Digital Watermarking in Color Image Based On Joint Between DCT and DWT

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Abstract

The massive distribution and development in the digital images field with friendly software, that leads to produce unauthorized use. Therefore the digital watermarking as image authentication has been developed for those issues. In this paper, we presented a method depending on the embedding stage and extraction stag. Our development is made by combining Discrete Wavelet Transform (DWT) with Discrete Cosine Transform (DCT) depending on the fact that combined the two transforms will reduce the drawbacks that appears during the recovered watermark or the watermarked image quality of each other, that results in effective rounding method, this is achieved by changing the wavelets coefficients of selected DWT sub bands (HL or HH), followed by applying DCT transform on the selected sub band's coefficients, this method focuses on the invisibility for the embedded watermark bits, and the quality for the watermarked image; furthermore it focuses on a subjective for the recovered watermark after extraction stage. The proposed method was evaluated by using simple image quality matrix illustrated in the results, and it was found that the proposed method provide good objective quality, the recovered watermark extracted successfully and the quality of recovered watermark are survived.

Keywords: Authentication, Digital Watermark, Discrete Wavelet Transform, Discrete Cosine Transform.

Introduction

The fast development for the information technology in recent years makes the multimedia easy to modify by unauthorized user with easy way. Still image is one of the important media that we need to be secured and authenticated. So, we need a technique to recognize the original and forged images. Digital watermarking is a valid technique to solve this problem, digital watermarking is a process of embedding information inside the host directly with spatial domain; this is done by using least significant bit (LSB) or under frequency domain such as: discrete cosine transform (DCT), discrete wavelet transform (DWT), discrete fourier transform (DFT), singular value decomposition (SVD) techniques …etc, to help us in verifying the authentication of images and localizing the alteration after extraction process. In order to improve of further perform in DWT based digital image watermarking algorithms could be obtained by jointing DWT with DCT [1] [2]. The reason of applying two transforms is based on the fact that jointed transform could make up for the disadvantages of each other, so that effective watermarking approaches could be acquired. Kaushik D. and et al [3] embedded the watermark bits inside the low frequency bands for each DCT block of the selected DWT sub-band based on the joint between DWT and DCT, furthermore, another improvement by using correction to increase the imperceptibility. While Shinfeng D. Lin and Chin-Feng Chen [4] that suggest the energy of each block is concentrated on the low frequency after transformation in nature image and embedding bits inside the low frequency position and give the optimal quality for the watermarked image and survive loss of data compression, therefore the watermark bits information should not be embedded inside the higher frequency.

The main inconvenience with digital watermark is that the watermarked image should be secured with a good objective quality after embedding stage. The primary goal for our proposed method is focused on the invisibility for the embedded watermark and quality of the watermarked image after embedding stage and the recovered watermark after extraction stage that is achieved by using joint process between two transforms, in the existing paper the joint process is done between DWT and DWT.

The proposed method

The existing attempts is to join between DWT and DCT, the embedding stage is similar to one adopted in [5], but in our proposed method without using PN-sequences with hiding position in low frequency domain while [5] used middle frequencies. A binary logo bits with size of 128×128 are embedded in certain sub-bands (blue sub-band) of a 3-level DWT transformed of a host image with size of 256×256. Then, DCT transform of each selected DWT sub-band that computed and transformed to produce the selected coefficients randomly depending on the secret key that used a fixed position inside the host in transform domain to choose the coefficients and the watermark bits are embedded in the selected coefficients of the corresponding DCT positions in low frequency domain as shown in figure (1). The algorithms (1) and (2) illustrate the joint stage with embedding stage for our proposed method:

Algorithm 1: Embedding Watermark Stage with Joint Process.

Input: O as Original Image, W, as Original Watermark.
Output: WI_J Watermarked Image After Joint Stage.
Step 1: Read O, W
Step 2: Perform DWT on the O to produce the main four sites: LL_1, HL_1, LH_1, and HH_1.
Step 3: Perform DWT (3-level) again over the low frequency domain represented by LL_1 sub-bands to get other smaller sub-bands and choose the coefficient randomly C_{DWT}'.

Step 4: Divide O' into 8x8 non-overlapping block size to produce the corresponding block O_B' from C_{DWT}' depending on S_k.
Step 5: Perform DCT for each O_B' of the whole O' to obtain DCT coefficients C_{DCT}.
Step 6: Embed the watermark bits inside C_{DCT} of O_B'.
Step 7: Perform inverse DCT (IDCT) on each block for the whole image after its middle sub-band coefficients have been modified to embed the watermark bits as described in [6], while the embedding site for the existing paper use the low frequency domain rather than the middle frequency domain to make the proposed scheme more robustness.
Step 8: Perform the inverse DWT (IDWT) on the transformed image, including the modified coefficient sets, to produce the watermarked image WI_J.
Step 9: **END.**

The same steps from algorithm 3.3 are used with extraction stage to recover the watermark from WI_J, the following algorithm illustrates the extraction stage after joint stage:

Algorithm 2: Extraction Stage.

Input: WI_J as Watermarked Image after Joint Stage.
Output: R_J' Recovered Watermark.
Step1: Read WI_J.
Step2: Perform DWT over WI_J to produce the main four sites: $LL_{1'}$, $HL_{1'}$, $LH_{1'}$, and $HH_{1'}$.
Step3: Perform DWT (3-level) again over the low frequency domain represented by $LL_{1'}$ sub-bands to get other smaller sub-bands and choose the coefficient randomly C_J'.
Step 4: Dived WI_J into 2x2 non-overlapping block size to produce the corresponding block O_{BJ}'.
Step 5: Perform DCT for each O_{BJ}' of the whole WI_J to obtain DCT coefficients C'_{DCT}.
Step 6: The watermark is reconstructed using the extracted watermark bits.
Step 7: **END.**

Performance measures

The following evolutionary matrix is used to evaluate the objective quality and imperceptibility after embedding stage. The quality for the watermarked image can be measured by using the Peak Signal to Noise Ratio (PSNR), illustrated in the following equation (1) [6]:

$$PSNR = 10 \log_{10} \frac{(R)^2}{MSE} \qquad (1)$$

While, Mean Square Error (MSE) that is obtained from equation (2), is used to assess the extent of tampering between the original watermark O, and the recovered watermark R, where W represented the width, H represented the height for the watermark [7].

$$MSE = \frac{\sum_{x,y}[O(x,y) - R(x,y)]^2}{W \times H} \qquad (2)$$

While the similarity between the original watermark and the recovered watermark from the attacked watermarked image is obtained by using the Normalized Correlation (NC) factor that is computed from the following equation (3) [8]:

$$NC = \frac{\sum_{j=0}^{j-1}\sum_{k=0}^{k-1} W1(j,k) \times W2(j,k)}{\sum_{j=0}^{j-1}\sum_{k=0}^{k-1} W1(j,k)^2} \qquad (3)$$

Results

Figure (2) shows the original image that is used in the work, while figure (3) shows the watermarked image after embedding stage.

A watermarked image was exposed for some type of pre-processing such as spatial filter (median filter) that is applied over the watermarked image illustrated in figure (4), mild processing such as salt and pepper that illustrated in figure (5), and the results was treated by using median filter in figure (6), the previous processes aim to assessment the ability of our proposed method in resistance this type of attacks.

To evaluate a subjective for the proposed watermarking scheme, after embedding watermark in color images of 256×256 pixels, are conducted in the following tables, the experimental results that represent the quality of the watermarked image obtained from equation (1), illustrated in table.1, while quality for the recovered watermark after extraction stage is illustrated in table.2 that is obtained from equation (2), another performance measure that is used in work to assess the similarity between the O and the R after extraction stage from the noised watermarked image computed from equation (3), and the results are illustrated in table.3.

Figure (7), shows the original watermark in the left hand side and the recovered watermark in the right hand side after embedding stage under DCT transform, while figure (8), shows the result after embedding stage under DWT in the same hand side, and figure (9), showed the quality for the recovered watermark under joint process between DCT and DWT.

Conclusion

In this paper, the joint processes between (DCT/DWT) apply over the color Bitmap-Image BMP to obtain a high-quality for the watermarked image and the recovered watermark. The proposed method focuses on the invisibility for the embedded watermark bits, and the quality for the watermarked image; furthermore it focuses on a subjective for the recovered watermark after extraction stage. In the experimental results, the proposed method survived the quality of the watermarked image after median filter, the value of quality matrix that is used in the work to assess the subjective for the proposed method indicates that the proposed method also survives the quality for the recovered watermark after joint process between the two transforms (DCT/DWT). We exposed the watermarked image to spatial filter as pre-processing and the results registered, the processed watermarked image is exposed to the Salt & Pepper noise, and the results also registered, the noised watermarked image is treated by median filter at last. The results that are indicated in the existing paper proved that the proposed scheme has ability to survive the quality for the watermarked image after unintended attack such as median filter. Furthermore, the secret watermark is extracted successfully when the watermarked image is exposed to some type of unintended attacks such as Salt & Pepper noise followed by spatial filter.

References

1- Tsai, M. and Hung, H., (2005), "DCT and DWT based Image Watermarking Using Sub sampling", in Proc. of the IEEE Fourth Int. Conf. on Machine Learning and Cybernetics, 5308-5313, china.
2- Ali Al-Haj,(2007), "Combined DWT-DCT Digital Image Watermarking", Journal of Computer Science 3 (9): 740-746.
3- Kaushik, D.; Md, S.; Mir, M. and Iqbal, H., (2013), "A Joint DWT-DCT Based Watermarking Technique for Avoiding Unauthorized Replication", IEEE.
4- Shinfeng, D. Lin and Chin-Feng, Chen,(2000), "A Robust DCT-Based Watermarking for Copyright Protection", IEEE Transactions on Consumer Electronics, 46, 3, AUGUST.
5- Saied, A. and Ahmadreza, N.,(2008), "A New Robust Digital Image Watermarking Technique Based On Joint DWT, DCT Transformation", Department of Computer Engineering, University of Isfahan, Isfahan, Iran, IEEE.
6- Qian-chuan, Z. and Qing-xin,(2009), "A DCT Domain Color Watermarking Scheme Based on Chaos and Multilayer Arnold Transformation", International Conference on Networking and Digital Society, IEEE, Chengdu, China.
7- Kaushik, D.; Md., S.; Md., M. and Md., I.,(2012), "Combined DWT-DCT Based Digital Image Watermarking Technique for Copyright Protection", 7th International Conference on Electrical and Computer Engineering, Dhaka, Bangladesh, 20-22 December.
8- Shang-Lin; I-Ju T.; Bin-Yuan H. and Jh-Jie,(2008), "Protecting Copyright of Color Images Using a Watermarking Scheme Based on Secret Sharing and Wavelet Transform", Journal of Multimedia, 3, 4, October.

Table (1) PSNR for the watermarked image

DCT/DWT db units	Peppers	Lena
PSNR	46.226	48.107

Table(2) MSE for the recovered watemark

DCT/DWT db units	Peppers	Lena
MSE	0.626	0.871

Table (3) NC for the recovered watemark

DCT/DWT db units	Peppers	Lena
NC	0.335	0.887

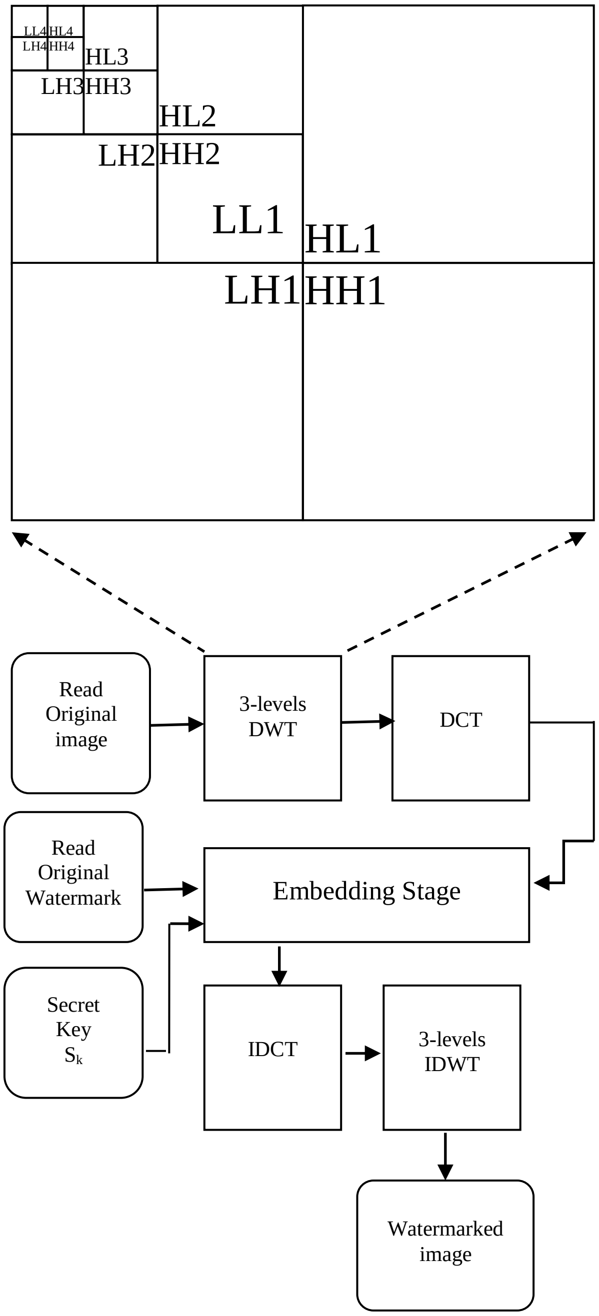


Figure (1) General Diagram for Joint DWT-DCT

Figure (2) The original image

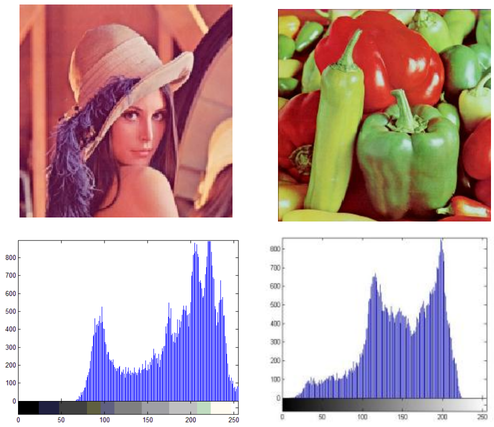


Figure (3) The Watermarked image

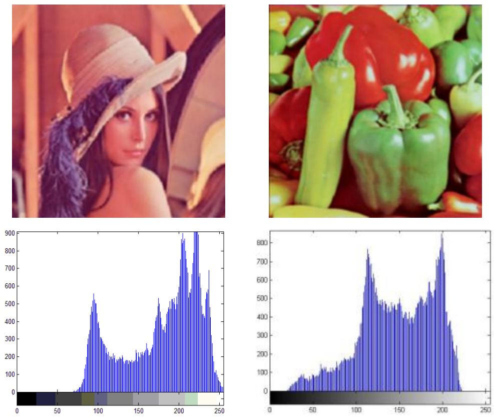


Figure (4) The watermarked image after median filter

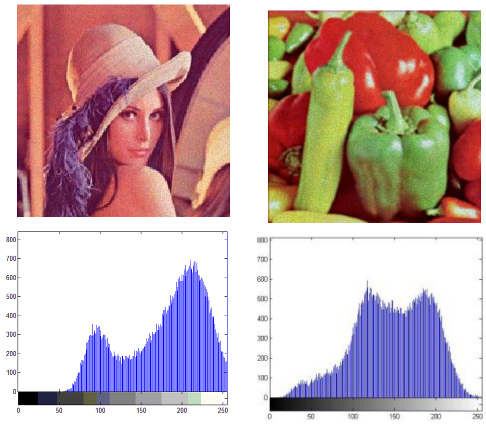


Figure (5) The Watermarked image, after salt and pepper with (0.10) degree

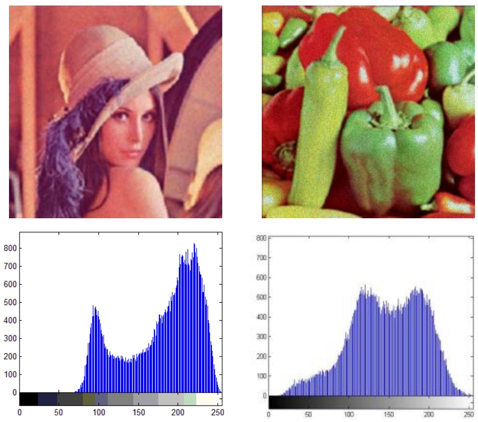
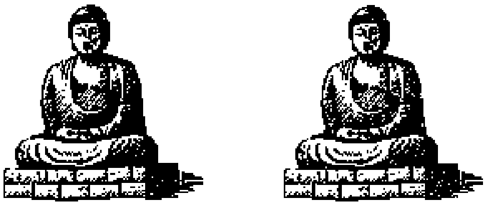
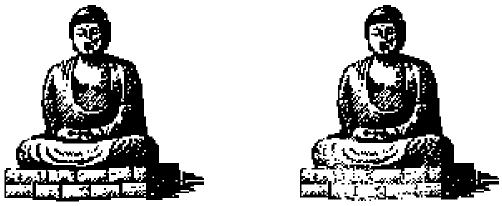


Figure (6) The noised Watermarked image, after median filter



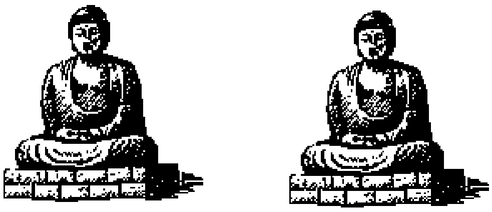
a b

Figure (7) The recovered watermark after DCT,
a: the original watermark,
b: the recovered watermark



a b

Figure (8) The recovered watermark after DWT,
a: the original watermark,
b: the recovered watermark



a b

Figure (9) The recovered watermark after DCT/DWT,
a: the original watermark,
b: the recovered watermark

العلامة المائية الرقمية في الصورة الملونة على أساس الربط بين DCT وDWT

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الخلاصة

أن التطور الحاصل في مجال الصورة الرقمية مع توفر البرمجيات المختصة بمعالجة الصور وسهولة استعمالها جعل من عملية التزوير والتلاعب متاحاً للجميع. العلامة المائية الرقمية كانت من أهم الحلول لحل هذه المشكلة. تقدم هذه الورقة البحثية طريقة مقترحة تتضمن عملية ربط كلٍّ من DCT وDWT في بيئة واحدة لغرض تضمين العلامة المائية داخل الصورة الملونة. ضمن هذه البيئة وذلك لغرض الحصول على أعلى جودة للصورة المضمنة للعلامة المائية ما بعد الإخفاء وكذلك لتجنب المشاكل التي قد تظهر نتيجة استعمال إحدى الطريقتين بشكل منفصل، من خلال التلاعب بقيم معاملات DWT ضمن نطاق الترددات الواطئة متبوعة بعملية تطبيق DCT خلال عملية التضمين، وتركز هذه الطريقة على عدم وجود تشوهات بعد تضمين العلامة المائية في الصورة الأصلية وعلى جودة الصورة النهائية بعد تضمين العلامة المائية فيها بالإضافة إلى التركيز على العلامة المائية المسترجعة بعد عملية الاستخراج. لقد تم تقييم الطريقة المقترحة من خلال استعمال بعض المعايير الرئيسة ضمن هذا المجال والتي تم تفصيلها في فقرة النتائج، أظهرت النتائج ان الطريقة المقترحة لها القدرة على المحافظة على جودة الصورة المضمنة والعلامة المائية المسترجعة، إذ ان جودة الصورة المضمنة كانت جيدة.

الكلمات المفتاحية : الموثوقية، العلامة المائية الرقمية، التحويل المويجي المتقطع، تحويل دالة الجيب تمام المتقطع.