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著作權保護小波樹浮水印(1/2)

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著作權保護小波樹浮水印
Wavelet Tree Quantization for Copyright Protection Watermarking
計畫編號：NSC 93-2213-E-009-115-
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1 摘要

We proposed a blind watermarking scheme using wavelet tree quantization. With the use of wavelet trees, each watermark bit is embedded in all frequency bands. The wavelet coefficients of the host image are grouped into wavelet trees and each watermark bit is embedded using two trees. The trees will be quantized so that they are statistically different. Such a difference will later be used for watermark extraction.

Keywords: wavelet tree, watermark, copyright protection

2 緣由與目的

We proposed a wavelet based watermarking scheme for the application of copyright protection. In the application of copyright protection, a watermark is embedded in a host image using a watermark encoder. The watermark can later be extracted using a watermark decoder to prove ownership. The watermark decoder gives a binary decision on the existence of the watermark by comparing the extracted watermark and the owner's watermark. In addition, for the watermarking scheme to be useful, the method should be a blind one, meaning the original image is not used in the watermark extraction process.

We will use the tree marking technique to embed watermark bits in wavelet coefficients based on their perceptual importance. When the attacked image is so that there are clearly distortions, there is no need resorting to watermarks to show ownership. As the tree marking approach is based on wavelet trees, which encompass large spatial areas, more robustness against geometric attacks such as pixel shifting and image rotation can be expected. We will investigate the embedding of watermark bits by quantizing wavelet trees. The trees should be so quantized that they exhibit a large enough statistical difference. The resulting difference between quantized and unquantized trees will allow for watermark extraction at a later time.

3 結果與討論:

In the proposed tree watermarking scheme, the host image is transformed into wavelet coefficients using DWT (discrete wavelet transform). The wavelet coefficients are grouped into wavelet trees. Fig. 1 illustrates the embedding procedure. The watermark W is a binary PN sequence of ± 1. The seed of the sequence can be generated by mapping a meaningful signature or text through a certified one-way deterministic function [1]. Fig. 2 illustrates the extraction procedure. After a watermark W' is extracted, it is compared with the owner's watermark W, and a normalized correlation coefficient between the stored watermark W and the extracted one W' is computed. If the correlation is above a chosen threshold, we determine that the watermark exists. The choice of the threshold depends on the desired false positive probability.

For the convenience of illustration, we will use a discrete time wavelet transform of 4 levels (see [2] and the references therein for details of wavelet transforms). A 512×512 image will be used as an example. With a 4-level decomposition (Fig. 3(a)), we have 13 frequency bands as shown in Fig. 3(b). We will use the coefficients in bands labeled as $C_{i,j}$ in Fig. 3(b) for watermarking. The coefficients in high frequency bands are not used as they often contain little energy. If we place the 13 subband images in their corresponding slots in Fig. 3(b), we get a 512×512 array of wavelet coefficients in Fig. 4. We group the coefficients corresponding to the same spatial location together (Fig. 4). Fig. 5(a) shows an example of a group with one coefficient from $C_{4,3}$, 4 coefficients from $C_{3,3}$ and 16 coefficients from $C_{2,3}$. There are 21 coefficients in each group. Coefficients of the same group correspond to various frequency bands of the same spatial location. The total number of groups is equal to the number of coefficients in $C_{4,1}$, $C_{4,2}$ and $C_{4,3}$, each of which has 32^2 coefficients. There are a total of $3 \times 32^2 = 3072$ groups. We order the groups in a pseudo-random manner. A pseudo-random order of the numbers from 0 to 3071 can be obtained by repeatedly generating random numbers and taking modulo 3072. If

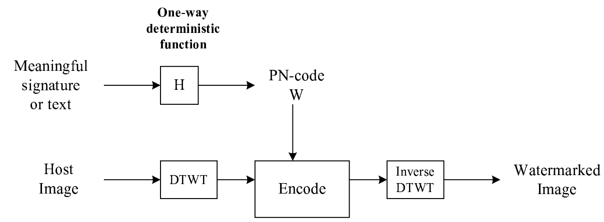

圖 1: Block diagram of the proposed encoder.

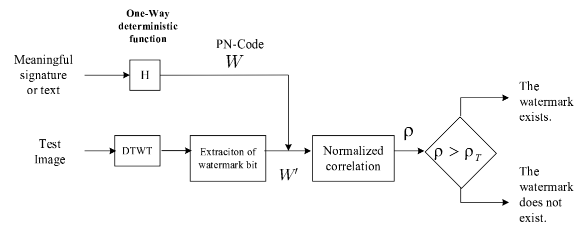

圖 2: Block diagram of the proposed decoder.

a number between 0 and 3071 has appeared already, the number is discarded. We do this until we have a set of numbers from 0 to 3071. The random numbers can be generated using the same seed in generating the watermark W.

We use two trees to embed the n-th watermark bit w_n. For this, we find the smallest quantization index q_n such that $\mathcal{E}_{2n-1}(q_n) \geq \mathcal{E}$ and $\mathcal{E}_{2n}(q_n) \geq \mathcal{E}$, where $\mathcal{E}$ is some appropriately chosen quantity called reference error. To maintain the quality of watermarked images, we can constrain the maximum value of q_n to be a pre-determined value q_{max}, known to both the encoder and the decoder. If we can not find $q_n \leq q_{max}$ such that $\mathcal{E}_{2n-1}(q_n) \geq \mathcal{E}$ and $\mathcal{E}_{2n}(q_n) \geq \mathcal{E}$, the index q_{max} will be used as the quantization index. If $w_n = -1$, the first tree is quantized with respect to q_n. If $w_n = 1$, the second tree is quantized with respect to q_n. When all the watermark bits are embedded, we apply the inverse DTWT on the new wavelet coefficients. The output of the inverse DTWT is quantized to have integer values between 0 and $2^b - 1$, where b is the number of bits per pixel of the original host image.

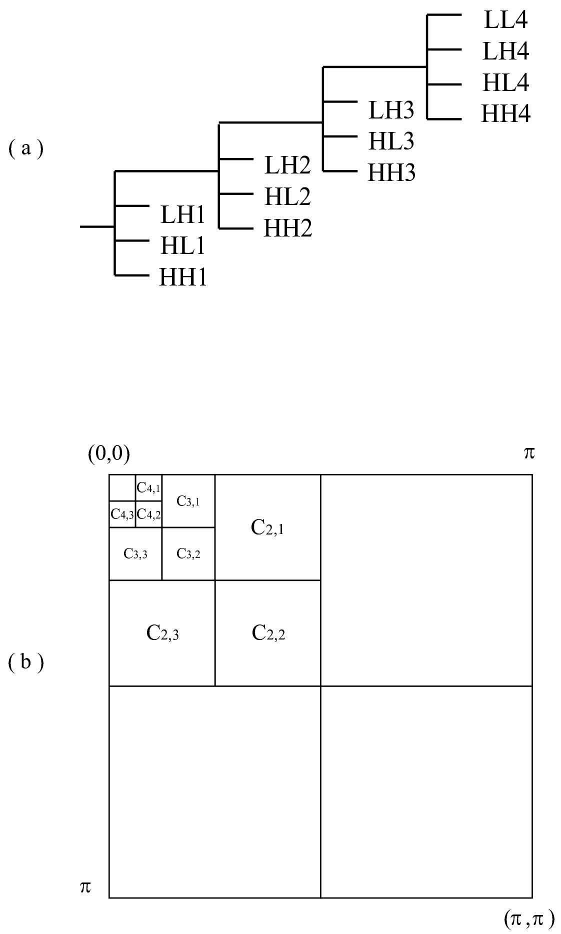

圖 3: (a) A four-level wavelet decomposition and the resulting 13 subbands; (b) the 13 frequency bands corresponding to the subbands in (a).

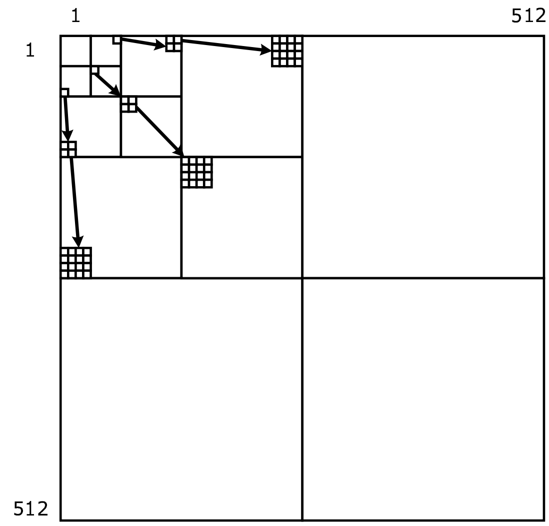

圖 4: Illustration of grouping wavelet coefficients that correspond to the same spatial area.

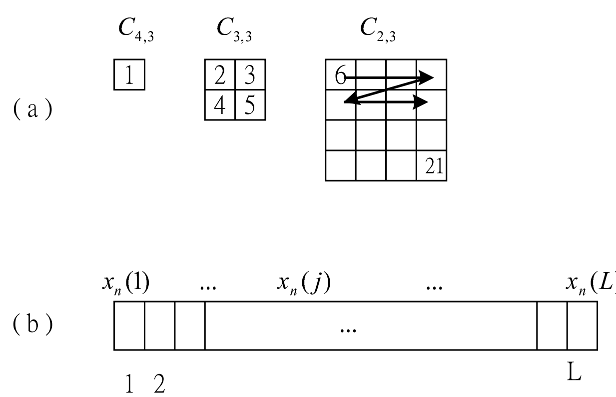

圖 5: (a) A group of wavelet coefficients with one coefficient from $C_{4,3}$, 4 coefficients from $C_{3,3}$ and 16 coefficients from $C_{2,3}$. (b) A super tree obtained by combining two groups of wavelet coefficients.

參考書目

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