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A Study on Effective Digital Watermarking Method Suitable for QR code

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Abstract. Recently, many studies are being conducted related to the method of inserting the digital watermark in the QR code. The QR code is made up of a simple repeating black and white module and has many differences compared to general images. In this paper, a watermarking algorithm that can increase the amount of information to be concealed by minimizing the degradation of QR code image quality is proposed. The algorithm proposed in this paper is not a new algorithm. After conducting a comparative analysis of few algorithms previously developed, one type of algorithm that meets the characteristics of QR code image was selected. And through experiments, show that it will not degrade the image quality even when more amount of watermark is inserted than the previously proposed methods, and also show that the algorithm selected in this paper is suitable for inserting the watermark in the QR code.

Keywords: Digital watermark, QR code, Authentication

1 Introduction

QR-code is a binary matrix-type Bar-code which shows the information with cross stripes patterns. QR-code is much used mostly in Japan, Korea, the UK and the US and the name is originated from the registered trademark of Denso Wave which is Quick Response. It is a two-dimensional bar-code which overcomes the capacity limitation of Bar-code that has been much used in the past and expanded its forms and contents. It can save character data as well as numbers because it has vertical and horizontal information. Normally, it is used by reading through smart phone or exclusive scanner.

Recently, many studies are being conducted related to the method of inserting the digital watermark in the QR code. The QR code is made up of a simple repeating black and white module and has many differences compared to general images.

In this paper, a number of conventional methods were analyzed in order to conceal a larger amount of watermark by minimizing the degradation of image quality. Based on the analysis results, the previous methods had many differences in terms of performance according to the characteristics of the image. In other words, there are medical images where black and white images are suitable, and there are algorithms that exert performance in the complex images such as general natural images.

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The configuration of this paper is as follows. In chapter 2, the previous watermarking methods will be classified and its characteristics will be explained. Also, an efficient digital watermarking method suitable in QR code will be selected. In chapter 3, the experiment results using the selected algorithm will be examined, and in chapter 4, conclusion is made and the future study subjects are examined.

2 Analysis of Watermarking Methods

2.1 Advantageous Watermarking Method for Simple Image

The early improvement of Tian's technique [1] was proposed by Alattar [2-4]. He proposed schemes that can achieve high embedding capacity without losing the simplicity of the original DE technique.

Chiang et al have proposed the two-level DE scheme for medical imaging [5]. This method inserts 14-bit watermark into the smooth block of 4 x 4 pixel. The original image is divided into the blocks of 4 x 4 pixel during inserting, and two-level DE transformation is applied in each block. The insertion rate for the smooth block is theoretically 0.875 bpp[6]. However, the disadvantage of this method is that the hiding capacity is limited by the number of smooth blocks. It is suitable to a particular image with a large number of smooth blocks such as medical imaging, but the efficiency falls in general complex image.

2.2 Selection of Effective Digital Watermarking Method Suitable for QR code

In Qershi's new scheme, based on DE is proposed in order to increase the hiding capacity for medical images. One of the characteristics of medical images, among the other types of images, is the large smooth regions. Taking advantage of this characteristic, his scheme divides the image into two regions; smooth region and non-smooth region. For the smooth region, Chiang's scheme is applied, while Alattar's method is applied to the non-smooth region [6]. A comparison between the actual embedding capacities is shown in Table 1. The experimental results showed that the best embedding capacity and PSNR, using the Qershi's scheme (Alattar+Chiang).

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Table 1. A comparison between the actual embedding capacities[6].

	Tian	Alattar	Chiang	Qershi(Alattar +Chiang)
MRI	0.330	0.291	0.232	0.554
CT	0.450	0.531	0.177	0.702
US	0.440	0.282	0.485	0.722
X-Ray	0.460	0.715	0.028	0.740

In this paper, it has discovered that the QR code histogram has similar characteristics as the histogram of medical image. Because the histogram of QR code has similar characteristics as the histogram of medical image, the digital watermarking algorithm suitable for medical image was selected. The algorithm selected in this paper was Qershi method and all experiments were conducted using the Qershi method.

3 Experimental Results

Experiment with the Intel Core 2 2.3GHz CPU PC's Windows 7 environment was conducted by the C language implementation. The images used in this experiment are same as in Figure 1.

(a) (b) (c)

Fig. 1. The images used in this experiment (a) QR code1 (b) QR code2 (c) QR code3.

Through experiments, measures embedding capacities about QR code1, QR code2, QR code3 in figure 1. A comparison between the actual embedding capacities is shown in Table 2. The experimental results showed that the best embedding capacity using the Qershi's scheme.

Table 2. Maximum available capacity(bpp).

	Tian	Alattar	Chiang	Qershi(select)
QR code 1	0.450	0.492	0.465	0.715
QR code 2	0.421	0.545	0.615	0.743
QR code 3	0.424	0.523	0.584	0.732

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4 Conclusion

In this paper, a number of conventional methods were analyzed in order to conceal a larger amount of watermark by minimizing the degradation of image quality. Based on the analysis results, the previous methods had many differences in terms of performance according to the characteristics of the image. In other words, there are medical images where black and white images are suitable, and there are algorithms that exert performance in the complex images such as general natural images.

In this paper, a watermarking algorithm that can increase the amount of information to be concealed by minimizing the degradation of QR code image quality was proposed. The algorithm proposed in this paper is not a new algorithm. After conducting a comparative analysis of few algorithms previously developed, one type of algorithm that meets the characteristics of QR code image was selected. And through experiments, shows that it will not degrade the image quality even when more amount of watermark is inserted than the previously proposed methods, and also showed that the algorithm selected in this paper was suitable for inserting the watermark in the QR code image.

Future research subject is to develop new digital watermarking algorithm suitable for QR code.

References

1. Tian, J.: High Capacity Reversible Data Embedding and Content Authentication. In: ICASSP 2003. vol. 3, pp. 517--520(2003)
2. Alattar, A. M.: Reversible Watermark using Difference Expansion of Triplets. In: Proceedings of International Conference Image Processing (ICIP 2003), pp.501--504(2003)
3. Alattar, A. M.: Reversible Watermark using Difference Expansion of Quads. In: Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP '04), vol. 3, pp. 377--380(2004)
4. Alattar, A. M.: Reversible Watermark using the Difference Expansion of a Generalized Integer Transform. In: IEEE Transactions on Image Processing 13, 1147--1156(2004)
5. Chiang, Chang-Chien, Chang, Yen: Tamper Detection and Restoring System for Medical Images using Wavelet-Based Reversible Data Embedding. In: Journal of Digital Imaging, vol. 21, pp. 77--90(2008)
6. Osamah, M., Al-Qershi, B. E. Khoo: High Capacity Data Hiding Schemes for Medical Images based on Difference Expansion. In: Journal of Systems and Software, vol. 84, Iss. 1, pp. 105--112(2011)

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