Implementation of Invisible Digital Watermarking Technique for Copyright Protection using DWT-SVD and DCT

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***Abstract*—*The digital watermarking is a process of hiding an information in multimedia for copyright protection. Where, one data is hidden inside another data. We implement the watermarking algorithm in frequency domain by using a combination of DWT (Discrete Wavelet Transform) and SVD (Singular Value Decomposition) with DCT (Discrete Cosine Transform) algorithms. In which the performance analysis of an invisible watermarking can be measured with comparison of MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio) with respect to the embedded and extracted images respectively. Here, the invisible watermarking is used to protect copyrights of multimedia contents. The invisible watermarks are the technologies which could solve the problem of copyright protection. Which is required for ownership identification as well as the hidden information can also be identified.*

***Keywords*— DWT(Discrete Wavelet Transform) and SVD (Singular Value Decomposition) based transform, DCT (Discrete Cosine Transform), MSE (Mean Square Error), PSNR (Peak Signal Noise Ratio).**

I. INTRODUCTION

Digital watermarking is a technique of hiding one data with other data. Where, the method of hiding data is invisible. In case of DWT (Discrete Wavelet Transform) watermarking technique, decomposition of the original image is done to embed the watermark and in case of DWT-SVD watermarking technique, firstly original image is decomposed according to DWT and then watermark is embedded in singular values obtained by applying SVD (Singular Value Decomposition). Where, theDCT(Discrete Cosine Transform) helps to separate the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality).Here, the frequency domain analysis is used for invisible watermarking. Where, the watermark is embedded after taking image transforms, because the frequency domain methods are more robust than the spatial domain techniques.

II. COPYRIGHT PROTECTION

Copyright protection is used to claim the ownership of an designed data, which may be image, audio or video. The copyright protection plays necessary role for protection of data. Hence, the concept of invisible watermarking is used for copyright protection. The digital watermarking technique is one of the process to avoid illegal copying of multimedia data. The protection of multimedia information becomes more and more important. So, the digital watermarking is mostly used for copyright/piracy protection [1].

III. INVISIBLE WATERMARKING TECHNIQUE

The watermark which is invisible i.e. known as invisible watermarking. Such watermarking is very much secure for copyright protection. The digital watermark is embedded in to an image just like a code. To protectillegal access basically such invisible digital watermark technique is used. The invisible watermark is used to maintain the ownership, authenticity of the original data like audio, images, video or even text. Where, the digitalwatermarking provides copyright protection of data [5]. The invisible watermarking is a process of embedding information into a digital data (Such as; Image, audio and video) which is difficult to remove.In thetransform domain (DWT, DCT, and DWT-SVD etc.) are more robust tovarious attacks while the computational complexity is greater than the spatial domain transform [6].

DWT-SVD based transform:

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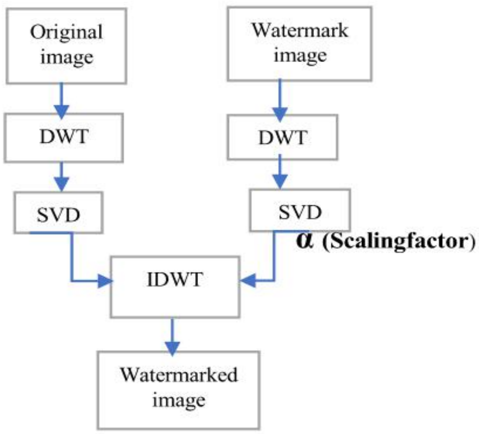

Fig.1: Watermark Embedding Process

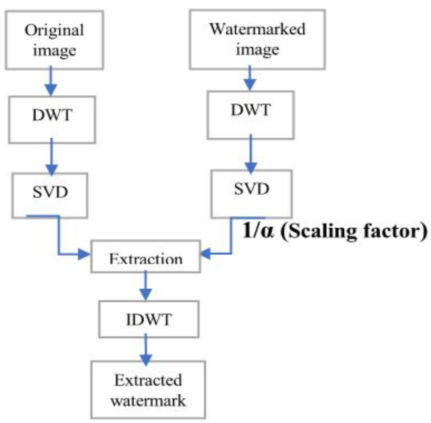

Fig.2: Watermark Extracted Process

DCT based transform:

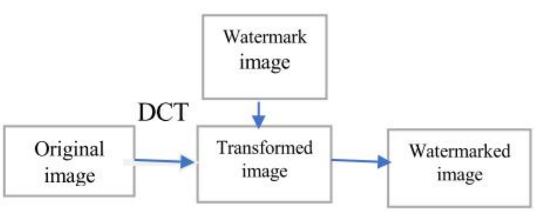

Fig.3.Watermark Embedding Process

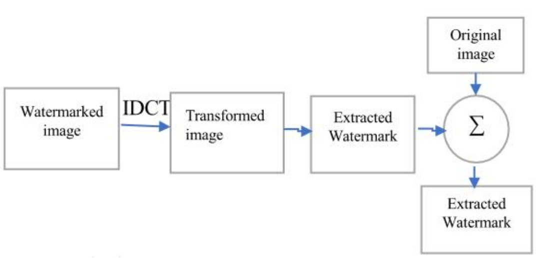

Fig.4: Watermark Extracted Process

IV. PROPOSED SCHEME

Here, the proposed scheme can be explained as follows;

DWT-SVD based transform: A hybrid image watermarking technique based on DWT and SVD has been presented where the watermark is embedded on the singular values of the cover image's DWT sub bands [2].Such a technique is known as hybrid watermarking algorithm.

DWT (Discrete Wavelet)transform:The DWT based transform-domain watermarking techniques are generally more effective in terms of the imperceptibility and robustness of digital watermarking algorithms . The DWT technique is proposed which performs greater robustness to common signal distortions. The advantage of the wavelet-based technique lies in the method used to insert the watermark in low frequency band using blending(Invisible) technique. In case of DWT the Performance could be obtained by increasing the level of DWT [7].The DWT in one dimensional signal is divided in two parts one is low frequency part and another is high frequency part. Next 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 information of the signal. The decomposition in DWT (Discrete Wavelet Transform) on an image divides into four parts of approximation image such as; (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) for detail components [9].

Singular Value Decomposition: The singular value decomposition (SVD) is a factorization of a real or complex matrix, with many useful applications in signal processing and statistics. The fundamental properties of SVD from the viewpoint in the field of image processing applications are: the singular values(SVs) of an image have very good stability, i.e. when a small perturbation is added to an image whose SVs do not change significantly; and ii) SVs represent intrinsic algebraic image properties [4].Here, an image can be represented as a matrix of positive scalar values. The SVD for any image let, A of size m×m is a factorization of the form given by A=USVT, where U and V are orthogonal matrices in which columns of U are left singular vectors of image A. S is a diagonal matrix of singular values in decreasing order. The basic idea behind SVD technique of watermarking is to find SVD of image and the altering the singular value to embed the watermark. In digital watermarking schemes, SVD is used due to its main properties: 1) A small agitation added in the image, doesnot cause large variation in its singular values 2) The

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singular value represents intrinsic algebraic image properties [5].

DCT (Discrete Cosine Transform): The discrete cosine transform (DCT) helps separate the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality). The DCT is like the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain. The DCT is performed on an N × N square matrix of pixel values and it yields an N × N matrix of frequency coefficients. Here, N most often equals 8 because a larger block, though would probably give better compression, often takes a great deal of time to perform DCT calculations; creating an unreasonable tradeoff. As, a result, DCT implementations typically break the image down in to more manageable 8 × 8 blocks. -Here, an image into non-overlapping blocks where (8 x 8) blocks are commonly used and applies DCT to each block. This will divide an image into three main regions such as; low frequencies sub-band (FL), middle frequencies sub-band (FM) and high frequencies sub-band (FH) which makes it easier to select the band in which the watermark is to be inserted. Many studies indicate that the middle frequency bands are commonly chosen, because embedding the watermark in a middle frequency band does not scatter the watermark information to most visual important parts of the image. The remaining steps involves embedding the watermark by modifying the selected coefficients and finally applying inverse DCT transform on each watermark image, original image, transformed image,watermarked Image, extracted watermark, Original Image.Watermark is embedded into an image by modifying the coefficients of the middle frequency sub-band, this is done so that the visibility of the image will not be affected, and the watermark will not be removed by compression [3].

V. EXPERIMENTAL RESULTS AND ANALYSIS

The above procedure has been implemented using the DWT-SVD on two color images and DCT transform on two gray scale images in MATLAB and the results are tested respectively. Where, one is the original image and another one is the watermark image. For DWT-SVD based transform the original color image (5), watermark color image (6),watermarked image (7), extracted watermark image (8) and similarly, for DCT based transform the original color image and watermark color image both are converted in to gray scale image then the watermark image can be embedded and extracted. So, for DCT original color image(9), original watermark image (10), Gray scale watermark image(11), Gray scale watermarked image (12), Extracted watermark image(13). **Results:**

i) DWT-SVD on color image

Fig.5: Original image

Fig.6.Watermarkimage

Fig.7: Watermarked image

Fig.8: Extractedimage

ii) DCT on gray scale image

Fig.9: Original image

Fig.10:Watermark image

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Fig.11:Gray scalewatermark image

Fig.12: Gray scale watermarked image

Fig.13: Extracted watermark

VI. COMPARISONS (Comparing of different % of embedding watermark)

After embedding the watermark image in to an original image there is a variation of characteristics of the final watermarked image. According to the addition of % of watermark we obtain different values of PSNR (Peak signal to noise ratio) and MSE (Mean square error). For the restoration result that requires a measurement of image quality.

Here, different value of watermark can be embedded and extracted in both the DWT-SVD and DCT based transforms.Hence, there are two methods which are commonly used for this purpose. Such as; Mean-squared error and Peak signal to noise ratio.

MSE (Mean square error): The mean square error (MSE) is the error or difference between the original image and watermarked image. Let us, consider that the original image is g(x, y) and the watermarked image is g^(x,y) then the MSE can be calculated as;

eMSE$=1/MN \sum_{n=1}^{M} \sum_{m=1}^{N} [g^{n,m} - g(n,m)]$^ 2

But, one problem in Mean square error is that it depends strongly on the image intensity scaling.

***PSNR (Peak signal to noise ratio*):** The PSNR is a good measure for comparing restoration results for the same image, but between image comparison of PSNR are meaningless. For example, if one image with 15 dB PSNR may look much better than another image with 30 dB PSNR. The PSNR is measured in decibels(dB). But, PSNR avoids the problem of MSE by scaling the MSE according to the image range.

PSNR=-log (eMSE/S^2)in dB

The DWT-SVD based transform has good imperceptibility on the watermarked image and superior in terms of Peak Signal to Noise Ratio(PSNR) [4].

MSE Extraction: The difference between the error between final watermarked image and extracted watermark image.

PSNR Extraction: The difference between the Peak signal to noise ratio between final watermarked image and extracted watermark image.

Comparison Table:

Table.1: For DWT-SVD based transform

SL.NO.	% of watermark	MSE for embedded	PSNR for embedded (In dB)	MSE for extraction	PSNR for extraction(In dB)
1.	0.089	0.0341	62.837	0.0018	74.1073
2.	0.0008	0.0381	62.355	0.0020	73.2433
3.	0.0689	0.0348	62.749	0.0022	72.3376
4.	0.7	0.0370	62.482	0.0024	71.4064
5.	0.0342	0.0356	62.650	0.002	70.4632

Graphs:

(**For DWT-SVD based transform**)

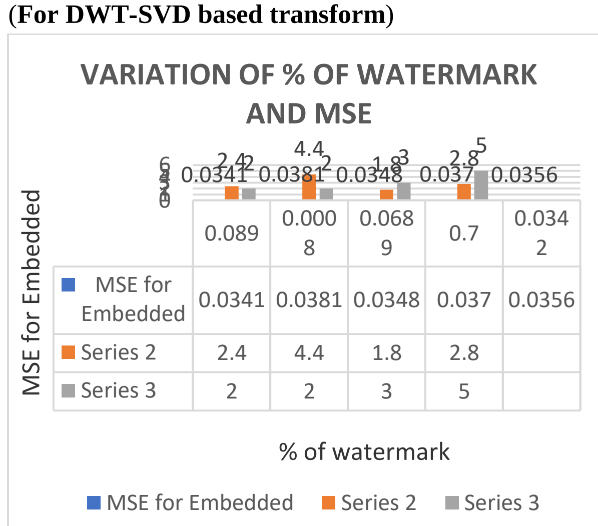

Fig.14: (a) Variation % of watermark and MSE

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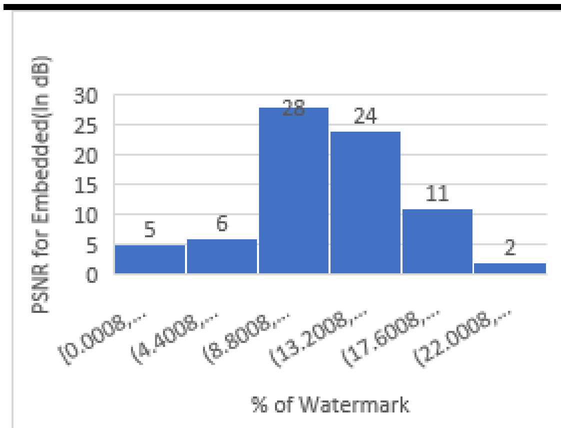
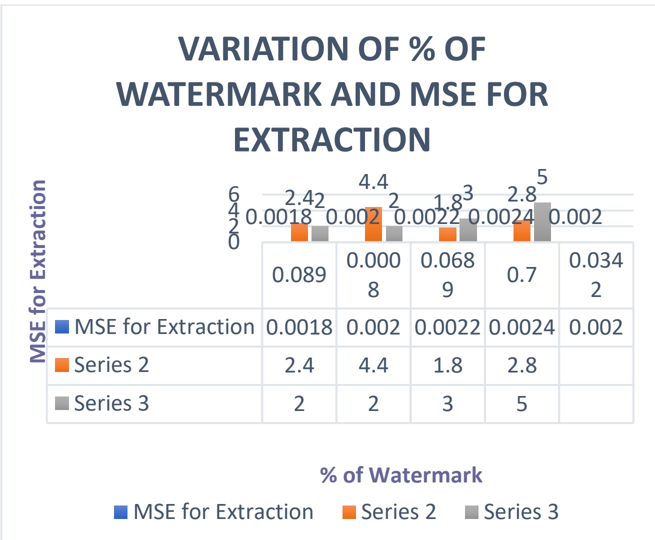
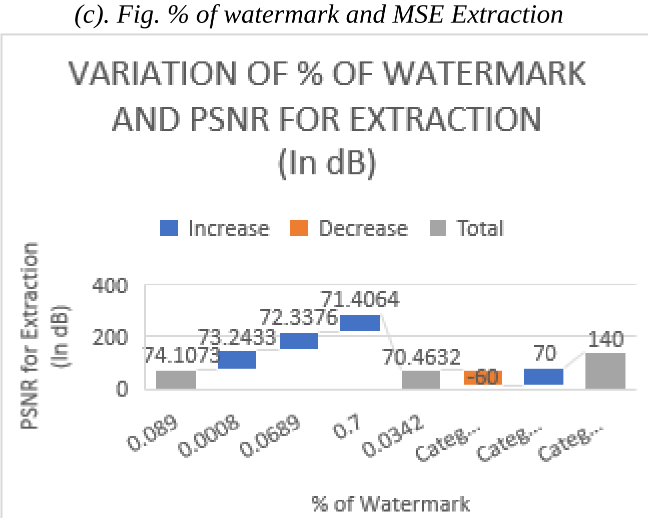


(b) Fig. % of watermark and PSNR (in dB)



(c). Fig. % of watermark and MSE Extraction



(d). Fig. % of watermark and PSNR Extraction (in dB)

Table.2: For DCT based transform (Values from [8])

SL.NO.	% of watermark	MSE for embedded	PSNR for embedded (In dB)	MSE for extraction	PSNR for extraction (In dB)
1.	0.089	0.0437	29.6702	1.9998e+003	77.6418
2.	0.0008	0.0452	29.3405	0.0103	44.0937
3.	0.0689	0.0439	29.6145	1.1906e+003	72.4558
4.	0.7	0.0491	28.5111	1.2618e+005	119.0881
5.	0.0342	0.0449	29.3947	284.6479	58.146

Graphs:

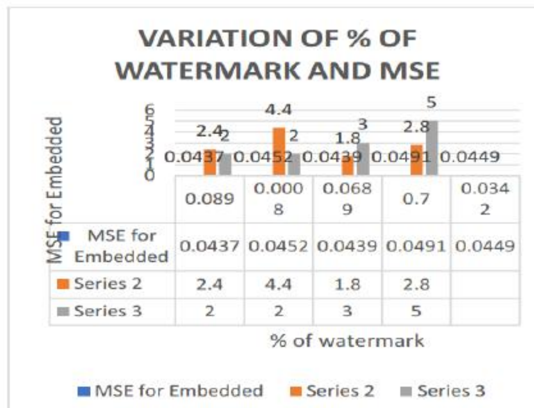
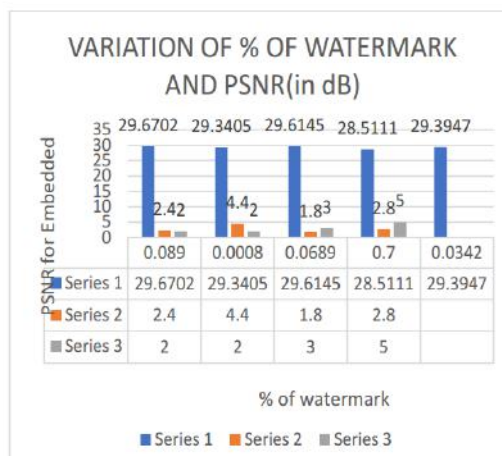
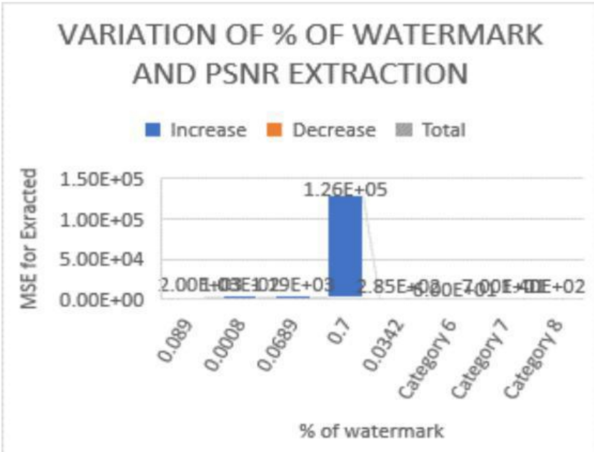


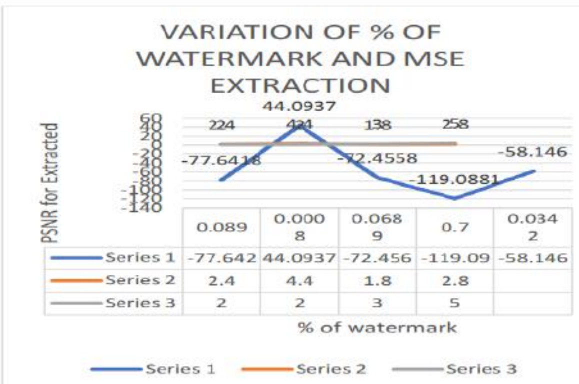
Fig.15 (a) Variation % of watermark and MSE



(b) Fig. % of watermark and PSNR (in dB)



(c). Fig. % of watermark and MSE Extraction



(d). Fig. % of watermark and PSNR Extraction (in dB)

The result what we have got shown in table 1 and 2 related to MSE and PSNR for embedded and extraction in DWT-SVD is improved as compared to DCT. The algorithm DWT-SVD is better than DCT for invisible watermarking.

VII. APPLICATION OF WATERMARKING IN VARIOUS FIELDS

-Television Broadcasting: Broadcast monitoring also watermarking technique is able to track when a specific video is being broadcast by a TV station. Where, information used to identify individual videos which could be embedded in the videos themselves using watermarking, making broadcast monitoring easier.

-Copy control is a very promising application for watermarking. In this application, the watermarking can be used to prevent the illegal copying of songs, images, movies by embedding a watermark in them, that would instruct a watermarking in a compatible DVD or CD writer to not write the song or more because it is an illegal copy.

- The producer of a movie could identify which recipient of the movie was the source of leak. Because the watermarking could be used to reach recipient of every legal copy of a movie by embedding a different watermark.

-Medical applications: For providing authentication and Confidentiality without affecting the medical for secure purpose.

VIII. CONCLUSION

The DWT-SVD based transform get better quality of the invisible watermarking. By combining DWT-SVD approaches for watermarking so that their fusion makes very much secure watermarking technique [10].From the above comparison we found that the DWT-SVD based transform is much better than the DCT based transform. Also, the MSE and PSNR value of DWT-SVD is better than the DCT based transform. Digital watermarking provides owner authentication, Copyright Protection. Digital watermarking tries to hide a message related to the actual content of the digital signal. The simulation results also showing that the watermarking transform method having image quality as well as robust against many common image processing operations by using DWT-SVD based transform in comparison to DCT based transform.

IX. FUTUREWORK

The future work can be implemented on DWT-SVD and DCT based transform on invisible audio and video watermark with comparison of MSE (Mean Square Error) and PSNR (peak Signal to Noise Ratio) with addition of secret key in both audio and video. Using invisible watermarking FFT and LWT will be performed. This work can be extended to watermark an image, audio, video and also use other transform domain techniques individually and measure the various performance parameters. The future watermarking techniques will be equipped with intelligence that reveals the content of image, audio and video.

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