www.thecreativelaucher.com Vol. III & Issue II (June- 2018) ISSN-2455-6580

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An International, Open Access, Peer Reviewed, Refereed, E- Journal in English

An Illustrative Review on Steganography Techniques Using QR Code Images

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DOI: 10.53032/tcl.2018.3.2.08

Abstract

This review paper concentrates on the concept of QR code steganography and its de-noising filters. The goal of this review paper is to explore and analyze QR Code generation, QR code versions, Steganography techniques and Problems of QR code. In this paper, we present review on two challenges of the work i.e. first one is QR code steganography and its major problem noise, noise creates a problem to read the QR code, and reduce the readability of QR code. The literature review is done on QR code steganography technique and filters that basically reduce the noise of Image of QR code and as well as performance parameters PSNR and MSE. We have also discussed various Error correction levels of the QR code, steganography techniques and de-noising filters. Error Correction and noise removal from Cover image is challenging task and calculating the PSNR and MSE values for QR Code images with different image file format.

Keywords*- Quick Response Code, Steganography, De-noising Filters MSE, PSNR*

Introduction

QR code is the trademark type quick response matrix barcode two-dimensional barcode first time designed for the automotive industry in 1994 by Japanese DENSO WAVE Company [2]. A barcode is a machine-readable optical label or sign that contains information about the product on it is attached. A QR code uses four standard encoding modes like numeric, alphanumeric, byte / binary, and kanji to easily store data. The QR Code also becomes a popular outside automotive industry due to its fast readability and greater storage capacity as compared to UPC barcodes. Applications include product time tracking, document management, tracking, item identification, general marketing. A QR code consists of black modules (square dots) arranged in a square grid on the white background, which can be read by bar code scanner. The required data are then extracted from patterns present in both vertical and horizontal components of the image.

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1.1 QR Code Creation

To conduct our experiments we used the following tools:

Mobile phone with a built-in camera for scanning barcodes: QR code Scanner app from Android OS smartphone with different bar-code scanning applications installed. Computer running Windows 7 OS with Free Online QR Code Generator [16].

Figure 1: QR Code

1.2 VERSION AND ERROR CORRECTION

Version is the capacity of a QR Code which 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.

1.2 .1 VERSIONS OF QR CODE

Versions of QR Code range from Version 1 to Version 40 having different number of modules. The module refers to the black and white dots that make up QR Code in module configuration that means the number of modules in which contains symbols with Version 1 (21 × 21 modules) to Version 40 (177 × 177 modules). Each higher version number consists of four extra modules per side because each QR Code having higher version has the large data capacity according to the amount of data, character type and error correction level. In Figure 2 Shows that Version list in which versions of QR code. The amount of data increases, more modules are required to comprise QR Code, result a large QR Code.

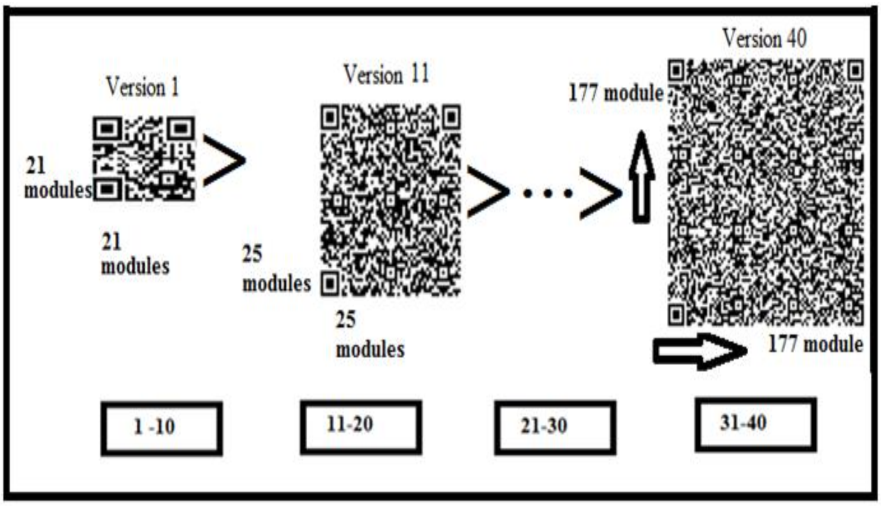

Figure 2: Version List

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1.2.2 ERROR CORRECTION

Error Correction in QR Codes is based on Reed-Solomon Codes specific form of Bar-code error correction. There are four levels of error correction that can be chosen by the user at creation time. 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 [2].

Level L (Low)	7% of code words can be corrected.
Level M (Medium)	15% of code words can be corrected.
Level Q (Quartile)	25% of code words can be corrected.
Level H (High)	30% of code words can be corrected.

I. QR CODE STEGANOGRAPHY

Steganography is the process in which secret message embedded into digital QR code cover images basically this is represented to protection of confidential information, QR Code steganography in which image, text and audio type information can be hidden. Steganography shows the basic process involved in Steganography which consists of Cover Image, Secret Message and Key. Cover Image is also known as cover-object, in which message is embedded and serves to Comparison of different techniques for Steganography in images hide the presence of the message. The Secret Message can be any type of data (plain text, cipher text or other image) that the sender wishes to remain confidential. Following are important techniques used in QR code Steganography.

2.1. LEAST SIGNIFICANT BIT TECHNIQUE

Least significant bit (LSB) replacement is a common and simple approach for embedding information in a cover image. The least significant bit is 8 bit of some or all of the bytes inside an image are replaced with bits of the hidden message in selected part of the cover image. When using a 24-bit image, a bit of each of the red, green and blue colours can be used, since they are each represented by a byte.

It allows to stores 3 bits in each pixel. The image of 800 X 600 pixels, can thus store a total amount of 1,440,000 bits or 180,000 bytes of embedded data [10].

For example, 3 pixels grid for of a 24-bit image can be as follows:

(00101101 00011100 11011101)

(10100111 11000101 00001101)

(11010010 10101101 01100011)

When the binary number 10110110, is embedded into the least significant bits of this part of the image.

The resulting grid is as follows:

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(00101101 00011100 11011101)
(10100111 11000100 00001101)
(11010011 10101100 01100011)

The number was embedded into the first 8 bytes of the grid, from these only the 3 underlined bits are required to be changed according to the secret message which is embedded. Mostly half of the bits in image are required to be modified to hide a secret message using the maximum cover size. Seeing that there are 256 intensities of colour of each pixel, by changing the LSB of a pixel, it results in small changes in the intensity of the colours. These changes cannot be identifies by the human eye, finally the message is successfully hidden in image.LSB technique also called simple steganography technique.

Figure 3: The cover image [14]

Figure 4: The stego-image [14]

2.2. MID BAND DCT STEGANOGRAPHY TECHNIQUE

This method is used for hiding a large amount of data and provides high-level security, a good invisibility and without loss of confidential message. The goal behind it is to hide information in frequency domain by changing magnitude of all of discrete cosine transform coefficients of cover image. The 2-D DCT converts image blocks from spatial domain to frequency domain. The cover image is divided into non overlapping blocks of size 8×8 and applies mid band DCT on each of blocks of cover image using forward DCT [3].

2.3. DWT-SVD STEGANOGRAPHY TECHNIQUE

The hiding of a message will reduce the possibility of detection of the real secret message. This method allows us to hide gray image in one form to another. In this method the cover image is divided into number of blocks of equal sizes, each block size is same as that size of the embedding image. Differentiate each pixel in embedding image with all the closing pixels in the blocks of the cover image. In DWT-SVD Steganography technique uses the QR code generator to produce a secret message which is changed into one dimensional vector with sequence 1's and 0's. To embed the payload in DWT bands, a degraded image quality is

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imminent. We chose to decompose the LL sub band upto three levels HL, LH and HH. HH typically contains more information then Hl and LH. Each sub band LH and HL are divided into numbers of 16X16 Overlapping blocks [11].

2.4. JPEG IMAGE STEGANOGRAPHY TECHNIQUE

One of the main features of steganography is that the information is hidden in the duplicate bits of an object and since duplicate bits are left out when using JPEG it is the problem that the hidden message would be damaged [12]. One of the characteristics of JPEG is to make the changes to the image to make it unnoticeable to the human eye. During the DCT transformation part of the compression algorithm, rounding errors occur in the coefficient data that are not noticeable and understandable [5]. It is to recognize that the JPEG image compression algorithm is actually divided into loss and lossless stages [10].

In this paper, we compared the following Steganography technique and de-noising filter methods according to their design characteristics like PSNR and MSE parameters.

II. QR CODE IMAGE QUALITY EVALUATION

Image quality after steganography implementation tested on various quality parameters. To test the best suitable error correction level of this research work the Peak Signal to Noise Ratio (PSNR) is calculated in which PSNR values are calculate to judge quality of digital QR code image [12].

(i) PSNR: It is Peak Signal to Noise Ratio reflect the ratio between the maximum possible power of a signal and power of corrupting noise. It also affects the originality of the signal. The PSNR is usually expressed in terms of the logarithmic decibel scale. It is commonly used to check quality construction of loss compression [15].

$$\mathbf{PSNR=10log_{10}\left(\frac{(255)^2}{MSE}\right)\ dB}$$

(ii)MSE: MSE is nothing but Mean Squared Error [3]. If one have a noise-free m x n monochrome image A and it has noisy approximation of K, then MSE is defined as: The PSNR calculation (in dB) is defined as:

$$\mathbf{MSE = \frac{(255)^2}{Anti\ log_{10}\left(\frac{PSNR}{10}\right)} = \frac{65025}{Anti\ log_{10}\left(\frac{PSNR}{10}\right)}}$$

Table 2: Comparisons of Different Steganography Techniques

Year	Author's Name	Paper Name	Steganography Technique	PSNR (dB)	MSE
2013	Saravanan, V., and A. Neeraja[5]	Security issues in computer networks and steganography	Simple Steganography	34	25.89
2015	Barhate and Ramteke[9]	Comparative Analysis and Measuring Qualitative Factors using Colour and Gray Scale Images for LSB and DCT-Mid Band Coefficient Digital Watermarking	Least Significant Bit Method	3.18	1000
2012	Chaturvedi, Rekha, Abhay, Naveen and Dinesh Goyal[3]	Analysis of robust watermarking technique using mid band DCT domain for different image formats	Mid Band DCT method	42.09	158.93
2013	Islam, Md Wahedul. [11]	A novel QR code guided image steganographic technique	DWT-SVD steganography technique	40.52	100
2016	Vladimir Hajduk, martin Broda Ondrej Kovac Dusna [8]	Image Steganography with Using QR Code and Cryptography	JPEG Image Steganography	59.48	0.77
2014	M. Ramesh, Prabakaran and Bhavani [12]	QR-Code Image Steganography	JPEG Image Steganography	48.64	0.96

QR CODE RECOGNITION PROBLEMS

[i] QR Code having distorted modules

When a QR Code is made smaller or enlarged using an image processing tool then, every module becomes distorted. It may look like a normal QR Code, but it may be difficult or impossible to read the code [17].

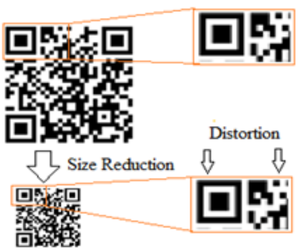

Figure 5 : Distorted QR code

[ii] QR Code having letters

If letters are placed around a QR Code, the required margin cannot be read by the QR code reader or Mobile phone App.

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Figure 6 : QR code with letters

[iii] QR code having noise

Digital images play key role in different like remote sensing, ultrasound, television and CT scan etc.

Images capture by different devices generally adds the different type of noise while capturing with the help of faulty instrument or wrong methods of data capturing. Following are the image de-noising Filters.

Figure: 7 Image with Noise Figure: 8 Image without Noise

4.1. TYPES OF NOISE WHEN CAPTURES THE QR CODE

[i] GAUSSIAN NOISE

Principal sources of Gaussian noise in digital images appear during acquisition like as electronic circuit noise. Gaussian noise: (with zero mean and prescribed standard variation) via the addition to each pixel of the standard variation times a pseudorandom number drawn from the standard normal distribution [13].

[ii] SALT AND PEPPER NOISE

Salt and pepper noise or spike noise is also called Impulsive noise. An image contains salt-and-pepper noise have dark pixels with bright regions and bright pixels in dark regions. This type of noise can be caused when image is converted analog to digital.

[iii] QUANTIZATION NOISE

The noise caused by quantizing the pixels of a sensed image to a number of discrete levels is known as quantization noise. Though it can be signal dependent, it will be signal independent if other noise sources are big enough to cause dithering [13].

[iv] SPECKLE NOISE

Speckle noise is found on ultrasound images, this noise results the poor effective resolution

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of ultrasound as compared to MRI. Speckle noise is commonly found in satellite images, medical images and synthetic aperture radar images.

4.1.1. QR CODE COVER IMAGE DE-NOISING

Image de-noising is an important image processing task, in which basically remove the noise from QR cover image because the noisy images are difficult to read by QR code scanner. It is a process which main motive is refines the cover image itself as well as a component of other process. There are various ways to de-noise an QR code cover image. A good image de-noising model is that which is capable to remove noise completely as possible [6]. In other words Filters play a major role in the Image Restoration process. Following discuss about various Filters.

Table 3: Comparisons of Different Image De-Noising Filters

Year	Author's Name	Paper Name	Filter Methods	PSNR (dB)	MSE
2014	Inderpreet Singh and Nirvair Neeru [6]	Comparison of Various Image Denoising Filters Under Spatial Domain	Gaussian Filter	23.72	199.55
2014	Inderpreet Singh and Nirvair Neeru [6]	Comparison of Various Image Denoising Filters Under Spatial Domain	Average Filter	25.80	316.22
2013	Kumawat, Deepika, Ranjeet , Deepak and Shikha Gupta [1]	Impact of Denoising using Various Filters on QR Code.	Mean filter	21.66	447.02
2013	Kumawat, Deepika, Ranjeet , Deepak and Shikha Gupta [1]	Impact of Denoising using Various Filters on QR Code.	Median filter	22.04	409.47
2014	Inderpreet Singh and Nirvair Neeru [6]	Comparison of Various Image Denoising Filters Under Spatial Domain	Min Filter	12.78	15.84
2014	Inderpreet Singh and Nirvair Neeru [6]	Comparison of Various Image Denoising Filters Under Spatial Domain	Max Filter	11.21	12.58

4.1.1 GAUSSIAN FILTER

Gaussian filter is a non-uniform low pass filter. Gaussian filter is used to blur images and remove noise and detail. It does not remove salt & pepper noise effectively [6].

4.1.2. AVERAGE FILTER

The output of average filter is simply the average of of pixels contained in the neighbourhood of filter. It calculates the intesnsities of neighbourhood of the central pixels with average value.

4.1.3. MEAN FILTER

Mean filter is the Linear model and each type of filter have a specific application, If we remove grain noise from a photograph, is the most relevant filter and is an averaging filter because each pixel needs to be set to be average of the pixels in its neighbourhood and reduce local variations caused by grain. This filter is also called average filter [1].

4.1.4. MEDIAN FILTER

Median filter is the Non-Linear model of filtering for removing noise. Such noise makes correction in pre processing procedure. A major advantage of the median filter over linear filter is that the median filter is capable of eliminating the effect of input noise values whose magnitude is very large [1].

4.1.5. MIN FILTER

Min Filter is also called 0th percentile filter. It replaces the value of pixel by the maximum intensity level of the neighbourhood pixel value. It removes the salt noise this is occurred in digital images due to high intensity value [6].

4.1.5. MAX FILTER

Max filter is called 100th percentile filter. It replaces the value of pixel by the maximum intensity level of the neighbourhood of the pixel. This filter is used to find out the brightest point in the images [6].

CONCLUSION

Although some of the popular image steganography techniques and image de-noising filters were discussed in this paper, there exists a large selection of approaches to hiding information in images using steganography, we already discussed the different techniques as per the relevant image file formats. In QR code versions, every version of QR code having own Features. QR code cover image is affected due to noise like QR code Cover image degraded and to remove the noise from the unreadable QR code cover images, de-noising filters used to remove the noise, after that the image quality measure by the PSNR and MSE performance evaluation parameters. Thus this paper provides the pros and cons of QR Code, steganography techniques and de-noising Filters. Filter methods are proposed here will be used to enhance the scanning process of QR Codes. It is difficult to read QR code with letters and pictures around it, and sometimes QR code with overlaid letters and pictures, that two difficulties are challenging task for future.

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