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Image Data Security Using Singular Value Decomposition (SVD)

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Abstract: Several watermarking schemes have been widely used to solve the copyright protection problems of the image. In that very few watermarking schemes have been used for defining the copyrights of color image. We used an effective, robust and imperceptible color image watermarking scheme to resolve the copyright protection problem of color image. For content owners and service providers, protection of digital multimedia content has become an important issue. Watermarking of various approaches for embedding data into multimedia element (basically images, audio, and video).Because of this, Discrete Wavelet Transform (DWT) is many times used in recent watermarking schemes. The combinations of Discrete Wavelet Transformation (DWT) and Singular Value Decomposition (SVD) of Blue channel are used to embed the watermark.

Keywords: Digital Image Watermarking, Discrete Wavelet transform, MSE, PSNR, Singular Value Decomposition.

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I. INTRODUCTION

Watermarking is a system for embedding data (the watermark) into a picture, which can be later removed or distinguished for assortment of purposes including recognizable proof and verification purposes. Watermarking is a vital instrument connected to physical items like bills, papers, piece of clothing names, item pressing. Physical articles can be watermarked utilizing unique colors or inks or amid paper producing. The watermark is avoided view amid ordinary use, just get to be obvious by receiving a unique survey process. E.g. hold the bill up to light. The watermark conveys data about the article in which it is covered up. E.g. Realness of the bill, the trademark of the paper maker. Watermarking can likewise be connected to advanced signs. A watermark might be delicate, semi-delicate, and strong. The necessities for watermarking are straightforwardness, limit, powerful.

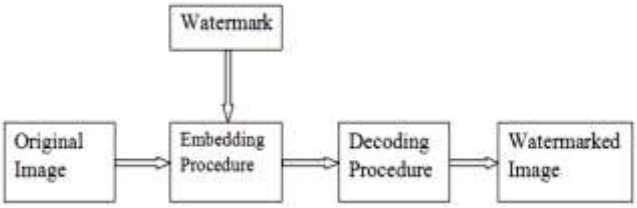

Fig1. An overview of Watermarking Procedure

The method of installing and recovery of watermark from watermarked picture is appeared. Take the first picture on which watermark ought to apply and after that utilization some fitting watermark inserting method utilizing which watermark can securely apply on unique picture. After that the deciphering strategy at the flip side, in which utilizing some interpreting calculation on that picture the watermarked can without much of a stretch acquire. In the mean time some assault may apply on your watermarked picture by some obscure gathering. So pick such watermark implanting system which is vigorous to such assaults.

The term watermark was most likely begun from the German expression "wassermarke". Since the name is most likely given on the grounds that the imprints take after the impacts of water on paper, watermark is of no significance in the making of the imprint. Papers are imagined in China more than thousand years prior. However the principal paper watermark did not show up until 1282,in Italy. By the eighteenth century, watermarks on paper in Europe and America had been utilized as trademarks, to record the made date, or to show the extent of unique sheets. Watermarks are usually utilized on bills these days to abstain from falsifying.

The specific watermarking strategies were powerless to fake assaults was noted by the Craver et al [9]. The technique proposed by Cox et al. can be assaulted by making a fake unique picture and fake watermark that is indistinct from the genuine unique picture and watermark was appeared by them. They adjusted the Cox et al. calculation by making the watermark subject to the first picture to keep the situation. This new plan was less powerless to falsifying and still looked after strength.

A watermarking framework utilizing fractal codes was presented by Bas, Chassery, and Davoine [10] presented. An arrangement guide was made from 8x8 pieces out of the first picture and from the picture's DCT. The watermark was added to the arrangement guide to create a checked picture. Fractal coding in the DCT space performed superior to anything coding in the spatial area. Spatial fractal coding delivered piece antiquities after pressure while the DCT-based watermarking method was vigorous to JPEG pressure.

In watermarking calculations, spatial area and change space systems are utilized. Change area may incorporate DFT, DCT, DWT, DET or SVD. The vast majority of the change space watermarking plans works with DWT. The a standout amongst the most capable system utilized as a part of different applications is SVD. The huge adjustments are made to the host picture either in spatial or change area are because of the vigor.

II. DISCRETE WAVELET TRANSFORM (DWT)

Discrete wavelet transform is a multi-resolution decomposition of a signal. The low pass filter applied along a certain direction extracts the low frequency (approximation) coefficients of a signal. On the other hand, the high pass filter extracts the high frequency (detail) coefficients of a signal.

The two-dimensional wavelet transform that describe can be seen as a one-dimensional wavelet transforms along the x and y axes. Mathematically the wavelet transform is convolution operation, which is equivalent to pass the pixel values of an image through a low pass and high pass filters. The image is represented by two dimensional signal functions; wavelet transform decomposes the image into four frequency bands, namely, the LL1, HL1, LH1 and HH1 bands. H and L denote the high pass and low pass filters respectively.

To obtained the Image LL, low pass filtering in both row and column directions is used. The detailed images, LH, HL and HH contain the high frequency components. The sub Â band LL1 alone is further decomposed and critically sampled to obtain the next level of wavelet coefficients. Similarly LL2 will be used to obtain further decomposition. By decomposing the approximated image at each level into four sub-images forms the pyramidal image tree. This result in two-level wavelet decomposition of image, the two-level DWT decomposition is shown in Figure.

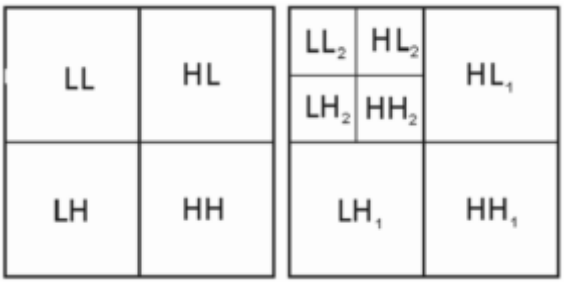

Fig2:-Scale and 2-Scale2 Dimensional Discrete Wavelet Transform.

III. SINGULAR VALUE DECOMPOSITION (SVD)

SVD is the most powerful numeric analysis technique with numerous applications including watermarking. SVD is a special matrix transform. The singular value of image can capture the intrinsic characteristics rather than the visual effects, and its excellent stability prevents big changes of the singular value due to small image disturbance. All these features make SVD widely used in digital watermarking.

In linear algebra, the singular value decomposition (SVD) is factorization of a real or complex matrix, with many useful applications in signal processing and statistics. To solve the many mathematical problems, a linear algebra technique used called as Singular value decomposition. Any image can be considered as a square matrix without loss of generality. So SVD technique can be applied to any kind of images. The SVD belongs to orthogonal transform which decompose the given matrix into three matrices of same size. To decompose the matrix using SVD technique it need not be a square matrix. Let us denote the image as matrix A. The SVD decomposition of matrix A is given using equation,

If A is any N x N matrix, it is possible to find a decomposition of the form,

$$A=US{V^T} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where U is an mxm real or complex unitary matrix and (the conjugate transpose of V) is an nxn real or complex unitary matrix such that,

$$U * U^T = I$$
$$V * V^T = I$$

Where, I represents an Identity matrix and S is the diagonal matrix of order mix having elements Si (i=1, 2, 3, n). The singular values of A are represented by the diagonal elements of S. The columns of U matrix are known as the left singular values of A, and the columns of V are known as the right singular values of A. Such a factorization is called the singular value decomposition of A.

IV. WATERMARK EMBEDDING

This watermarking embeds the monochrome watermark image into color cover image. The color image consists of three channels as Red(R), Green(G) and Blue(B). From these three channels, B channel is used for embedding.

Watermark Embedding Algorithm

The Watermark Embedding Algorithm is given as:-

Input-

The color image I and monochrome watermark W.

Output-

The watermarked color image I'.

1. Separate Red(R), Green (G), and Blue (B) channels from the color image I.
2. Apply one-level DWT on B channel to produce the sub band coefficients {LL, LH, HL, and HH}.
3. Apply SVD on each sub band coefficients to get singular values.
4. Apply inverse SVD using singular values to get modified sub bands.
5. Apply inverse DWT on modified sub band coefficients to produce the watermarked B channel.
6. Transform the R, G and watermarked B channels onto color image.

Watermark Extraction Algorithm

The extraction of watermark is exactly opposite to the watermark embedding process. This is applied to various test images.

The Watermark Extraction Algorithm is given as:-

Input-

The cover color image I, watermarked cover image I' and watermark W.

Output-

The monochrome watermark W

1. Separate R, G and B channels from the color image I.
2. Separate R',G' and B' channels from the watermarked image I'.
3. Apply SVD on watermark to get the singular values.
4. Apply one-level DWT on Band B' channel to produce the sub band coefficients {LL, LH, HL,HH} and {LL',LH',HL',HH'} .

5. Apply SVD on all the sub band coefficients B and B' to produce singular values {LL, LH, HL, HH}.
6. Construct the four watermark images using singular Vectors.
7. Extracted Watermark vectors contain non binary value since the watermark is a monochrome image this vector is optimized by using root mean square value.

V. RESULTS

Watermark embedding results

Fig3: Results of Watermark Embedding

Fig shows the result of watermark embedding. Where colored Lena image is used as a test image and JNTU is used as the logo image i.e. watermark image**.** MSE and PSNR for the logo image is 3.795 and 42.3386 respectively.

Watermark extraction results

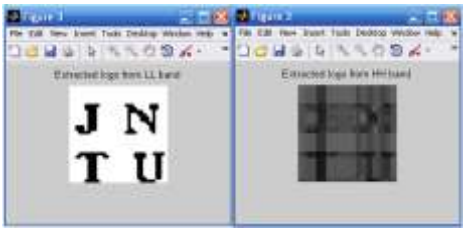

Fig 4a: Extracted logo from LL band

fig4b: extracted logo from HH band

Fig 4c: Extracted logo from LH band

fig4d: extracted logo from HL band

Fig4: Results of Watermark Extraction

Fig shows the results of watermark extraction. Where logo image JNTU is extracted from the Lena cover image. And it also shows the extracted logo from various bands.

VI. CONCLUSIONS

To resolve the copyright protection problem of color image, an effective and imperceptible color image watermarking scheme is used. The watermark embedded into four subband coefficients which is very difficult to remove. For increasing the security, robustness and imperceptibility of the scheme, the combination of DWT and SVD is used.

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