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An Ameliorated DWT-SVD Entrenched Digital Watermarking in Consideration of Polychrome Effigy

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Abstract: ***The Digital Watermarking Technique has gained its importance attributable to its ability to produce the secure mechanism for copyright protection and genuineness of the digital knowledge during this high growing net and engineering wherever the meddling and distribution of digital knowledge illicitly from unauthorized users is inevitable. For these two vital properties of Digital Watermarking, i.e. Robustness and Imperceptibility of watermarked image should take into thought. During this paper, invisible sturdy digital watermarking is projected Discrete wavelet transform and Singular Value Decomposition in YCbCr Color area. The performance of the projected algorithmic program is compared with some previous works and results found are more robust against various geometric attacks.***

Keywords: Alpha Blending, Arnold Transformation, Digital Watermarking, Discrete Wavelet Transform, Singular Value Decomposition.

1. Introduction

The rapid climb of web technology has augmented exchange and transmission of digital data. Owing to this, it demanded the requirement of techniques and ways to forestall the meddling and banned distribution of digital information. One in every of the techniques wont to accomplish copyright protection and genuineness of digital information is Digital Watermarking. Digital watermarking is that the act of concealing a message associated with a digital signal (i.e. An image, song, and video) inside the signal itself. Watermarking tries to cover a message associated with the particular content of the digital signal [1]. There are numerous applications of Digital Watermarking like Broadcast observation, Owner Identification, Proof possession, dealings pursuit, Content Authentication, Copy management and Device management [2] [3].The watermarking techniques fall under 2 classes. Spatial-Domain methods and Frequency transform domain modes [4] [5]. In abstraction Domain, it directly manipulates digital information to cover the watermark. Its main advantage is low process complexness. However, this methodology is prone to totally different attacks. In frequency domain, digital information to be protected area unit regenerate into a frequency domain. Compared to abstraction domain ways, it desires additional computation, however it will give higher strength from totally different attacks [6].

According to distinction, the watermarking system are often classified as Blind, Semi-Blind and Non-Blind [7]. The Blind watermarking theme is additionally called public watermarking theme. this is often the foremost difficult sort of watermarking system because it needs neither the duvet (original data), nor the embedded watermark. These systems extract n bits of the watermark information from the watermarked information (i.e. the watermarked image). The Semi-blind watermarking theme is additionally called semi-private watermarking theme. this technique doesn't need the duvet (original data) for detection. the aim of this technique is to search out whether or not that the watermark are often detected. Non-blind watermarking theme is additionally called personal watermarking theme. this technique needs a minimum of the duvet (original data) for detection. The System extracts the watermark from the probably distorted information and uses the initial information as a touch.

The paper is organized as follows: Section two describes connected works, Section three delineated the basic idea, in brief, Section four describes the planned theme, and Section five describes the experimental results. The paper complete in Section vi followed by references.

2. Related Works

A number of earlier works related to digital image watermarking inspired us to do this research. Some of such recent researches are briefly described in this section. R. Kaur and H. Singh [13], introduced DWT-DCT-SVD based digital watermarking and implement different attacks on watermarked image such as Gaussian Noise Attack, Salt and Pepper attack and Compression attack. The maximum NC value recorded was 0.995 for Salt and Pepper noise attack. M. Chaudhary, S. Srivastava and V. Chaubey [14], introduced digital watermarking based on DWT-DCT-SVD and Salt and Pepper as an attack on watermarked image. The maximum PSNR value recorded was 19.0941 dB after the Salt and Pepper attack on the watermarked image. S. R. Hallur, S. Kuri and G. H. Kulkarni [15], proposed a DWT-DCT-SVD based color image digital watermarking in RGB Planes. Different attacks such as AWGN Noise, JPEG 50% compression, Median filter, Wiener filter, Gaussian Filter, Salt and pepper etc. The the maximum recorded NC value was 1. C. N. Sujatha and P. Satyanarayana [16], proposed DWT-DCT-SVD based color image digital watermarking in RGB planes. Different attacks such as Gaussian Noise, Salt and pepper, Compression, Median Filtering, Average filtering, Sharpening, Rotation etc. to check the robustness of the watermarked Image. The the maximum recorded NC value was 0.9800 for Autumn image for sharpening attack. K. Chaitanya, S. Reddy and G. Rao [17], proposed a color image digital watermarking in RGB planes using DWT-DCT-SVD Coefficients. The the maximum recorded NC

value was 0.99 without attack. N. Divecha and D. N. N. Jani [18], proposed a Non-Blind DWT-DCT-SVD based digital watermarking technique for RGBimage. Different attacks like JPEG 50%, Rotation, Cropping, Gaussian Noise, Gamma Correction, etc. are carried out to check the robustness of the watermarked image. The the maximum recorded NC value was 0.987 for pepper image for Gaussian noise attack. M. A. Rahman and M. M. F. Rabbi [19], proposed a Non-Blind DWT-SVD based watermarking technique for RGB Image. 3-Level DWT is applied on each RGB planes of The cover image and watermark. The SVD is applied to embed the watermark into the cover image. Different attacks like Gaussian, Laplacian, Sobel, Average, Prewitt, Cropping etc. are carried out to check the robustness of the watermarked image. The PSNR value after attacks seems to be at around 54db to 8db with different attacks. S. Shekhawat and S. Yadav [20], proposed a NonBlind DWT Based Multiplicative SVD Watermarking Algorithm.1 - Level DWT is applied to the red component of the RGB planes and SVD is applied to embed the watermark into the cover image. Different attacks such as Salt and Pepper Noise, Speckle Noise are carried out to check the robustness of the algorithm.

3. Concepts

3.1. Discrete Wavelet Transformation

Discrete wave transformation relies on little waves of restricted length and ranging frequency. This can be a frequency domain technique that during within which the first of all the duvet image is reworked into the frequency domain and so its frequency coefficients are changed in accordance with the reworked coefficients of the watermark and watermarked image is obtained which is incredibly far more strong. DWT rotten image hierarchically, providing each abstraction and frequency description of the image. It decomposes a picture in primarily 3 abstraction directions, i.e. horizontal, vertical and diagonal in result separating into four completely different parts, namely LL, LH, HL and HH. Here the primary letter refers to applying either low pass frequency operation or high pass frequency operations to the rows and also the second refers to the filter applied to the columns of the duvet image. LL level is that the lowest resolution level, that consists of the approximation a part of the duvet image and rests 3 levels, i.e., LH, HL, HH offer the elaborated information of the duvet image.

3.2 Singular value Decomposition

Singular price Decomposition remodel could be a algebra remodel that is employed for factorisation of a true or complicated matrix with varied application in numerous fields of image process. As a digital image, may be depicted during a matrix kind with its entries giving the intensity price of every picture element within the image, SVD of a picture M with dimension in mxm is given by.

$$M=USV^T \quad (1)$$

Where, U and V area unit orthogonal matrices and S called square matrix could be a square matrix carrying non-negative singular values of matrix M. The columns of U and V area unit decision left and right singular vectors of M, severally. They essentially specify the pure mathematics details of the first image. Left square matrix, i.e. U represents the horizontal details and right square matrix, i.e., V represents the vertical details of the first image. The diagonal price of Matrix S is organized in decreasing order that signifies that importance of the entries is decreasing from the primary singular price for the last one, this feature is utilized in SVD based mostly compression techniques. [10]

There are two main properties of SVD to use in digital watermarking theme.

- Little Variation in singular values doesn't have an effect on the standard of image and
- Singular Values of a picture have high stability so; they don't amendment once numerous attacks.

3.3 Alpha Blending

In Digital Watermarking, the Alpha mixing Technique is used for embedding watermark into the quilt image and extracting watermark from the watermarked image exploitation the below equations, [12].

For Watermarking Embedding,

$$WMI=k^* (LL1) +q^* (WM1) \quad (2)$$

For Watermarking Extraction,

$$RW= (WMI-k^*LL1) /q \quad (3)$$

Where, WMI=Watermarked Image, LL1=Frequency Approximation of the initial Image, WM1=Watermark Image, RW=Extracted Watermark Image and k, Q ar the scaling factors of the initial image and watermark severally.

3.4 Arnold Transformation

Arnold transformation is employed to scramble the watermark image. Arnold transformation is exhibit within the analysis of Arnold and also the random theory, that is additionally referred to as face transformation. For N*N image, Arnold transformation is defined as

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 1 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} \bmod(N) \quad (4)$$

Where x, y ar the coordinates of the watermark image and x', y' ar the coordinates when scrambling and N is the size of the watermark image. The time of restoring a watermark image when scrambling by exploitation Arnold transform is rising with increasing the image size [6].

3.5 YCbCr Color house

YCbCr may be a family of color house used as a neighborhood of the colour image pipeline in video and photography system.Y is that the luma element that shows the brightness and Cb and Cr are blue distinction and red distinction Chroma parts. YCbCr isn't Associate in Nursing absolute color space; rather, it's some way of secret writing

RGB information. RGB to YCbCr conversion is obtained from the subsequent equations

$$Y = 0.299R + 0.587G + 0.114B$$
$$Cb = 0.596R - 0.272G - 0.321B$$
$$Cr = 0.212R - 0.532G - 0.311B$$

4. Proposed Work

The algorithmic rule planned here may be a Non-Blind Digital Watermarking wherever there's a desire of the quilt image for the watermark extraction.

4.1 Watermark Embedding

- Browse RGB Color the quilt image
- Convert RGB Color Image into YCbCr every color house
- choose by Color channel and apply 4-level DWT to subdivide the image into LL4, LH4, HL4 and HH4
- Choose HH4 sub-band and apply SVD to it sub band, ensuing copper, CS, CV.
- Browse Color watermark image
- Extract R Channel from RGB Color Watermark
- Apply Arnold Transformation to Scramble the R Color Channel.
- Apply 3-level DWT on the disorganized R Channel to divide the image into WLL3, WLH3, WHL3 and WHH3
- choose WHH3 sub band and apply SVD to it sub band, ensuing Chinese, WS, WV
- Infix watermark to the quilt image exploitation following alpha mixing equation
- SNEW= atomic number 55 *k+ letter*WS wherever k and q ar scaling issue
- S= CU* SNEW*CV'
- Apply inverse 4-Level DWT on S to get Y Channel Watermarked Image
- Combine Y, Cb and metal color channels to create RGB Color house watermarked image

4.2 Watermark Extraction

- Read the quilt image and Watermarked Image a pair of.
- Convert the quilt image and Watermarked Image From RGB Color house to YCbCr Color house
- Apply 4-Level DWT on Y Channel of the quilt image to sub divide the quilt image into HLL4,HLH4,HHL4 and HHH4
- Apply 4-Level DWT on Y Channel of Watermarked Image to subdivide the Watermarked Image into WMLL4, WMLH4, WMHL4 and WMHH4
- Read Color Watermark Image
- Extract R,G and B Channel from RGB Color watermark Image
- Apply Arnold Transformation to Scramble the R Color Channel.
- Apply three level DWT on disorganized R channel to divide the it into WLL3, WLH3, WHL3 and WHH3
- Choose WHH3 sub band and apply SVD to it sub band, ensuing Chinese, WS, WV
- Choose a HHH4 sub - band and apply SVD to it sub band, ensuing copper, CS, CV
- Choose WMHH3 sub-band and apply SVD to it sub band, ensuing WMU, WMS, WMV
- Extract watermark exploitation following alpha mixing equation
- SNEW= (WMS–q* CS) /k
- S= WU * SNEW* WV'
- Apply Inverse 3-Level DWT on S
- Apply Anti-Arnold Transformation to unscramble the image extracted from Step15
- Combine R, G and B Color Channel to urge the RGB Color Watermark

5. Experimental Result

In this section, experimental results of the projected methodology square measure bestowed The performance is evaluated victimisation Peak Signal to Noise quantitative relation (PSNR) and Normalized Cross-Correlation (NC). The Standard RGB color images (Lena and Pepper) of size 512x512 are used as the cover image and RGB color image of size 256x256 is used as the watermark image. The cover images and watermark image are shown in figure 1. Two major tests, imperceptibility and robustness are carried out with varying values of scaling factor k and q and results are compared with other existing watermark algorithms

Figure 1: Standard Test and Watermark Image (a) Pepper (b) Lena (c) Watermark

5.1 Imperceptibility Test

Imperceptibility is live of transparency and is measured via performance measures sort of a peak signal to noise magnitude relation (PSNR) and Mean sq. Error (MSE). the height signal to noise magnitude relation (PSNR) is usually used as a measure for the physical property of a watermarked image victimisation performance lives. If W is that the original image and W' is changed image, then PSNR is calculated as

$$PSNR_{dB} = 20 \times \log_{10}\left(\frac{MAX}{\sqrt{MSE}}\right) \quad (6)$$

Where MSE= Mean square Error is given by

$$MSE = \frac{1}{m \times n}\sum_{k=n}^{m}\sum_{l=1}^{n}\left(f(k,l) = f'(k,l)\right)^2 \quad (7)$$

Where, f (k, l) is host image and f '(k, l) is watermarked image to determine the optimum value of k and q, both are varied from 0.01 to 0.90 and best value of PSNR, MSE and NC are recorded at k=0. 3 and q=0. 9. The Table 1 shows the recorded value of PSNR for Lena and Pepper.

Table 1: PSNR and MSE (The cover image vs. Watermarked Image) for Pepper and Lena with q=0. 3 and k=0. 9

Image	MSE	PSNR(dB)	NC
Pepper	0.98828	48.1819	0.9999
Lena	1.3015	47.9971	0.9999

a) (b)

Figure 2 below shows the watermarked Pepper image and Lena image

5.2 Robustness Test

To test the lustiness of the projected rule, totally different geometric attacks were performed on the watermarked image and watermark was extracted. lustiness of image was tested by comparison the similarity of extracting a watermark image with the initial watermark image. Similarity of watermarks were meted out on the premise of normalized cross correlation (NC).

$$NC = \frac{\sum\sum[W(u,v)W'(u,v)]}{\sqrt{\sum\sum W(u,v)^2}\sqrt{\sum\sum W'(u,v)^2}} \quad (8)$$

Table 2: NC (Original watermark Image vs. Extracted watermark) for Pepper and Lena with q=0.3 and k=0.9

Attacks	Pepper	Lena
JPEG Compression 10%	0.9998	0.9999
JPEG Compression 50%	0.9999	0.9999
Rotation 5 Degree	0.9999	0.9999
Rotation 45 Degree	0.9999	0.9999
Rotation 90 Degree	1	1
Normal Blur	0.9998	0.9999
Gaussian Blur	0.9998	0.9998
Motion Blur	0.9998	0.9999
Salt and Pepper (80)	0.9996	0.9996
Gaussian Noise	1	1
Contrast Stretching	1	1
Sharpening	0.997	0.9972
Histogram Equalization	0.9998	0.9999
Gray Scale	1	1
Median Filter	0.9999	0.9999
Mean Filter	0.9998	0.9999
Top Cropping	1	1
Bottom Cropping	1	1
Left Cropping	1	1
Right Cropping	1	1
Center Cropping	1	1

The recorded NC values are close to 1 which depicts high similarity between the original watermark and extracted watermark after different geometric attacks. The different geometric attacked watermarked pepper image is shown in figure 3.The Tar Heel State price of the planned algorithmic rule ascertained to be higher for geometric attacks listed in table five than that of reference algorithmic rule.

The planned algorithmic rule appears to be terribly sturdy for various geometric attacks as compared to the opposite existing watermarking algorithmic rule attributable to the subsequent reasons. The YCbCr Color house is employed rather than RGB Color house as, RGB Color Channel is complicated in describing the colour pattern and has redundant data between every element and ar extremely related . Also, in step with [11], embedding watermarks within the color channels of YCbCr ar additional sturdy and inaudible than RGB Color Channels. The Arnold Transformation is employed as a picture scrambling technique to scramble the watermark image. The image scrambling technique is employed because the pre-processing or post-processing, to rework a purposeful image into insignificant or disordered image so as to boost the facility to resist attacks and successively increase the strength [6]. For embedding watermark image within the cowl image and extraction watermark from watermarked image, Alpha mixing technique is getting used. during this technique, 2 scaling parameters ar opted for watermarking. With, Alpha mixing has 2 scaling factors, we will vary scaling factors for each watermark image and therefore the original image to induce higher results for embedding and extraction of the watermark [12]. during this paper, four Level DWT is administrated for the quilt image and three Level DWT for watermark image.The higher the DWT Level, the upper are the strength of the watermarked image [10].

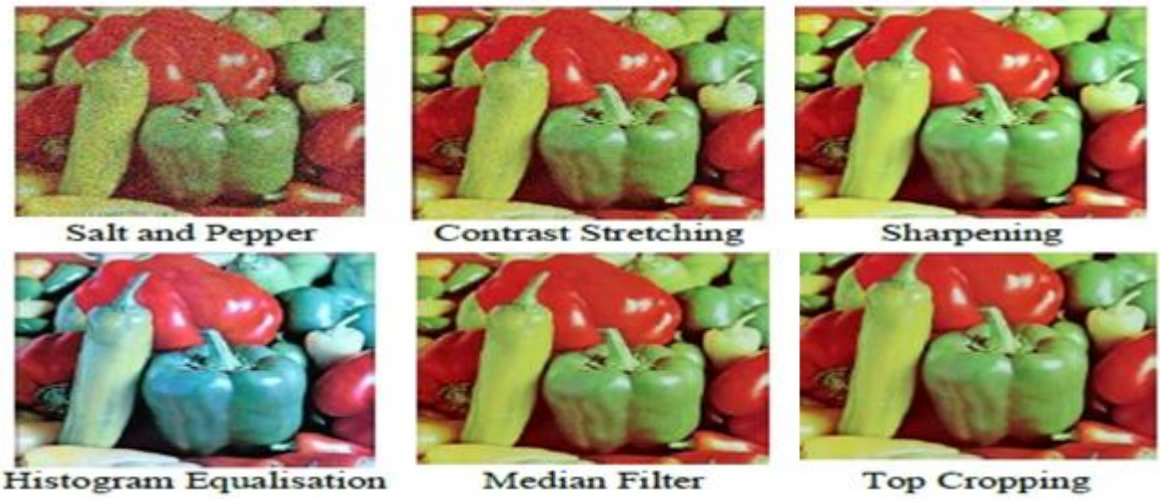

Fig.3. Geometric attacked Pepper Watermarked Images

5.3 Comparison with existing Algorithms

For Comparison, the performance measures recorded for proposed algorithm were compared with performance measures of 3 other existing algorithms. The same cover image and watermark that was used by comparing algorithm was used to compare the performance measures.

The NC value of the proposed algorithm observed to be better for geometric attacks listed in table 3 than that of reference algorithm.

The proposed algorithm seems to be very robust for different geometric attacks as compared to the other existing watermarking algorithm because of the following reasons. The YCbCr Color Space is used instead of RGB Color space as, RGB Color Channel is complex in describing the color pattern and has redundant information between each component and are highly correlated.

Table 3: Comparison of Robustness between Proposed Algorithm and Referenced Algorithm

Attacks/Image	Referenced Algorithm [16]	Proposed Algorithm
Autumn	**NC**	**NC**
Gaussian Noise	0.9797133	0.999962
Salt and Pepper (80)	0.9799189	0.999464
JPEG Compression	0.9795032	0.999943
Median Filter	0.9795671	0.999965
Average Filter	0.9795031	0.999948
Sharpening	0.9800366	0.998923
Rotation	0.9795475	0.999968
Histogram Equalization	0.9798538	0.999929
Right Cropping	0.9766723	0.999997
Left Cropping	0.9763842	0.999997
Top Cropping	0.9732001	0.999997
Bottom Cropping	0.9730237	0.999997
Motion Blur	0.9794848	0.99995

Table 4: Comparison of Robustness between Proposed Algorithm and Referenced Algorithm

Attacks/Image	Referenced Algorithm [15]	Proposed Algorithm
Pepper	NC	NC
AWGN Noise	0.9983	0.99998
JPEG Compression 50 %	0.9999	0.99996
Median Filter	0.9999	0.99994
Gaussian Filter	1	0.99991
Salt and Pepper	0.999	0.99993
Sharpen Image	1	0.99822
Image Rotation 45	0.9997	0.99996
Image Rotation 90	0.9999	1

The NC value of the proposed algorithm observed to be better for geometric attacks listed in table 4 than that of reference algorithm.

Table 5: Comparison of Robustness between Proposed Algorithm and Referenced Algorithm

Attacks/Image	Referenced Algorithm [18]	Proposed Algorithm
Peppers	NC	NC
JPEG 20%	0.9995	0.999839
Crop	0.9992	0.999996
Rotation 45	0.9988	0.999901
Gamma Correction 0.8	0.999	0.999919
Gamma Correction 1.2	0.9991	0.999911
Gaussian Noise	0.985	0.999989
Contrast Adjust	0.9991	0.999994
Salt and Pepper	0.994	0.999594
Sharpen	0.9952	0.996976

The NC value of the proposed algorithm observed to be better for geometric attacks listed in table 5 than that of reference algorithm.

The proposed algorithm seems to be very robust for different geometric attacks as compared to the other existing watermarking algorithm because of the following reasons. The YCbCr Color Space is used instead of RGB Color space as, RGB Color Channel is complex in describing the color pattern and has redundant information between each component and are highly correlated. Also, according to [11], embedding watermarks in the color channels of YCbCr are more robust and imperceptible than RGB Color Channels. The Arnold Transformation is used as an image scrambling technique to scramble the watermark image. The image scrambling technique is used as the pre-processing or post-processing, to transform a meaningful image into meaningless or disordered image in order to enhance the power to resist attacks and in turn increase the robustness

[6]. For embedding watermark image in the cover image and extraction watermark from watermarked image, Alpha blending technique is being used. In this technique, two scaling parameters are opted for watermarking. With, Alpha Blending has two scaling factors, we can vary scaling factors for both watermark image and the original image to get better results for embedding and extraction of the watermark [12]. In this paper, 4 Level DWT is carried out for the cover image and 3 Level DWT for watermark image. The higher the DWT Level, the higher will be the robustness of the watermarked image [10].

6. Conclusion

In this paper, a DWT-SVD based mostly digital watermarking was planned mistreatment Alpha mixing and Arnold Transformation in YCbCr Color house. The planned technique is that the Non-Blind Digital Watermarking wherever there's a requirement of the quilt image for the watermark extraction. With the great worth of PSNR that defines the physical property, we {are able to} say that the quilt image and watermarked image are visually same. And with high worth of NC that defines the hardiness, when totally different geometric attacks, shows the high similarity between the initial watermark and extracted watermark. These readings show that the planned algorithmic program appears to behave a lot of hardiness against totally different geometric attacks as compared to documented algorithms.

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