALUATION OF RESULTS

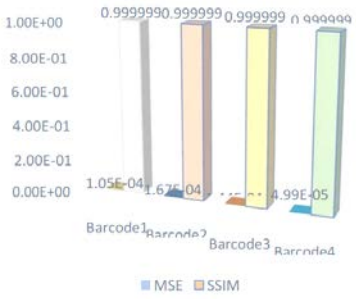


Figure (a) Evaluation of MSE and SSIM

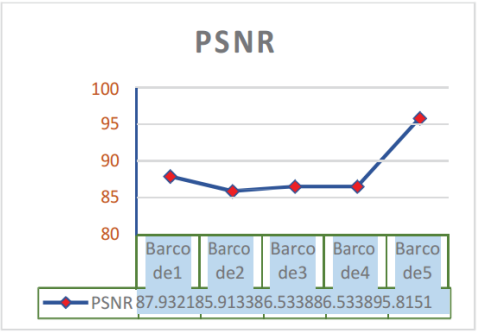
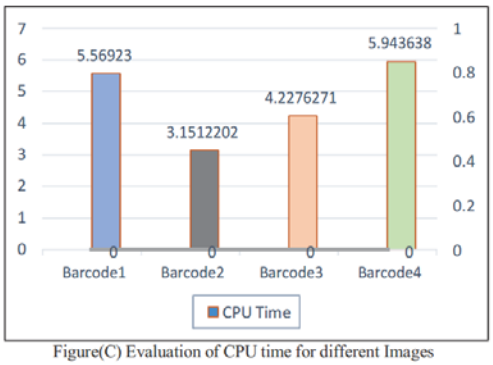


Figure (b) Evaluation of Peak Signal to Noise ratio for different Images



Figure(C) Evaluation of CPU time for different Images

V. CONCLUSION AND FUTURE SCOPE

In this paper, we presented a new technique for concealing data in the least significant bits of a colored 3D barcode image. The technique used, first extracts red component of the image based on some key value. The secret image is converted into encoded text by using XOR encryption algorithm. Then the least significant bits of the extracted components are replaced with the least significant bits of the text to be concealed. The approach uses simple LSB (Least significant Bit) Method.

The proposed scheme maintains the quality of stego image with an average peak signal to noise ratio of 87.93 and Mean Square Error of 1.078 and structure similarity index matrixof 0.999. The proposed scheme increases the quality of stego image and also increases the embedding capacity of 3D colored Barcode images. In future this approach can be improved by using several optimizing algorithms for enhancing the embedding capacity and quality of stego image with less distortion in the image. Several secret messages can also be concealed in a single cover image.

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