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OPTIMIZED QR CODE WATERMARKING SCHEME FOR COPYRIGHT PROTECTION BASED ON DISCRETE WAVELET TRANSFORM

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Abstract

Digital Watermarking is a technology used for the copyright protection of digital applications. Watermarking is a concept of embedding a special symbol, watermark, into an electronic document so that a given piece of copyright information is permanently tied to the data. It is an effective way to protect copyright of multimedia data even after its transmission. In recent years image watermarking techniques are grown-up. In this science era with the development of technology and internet, the protection and authentication of data is essential. Watermarking techniques provide solution to this problem. QR code being so versatile because of its structural flexibility that it leads to so many diverse field for research such as increasing data capacity, security applications such as different kinds of watermarking . We have used QR code as cover image and as secret image to protect it from other users. This paper is representing a new watermarking technique with QR code to protect the secret image. In the method described here the image is first encrypted in random matrix, then it is invisibly watermarked in cover image and no information about the secret image and cover image is needed for extraction of secret image, so it more secure.

KEYWORDS: Watermarking, DWT, QR code, Watermark embedding, Watermark extraction

1. INTRODUCTION

Increase in use of Digital Media, raises the problem of data protection and authentication. Data can be easily copied. Digital Watermarking Technique gives the best solution to protect data. In this technique the data is hidden within the cover image so stranger cannot get it without having proper guidance. Many methods used for the invisible Digital Watermarking required some information about the cover image. But we do not require it for secret image extraction, so it is more secure. We are using QR code which itself hide the information but which can be easily scanned .We can use this method to hide image in QR code and to hide QR code in an image. In both the cases the information is detectable under the influence of various attacks.

1.1 Discrete Wavelet Transform

It decomposes the image into different frequency ranges such as low frequency, middle frequency and high frequency. In same way the image can further be decomposed into n levels. Here we are using 3level decomposition for better result.

In two dimensional applications, for each level of decomposition, we first perform the DWT in the vertical direction, followed by the DWT in the horizontal direction. After the first level of decomposition, there are 4 sub-bands: LL, LH, HL, and HH. For each successive level of decomposition, the LL sub-band of the previous level is used as the input. To perform second level decomposition, the DWT is applied to LL and so on.

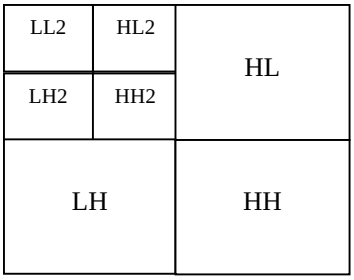

Figure 1: DWT decomposition

1.2 Quick Response Code

It is two dimensional barcode consists of black modules arranged in white background. It can store large alphanumeric information and easily readable by scanner. A QR code is capable of being read in 360 degree from any direction thus eliminating interference. The QR Code system has become admired outside the automotive industry due to its fast readability and greater storage capacity than that of the UPC barcode.

- It has higher information density.
- It is small in size than that of Barcode.
- Data can be restored even if the symbol is partially dirty or damaged.

Some features that describe how QR code is better in comparison with conventional barcodes have been listed out in following table

Table 1: Comparison of QR code and Barcode

QR Code	Barcode
	
UPTO 7089 numeric digits	10-20 digits
40 digit Numeric (approx 5 mm 5mm)	10 digit Numeric (approx 50 mm 20 mm)
Supports 360d reading	Horizontal reading

g, Business cards,
tration.

The steps of embedding process are outlined as follows

Step of watermark image with secret key

(1) The watermark image was produced as a bit sequence of watermark S. The data and background values were set to 1 and –1, respectively.

$$\mathbf{S} = \{s_i, 1 \le i \le N\}, s_i \epsilon \{-1,1\} \quad (1)$$

Where, N is the total number of pixels in the watermark image

(2) The pseudo-random sequence (P) whose each number can take a value either 1 or –1 was randomly generated with a secret key for embedding and extracting of the watermark.

$$\mathrm{P} = \{p_i, 1 \le i \le N\}, p_i \epsilon \{-1,1\} \quad (2)$$

Step of QR code image

(1) The two-level DWT of $M \times M$image (t_i) i t was computed for QR code image.

(2) A watermark was then embedded in sub band LH_2or HL_2 or HH_2. According to the rule:

$t_i' = t_i + \alpha . p_i . s_i, i = 1,2, \dots , N$ (3)

Where, $t_i$is input image, $'t_i'$ is output image with watermark. α is a magnitude factor which is a constant determining the watermark strength.

(3) After that, the inverse DWT (IDWT) was then applied to obtain the watermarked image.

(4) Compute PSNR

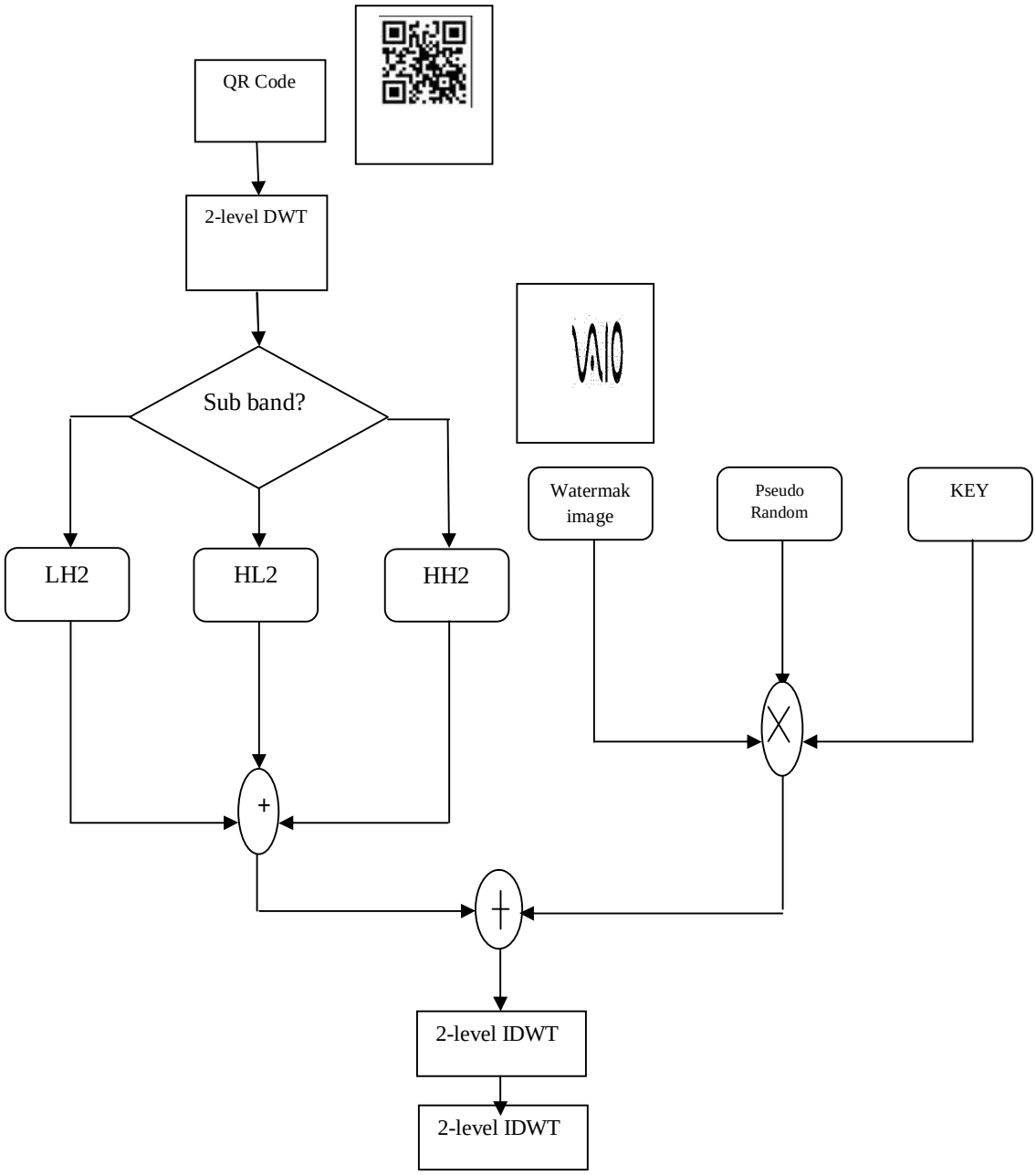

Figure 2: Watermark Embedding Process

2.2 Watermark Extraction

The watermark extraction algorithm did not use the original QR code image. A prediction of the original value of the pixels is however needed. Thus, a prediction of the original value of the pixels was performed using noise elimination technique. In this paper, we use an averaging3×3 mask whose elements were fixed to 1/9. The extraction process are outlined as follows

(1) The predicted image $\hat{t_i}$ could be obtained by smoothing the input image t_i^* with a spatial convolution mask. The prediction of the original value can be defined as:

$$\hat{t_i} = \frac{1}{c \times c} \sum_{i}^{c \times c} t_i^* \quad (4)$$

Where, c is the size of the convolution mask. The watermarked image and the predicted image were DWT transformed independently

(2) The estimation of the watermark $\hat{S_i}$ is indicated by the difference between $t_i^* \; and \; \hat{t_i}$ as:

$$\delta = t_i^* - \hat{t_i} = \alpha . p_i . \hat{s_i} \quad (5)$$

(3) The sign of the difference between the predicted and the actual value is the value of the embedded bit:

$$sgn(\delta_i) = p_i . \hat{s_i} \quad (6)$$

3. COMPUTE NC

The watermark was then estimated by multiplying pseudo- random number to the embedded bit. If an incorrect pseudo random sequence was to be used, the scheme would not work

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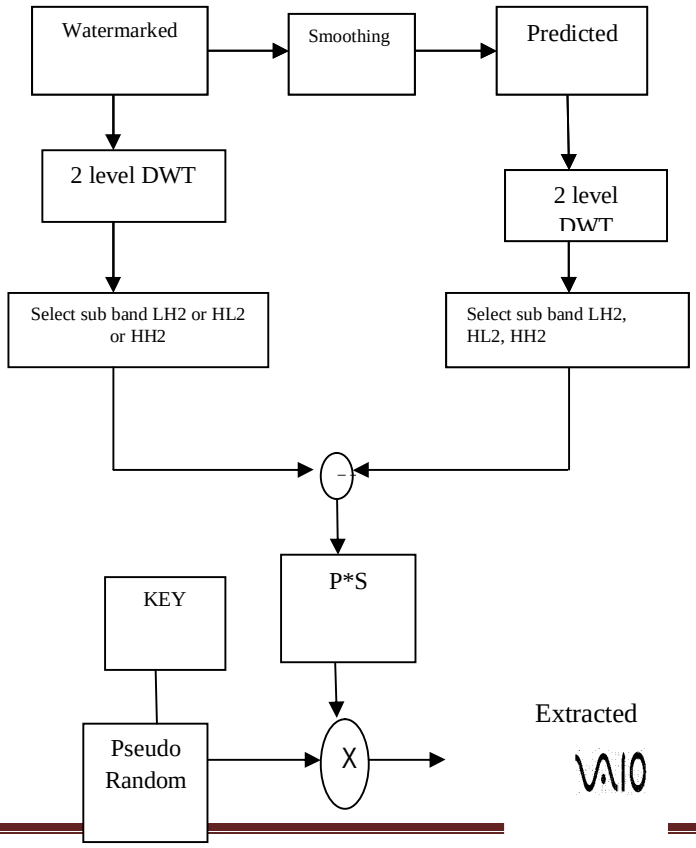

Figure 3: Watermark Extracting Process

4. SIMULATION RESULTS

Table 2: PSNR vs NC

Sub band	PSNR	NC	Extracted watermark
LH	43.0615	0.9525	
HL	43.1514	0.9611	
HH	44.2675	0.9916	

Table 3: PSNR vs NC with attacks

Attack Type	PSNR	NC	Decode QR code
Salt & Pepper Noise (0.02)	40.8837	0.9851	√
Salt & Pepper Noise (0.05)	38.4989	0.9687	√
Gaussian Noise (0.02)	37.2879	0.9945	√
Gaussian Noise (0.05)	37.1402	0.9943	√
JPEG (40)	39.3897	0.9942	√
JPEG (50)	39.3897	0.9942	√

Table 4: Watermark Extraction

 Alpha 5	 Alpha 10	 Alpha 15
 Alpha 20	 Alpha 25	 Alpha 30
 Alpha 35	 Alpha 40	 Alpha 45

Table 5: PSNR and NC of QR decode Image

α	PSNR	NC	DECODE QR Code
5	47.1617	0.9826	✓
10	44.1514	0.9934	✓
15	42.3905	0.9961	✓
20	41.1411	0.9967	✓
25	40.1720	0.9975	✓
30	39.3802	0.9980	✓
35	38.7107	0.9986	✓
40	38.1308	0.9991	✓
45	37.6193	0.9995	✓

Table 6: PSNR and NC with Extracted watermark

Attack Type	Attacked QR code image	Extracted Watermark
Salt & Pepper noise (0.02)		
Salt & Pepper noise (0.05)		

Gaussian noise (0.02)		
Gaussian noise (0.05)		
JPEG (40)		
JPEG (50)		

5. CONCLUSION

This paper presented a digital watermarking technique where by a binary image is watermarked an embedded in a QR code image. The embedding process is presented in a LH, HL or HH sub band based on wavelet transform. The experimental results demonstrated that the algorithm can be recover the watermark with an acceptable visual quality .The objective measures such as PSNR and NC are subject to magnitude factor. As the future work, we are trying to find more efficient ways to withstand more severe attacks such as stronger noise, high compression, geometric distortion and occlusion etc.

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