A DIGITAL WATERMARKING SCHEME FOR IMAGE BASED ON DCT

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ABSTRACT
With swift developments and evolutions in the field of Information technology and wide range of application of unsafe networks like internet it is necessary to ensure the protection of interests of copyrights of content owners. The traditional information encryption system does not serve this purpose successfully as contents over internet could be copied and distributed easily. In contrast to traditional method digital watermarking as emerged as a successful technique to protect the copyright of digital documents, especially the ownership of digital images. In some past years digital watermarking technology have been studied a lot for this purpose. Techniques for digital watermarking of image can be bifurcated into two categories, spatial domain techniques and frequency domain techniques. In spatial domain technique watermark is embedded into image in straightforward way. In the other way, in the frequency domain, the original image is first transformed into the frequency, and then the transformed coefficients are modified by the information of watermarking. Among these One of the widely used frequency domain watermarking techniques is based on DCT (discrete cosine transformation), which is robust against compression, filter and other transformation on image, and is compatible with the JPEG compression.

Keywords
Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), Least significant Bit (LSB).

1. INTRODUCTION
DCT like a Fourier Transform, it represents data in terms of frequency space rather than an amplitude space [1]. This is useful because that corresponds more to the way humans perceive light, so that the part that are not perceived can be identified and thrown away. DCT based watermarking techniques are robust compared to spatial domain techniques. Such algorithms are robust against simple image processing operations like low pass filtering, brightness and contrast adjustment, blurring etc. However, they are difficult to implement and are computationally more expensive. At the same time, they are weak against geometric attacks like rotation, scaling, cropping etc. DCT domain watermarking can be classified into Global DCT watermarking and Block based DCT watermarking [2]. Embedding in the perceptually significant portion of the image has its own advantages because most compression schemes remove the perceptually insignificant portion of the image.

The discrete cosine transform (DCT) helps separate the image into parts (or spectral sub bands) of differing importance (with respect to the image's visual quality).[3] The DCT is similar to the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain. A discrete cosine transform (DCT) expresses a sequence of finitely many data points in terms of a sum of cosine functions oscillating at different frequencies [4]. DCTs are important to numerous applications in science and engineering, from lossy compression of audio (e.g., MP3) and images (e.g., JPEG) (where small high-frequency components can be discarded), to spectral for the numerical solution of partial differential equations.[5] The use of cosine rather than sine functions is critical in these applications: for compression, it turns out that cosine functions are much more efficient (as described below, fewer are needed to approximate a typical signal), whereas for differential equations the cosines express a particular choice of boundary conditions. In particular, a DCT is a Fourier related transform similar to the discrete Fourier transform (DFT), but using only real numbers.[6]
2. Different methods of Image watermarking

A. Watermarking Techniques for Image in Spatial Domain.

LSB Algorithms

LSB technique arranges watermarking information to the least significant bit or multiple bit layers, has a large information capacity, and watermarking information is invisible to human eyes.[7] However, the watermarking information embedded by this method is rather fragile, and is distorted easily by filtering, image quantizing and geometric distorting.

Patchwork Algorithm

Patchwork algorithm, proposed by Bender et al in 1996, embeds the information into the brightness of pixels by changing the statistical properties of the image.[8] The algorithm selects N pairs of pixel points \((a_i, b_i)\) randomly, and the difference between two randomly selected pixels is zero centered Gaussian distribution. Then the brightness value of the pixel point \(a_i\) increases by 1, the brightness value of pixel point \(b_i\) decreases by 1. In this way, the distribution center is changed, however the average brightness of the image remains unchanged. [9] The algorithm detects the watermarking information by statistical methods. For the sake of resisting the attack of loss compression and filtering process, it extends the pixels to pairs of blocks, the brightness of pixels in one block is increased, while the brightness of pixels in corresponding block is decreased.[10]

B. Watermarking Techniques for Image in Frequency Domain

Block DCT Domain Image Watermarking Algorithm

E. Koch and J. Zhao presented a block DCT domain watermarking algorithm [11], in which the image is segmented into blocks by \(8 \times 8\) pixels and transformed by DCT, and then a subset of DCT blocks is selected pseudo randomly, each block of which is embedded with watermarking information. Taking into account that human eyes are imperceptible to low-frequency coefficients, while the high frequency coefficients are vulnerable and liable to attack, the watermarking information is embedded into middle frequency coefficients.[12]

Global DCT Domain Image Watermarking Algorithm

Cox et al presented a global DCT domain watermarking approach, in which the image is transformed by DCT, and then the watermarking information is embedded into the first \(L\) largest coefficients in DCT domain, generally are the low-frequency coefficients [13]. The first \(L\) largest coefficients in DCT domain \(D\) is denoted as follow:

\[
D = \{d_i\}, \quad i = 1, \ldots, L
\]  

(1)

Watermarking information \(W\) with Gaussian random sequence is denoted as follow:

\[
W = \{w_i\}, \quad i = 1, \ldots, L < 0
\]

(2)

Watermarking embedding algorithm is denoted as follow:

\[
d_i = d_i(1 + aw_i)
\]

(3)

Converse to watermarking embedding algorithm, Watermarking recovering algorithm is denoted as follow:

\[
w_i = (d_i/d_i - 1)/a
\]

(4)

The parameter \(a\) is scale of the intensity of watermarking information.

3. A DCT-BASED WATERMARKING ALGORITHM FOR IMAGE

Although watermarking techniques in DCT domain have strong robustness, they also have their own deficiency, such as low watermarking capacity[14]. For example, the watermarking capacity in Block DCT Domain Algorithm is only \(N_1 \times N_2 / 64\) (\(N_1\) - width of the original image; \(N_2\) - height of the original image). The watermarking capacity in Global DCT Domain Algorithm is \(L\).[15] Due to the shortage of the algorithms mentioned above, the dissertation puts forward an improved DCT domain watermarking algorithm. The main idea is described as follow[16].

An image is firstly segmented by \(8 \times 8\) block, each blocks is transformed by DCT. The watermarking information is embedded and extracted using Global DCT Domain Watermarking Algorithm [17].

\[
X = \{x(i,j), 0 \leq i < N_1, 0 \leq j < N_2\}
\]

(5)

\[
W = \{w(i,j), 0 \leq i < M_1, 0 \leq j < M_2\}
\]

(6)

\(X\) donates 8-bit gray image, \(N_1\) is the width of image, \(N_2\) is the height of image. \(W\) donates 2-dimensional
gray image. $M_1$ is the width of image, $M_2$ is the height of image[18].

$$M_1 \leq N_1, \quad M_2 \leq N_2$$

$$x(i,j) \in \{0,1,2,\ldots,255\}, w(i,j) \in \{0,1\}$$

(7)

There are $N_1 N_2 / 64$ blocks size $8 \times 8$ pixels, each block is transformed by DCT, and then the watermarking is embedded to the first $L$ largest coefficients in DCT domain[19].

4. Result

Analysis of result and simulation of the work is given as follows

5. Conclusion

Analysis shows that the watermarking information capacity of this DCT-based algorithm is $N_1 N_2 / 64 L$, while the Block DCT Domain Algorithm is only $N_1 N_2 / 64$, and the watermarking capacity in Global DCT Domain Algorithm is $L$. Hence it can be concluded conveniently that this algorithm is robust against attacks on watermarking information, and has a larger watermarking capacity than Block DCT Domain Algorithm and Global DCT Domain Algorithm[20]. Digital data can be easily copied, modified and forgeries be created by anyone having a computer. Most prone to such malicious attacks are the digital images published in the Internet. Digital Watermarking can be used as a tool for discovering unauthorized data reuse and also for copyright protection.

REFERENCES


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