QR Code Application based Reversible Watermarking in Image Processing

Jagruti R. Mahajan
PG Student, Department of Computer Engineering
SES's R. C. Patel Institute of Technology, Shirpur, MS, India

Nitin N. Patil
Associate Professor, Dept. of Computer Engineering
SES's R. C. Patel Institute of Technology, Shirpur, MS, India

ABSTRACT
In digital watermarking, images which have specific pattern images. They used as digital watermarks for variety purposes in copy prevention emerging solution. Conversely, several attacks still get unsolved in a robustness of invisible watermarking techniques. An effective technique for visible watermarking can be retrieved to identify the ownership of the protected media. The purpose to show the media's ownership an open algorithm used. That is to extract the digital watermark. Here a novel method for reversible visible watermarking with a capability of lossless image recovery proposed. The technology that combines 2D Barcode with a digital watermark is a topic of great interest. It is in current research related to the security field. This paper presents a new digital watermark method for the QR Code (Quick Response Code). In this, the method which embeds the QR code into gray-scale image to produce visible watermark. Here, it simply tries to change the pixel values to accomplish digital watermark image. In addition, a reversible steganography method is used to embed watermark information, which can be recovers the original, from embedding media.

Keywords
Barcode, Quick Response (QR) Codes, Reversible data hiding, Security, Watermark.

1. INTRODUCTION
In this verified length of existing era mobile and wireless technology skill is delightful over all fields of life. They are in the matter of than a communication device; they act as PC, music player, your bank, shopping area and all [1]. In the future the smart glasses like google glass are going to change the existing hand held plans which make to cover the physical world with a digital layer of tags, advertisements, maps etc [2]. In present state, the one of the key technology used to connect the physical globe to internet or digital world using smart phone, i.e. with the help of QR codes.

A QR ("Quick Response") code is a two dimensional (2D) bar code invented by the Japanese corporation Denso Wave in 1994, with a main objective of "Code read easily for the reader". More in recent, the system protocol has enhanced approve due to its fast readability & large storage capacity compared to standard 1D UPC barcodes. The QR code carries meaningful information in the vertical direction as well as the horizontal; hence it says the two-dimensional (2D) phrase. By carrying information in both directions mutually, QR can carry up to several hundred times the amount of data carried by ordinary bar codes [3]. Types of input data possible for QR code to be encode as follows:

1. Numeric: digits 0-9 (expressed in bits 30HEX- 39HEX), **2.Alphanumerical data:** Digits 0-9 (30HEX-39HEX), Capital letters A - Z (41 HEX -5A HEX), Special signs: space % $ * + - . , / etc. **3.Binary data:** each byte sign is coded with 8 bits; **4.Kanji characters** (representation of Chinese signs).

People have made linking to the web pages easy by directly obtain information such as URLs, images, text data, picture information (like maps) via the mobile phone software decoder at the time of input. A smart phone device also input a URL, who brings many difficulties. In 2008, Tan [4] presented a method that uses the quick response code (QR code) to solve difficulties of the input problem.

As a visual watermark embeds the QR code into the grayscale - image and using reversible data hiding provides the ability to restore the original image. We are making the QR code as invisible watermark in image using digital watermark technology. Other alternatives proposed, were mark QR code in invisible ink which is only visible with Ultraviolet, QR transparent stickers etc.

Data hiding is a vital way of recognizing copyright protection for multimedia. It has been invisibly embed the data into a cover media, so that messages can be delivered secretly. Digital images are sometimes used as carriers to send such messages. The image distortion gets occurs when data is embed into the cover image such as for the information hiding. Many approaches to information hiding have been proposed for different attributes, such as capacity, imperceptibility, robustness, and reversibility.

2. CONVENTIONAL SCHEMS IN REVERSIBLE DATA HIDING
Reversible data hiding has a newly developed branch in watermarking researches. This technology not only embeds secret messages into images, but also reversibility can return completely the original images after messages are extracted. Various reversible data hiding approaches have been proposed. According to where the data are embedded, these approaches can be classified into three categories: the spatial domain, the frequency domains and other compression types, such as vector quantization. In the literature, there are technologies applied: Compression based, Difference expansion based, Histogram-based and visible watermarking. For compression, in 2002, Fridrich et al. compressed the LSB's plane to obtain extra space for embedding private data [5]. For Difference expansion, In 2007, Thodi et al. used the concepts directly from wavelet transform by turning the special pixel values into frequency coefficients. This technique better exploits the correlation inherent in the neighborhood of a pixel than the difference-expansion method. Prediction-error expansion and histogram shifting combine to form an effective method for data embedding [6], [7]. For Histogram-based, Ni *et al.* [8] is proposed a reversible data hiding method that constructs the histogram for intensity levels of pixels of a host image to be embedded the secret

data. The histogram is then used to recognize the pairs of zero and peak points, which signify the values that none and most pixels assume in the cover image, respectively. The vacate space between a pair of peak and zero points can be shifted in order to generate free empty space for embedding of the secret data. Hong *et al.* [9] proposed a different scheme to construct the histogram using a difference image generated by the median edge detection predictor. The goal of this treatment was to generate a more centralized histogram and raise the height of the peak points to improve the embedding capacity upon the histogram-based method Ni *et al.* [8] proposed in 2009.In 2011, Huang et al. proposed a algorithm in reversible data hiding, which gives the abundant capacity for hidden information and the little amount for side information i.e. the linked integration that can utilize the capability of the QR code [10].

For visible watermarking, the watermark should be perceptually visible to the human eye and robustness. It is lightly embedding watermark image on the primary image/host image. For this watermark the bit rate and signal strength is high. The visible watermark distortion quality is more as invisible watermarking. However, reversible watermarking method can completely reconstruct the visible watermark and original image. For this proposed technique, an approach is to compress the section of original image & then embed the information with the proposed payload into the image [11]. In 2010, Liu et al. uses the one-to-one compound mapping on cover image for overlying a variety of visible watermark [12].

Compared with the invisible watermarking, the watermark should be perceptually transparent and robustness. The detection is expected to be done in smart phone which has slower processors, the detection must be very simple with very little processing required before passing information to QR reader. But in this paper we use this technology to hide QR code in the background rather than using it to protect the information. The most common approach is same as refer [11]. Another approach is the spread spectrum signal of the payload on the host so that the signal is detectable & removable [13]. A third approach is to manipulate a group of pixels as a unit to embed a bit of information [14].

This paper is organized as follows, in next section, a conventional scheme for reversible data hiding to be proposed. Related works to this proposes algorithm described. A new reversible visible watermarking technology is proposed, where the binary image is to be used for watermark. First embedding approached is based on the changing pixels. After the embedding process which is visible to human. Some information embeds by using reversible staganographic method. This can be extracted watermark and recover completely the original one. Our proposed algorithm details in watermark algorithm section see. And lastly shows performance analysis and experimental results and the conclusions.

3. RELATED REVIEW

In the literature, we review the visible watermark and data hiding as well as for histogram-based reversible data hiding method short description that we utilize the concept in this paper algorithm. We will see in this section as follows:

In 2006, Hu et al. [11] proposed the reversible visible watermarking scheme, by modifying 1 significant bit plane of the pixels of host image. Here hide the compressed edition of the altered bit plane without loss in the host (original) image region via the reversibility hiding concept. Though, visibly embedding watermark will degrade the quality of the non-watermark image because it appears to the some extent blurred in that. For this reason there are two procedures to be simulate in algorithm: firstly data hiding & the next visible watermark insertion. Illustrate the proposed procedure. Denote the visible watermark and image region as W and R respectively. Both have the same size. At the time of reconstruction of watermark we achieve lossless image I, i.e. for the single 1 bit plane of region R must be preserved in the non-watermarked image area I-R before W is embed into bit planes of R.

Step 1: The pixel set D which constitutes from bit plan region R. **Step 2:** A bit plan usually has a statistical structure, so D is compressed using open C code of JBIG-KIT into D_C. **Step 3:** A payload scheme is performed to constitute a subset S of the LSB. i.e. lowest bit plane in I - R. **Step 4:** To find out S, which is composed of the one-bit pixel of previous one. S satisfies the constraint $|D_c| = |S| - |S_c|$, where S_c is compressed result of S & the operator |.| shows cardinality of set. **Step 5 & 6:** Construct the payload bit stream as $H = S_c \cup D_c$ is hidden into image area I-R by directly replacing S with H. **Step 7:** Lastly, W embedded into R by directly replace the bit plane.

In 2010, Yang and Tsai [15] proposed the methodology to improve the histogram reversible hiding approach on the gray image by the interleaving prediction method. In this approach, the number of predictive values less than to the number of pixels in an image is their drawback. In these interleaving predictions, shows the predictive values are as many as the pixel values. The predictive error values are transformed into histogram to create higher peak values and to improve the embedding capacity. Additionally, one level data hiding for each pixel, its variation value between the original image and the stego-image remains within +1.

It can provide the new scheme using column-based interleaving predictions to increase the performance of the histogram-based approach. In this scheme, the odd-column pixels are predicted by pixels in even columns; then the even-column pixels are predicted by pixels in odd columns, or vice versa. Yang *et al.* [15] also studied a chessboard prediction method, which is an extension of the original interleaving prediction scheme. Because the prediction errors can be reduced significantly, the heights of the peak points can be raised further to increase the embedding capacity. It illustrates that the histogram-based reversible data hiding approach can increase a larger capacity and still remains a good image quality.

Lin *et al.* [16] shortly later provided a 3-by-3 box filter methodology to improve the embedding capacity for complex images upon the chessboard-based method. In level images, the differences along with the intensity levels of neighboring pixels may be small, thus averaging the intensity levels of the four adjacent pixels by Yang *et al.*'s method would calculate the target pixel as well. On the other hand, in composite images, more neighboring pixels may be mandatory for better prediction. Lin *et al.* thus proposed to raise the number of the reference pixels to eight by using the 3×3 box filter, and the prediction of the target pixel is then the average of the eight surrounding pixels.

4. WATERMARK ALGORITHM

In this scheme, proposes a visual watermark methodology to be constructed by implementing two types of watermarking i.e. dual watermarking method we propose here. Firstly visible watermarking by embedding the QR code image (hiding information black and white binary image) i.e. watermark data into target gray scale image. These embedding method can changes a pixel values to them, in such way that the changed insertion results visible. After that, proceeds with the same watermark image. Using invisible watermarking method, watermark information is hidden into gray image by a reversible steganograhic technique. The sequence process for embedding watermark, the same way reversely watermark information to be extracted completely for recover the watermark image without loss much quality of original gray image.

In this subsection we propose to evaluate our visual watermark method, watermark embedding and reconstruction procedure as follows.

A. Visible Watermarking Embedding /insertion

Here we present the algorithm for a visual watermark method by firstly embedding QR code into original gray image. The insertion method can changes the pixel value by adding/minus positive values to them, so that getting watermark image resultant result are visible by scanning through mobile smart phone. After that, invisibly hide the QR code information into gray image using reversible steganography method. And now to completely recover the watermark image to be extracted to get the QR code information which is to be embedded in that for the image recovery. The watermark embedding and removing procedure to be introduce as follows.

The source image and the digital watermark are defined as:

$I = \{I(i, j) \mid 0 \le i < A_1, 0 \le j < A_2\}$ &

$Q = \{Q(i, j) \mid 0 \le i < B_1, 0 \le j < B_2\}$ with setting pixel co-ordinates (i , j). Where I denote the source image and Q denotes the QR code binary image. The source image is of $A_1 \times A_2$ gray scale image and digital watermark image Q is of $B_1 \times B_2$ QR image with binary black and white background pixels denoted as 0's and 1's respectively. Then, defined the size of watermark image is less that or same as original image. i.e. $B_i \le A_i$, for I = 1,2,3,… In words, in Stage1, Region is selected for embedding, by representing co-ordinates where watermark Q begins to embed in source image I. In Stage2, the digital watermark Q is visibly embedded into image I to form watermark image say I'. In Stage3, bit plane data is usually has statistical structure, so Q is further compressed into Q' using jar compressor which the standard java encryption toolkit, so after that the watermark Q' and the region information are get invisibly embedded into visibly watermark image I' to form the reversible watermarked image say I''. For all this, QR code to be successfully reading out by the mobile phones. In the Stage3, we have to set the threshold defined as T and a threshold value equal to 32 and then record them to 3-bit plane flag string as say F. The detailed algorithm steps:

Input: Source image i, and qr code q.

Step 1: The embedding region is selected by representing co-ordinate of image I where watermark to be embedded.

Step 2: Read and check the pixel values Q (i, j) of QR code Q. Let I (x, y) be the pixel of the source image I into which watermark bit Q (i, j) will be embedded.

if Q (i, j) = 0 ….(if black)

if ($I(x, y) \ge T$ and $I(x, y) < 2T$)

flag string $F = F \parallel 001_{(2)}$

$I'(x, y) = I(x, y) - T$

else if ($I(x, y) \ge 2T$ and $I(x, y) < 3T$)

flag string $F = F \parallel 010_{(2)}$

$I'(x, y) = I(x, y) - 2T$

else if ($I(x, y) \ge 3T$ and $I(x, y) < 4T$)

flag string $F = F \parallel 011_{(2)}$

$I'(x, y) = I(x, y) - 3T$

else if ($I(x, y) \ge 4T$ and $I(x, y) < 5T$)

flag string $F = F \parallel 100_{(2)}$

$I'(x, y) = I(x, y) - 4T$

else if ($I(x, y) \ge 5T$ and $I(x, y) < 6T$)

flag string $F = F \parallel 101_{(2)}$

$I'(x, y) = I(x, y) - 5T$

else if ($I(x, y) \ge 6T$ and $I(x, y) < 7T$)

flag string $F = F \parallel 110_{(2)}$

$I'(x, y) = I(x, y) - 6T$

else if ($I(x, y) \ge 7T$ and $I(x, y) < 8T-1$)

flag string $F = F \parallel 111_{(2)}$

$I'(x, y) = I(x, y) - 7T$

else

flag string $F = F \parallel 000_{(2)}$

else if (Q (i, j) = 1) ….(if white)

if ($I(x, y) \le 64$)

flag string $F = F \parallel 1_{(2)}$

$I'(x, y) = I(x, y) + T$

else

$I'(x, y) = I(x, y)$;

flag string $F = F \parallel 0_{(2)}$

Step 3: Use jar compressor which is the standard java encryption toolkit to compress Q into Q'. Use a Yang and Tsai concept method, for Q', L and F, to embed them into the image I' to construct image I''.

Step 4: Output image I''.

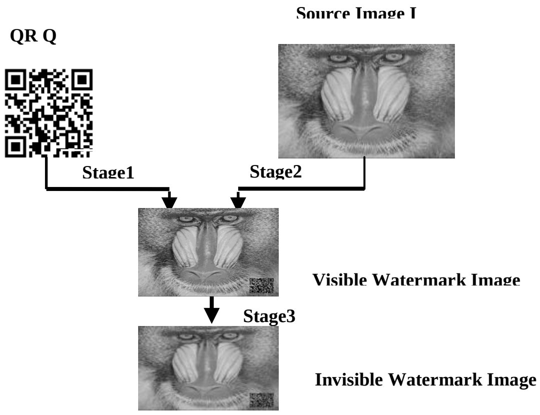


Fig 1: Framework for the visual watermarking embedding procedure

OUTPUT:
REVERSIBLE WATERMARKED IMAGE I''.

B. Watermark Removal for Image Recovery

On the other hand, extraction of data and the original is relatively simple as that of the embedding procedure followed the reverse order. Extraction procedure for the hidden data and original image can be performed. In Stage1, firstly the embedding information compressed Q', L and flag string F in invisibly watermark image I'' is to be extracted and I'' is recovered into the visibly watermarked image I'. Then, in a Stage 2, the information Q, L and flag string F is used to recover original source image I from I'. The detailed algorithm steps:

INPUT: IMAGE I''

Step 1: Firstly by using reversible steganography method, to extract the compressed watermark Q', binary flag string F and the co-ordinate L. After these recover the image I' from the I'' one. Here use java encryption toolkit jar compressor to decompose Q' into Q.

Step 2: Next remove each watermark bit of Q (i,j) from the visibly watermark image I' to obtained image I shows in following way-

Suppose, be the pixel into which watermark bit Q (i,j) has been get embedded and denoting f be the last 3-bit plane data of flag string F corresponds to the I' (x, y).

if Q(i, j) = 0, then

if F = $001_{(2)}$, then I(x, y) = I'(x, y) + T

else if F = $010_{(2)}$, then I (x, y) = I'(x, y)+ 2T

else if F = $011_{(2)}$, then I (x, y) = I' (x, y)+ 3T

else if F = $100_{(2)}$, then I (x, y) = I'(x, y)+ 4T

else if F = $101_{(2)}$ then I (x, y) = I'(x, y) + 5T

else if F = $110_{(2)}$ then I (x, y) = I'(x, y) + 6T

else if F = $111_{(2)}$ then I (x, y) = I'(x, y) + 7T

else I (x, y) = I'(x, y)

else

if Q(i, j) = 1 & F = 000 $_{(2)}$ then,

I (x, y) = I' (x, y) - T

Step 3: Output watermark Q and original image I.

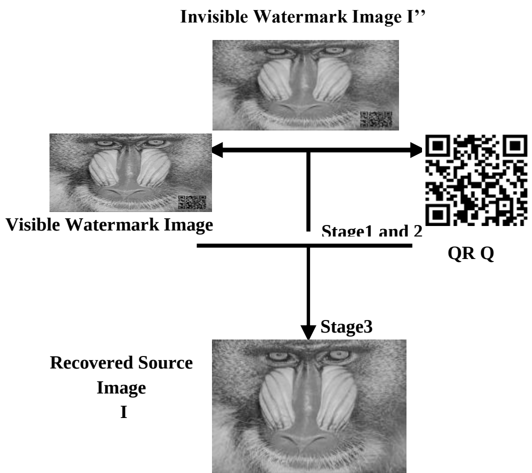


Fig. 2: Framework for the watermarking removal procedure

OUTPUT:
SOURCE IMAGE I and QR CODE IMAGE Q.

C. QR codes generation and Message Selection information

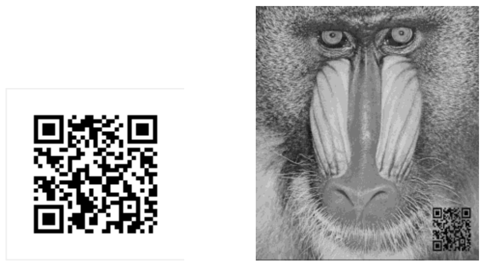
At the opening, we enter the selected textual message or the URL corresponding to the source image. Then next, produce the QR code by the QR code generator, which is helping online too [18]. Then this code is set to be located at the corner of the original image. However, if we add the product information into image, viewers can make instant evaluations and such product info. Publicized in the original image may be purchased online afterward. There can be produced to meet the user's needs accordingly.

5. EXPERIMENTAL RESULTS

Here in this part, the simulation results performance of the gray level image is as shown on considering the two URL link of QR Code image performing Dual watermarking method. First URL link (a) http://in2.csie.ncu.edu.tw/~hsufh/, and second link (b) http://hera.im.cpu.edu.tw/sjw_2006/ in QR Code image itself that embedded using the algorithm perform watermarking on test gray-scale Baboon image as shown figure 5.1. The considering gray scale cover image standard size is of 512 × 512.For to the resultant result quality calculated by using the PSNR (Peak Signal to Noise Ratio) which defined as follows:

PSNR Value = $10 \times \log_{10} 255^2/MSE$.

Where, MSE = Mean Square error.



(a) http://in2.csie.ncu.edu.tw/~hsufh/

(b) http://hera.im.cpu.edu.tw/sjw_2006/

Fig 3: Experimental URL link of QR Code image and embedding stego image

In Table 1, shows the comparison between ours proposed method using Jar compressor and the Hsu et al.'s method using JBIG compressor. Watermark the reversible image gets with the coded QR data Link URL into the test image the results visible clearly. Then reversible data hiding used to embed the data's of QR Q and flag string F based on Yang and Tsai proposes. The images I, I', and I'' PSNR values are mainly used to evaluate the distortion between these two of the images.

Table 1. The comparison of PSNR values between two of the image of Baboon I, I' and I''

Test image Method	Image Size	QR code info.	PSNR		
			I' to I	I'' to I'	I'' to I
Using JBIG KIT [17]	512×512	a.	21.96	48.51	21.91
		b.	23.54	48.51	23.47
Proposed Method using Jar compressor	512×512	a.	24.63	68.62	24.64
		b.	24.76	68.76	24.76

Based on Table 1, Fig. 4 represents graphical comparison. This comparison is in between the JBIG KIT binary image compression and jar compression technique. In our proposal scheme, here the binary image QR code can be inserted into any corner of original cover image and then proceeds with Method.

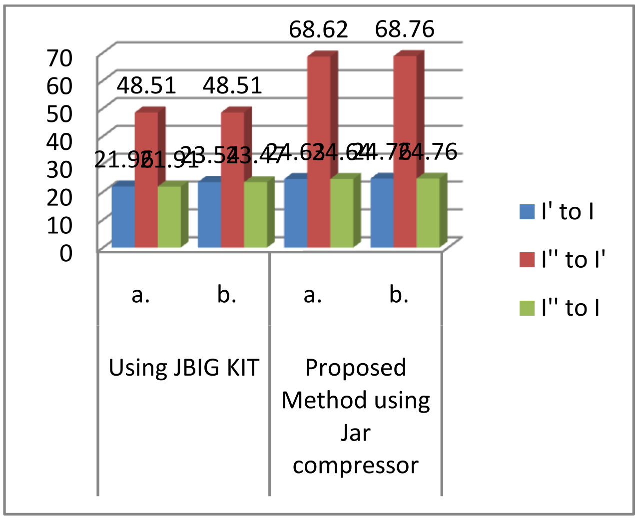


Fig 4: Graph comparison on Methods

In Table 2, we choose to perform some of the test results with the other test images based 512×512 size as follows. With the help of standard gray-scale images Lena, pentagon, bridge and including baboon itself (Fig. 5.).

Fig 5: Test Image – (i) Lena, (ii) Pentagon, (iii) Bridge

Table 2. Test image resultant results access

Test Images	Coded Information in QR	PSNR Evaluation
Lena	www.gmail.com	24.37
Baboon	www.rediffmail.com	25.82
Pentagon	http://news.google.co.in/	22.48
Bridge	http://www.qrcode.com/	24.75

The PSNR value of our proposed work is some of test images are close to that of using JBIG Kit or much more getting robust result than that of Hsu et al. Method [17]. Here, the experimental data demonstrate that the using this jar compressor technique, the more robustness the watermark to be obtains. For the recovery of original source image, by use of the our proposed algorithm, after inserting the QR code, the gray scale image qualities have degraded in between to 14 to 26 db. The evaluating MSE's is to low means to our original and the stego image quality is similar say that recovered one are identical to original one's close counterpart. Therefore, we can conclude that our algorithm using this compressor technique can be well applicable to these working images.

6. CONCLUSION

In this paper, a visual watermarking methodology, proposing reversible visible watermarking technique can embeds the QR code hidden information into the gray scale image to form watermark image. Furthermore, again embed the information of watermark by compressing it into the previously form watermark image with a reversible steganographic method. This method can get successfully the recover original image. Here, the quality of the reversible watermarked image is as analogous to the watermark image with not made much distortion in this two. This paper tries to show that experimental result can completely recover the watermark and visibly display the watermark information which can be read by the mobile device correctly.

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