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A Novel Color Image Watermarking Scheme Based on Arnold Transform and Discrete Wavelet Transform using B Channel

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Abstract:- The expansion of Internet has frequently increased the use of digital media publically. Digital media can be in the form such as audio, images, text and videos to the public. In this paper we have presented a Novel color image watermarking technique using two methods Arnold transform and discrete wavelet transform . The binary watermark is processed by using error correcting coding and Arnold Transform. Arnold transform is applied for the best scrambling round and then the watermark is embedded in the Blue color channel into the Cover image. Discrete wavelet transform method is applied on the cover image for further security. The proposed method concludes to give better results compared to the simple DWT method in image sharpening, smoothening, noise tolerance, rotating, cropping, etc aspects of image transformations and enhancement.

Keywords:- *Watermarking, Arnold Transform, DWT, B channel, Image transformations and Enhancement*

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1. Introduction

Watermarking is basically used for the copyright protection, security and authentication of your digital media or record. The basic concept is to embed a security pattern in the cover image. Proper protection is done using watermarking that can be visible or invisible. In this paper we have presented a Novel technique using Arnold transform and discrete wavelet transform for color images. The binary watermark is processed by using error correcting coding and Arnold transform is applied for the best scrambling rounds. The watermark is embedded in the B channel that is the Blue color channel of the cover image. Discrete wavelet transform method is applied on the embedded cover image for further security and more robust results.

2. Arnold Transform

The transformation of point (x, y) in the unit square change to another point (X ', Y ').

This transformation is called two-dimensional Arnold scrambling. To be specific to digital image, we need to change the two-dimensional Arnold scrambling of mod 1 to:

$$\begin{bmatrix} X' \\ Y' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} X \\ Y \end{bmatrix} (\mathrm{mod}\, N) \quad [16]$$

(1.1)

It is mod2 which is Arnold scrambling. For x,y ∈ {0,1,2,...N-1}, N is the order of digital image matrix. The transformation of mod2 is matrix A. (x, y)T in the right is the input,(x ', y')T in the left is the output, considering the feedback, iterative process which can do as the following.Where: n representative of the time of iterations, n = 0, 1, 2.... Image information (such as the gray value) with the replacement of the discrete lattice for transplantation, they generated a new image after all of the points of the original image have been traversed.

$$P_{xy}^{n+1} = AP_{xy}^{n} (\mathrm{mod}\, N)$$
$$P_{xy}^{n} = (x, y)^T \quad [16]$$

(1.2)

3. Discrete Wavelet Transform(DWT)

The basic idea of DWT in which a one dimensional signal is divided in two parts one is high frequency part and another is low frequency part. Then the low frequency part is split into two parts and the similar process will continue until the desired level. The high frequency part of the signal is contained by the edge components of the signal. In each level of the DWT (Discrete Wavelet Transform) decomposition an image separates into four parts these are approximation image (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) for detail components. In the DWT decomposition input signal must be multiple of 2n . Where, n represents the number of levels.

To analysis and synthesis of the original signal DWT provides the sufficient information and requires less computation time. Watermarks are embedded in these regions that help to increase the robustness of the watermark.

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4. Comparision of Various methods

Algorithm	Concluded Results
LSB	Does not resist much in attacks like JPEG Compression and Noise
ARNOLD	Robust and more secure against Noise and JPEG Compression
DCT	Resist attacks like filtering
DFT	Not so better results when filtered
DWT	Resist attacks like filtering, sharpening, scaling
SVD	Which gives results in scaling and filtering for gray scale images
Using B channel	filtering, compression, cropping

Table 1 : Comparison of different methods

5. Comparision Table

Paper Title	Summary	Advantages	Disadvantages
Digital Image watermarking Based on LSB for grayscale image	Aim is to Hide watermark with any number of bit substitutions instead of 1-LSB	Watermark is completely hidden	Not so robust on all geometrical attacks
Color Image watermarking Based on Arnold Transfer	Invisible watermark generated using a security method and watermark is embedded in G channel,better results compared to LSB method	Robust against noise and commonly used image processing methods like cropping, Blurring,transformations	Less robust compared to when embedded to B channel
Robust public watermarking scheme based on DWT	A novel method based on DWT is used for better results.	Ensures robustness of the watermark and protects the copyright of a grayscale image,has better Jpeg compression attacks than reference schemes for 512*512 gray level image size, results resist various attacks like filtering and sharpening	The scheme does not resist geometric attack completely
A secure semi fragile JPEG Image Authentication Scheme Based on DCT	Works for JPEG gray scale images with secret key and	Reversible and robust upto 80%, good tolerance to noise	Works on Gray Scale images and sensitive to malicious attacks as cutting and pasting
Watermarking of colour images in the DCT Domain using Y channel	RGB image transformed to YCbCr colour space,watermark embedded to Y channel by selectively modifying the very	Resist Jpeg compression, filtering, cropping	-

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	low frequency parts of the DCT transforms.		
New integration scheme for robust and fragile digital watermarking	Process the original watermark and then embed it into blue componene of image in robust process.In fragile process red component of image are hashed and then encrypted .Method used is DCT with MAC for hashing	Can resist noise,cropping,filter, Jpeg compression	

Table 2 : Analysis and Comparison of Papers

6. Proposed Method

Input : Watermark Image, Color Image
Output : Watermarked Color Image

Step 1 : Read watermark image
Step 2 : Watermark is made Secure by first applying error correction method on it i.e. Hamming code.

Step 3 : Apply Arnold Transform method using the equation $\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 1 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} \bmod N$ where x, y € {0,1,2,3,…,N-1} on the Watermark image through scrambling of various rounds.

Step 4 : Read color image I(x, y)

Step 5 : Select B channel of the cover image.
Step 6 : Embed the watermark into the B channel

Step 7 : Apply DWT on the cover image for more secure and robust results in the middle and higher level bands i.e. {HL,LH,HH}

Explanation :

First the watermark image is read and made secure using error correction method that is by using hamming code. On the watermark image again Arnold Transform is applied on it where scrambling of various rounds is performed. Also the Cover image that is a colored image is read. The watermark is embedded into the B channel (that is the Blue color channel, as Blue color is least sensitive to the human eye, so embedding the watermark in the Blue color gives us much robust results). Further for more robustness and security Discrete Wavelet Transform method is applied on the Cover image in the Higher and Middle level Bands.

7. Dataset (Color Images)

Hawk.png color image of size 512X512 is selected as a cover image and coins.jpg color image of size 128X128 is chosen as a watermark color image. Blue channel of the cover image is selected for embedding process, as blue channel is more resistance to changes compared to red and green channels, because Blue color is least sensitive to the human eye so embedding the watermark in the Blue color channel gives us better robust results. Figure 1 shows the original dataset images of Hawk, Mandrill, Lena, Flower, Strawberry and peppers which are used for testing as color cover images and the watermark image of coins.

Dataset Images Tested :


Hawk


Mandrill


Lena


Flower


Strawberry


Peppers

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House


Scene


Peppergreen


bicycle


Caps


Portrait

Image Watermark:


Coins

Fig.1 Dataset images (Cover and Watermark Images)

8. Experimental Image Results

Fig. 2 The Cover Image : Peppers

Fig. 3 The Watermark Image : Coins

Fig. 4 The Final Watermark Image applying hamming code

Fig.5 Watermarked Image : Peppers

Transformation Results of previous approach and My approach for Peppers:

Peppers	Previous Approach	My Approach
Sharpening		
Smoothing		
Noise Tolerance		

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Cropping		
Rotation		
Scaling		

Fig.6 Experimental Image Results on Image transformation and Image enhancement

8. Result Analysis

Sharpening	Psnr1	Psnr2	% Difference
Hawk	7.630441	7.706201	7.576
Peppers	12.65037	12.732119	8.1749
Mandrill	10.114539	10.205698	9.1159
Lena	9.96816	10.017559	4.9399
Flower	10.610599	10.697135	8.6536
Strawberry	8.255629	8.2977	4.2071

Table 3 : Result Analysis on Sharpening

Smoothing	Psnr1	Psnr2	% Difference
Hawk	7.785282	7.794434	0.9152
Peppers	12.761136	12.793787	3.2651
Mandrill	10.080675	10.104763	2.4088
Lena	10.080675	10.103763	2.3088
Flower	10.530224	10.576802	4.6578
Strawberry	8.197976	8.229584	3.1608

Table 4 : Result Analysis on Smoothing

Noise	Psnr1	Psnr2	% Difference
Hawk	7.741746	7.781767	4.0021
Peppers	12.656979	12.747255	9.0276
Mandrill	10.080675	10.106982	2.6307
Lena	9.900565	9.911254	1.0689
Flower	10.581216	10.632251	5.1035
Strawberry	8.233165	8.25369	2.0525

Table 5 : Result Analysis on Noise Tolerance

Cropping	Psnr1	Psnr2	% Difference
Hawk	7.724761	7.752635	2.7874
Peppers	15.438486	15.609903	17.1417
Mandrill	10.080675	10.118325	3.765
Lena	9.900565	9.921254	2.0689
Flower	10.576802	10.627318	5.0516
Strawberry	8.229584	8.249776	2.0192

Table 6 : Result Analysis on Cropping

Rotation	Psnr1	Psnr2	% Difference
Hawk	7.728633	7.724138	-0.4495
Peppers	12.785168	12.782324	-0.2844
Mandrill	10.080675	10.075	-0.5675
Lena	9.904038	9.900565	-0.3473
Flower	10.581052	10.576802	-0.425
Strawberry	10.581052	10.580921	-0.0131

Table 7 : Result Analysis on Rotation

Scaling	Psnr1	Psnr2	% Difference
Hawk	7.724138	7.758781	3.4643
Peppers	12.747277	12.789943	4.2666
Mandrill	10.080675	10.140528	5.9853
Lena	9.900565	9.91418	1.3615
Flower	10.576802	10.611264	3.4462
Strawberry	8.229584	8.234483	0.4899

Table 8 : Result Analysis on Scaling

9. Result Analysis

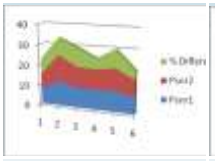
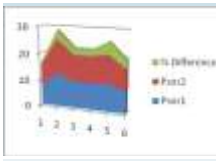
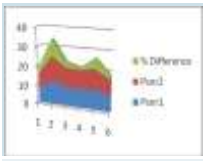
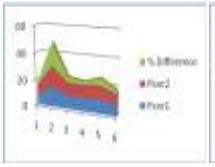
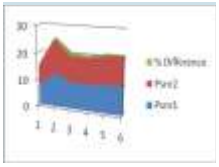
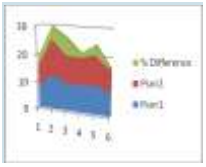
Sharpening	Smoothing	Noise Tolerance
		
Cropping	**Rotation**	**Scaling**
		

Table 8 : Graphical Result Analysis

10. Conclusion

Better results are obtained on image enhancement and image transformations like sharpening, smoothing, noise tolerance, cropping and scaling with my approach when Watermark is embedded in the B Channel compared to the Previous approach.

The Future directions are to improve results in other transformations on zooming and compression of image. When using both Robust methods of Spatial and Frequency Domain and embedding watermark in blue color channel as blue color is least sensitive to the human eye, so embedding the watermark into the blue color gives us better robust results comparatively.

7. Future Work

We will upgrade the method for 3D (3 Dimentional) images instead of using 2D (2 Dimentional) images.

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