

# Digital Watermarking for Image Tamper Detection using Block-Wise Technique

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## Abstract

*Fragile watermarking has the characteristics where the inserted watermark should be easily breakable for a trivial tampering of the image. So, fragile watermarking technique is proposed for the purpose of authentication or tamper detection. In this paper, we propose an efficient image tamper detection method using block-wise technique which is able to detect the tamper locations. In the proposed method, a digital signature is generated from the hash code of the blocks of the final level where the watermark is inserted and the blocks of the upper level where those blocks are included in the image division process and this signature is used as the watermark, which is randomly inserted into selected image blocks. As the result of experiment, the proposed method was confirmed to be able to detect the tampered parts of the image without testing the entire block of the watermarked image.*

**Keywords:** *Fragile Watermarking, Image Authentication, Tamper Detection, Digital Signature*

## 1. Introduction

Growth of computer and network technology has led to tremendous opportunities for creation and distribution of digital media content. And the digital data is easy to be edited and illegal duplication, and thus the technology to resolve such issues is in demand [1, 2]. The Digital watermarking technique makes use of a data hiding scheme to insert some information in the image [3, 4]. Robust watermarks are useful for copyright and ownership assertion purposes. So, they cannot be easily removed and should resist such as cropping, filtering, etc. Fragile watermarks can be broken easily which means it's not totally immune from various attacks. However because fragile watermarking is very sensitive to any malicious alteration it can be very valuable for the purpose of authentication or tamper detection [5-8]. The digital watermarking can be divided into block-wise and pixel-wise techniques. Block-wise watermarking is dividing the image into specified non overlapping blocks for the purpose of tamper detection [9, 10].

Many fragile watermarking methods are proposed. And the method of inserting watermark by dividing the image into many blocks of small sizes is weak against attacks like cut-and-paste, and thus the methods to resolve such are being proposed [11-14].

In this paper, a method is proposed such that the digital signature generated by the hash code of the blocks at the last level where the watermark is inserted during the image division process and the upper level containing those blocks is used as the watermark, and the private key used in the digital signature is used to select the block location to insert watermark for effective detection of even tiny tampering of the image.

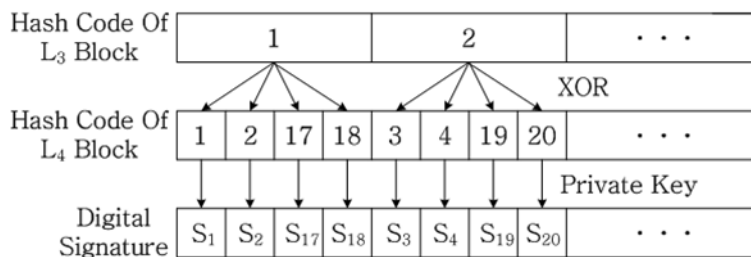


## 2.2. Watermark Generation

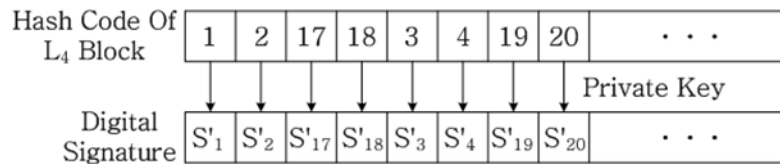
In this paper, two watermarks generated as follows will be inserted to the  $L_4$  blocks divided to the pixel size  $16 \times 16$ .

1) First watermark ( $WM_1$ ) generation: After performing XOR operation between the hash code for each block of  $L_3$  and the hash code of the  $L_4$  blocks included in this block, the result is enciphered with the private key to generate a digital signature ( $S_i$ ). Performing such process repeatedly for all  $L_3$  blocks, total of 256 digital signatures are generated, which are called the first watermarks ( $WM_1$ ).

2) Second watermark ( $WM_2$ ) generation: With the hash code for each  $L_4$  block, a digital signature ( $S'_i$ ) is generated. There will be total of 256 digital signatures for all  $L_4$  blocks, and these shall be called the second watermarks ( $WM_2$ ).



(a)  $WM_1$  generation process



(b)  $WM_2$  generation process

**Figure 3. Watermark Generation Process**

3)  $WM_1$  and  $WM_2$  generated in 1) and 2) shall each form a pair. The pair of  $WM_1$  and  $WM_2$  shall have  $S_1$  of Figure 3 (a) and  $S'_1$  of (b) form a single watermark pair, and  $S_2$  and  $S'_2$  shall form another pair. Repeating such would result in total of 256 pairs of watermarks.

## 3. Watermark Insertion and Extraction

### 3.1. Selection of Block for Watermark Insertion

The selection of block for insertion of watermark pair ( $WM_1$ ,  $WM_2$ ) will use the same block mapping equation (1) proposed by Lin et al [9] which uses the randomly selected key, but for the key value of equation (1), the prime number selected with the hash code of the private key in Figure 3 used in the digital signature generation is used to calculate the block to insert watermark.

$$X' = (\text{Key} \times X) \bmod N + 1 \quad (1)$$

Where,  $X'$  shows the  $L_4$  block to insert watermark, and  $X(\in \{1, N\})$  shows the  $L_4$  block used for watermark generation. And  $N$  shows the total number of  $L_4$  blocks.

### 3.2. Watermark Extraction

Watermark pairs are inserted to one of the all  $L_4$  blocks. The reason for inserting two watermarks in the LSB of the  $L_4$  block is to detect the tampered locks with minimal number of testing without testing all blocks of  $L_4$  for detecting the presence of tampering in watermarked image, which is determined as follows.

- 1) The watermark generated as  $L_3$  block 1 consists of 4 pairs as in  $(S_1, S'_1)$ ,  $(S_2, S'_2)$ ,  $(S_{17}, S'_{17})$ ,  $(S_{18}, S'_{18})$ . Such watermark pair is inserted into 4 blocks in the  $L_4$  image, and if the hash code and watermark earned by deciphering the extracted  $S_1$  with the public key is the same as the hash code calculated in the same manner as the watermark generation process in the watermark-inserted image, then  $L_3$  block 1 will be determined to have no tampering, and the three  $L_4$  blocks with  $S_2, S_{17}, S_{18}$  inserted will also be determined to have no tampering. This is because  $S_1, S_2, S_{17}, S_{18}$  are related to the hash code of  $L_3$  block 1, and due to the characteristics of hash function generating the hash code, the  $L_4$  blocks (1, 2, 17, 18) included in  $L_3$  block 1 are also determined to have no tampering.
- 2) In case the hash code deciphered with the extracted  $S_1$  as the public key and the hash code calculated for  $S_1$  generation are different, from the blocks inserted with the three watermark pairs of  $(S_2, S'_2)$ ,  $(S_{17}, S'_{17})$ ,  $(S_{18}, S'_{18})$ , watermark pairs are extracted and deciphered for comparing and determining the presence of tampering. In conclusion,  $S_1, S_2, S_{17}, S_{18}$  are used as the watermark to determine the presence of tampering in  $L_3$  block and  $S'_1, S'_2, S'_{17}, S'_{18}$  are used to determine the presence of tampering in  $L_4$  blocks included in  $L_3$  blocks.

## 4. Experiment and Result

The method suggested in this paper was experimented against the image of size  $256 \times 256$ .



(a)



(b)



(c)



(d)



(e)



(f)

**Figure 4. (a) The Watermarked Airplane, (b) Image Divided into 16×16 Pixels, (c) Tampered Airplane, (d) Detected Erroneous Regions, (e) Airplane with a Part of the Image Duplicated, (f) Airplane with a Duplicated Part Detected**



(a)



(b)



(c)



(d)



(e)



(f)

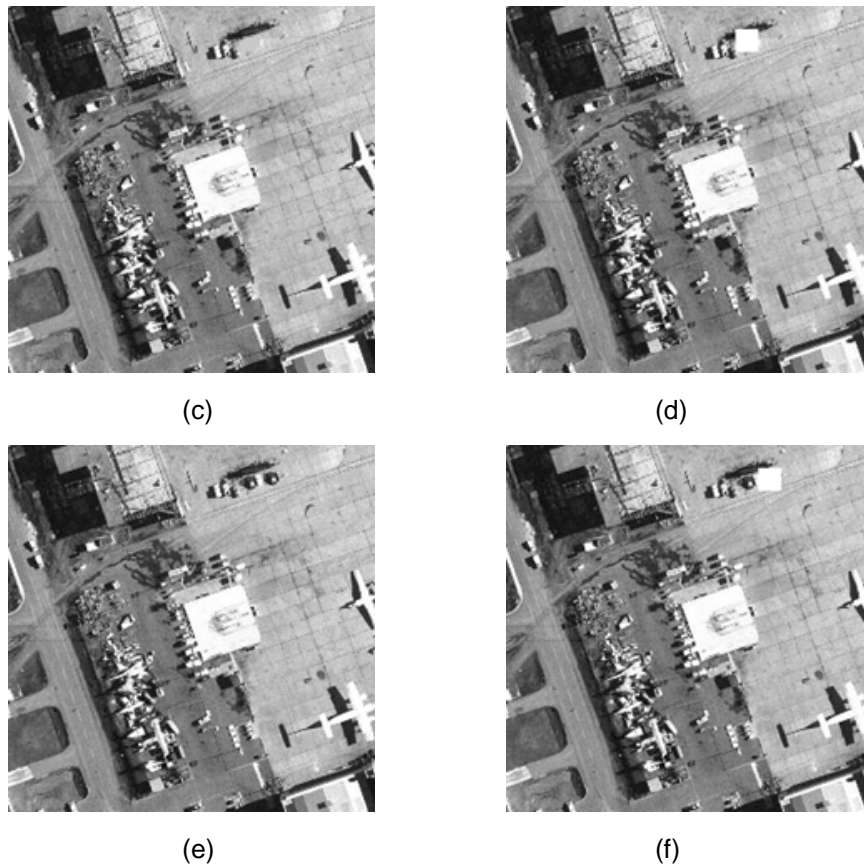
**Figure 5. (a) The Watermarked Camera, (b) Image Divided into 16x16 Pixels, (c) Tampered Camera, (d) Detected Erroneous Regions, (e) Camera with a Part of the Image Duplicated, (f) Camera with a Duplicated Part Detected**



(a)



(b)



**Figure 6. (a) The Watermarked Airfield, (b) Image Divided into 16x16 Pixels, (c) Tampered Airfield, (d) Detected Erroneous Regions, (e) Airfield with a Part of the Image Duplicated, (f) Airfield with a Duplicated Part Detected**

Figure 4, 5 and 6 (c) are the image with a part of the watermarked Airplane, Camera and Airfield image deleted, and (e) shows the copy of a part of the watermarked image. Figure 4, 5 and 6 (d) and (f) shows the result of the tampered blocks in (c) and (e) images being detected.

As the result of the experiment, it was confirmed that by testing the hash code of  $L_3$  blocks rather than all blocks of  $L_4$ , and testing the  $L_4$  blocks only if there is a discrepancy, the tampered blocks could be detected faster.

## 5. Conclusion

In this paper, the image block-wise watermarking method was proposed by using digital signature. For the proposed method, it was confirmed that the tampered blocks could be detected faster by testing the hash code of the upper level first without testing all inserted blocks with watermarks inserted. For future research subject, there should be more research on watermark insertion/extraction according to block size.

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