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Effectiveness of Median Filter in Threshold Determination of Digital Watermark Scheme Using DCT

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Abstract: This paper proposes a new method for determining the threshold value to detect embedded bits in digital watermarking using DCT. We investigated in detail the relation between the threshold value for determining the embedding information and the detection accuracy. The experimental results showed that the median filter method, which is used to determine the threshold value, had better performance in accuracy on detecting embedding bits, compared to the conventional method.

Keywords: Mobile Phone, URL, DCT, Digital Watermark, Median Filter.

Introduction

Recently, QR codes are generally used for reading information from a printed matter such as magazines to a mobile phone. However, there is a possibility that impair design of the image for which you want to add information by pasting the QR code. Therefore, several methods[1-9], embedding watermark information without impairing the design of the image using digital watermark and with detecting information by photographing with camera phone, has been proposed. Fig 1 shows examples in the case of using QR code and digital watermark.

Figure 1: Digital watermark and QR code

These techniques should have a resistance to printing and photographing with mobile phone. As the one of the watermarking methods, there are methods using DCT (Discrete Cosine Transform), in order to have a "resistance to printing and photographing". The watermark information is embedded in the coefficient of the DCT component. Watermark information is detected from DCT coefficients of the printed image to be embedded. In the method [2], it determines automatically a threshold value for the DCT coefficient. Furthermore, multiple DCT coefficients are used to detect embedded bit. The watermark information is detected by the magnitude of relation between the threshold value and the average value of these coefficients. The conventional method in [2] is not always enough complete, especially the method of determining a threshold value in detecting embedded bits. It is because the DCT coefficient value in embedding image is influenced by the photographic environments such as camera shake or lighting. This paper proposes a new method for determining the threshold value to detect embedded bits, URL information, in digital watermarking using DCT. We investigate in detail the relation between the threshold value for determining the embedding information and the detection accuracy. The experimental results showed that the median filter method, which is used to determine the threshold value, had better performance in accuracy on detecting embedding bits, compared to the conventional method.

Conventional Method

Color Model Conversion

In the method [2], uses YCrCb color model is used in embedding. Only Cr and Cb components are used in information embedding. This is because the change in color difference is hard to be identified to the human eye than a change in luminance.

Conversion to Frequency Domain

In watermark information embedding is the possible by either directly manipulate the pixel values or modify its values after converting the frequency region. In the method [2], the conversion to frequency region using the DCT to have resistance to printing and imaging is performed. Two-dimensional DCT of the image is represented by Equation (1).

$$F(u,v)=\frac{2C(u)C(v)}{N}\sum_{i=0}^{N-1}\sum_{j=0}^{N-1} f(i,j)\cos\frac{(2i+1)u\pi}{2N}\cos\frac{(2j+1)v\pi}{2N} \quad (1)$$

There are two types of two-dimensional DCT of the image. One is a method of two-dimensional DCT to the entire image, and the second one divides an image into small blocks and two-dimensional DCT perform on a block-by-block basis. These methods [1-5] select the method of two-dimensional DCT to the entire image.

Watermark Information Embedding Method

Embedding the watermark information is performed by changing the DCT coefficients. If embed a watermark into the low-frequency band on DCT region, its effect on the entire image is strong, and the closer to the high-frequency band becomes effect weaker. Therefore, the embedded target region has been with the medium frequency band. The embedding method of [2] is described below. First, calculate DCT coefficients of the Cr and Cb components of the original image. As shown in Fig 2, a line which was extended to the direction angle θ from u axis of the DCT region is regarded as the embedding baseline. And set the coordinates of T_{min} and T_{max}on this line. The rectangular region enclosed by T_{min} and $T_{max}$is used for embedding.

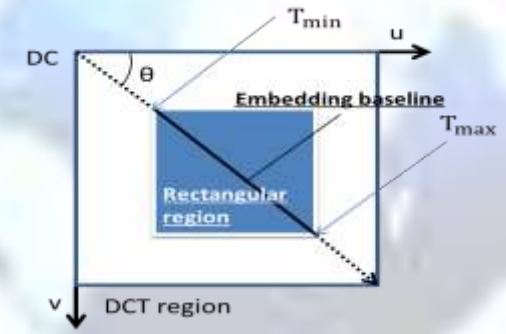


Figure 2: Rectangular region to be used for embedding

As shown in Fig 3, the rectangular region is divided into several blocks by using the DCT coefficients a and b. In addition, the range that was determined using the coefficient b is defined as buffer region between the elements to be used for embedding.

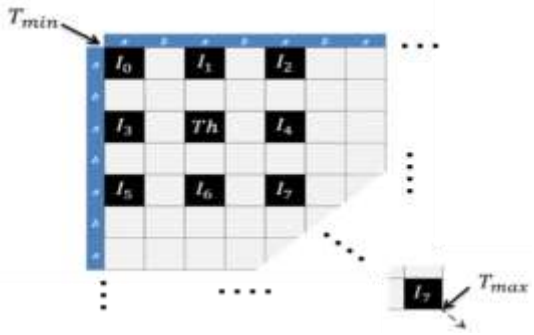


Figure 3: Rectangular region divided into blocks by using the coefficients a and b

The coefficients a and b, and parametersV_0, V_1, V_{Th} arepositive numbers. ($V_0 < V_{Th} < V_1$) Embedded bit string of length N, watermark information are x[n] (n = 0,1, · · ·, N-1).

(1) E_p = 0 as the pointer of the watermark.
(2) Conversion from RGB color model to YCrCb color model.
(3) Calculate DCT coefficients of the CrCb components.
(4) DetermineT_{min} and T_{max} on the basis of the conventional method.
(5) The rectangular region enclosed byT_{min} and T_{max} is divided into blocks by using the coefficients a and b. And the local region to be used for embedding the block indicated by the coefficient a.
(6) As shown in Fig3, nine blocks are selected from the local region in the rectangular region. Central block is determined as block threshold (Th block).The other eight blocks are determined as information block.
(7) V_{Th} is multiplied the sign of the DCT coefficients contained in Th block. And V_{Th} is assigned to the DCT coefficients contained in Th block.
(8) N_p = 0 as a pointer to the information blockI_n (n = 0,1, · · ·, 7).
(9) If x[E_p mod N]=1, the sign of the coefficient of the original DCT coefficients multiply to the sign of the V_1. If x[E_p mod N]=0, the sign of the coefficient of the original DCT coefficients multiply to the sign of the V_0.The multiplied DCT coefficient is substituted into I_{np} block.
(10) $E_p = E_p+1$, $N_p = N_p+1$.
(11) Repeat until N_p = 8, (9) (10) steps.
(12) The nine blocks which are embedded watermark are regarded as used blocks. Distinguish from the local region that is not embedding.
(13)
For the local region of the remaining unused, repeat (6) ~(12)steps.

Watermark detection method [2]

The watermark detection method of [2] is described below.Prepare the coefficients a, b and T_{min}, T_{max}. Detected watermark sequence is stored in the array Z.

(1) E_p=0 as the pointer of the watermark.
(2) Conversion from RGB color model to YCrCb color model.
(3) Calculate the DCT coefficients of the CrCb components.
(4) The rectangular region enclosed by T_{min} and T_{max} are divided into blocks by using the coefficients a and b.
(5) As shown in Fig 3, select nine blocks from the local region in the rectangular region. Central block is determined as block threshold (Th block).The other eight blocks are determined as information block.
(6) N_p=0 as a point to the information block I_n (n=0,1, · · · 7).
(7) The average of the absolute value of DCT coefficients in the Th block assign to aveTh. The average of the absolute value of DCT coefficients in the information block assign to aveI_{np}.
(8) If the aveI_{np} >aveTh, [E_p]=1,
if the aveI_{np} <aveTh, [E_p]=0.
(9) $E_p = E_p+1$, $N_p = N_p+1$.
(10) Repeat until N_p = (8), (9) (10) steps.
(11) The nine blocks which are detected watermark is regarded as used blocks. Distinguish from the local region that is not embedding.
(12) For the local region of the remaining unused, repeat (5) ~(11)steps.
(13) Obtain the array Z, complete.

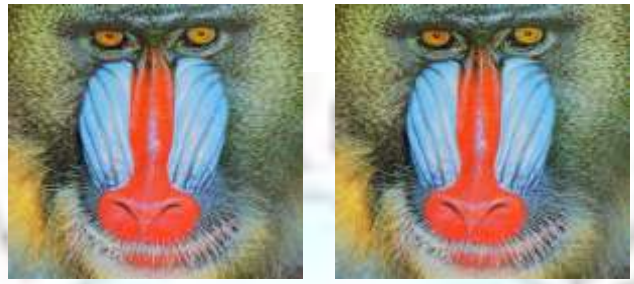
Our proposed method is based on this embedding method.

Proposed Method

The objective of this paper is to develop a method to embed URLs information into image. In the recent years, services that enable the "URL shortening" are provided. Any URL length is reduced into less than 18 characters by using this method. In the proposed method, the final goal is to enable to embed 18 characters, or in other words 144 bits. The embedding method in the proposed method is the same as the conventional method. The detecting method is different in the conventional method, which described in the previous section. Figure 4 shows the original Mandrill and Lena, not embedding information, andshowsthe embedded images, in whichembedded location is set to (20, 20). Figure 5, 6, and 7show the DCT coefficient values of the rectangular area that is used for embedding of each of Mandrill and Lena. Figure 5 show the DCT coefficient valuesbefore the embedding. Figure 6 shows the DCT coefficient values after

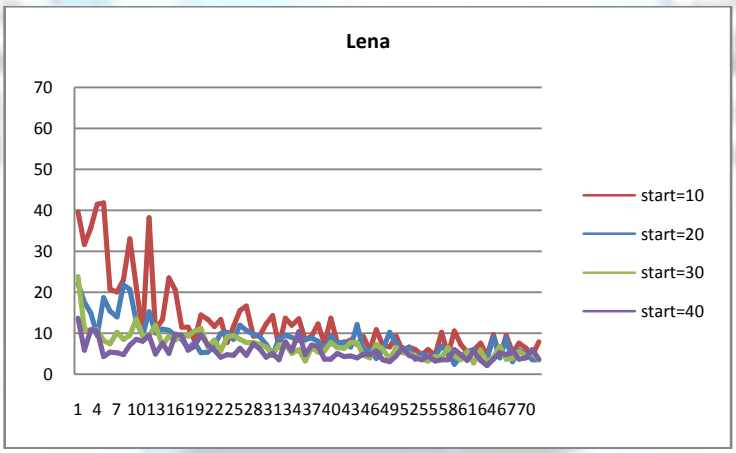
embedded the parameter ($V_0 = 0$, V_1=40, V_{Th}=20). Figure 7 shows the DCT coefficient values which is detected after photographing.

(a) Lena

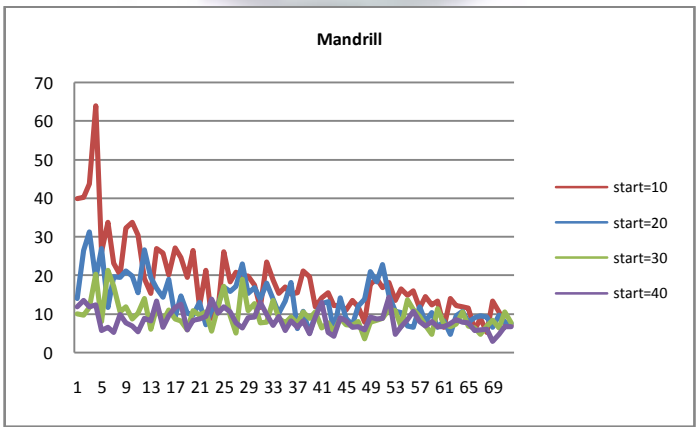


(b) Mandril

Figure 4: Original images and digital watermark embedded



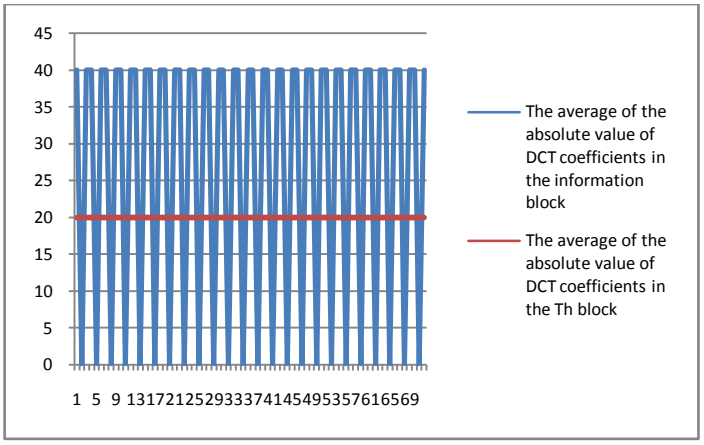
(a) Lena



(b) Mandril

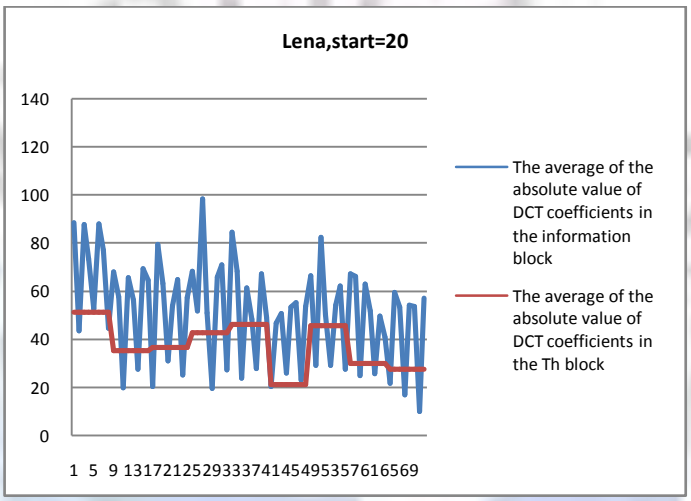
Vertical axis is the average of DCT coefficient values corresponding to 1bit. Horizontal axis is number of a bit.

Figure 5: Before performing embedding to Lena and Mandrill

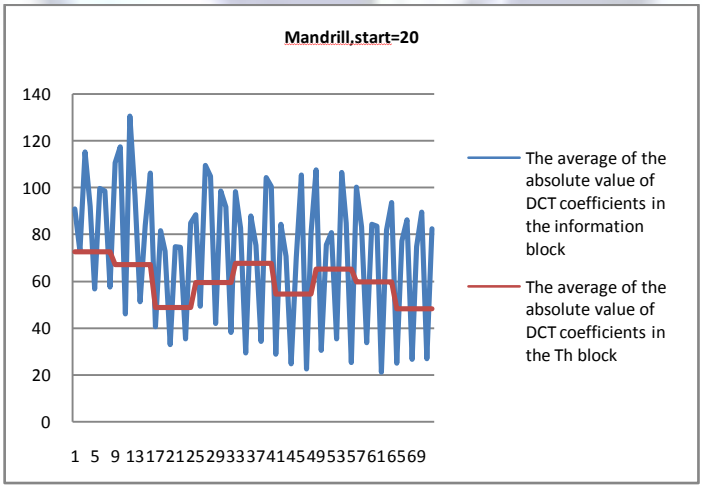


Vertical axis is the average of DCT coefficient values corresponding to 1bit. Horizontal axis is number of a bit.

Figure 6: After performing embedding to Lena and Mandrill



(a) Lena



(b)Mandrill

Vertical axis is the average of DCT coefficient values corresponding to 1bit. Horizontal axis is number of a bit.

Figure 7: Detected after photographing to Lena and Mandrill

As shown on Fig. 7 (b), threshold is set properly in the Mandrill, it is can be detected correctly.In the case of 25bit of Fig 7 (a) in Lena, it is happen to have a larger value than the threshold value when it is necessary to determine 0.We see there is a situation where the threshold is not set correctly.

Because the same value is embedded, the threshold should have the same value even when it is detected.We consider that the cause is the average value is used in the method of determining the threshold value.The reason is that the average value would include the value of the ostracized.

Therefore, we use the median filter in the proposed method. It is likely that in determining the threshold value, possibility of contain a value of the ostracized is reduced.

Experimental Procedure and Results

Experimental Procedures

Photographing is take place under optimal fluorescent light. Afterwards, the geometric distortions are corrected using the affine transform. The affine transform consists of four geometric transformations which are trimming, scaling, sharing and rotating. We embedded the images that location set to (20, 20) and (40, 40).Table1 shows printing details and devices.

Table 1: Experimental conditions

Image name	Lena
Image information	24bit color
Pixel size	256×256 pixels
Photographic Equipment	htc butterfly (3264×1840pixel)
Printing equipment	EPSON LP-S5000, Laser printer

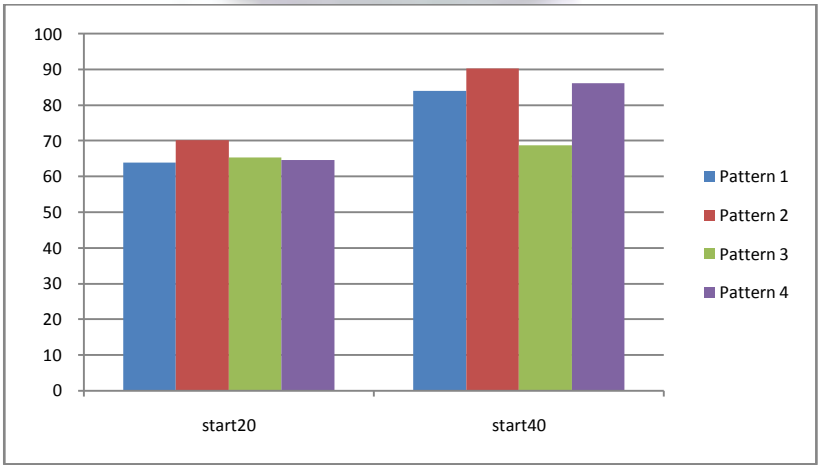
Experimental Results

Pattern 1：The average of the absolute value of DCT coefficients in the information block and the average of the absolute value of DCT coefficients in the Th block

Pattern 2：The average of the absolute value of DCT coefficients in the information block and the median of the absolute value of DCT coefficients in the Th block

Pattern 3：The median of the absolute value of DCT coefficients in the information block and the median of the absolute value of DCT coefficients in the Th block

Pattern 4：The average of the median of the three absolute value of DCT coefficients in the information block and the median of the three absolute value of DCT coefficients in the Th block



Vertical axis is the average of DCT coefficient values corresponding to 1bit.

Figure 8: Results of the detection accuracy for 4 patterns

Pattern 1 of Fig. 8 is a conventional method pattern 2 is what combination the average of the absolute value of DCT coefficients in the information block and the median of the absolute value of DCT coefficients in the Th block. By comparing these two patterns, it is found is improvement of detection accuracy of 6% in pattern 2.

Conclusion

This paper proposed a new method for determining the threshold value to detect embedded bits, URL information, in digital watermarking using DCT. We investigated in detail the relation between the threshold value for determining the embedding information and the detection accuracy. The experimental results showed that the median filter method, which is used to determine the threshold value, had better performance in accuracy on detecting embedding bits, compared to the conventional method. As some study to be remained, there are to improve the detecting accuracy and develop the geometric correction scheme instead of affine transform.

References

[1]. Tadashi Mizumoto, Kineo Matsui, "Robustness Investigation of DCT Digital Watermark for Printing and Scanning", The Journal of the Institute of Electronics, Information and Communication Engineers, Vol. j85-A No.4,pp.451-459, 2002.(in Japanese).
[2]. Akitaka Okou, Shinichiro Miyaoka, "Automatic Determination Method of the Threshold for Print-type Watermark Detection", The Journal of the Institute of Electronics, Information and Communication Engineers, 2012.(in Japanese).
[3]. M. Fuseya, A. Nobuka, H. Murakami, A. Koike,"Digital Watermark Scheme Using DCT for Embedding of URL Information", Forum on Information Technology, 2012.(in Jpapnese).
[4]. Nakanishi Kouji, Muneyasu Mitsuji,"Data Detection form Data Embedding Printing Images Using Cellular Phones with a Camera", The Journal of The Institute of Electronics, Information and Communication Engineers, SIS2007-77, March, 2008.
[5]. Shono Takafumi, Muneyasu Mitsuji, Hanada Yoshiko," Implementation of Data Embedding to Printing Images for Information Retrieving by Cellular Phones with a Camera", The Institute of Electronics, Information and Communication Engineers, July, 2009.
[6]. Examples of URL shortening services, http://0w0.tv/.
[7]. J.J.K. O Ruanaidh, S.Pereira, "A secure robust digital image watermark", Electonic Imaging: Proceeding and Publishing in Color, SPIE Proceedings, Zurich, Switzerland, May, 1998.
[8]. B.Prescott, G.F.Mcliean, "Line-Based Correstion of Radial Distortion", Graphical Models and Images Processing,Vol.59, No.1, Jaunary, pp.39-47, 1997.
[9]. M. Fuseya, A. Nobuka, H. Murakami, A. Koike, "Investigation of Digital Watermark Scheme Using DCT for Embedding of URL Information", IWAIT2013, pp. 945-950,Jan., 2013.