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碩士論文

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可調式變動長度數位影像浮水印

Blind Adaptive Shift Length Watermarking For Digital Images

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摘要

最近幾年由於網路的發達以及數位多媒體資訊的普及,數位浮水印技術已經是主要用來保障數位資訊版權的主要方法，本論文提出了一種不需原始影像(blind)數位浮水印(watermark)技術，首先將原始影像經過離散餘弦轉換(discrete cosine transform; DCT)至頻率域,再將片段的浮水印資訊嵌入 DCT 的係數中，並計算與原本係數的差異，以決定是否要調整嵌入浮水印資訊的 DCT 係數，此方式能夠提供與過去研究之數位浮水印技術相同的強韌度,卻能提供較佳的影像品質以及能嵌入更多的資訊，.還原的過程中僅需提供兩筆資料即可還原影像，不需要使用原始影像。同時，又因為是以位元角度將資訊嵌入到係數中，因此當影像經過失真式壓縮法壓縮之後，影像的檔案大小也不會有劇烈的改變。

關鍵字: 數位浮水印、多媒體、離散餘弦轉換、頻率域、資訊隱藏

ABSTRACT

In recent years, as a result of the development of the network and popularization of the multimedia information, watermark technology has been utilized for ensuring the copyright of digital information. This thesis proposed a new blind watermarking algorithm based on discrete cosine transform (DCT) for digital images. In the proposed method, the difference of DCT coefficients between the original and watermarked information was calculated and used to determine the adjustment of watermarked DCT coefficients. The simulation results show that the proposed watermark algorithm not only provides similar robustness as previous watermarking investigations but also improves the image quality of watermarked image and the quantity of hiding information. Moreover, the original image is unnecessary for acquiring the watermark information. In the reconstruction procedure, only two bytes side information is required for digital image codec. The file size of watermarked JPEG compressed image approximates one without watermarking.

Keyword: watermark, multimedia, discrete cosine transform, frequency domain, information hiding

CHAPTER 1
INTRODUCTION

Digital watermarking is intended to complement cryptographic process and becomes an important technology for multimedia. Spatial and frequency domain watermarking are two categories of digital watermarking. Many spatial domain watermarking methods have been proposed for digital image, audio and video [1-8]. However, [9-14] showed that frequency domain watermark techniques always achieve better performance in terms of image quality and watermark robustness for digital images.

In 1997, Cox et al. proposed a secure spread spectrum watermarking technique for multimedia [9]. The study supports that a watermark should be constructed as an independent and identically distributed Gaussian random vector that is imperceptibly inserted in a spread-spectrum-like fashion into the perceptually most significant spectral components of the data. The watermarked image quality can be adjusted to a desired quality by using a scale factor term. As the watermark strength is reduced to improve the image quality, the robustness of the watermark is also reduced. Content owners could decide what image degradation and what level of robustness is acceptable.

Further, a digital watermarking-based discrete cosine transform (DCT) and Joint

Photographic Experts Group (JPEG) model was proposed in [14]. The watermarking investigation develops a watermarking algorithm based on the DCT and image segmentation. The image is first segmented in different portions and then a pseudorandom sequence of real numbers is embedded in the DCT domain of each image segment. The simulation results of this approach show that the method is robust to common image processing distortions. They declared that the watermarking system outperforms the Cox algorithm.

In 2004, Wang et al. proposed a copyright protection watermarking by using wavelet tree quantization [15]. Each watermark bit is embedded in various frequency bands and the information of the watermark bit is spread throughout large spatial regions. The watermarking technique is robust to attacks in frequency domain, for example the removal of the high-pass band in low-pass processing, and the removal of high-pass details in JPEG compression. The watermarking scheme declared that can also be applied to data hiding or image authentication. However, this method only can really carry 768 bits watermark information for a 512 × 512 digital image.

Moreover, a fragile watermarking technique utilized the genetic algorithm (GA) to embed watermarks into the frequency domain of a host image [16]. In order to enhance the hierarchical watermarking security, the algorithm not only detects vector quantization attacks, but also provides a fundamental platform for other fragile watermarking techniques. This study asserted that the algorithm could redress the rounding errors caused by traditional watermarking approaches. However, the computational complexity of GA is too high for practical watermarking application.

This thesis proposes a new blind watermarking algorithm based on the DCT for digital images. In the proposed watermark algorithm, the difference of DCT coefficients between the original and watermarked information was calculated and utilited to adjust the watermarked DCT coefficients. The proposed algorithm not only provides similar robustness as previous watermarking investigations, but also improves the image quality of watermarked image and the quantity of hiding information. Remarkably, the original image is unnecessary for acquiring the embedded watermark in our scheme.

Chapter 2 presents the overview of the DCT-based watermarking. The proposed watermarking scheme is presented in Chapter 3. The experimental results are presented in Chapter 4. Finally, the conclusions were drawn in Chapter 5.

CHAPTER 2
REVIEWS OF DCT-BASED WATERMARKING

Many transform-based watermarking techniques have been proposed to protect copyrights and authenticate photographs. The host image first process a transformation and then embed watermark information by modifying the transformed coefficients. Possible image transformations include the fast Fourier transform (FFT), DCT, digital wavelet transformation (DWT) and sub-band coding (SBC) etc. DCT, the most effective and popular technique for image and video compression, has been adopted by most emerging image coding methods, including JPEG [17], H.261 [18], H.263 [19], and MPEG (Moving Picture Experts Group) [20-22]. In recent years, JPEG and MPEG have been extensively employed to compress images and thus save storage space and reduce transmission time. Thus this thesis only discusses the DCT-based watermarking techniques.

In DCT-based image coding, a 2-D DCT is used to map an image into a set of DCT coefficients, which are then quantized and encoded. Given an image $f(x, y)$ of size $N \times N$, its corresponding 2-D DCT and inverse DCT coefficients are defined as,

$$D(i,j) = \frac{1}{\sqrt{2N}} C(i)C(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2y+1)j\pi}{2N}\right] \quad (1)$$

and

$$f(x,y) = \frac{1}{\sqrt{2N}} \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} C(i)C(j)D(i,j) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2y+1)j\pi}{2N}\right], \quad (2)$$

where (i, j) it is the coefficient position in the frequency domain and (x, y) is the position of the image element. Firstly, intensity of each pixel in an image shifted -128 to obtain $f(x, y)$. $D(i, j)$ can be computed as the frequency coefficient on the position (i, j). C is given by,

$$C(u,v) = \begin{cases} 1 & \text{for } i + j = 0 \\ \dfrac{1}{\sqrt{2}} & \text{for } i \times j = 0 \text{ and } i + j \neq 0 \\ \dfrac{2}{\sqrt{2}} & \text{for } i \times j \neq 0 \end{cases} \quad . \tag{3}$$

In [9], Cox et al. presents the idea of using spread spectrum for embedding watermarks in frequency domain (denotes Cox method). The method transforms the materials of several multimedia into the frequency domain and then embed the watermark bit array in DCT coefficient, as shown in Fig. 1.

Fig 1. Stages of watermark insertion process

Cox