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Blocking Dwt-SPIHT Algorithm Based Self-Recovery Watermarking Scheme Using Improved Arnold Transform

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Abstract:
We have seen an explosive growth in digitization of multimedia (image, audio and video) content and data exchange in the Internet. Hence, digital data can be transfer across the Internet. So security and copyright protection of multimedia documents is area of interest. Watermarking technology has developed to check authenticity of multi-media content. A watermarking algorithm of self–recovery and Tamper Detection for color image is proposed based on wavelet transform and SPIHT (set partition on hierarchical tree) Algorithm. Firstly, each color channel (R, G, and B) is divided into blocks and then each block of HOST IMAGE is encoded using SPIHT ALGORITHM, and encoded data which is self-recovery base for color image is scrambled using improved Arnold transform and embedded to latter two bit place of host image. Comparing the difference of each block's self-recovery watermark and feature data of receiving image to find Tampered region, and replace each tampered block with decoded self-recovery watermarked data. Experimental results show that this algorithm can accurately locate the tampered position and has good ability of self-recovery.

1. Introduction

Images make up a major component of multi-media content. Examples of images are digital arts, illustrative diagram. Cultural heritage painting in digitized form and digital photograph advantages in computing hardware, software and network has created threads to copyright protection and content integrity. Image can be copied, distributed and edited easily. Digital watermarking has good integrity of content protection. Watermarking has better capability to embed information in image without degrading visual quality.

2. Digital Image Watermarking

Digital image watermarking can be modeled as a communication process that has embedded and encoder. Firstly a watermark signal is encoded into a cover image to create a stego image. No extra space is required to store the signal. The stego image is then transmitted to consumer. Distortion due to the unintentional modification and malicious attack, and data compression could occur in this process. Finally, a watermark detector is applied to detect that watermark can be detected in a distorted image.

3. Types of watermarks

3.1. Mostly Three Types of Watermarking System Adopted

1. Robust [1, 2] watermarks are watermarks that can resist non-malicious distortion.
2. Fragile watermark can easily be destroyed by all distortion.
3. Semi-fragile watermarks can be destroyed by certain types of distortions while resisting other minor changes

4. Wavelet Transforms

Wavelets are functions can be generated using basis function called mother wavelet by dilations (scaling) and translations (shifts) in time (frequency) domain [4]. If the mother wavelet is denoted by ψ (t), the other wavelets $\psi_{a,b}$ (t) can be represented as

$$\Psi_{a,b}(t) = \frac{1}{|a|}\psi\left(\frac{t-b}{\sqrt{a}}\right)$$

5. 2D- Discrete Wavelet Transform

A two-dimensional digital signal can be represented by a two-dimensional array X [m, n] with m rows and n columns, where m and n are non-negative integers. Two dimensional implementation is done by performing one – dimensional DWT row-wise or column-wise to get intermediate results and then performing column-wise of row-wise one-dimensional DWT on this intermediate result in order to get the final result

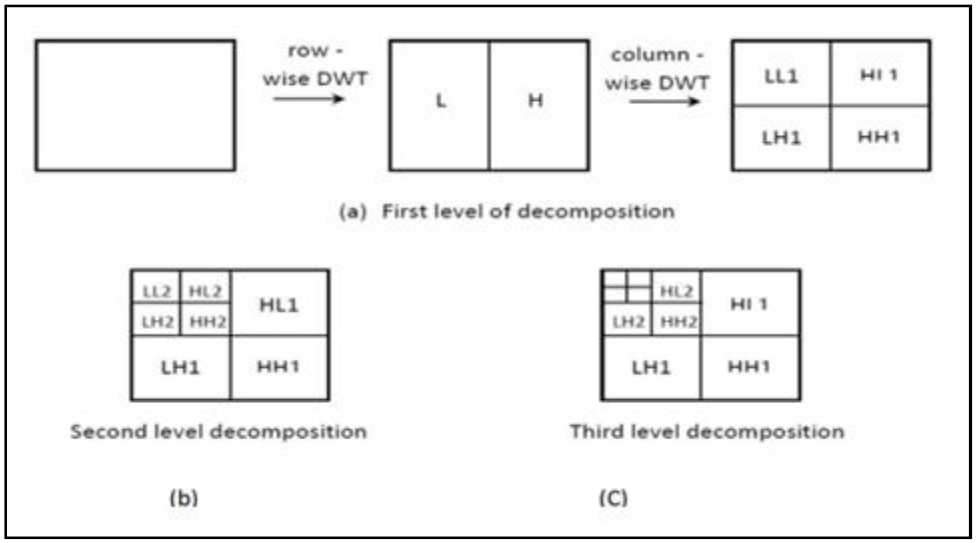

Figure 1: Row - Column computation of two-dimensional DWT

6. Arnold transform

Arnold transform [12, 13] is basically an image encryption and decryption method. It disturbs image auto-correlation and creates a chaotic image. This makes impossible to extract actual image information when it is encrypted without using inverse Arnold transform. It is named after Vladimir Arnold [13]

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 2 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

Arnold transform is a point to point mapping. It re-arranges every pixel of the image to get transformed image. After a certain number of Arnold transform original image re-appear. As size of image increases, number of iteration increases to get the original image. Let X is original image having pixel values (x, y), which is shifted using Arnold transform and transformed image pixels are (x‘, y‘) respectively. Number of iteration required to get the original image back, is known as frequency of Arnold transform.

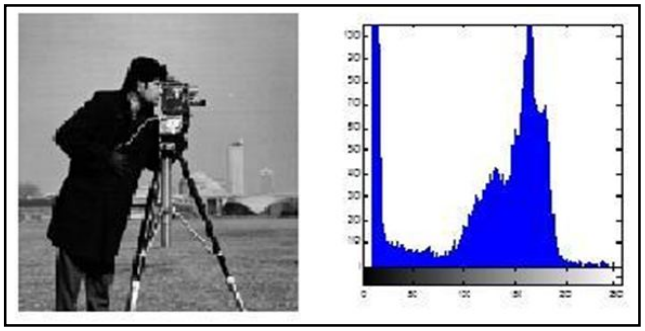

Figure 2:cameraman.tif image, size 256X256 and its histogram

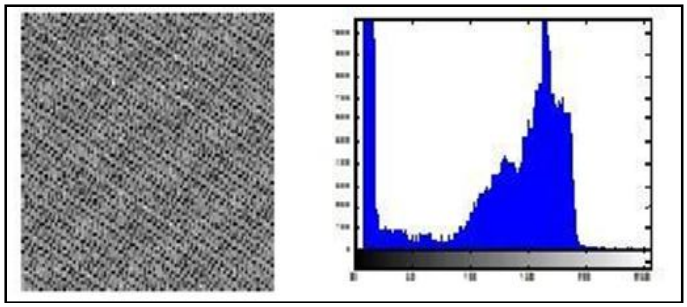

Figure 3: After 5 iteration image and its histogram

7. DWT-SPIHT watermark algorithm

Here I have taken spatio-temporal information in the wavelet domain. A majority of current semi-fragile watermarking technique uses block based processing of authentication and tamper localization. First of all, last two bits of cover image is set to zero. Now we have divided the whole new image into MXM small blocks, then apply DWT [15](Discrete Wavelet Transform) on each block. Level of decomposition is chosen such a way that $M=2^L$, where L is denote level of decomposition, then encode each block using SPIHT algorithm. These encoded blocks were known as self-recovery base.

8. Watermark Encoding

The watermark signal is generated using block based DWT-SPIHT [17] algorithm for the cover image in order to enable content authentication and self-recovery. The watermark signal should be embed far away from their original position to combat cropping attack. To do so we have used Arnold transform, it is most widely used encryption technique which is used in watermarking schemes. Arnold transform changes every pixel position of self-recovery base and then watermark on the cover image. So if cropping attack is there on the image it is easily detected can be recovered using inverse process

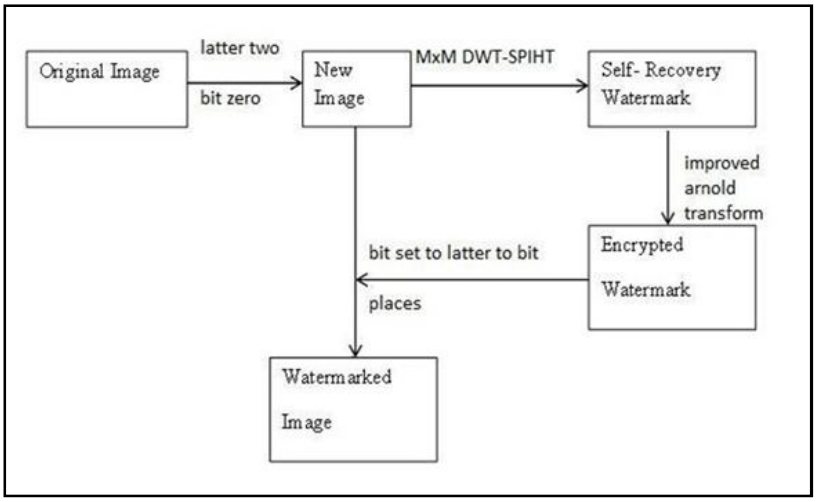

Figure 4: block diagram for self-recovery process.

9. Color Image Watermark Detection and Recovery

We are going to use the same algorithm used in gray scale image recovery. First, we separate R, G, and B component of received tampered image. Then apply blocked DWT-SPIHT algorithm based self-recovery scheme to check authenticity and tampered region of received image, and then replace these blocks using given algorithm. We are going to replace blocks if and only if received image found out to be tampered or unauthenticated.

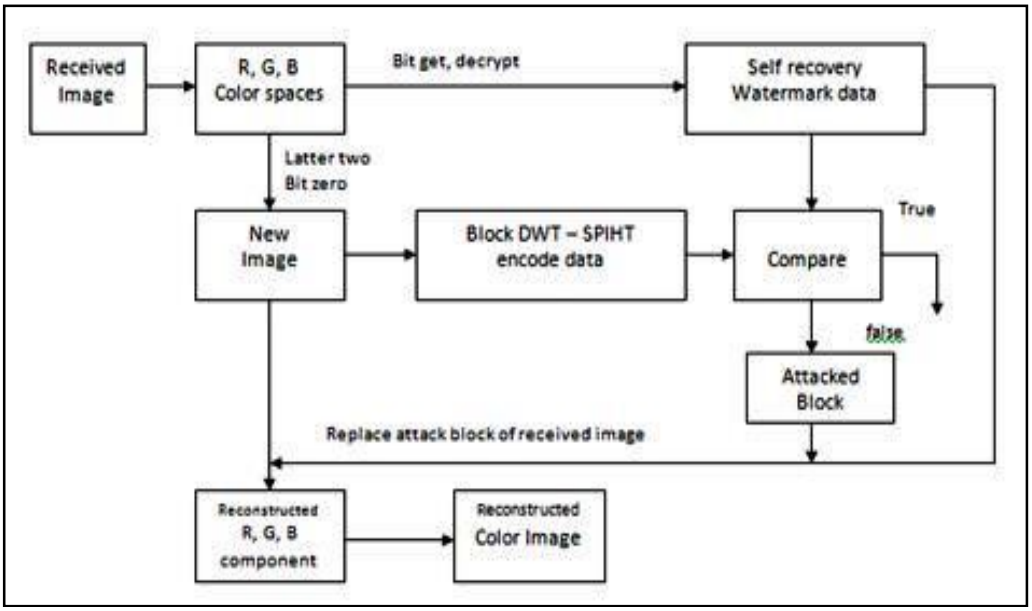

Figure 5: color image self-recovery process

10. Scrambling Factor

Scrambling factor is the measure of difference between pixel with its surrounding gray pixel and corresponding pixel. Here we increase scrambling factor with use of improved Arnold transform. We tested improved Arnold transform for gray scale image cameraman.tiff; size of image is 256X256. Experiment results are given in a table below

Transformation frequency	Coefficient 1	Coefficient 2	Coefficient 3	Coefficient 4	Coefficient5
	1,1,1,2	1,1,4,3	2,1,3,1	2,1,5,3	7,4,9,5
5	2.2975	2.5493	2.4583	2.562	2.3949
50	2.5559	2.5629	2.5658	2.5737	2.5686
100	2.4349	2.518	2.485	2.5054	2.5417
191	2.3277	2.4683	2.3835	2.4824	2.5419

Table 1: Comparison of scrambling degree

11. Self-Recovery of Tampered Image

Figure 6: (a) original image (b) watermarked image

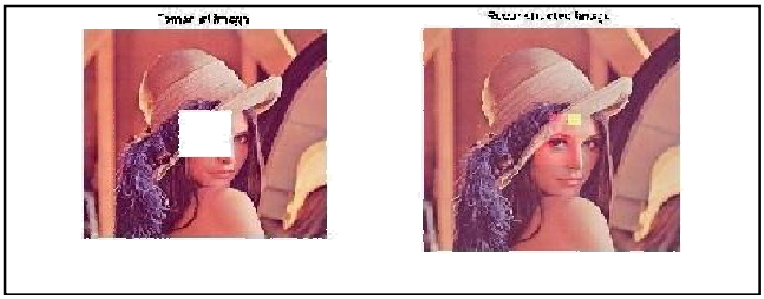

Figure 7: 5% cropped image with reconstructed image for transformation coefficient 1,1,4,3

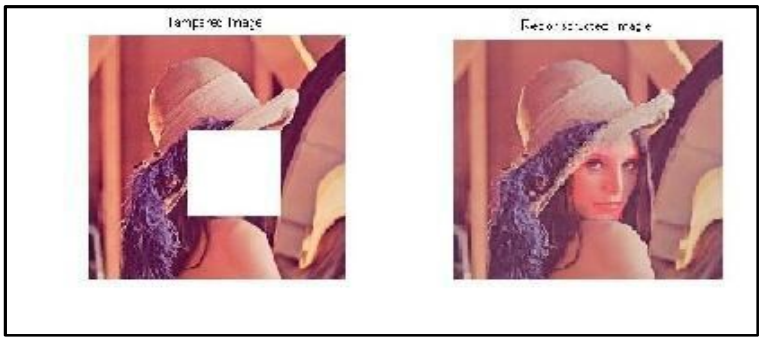

Figure 8: 10% cropped image with reconstructed image for transformation coefficient 2,1,3,1

We have tested the same algorithm for color image lena.jpg and girl.jpg with block size 16X16 and level of decomposition is 4.size of image is 256X256. PSNR value for original image to watermarked color lena.jpg is 50.13.Also algorithm is tested for other color images. List of PSNR value for different cropping percentage lena.jpg is given below

Cropping %	Coefficient 1	Coefficient 2	Coefficient 3
	1,1,1,2	1,1,4,3	2,1,3,1
5	38.58	40.97	42.62
10	36.49	38.56	37.35
20	28.32	30.06	31.02

Table 2: Comparison of PSNR value for different cropping Percentage of color image

12. Conclusion

A block DWT-SPIHT algorithm based self-recovery watermarking scheme using improved Arnold transform is presented in this paper. All color spaces, i.e. R, G, and B are compressed and encoded using DWT-SPIHT algorithm to create self-recovery base, then encoded bits are scrambled using improved Arnold transform to get high degree of scrambling ratio. When the watermarked image is cropped or attack. Self-recovery data is compared with feature data, here self-recovery data is having fewer bit in error because of scrambling. By choosing proper threshold value, we replace attacked block. Simulation result shows that this algorithm can reconstruct the attacked color image with good visual quality, and we will get high PSNR value for a higher degree of scrambling ratio i.e. if we use improved Arnold transform instead of traditional Arnold transform.

13. References

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