Hybrid DWT, FFT and SVD based Watermarking Technique for Different wavelet Transforms

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Abstract— The primary function of developing a digital image watermarking (DIW) procedure is to meet both imperceptibility and robustness requirements. Digital watermarking seems as an effective process of protecting multimedia contents such as copyright safeguard and authentication. In this paper, we endorse SVD founded digital watermarking procedure for powerful watermarking of digital pictures for copyright safety. In proposed research, a novel and robust digital watermarking method is introduced in which a mixture of DWT (Discrete Wavelet Transform) and FFT (Fast Fourier Transform) along with SVD (Singular Value Decomposition) is applied. Due to the usage of this combination of 3 techniques in our proposed work, it increases the robustness and imperceptibility of extracted image. One of the vital essential benefits of the proposed idea is the robustness of the system on extensive set of attacks. Analysis and experimental outcome show a lot accelerated effectiveness of the proposed method in evaluation with the pure SVD-established watermarking and the procedure without making use of some wavelet perform. The results are compared with Base Work in which single level DWT-SVD combination is taken for watermarking for copy right security. It is shown through PSNR (Peak signal-to-noise ratio) that it provided a very high imperceptibility. Experimental outcome verify that the proposed system given good quality picture value of watermarked pictures.

Index Terms—Watermarking; embedding; extraction; PSNR

I. INTRODUCTION

Web has appeared as indispensible and accordingly the safety and the privacy issue have come to the fore of the computing fraternity. These issues need to be addressed with utmost urgency and highest level of dedication.

Watermarking addresses the privacy and security issues. Watermarking has helped no longer just in protection but also in resolving numerous copyright and privations issues, which grew to become some of the contentious disorders at the similar time the increase of internet. Watermarking methods can be segregated on the founded of domain based, record based, notion centered and application situated. Domain of watermarking procedure is separated in to 2 materials equivalent to on the founded of spatial domain and other is on the foundation of frequency domain. In spatial area watermarking, watermark is embedded by way of changing the pixels worth of the host image/ video instantly. The major advantages of pixel based ways are that they're conceptually easy and have very low computational complexities and as a consequence are broadly utilized in video watermarking the place real-time performance is a important difficulty.

In frequency area, the watermark is embedded for the robustness of the watermarking mechanism. There are 3 primary approaches of information transmission in frequency area. As SVD FFT and DWT. The principal force supplied by transforming domain procedures is that they are able to take talents of designated houses of alternate domains to handle the boundaries of pixel-based ways or to aid further aspects. In general, transform domain methods require higher computational time. In become domain procedure, the watermark is embedded distributive in overall area of a fashioned data. Host video is first changed into frequency domain by using transformation techniques. The converted area coefficients are then altered to retailer the watermark know-how. The inverse transform is subsequently applied as a way to receive the watermarked video. On the basis of document watermarking may also be apply on picture, textual content, Audio and Video.[1]

A. Types of Watermarking

a) Visible: The watermark is visible that can be a text or a logo. It is used to identify the owner [2].

b) Invisible: The watermark is embedded into the image in such a way that it cannot be seen by human eye. It's used to guard the picture authentication and in addition prevent it from being copied.

B. Watermarking Applications

Watermarking technologies is applied in every digital media whereas security and owner identification is needed [3]

1. Owner Identification

2. Copy Protection

3. Medical Applications

4. Data Authentication

5. Fingerprinting

C. Watermarking Attacks

There are more than a few possible malicious intentional or accidental attacks that a watermarked object is likely to topic to. The availability of broad range of image processing soft ware's made it possible to perform attacks on the robustness of the watermarking systems. The aim of these attacks is prevent the watermark from performing its intended purpose [4].

1. Removal Attack

2. Interference attack

3. Geometric attack

4. Low pass filtering attack

5. Forgery attack

6. Security Attack

7. Protocol Attack

8. Cryptographic attacks

Another example of this type of attack is the oracle attack [5]. Within the oracle attack, a non-watermarked object is created when a public watermark detector system is available. These attacks are just like the attacks utilized in cryptography.

D. Watermarking Techniques

A number of watermarking ways are available. But, these methods are generally found in sound watermarking.

Discrete Wavelet Transform:

The DWT is just something of filters. You will get two filters included, one could be the "wavelet filter", and the other could be the "scaling filter". The wavelet filtration is just a large go filtration, as the scaling filtration is just a low go filter. Determine 2 reveals workflow of DWT. A benefit of DWT over various transforms is it enables great localization equally in time and spatial frequency domain. On account of that of these organic multi-resolution nature, wavelet progress schemes are principally excellent for applications where scalability and tolerable destruction are important. DWT is preferred, because it provides equally a parallel spatial localization and a volume distribute of the watermark within the host picture. The hierarchical house of

the DWT offers the possibility of analyzing an indication at numerous promises and orientations.
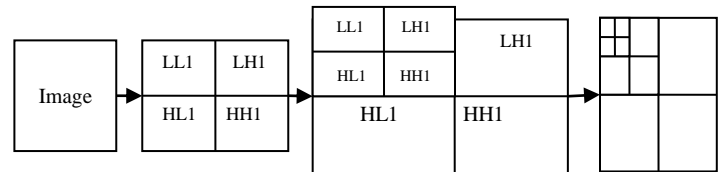

Figure 1.Workflow of DWT

Fast Fourier Transform:

FFT algorithm calculates the DFT of a sequence, or their inverse. Fourier examination turns a signal from their distinctive domain to a representation in the volume domain and vice versa. A FFT computes such transformation with the aid of factorizing the DFT matrix in to a manufactured from quick (frequently zero) factors. An FFT computes the DFT and produces exactly the same impact as examining the DFT classification straight away; probably the most essential huge difference is that the FFT is greatly extra quickly. (In the present presence of round-off problem, many FFT formulations will also be much more specific than examining the DFT classification straight away.[6]

SVD TECHNIQUE:

Surely the SVD is a numerical method which is used for diagonalizable matrices in numerical evaluation. In SVD transformation, a matrix can even be decomposed correct into a multiplication of three matrices which will also be linear algebra system that decomposes a specified matrix into 3 aspect matrices are left singular vectors, set of singular values and proper singular vectors.

SVD watermarking is designed to work on binary. For a picture of N x N pixels and a binary watermark of p pixels, divided the picture into (N/4) x (N/4) non overlapping blocks whose dimension is 4X4 pixels. This is established to come to a decision the positions of embedded blocks for each and every watermark bit. The steps are used in video watermarking are Inserting a watermark, it includes a watermark insertion unit that makes use of ordinary video, watermark and a individual key to get the watermarked video. Watermark insertion unit, It contains the person key, input video and the watermark is passed via a watermark insertion unit which outcome in a watermarked video. Watermark Extraction Unit, It has 2 phases are locating the watermark and recuperating the watermark expertise. Watermark Detection Unit includes an extraction unit to 1st extract the watermark for comparing it with the normal watermark inserted and the output is sure or no relying on whether the watermark is present [7].

II. LITERATURE SURVEY

This section represents some previous work in the area of DIW done in past which I have reviewed.

[8] In this paper video watermarking with 3-level DWT is proposed which is perceptually invisible. Perceptually invisible implies that the watermark is embedded in video in such a manner that the change to the pixels values isn't observed. In proposed work using two special videos and dissimilar logo images and shown how watermark is detected and watermarks not detected. The key key's given to watermark image at some stage in embedding system and while extracting the watermark photo the equal secret key is used.

[9] On this paper proposed a potent audio watermarking scheme based on LWT-DCTSVD, DWT-DCTSVD with exploration of DE optimization and DM quantization. The appealing residences of SVD, LWT/DWT-DCT, DE and quantization procedure make our scheme very robust to more than a few customary signal processing attacks. The experimental end result authenticate that the proposed watermarking scheme has just right imperceptibility too. The comparison results with other SVD-based and similar algorithms indicate the superiority of scheme.

[10] in 2013, here they have reviewed some recent algorithms, proposed a classification based on their intrinsic features, inserting methods and extraction forms. Many watermarking algorithms are reviewed within the literatures which show benefits in systems utilizing WT with SVD. In this paper they also have presented a review of the significant techniques in existence for watermarking those which are employed in copyright protection. Along with these, an introduction to digital watermarking, properties of watermarking and its applications have been presented. In future works, the use of coding and cryptography watermarks will be approached.

[11] In "Wavelet Bases and Decomposition sequence in the DIW" analyzes and compares the performance of unique wavelet bases in the DIW and the result of extraordinary wavelet decomposition series for the DIW embedding centered on the application of wavelet in the DIW. The experiments proved the DIW embedding based on biorthogonal wavelet better than others.

[12] in" A New Digital Watermarking Algorithm Based on IWT and SVD" proposed an new algorithm of digital watermarking based on combining the Non Sub Sampled Contour let Transform and SVD, they first applied the NSCT to the image and extract the low-frequency sub-band of image, and then decompose the low-frequency sub-band of image by SVD, finally embed the watermarking in the decomposed SV. The experiment results show that the new

algorithm has good ability in standing up to geometric attacking, especially rotation attacks.

III. PROPOSED METHODOLOGY

From literature review it has been observed that most of the approaches introduced in past having problems like Low Imperceptibility, Data embedding capacity is less, Quality and More conceptual complexity. These problems have been removed in proposed work.

A new digital watermarking approach based on hybrid DWT_FFT and SVD have been proposed in this work. The proposed algorithm is developed based on 3 stages. Firstly dissimilar types of wavelets are applied on the host image to calculate the four sub-bands of original gray scale image. After that FFT is applied on to the LL sub band of host image. Later on SVD is calculated on LL sub band. To manage as well as to develop the force of the watermark, we have taken a scale factor. At second stage watermarked image is retrieved by embedding SV of LL sub-band of both original gray scale image and watermark image. At the final stage of the algorithm exactly reverse practice is involved to remove watermark image from the watermarked image. The performance of this scheme was estimated with respect to the imperceptibility. It can be seen from the results that the PSNR value of our proposed algorithm is higher. The proposed system provided good imperceptibility and the robustness.
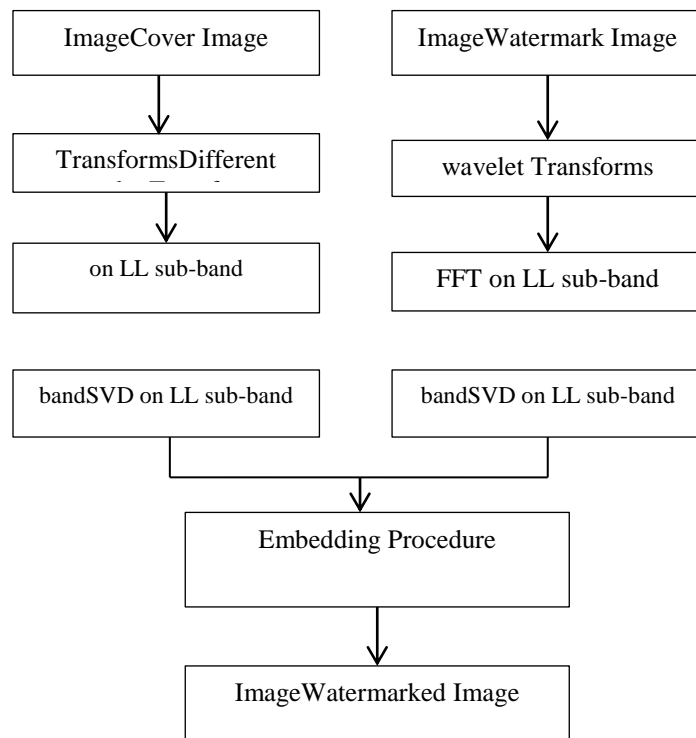

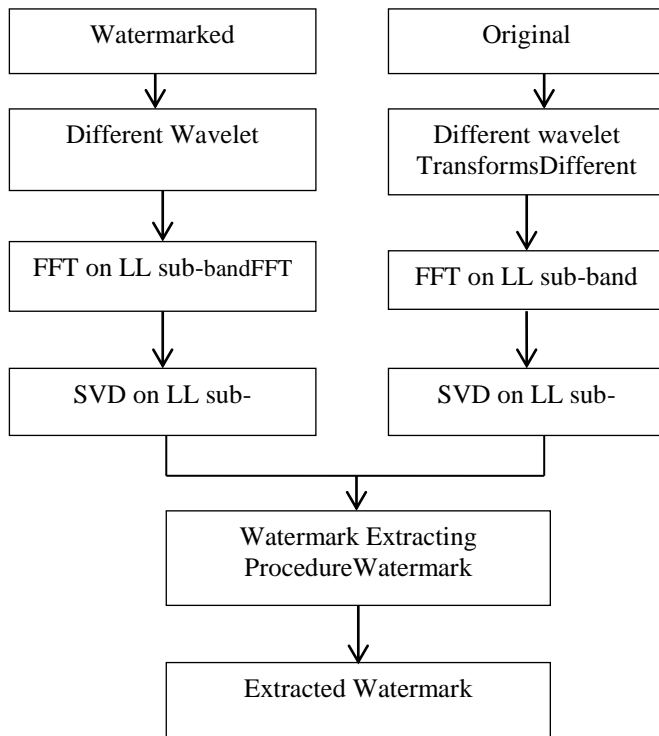Figure 2. Watermark Embedding Procedure

```
Watermarked          Original
     │                  │
     ▼                  ▼
Different Wavelet   Different wavelet
                   TransformsDifferent
     │                  │
     ▼                  ▼
FFT on LL sub-bandFFT   FFT on LL sub-band
     │                  │
     ▼                  ▼
SVD on LL sub-      SVD on LL sub-
     │                  │
     └────────┬─────────┘
              ▼
     Watermark Extracting
      ProcedureWatermark
              │
              ▼
      Extracted Watermark
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Figure 3. Watermark Extracting Pprocedure

A. Proposed Algorithm

The general steps followed in the proposed technique are as follows

1. Digital Watermarking

Step 1 Take the original image (a) and convert it into gray scale image using function-
$$I = rgb2gray(a)$$

Step 2 Now apply dissimilar types of WT to "I" and decompose it into 4 sub bands LL_3, LH_3, HL_3 and HH_3.

Step 3 Apply FFT onto the LL sub band of I.
$$F = FFT2(LLs)$$

Step 4 Apply SVD to the LL sub band i.e.
$$ILL = UISIVI^T$$

Step 5 Now take the watermark picture and apply 3 levels DWT to decompose it into 4 sub bands i.e. LL_3, LH_3, HL_3 and HH_3.

Step 6 Apply FFT onto the LL sub band of I.
$$F = FFT2(LLs)$$

Step 7 Apply SVD to the LL sub band of watermark i.e.

$$WLL = UW \times SW \times VW^T$$

Step 8 Modify the singular values(SVs) (**I_s**) of Ie with the SVs (**W_s**) of watermark i.e.
$$S_n = I_s + \alpha \times W\_s$$
Here α stands for scale factor.

Step 9 Now obtain modified DWT coefficient i.e.
$$IeLL' = U \times S\_n \times V^T$$

Step 10 At last, the watermarked picture "**W***" is obtained by applying inverse three level DWT.

2. Watermark Extraction

Step 1 take the watermarked image and apply the same process to calculate the SVs of watermarked image.

Step 2 Subtract the SVs of watermarked picture i.e. (Wm_s) from SVs of normal picture i.e. (I_s) to get the SVs of watermark image i.e.
$$S_w = (I_s - Wm\_s)/\alpha$$

Step 3 Obtain modified DWT coefficient i.e.
$$W * LL' = U\_w \times S\_w \times V\_w^T$$

Step 4 Get the watermark image by applying inverse DWT_FFT process.

IV. RESULT SIMULATION

This section represents the experimental analysis of the proposed techniques. Numerous experiments had been conducted using MATLAB.

The proposed technique uses mixture of hybrid DWT_FFT along with SVD for embedding the watermark on the Cover Image. The focus of digital watermarking in transform domain is to insert the max possible watermark signal without perceptually affecting image quality, so that the watermark must remain present as imperceptible and robust. There are a no. of watermarking way exists in transform domain. With the help of these techniques issues such as visual quality of the image and robustness can be accommodated, a single transform based watermarking is not able to satisfy diverse criteria desired for watermarking. The specifications reminiscent of imperceptibility with appreciate to payload ability and robustness of watermarking approach contradict each and every different. In order to increase the robustness, the payload should be increased but it decreases the imperceptibility of the image. The incorporation of imperceptibility and robustness simultaneously in watermarking system design is an issue that needs to be addressed. DWT reduces the image data and then watermark is embedded in high frequency sub bands. This will filtered out the unwanted information from the image. Thus whilst to

keep the robustness and imperceptibility of the watermarked picture.

(a)   (b)

(c)   (d)

Figure4. (a) host image, (b) Watermark Image (c)Embedded Image (d) Extracted Image

Table1 Shows the PSNR value of extracted watermark image. PSNR is a ratio most likely applied as the great measurement among the original and the compressed picture. The more PSNR, the improved quality of reconstructed or compressed image. The results of proposed algorithm gives the more PSNR values so the better quality of image.

Table2. Shows MSE Values of Base & Propose Algorithm. For the realistic purposes, MSE makes it possible for researchers to evaluate the "actual" pixel values of long-established knowledge with the degraded picture. As understood by using the identify, MSE represents the natural of squares of the "errors" between the exact picture and the noisy image. The error can be calculated as the amount by which the values of the original image differ from the degraded image. Minimum value of MSE leads to the higher the quality of picture.

The thought is that the bigger the PSNR, the simpler degraded picture has been   reconstructed to check the real picture and the easier reconstructive algorithm. This would occur because we wish to minimize the MSE between pictures with respect the maximum signal value of the image.

TABLE1. PSNR VALUE OF BASE & PROPOSE ALGORITHM

Wavelet Function	Noise	Base PSNR	Propose PSNR
Haar	No	21.4123	50.0913
Wavelet Function	Salt & Pepper	21.2431	34.0682
Bior 5.5	No	21.4221	50.4864

	Salt & Pepper	21.2229	34.0624
Bior 1.1	No	21.4123	50.0913
	Salt & Pepper	21.2431	34.0682
Sym8	No	21.4120	49.7629
	Salt & Pepper	21.2430	34.0430
Coif5	No	21.4126	49.4620
	Salt & Pepper	21.2434	34.0349

TABLE2. MSE VALUE OF BASE & PROPOSE ALGORITHM WITHOUT NOISE

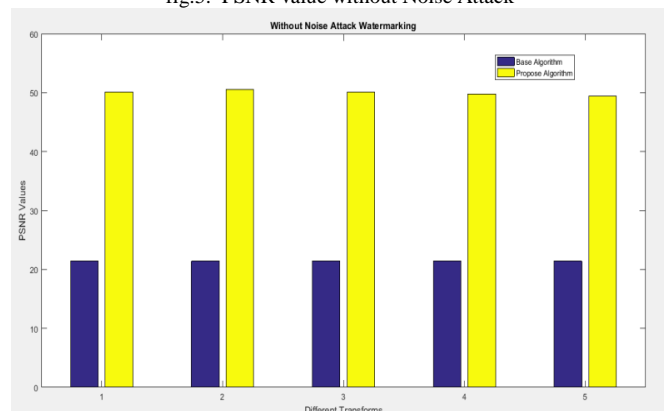| Wavelet Function	Base MSE	Propose MSE
Haar	0.0072	0.0031
Bior 5.5	0.0070	0.0030
Bior 1.1	0.0072	0.0031
Sym8	0.0071	0.0032
Coif5	0.0075	0.0034

fig.5. PSNR value without Noise Attack
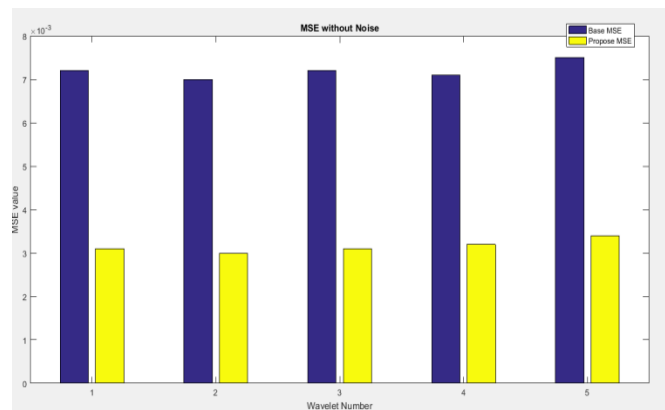

Figure 6. PSNR value with Noise Attack

Figure7. MSE value with Noise Attack

CONCLUSION

The proposed way uses the hybrid DWT-FFT technique along with SVD technique for embedding the watermark on

the Cover Image and follows the reverse scheme to extract the watermark picture. The proposed work is able to achieve moderate robustness, high imperceptibility with reduced amount of data to be processed. A no. of experiments have been taken and Analysis is done based on experimental results which shows improved performance of the proposed method when compared with the Single level DWT-SVD centered watermarking offered in Base procedure. PSNR value generated from proposed algorithm is much higher than base algorithm which assures the enhanced value of images. The grouping of 3 methods hybrid DWT-FFT along with SVD, introduced in proposed method is the reason behind the better performance, good imperceptibility and enhanced quality of image.

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