Development of Robust Alpha Blending based Digital Watermarking Technique for Images based on DWT-SVD

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Abstract— In today's techno savvy era, communication becomes digitally. Due to the explosion of World Wide Web and quick growth of high speed Internet, a huge amount of images are easily available and accessible by any person around the globe. This expansion facilitated that each and every person can communicate by distributing and exchanging the digital data. So in digital world editing, manipulation, copying of digital data has become widespread and becoming a serious issue in the present circumstances. So digital watermarking techniques are became a crucial solution for these issues. In this paper we have developed image watermarking model based on DCT, DWT and alpha blending watermarking technique. We embed and extract biometric watermark using the alpha blending technique in low frequency band. This paper illustrates models and modified algorithms for DCT, DWT and alpha blending watermarking techniques. To demonstrate working of the aforementioned model and algorithm, an experimental system is also developed with different value of alpha for different inputs. This paper also describes output of the experimental system with their comparison.

Key words: Digital Watermarking, Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), Alpha Blending, Biometric Watermark

I. INTRODUCTION

In current trends, due to high speed internet, the access, reproduction and transfer of digital image becomes effortless job for everybody. Because of the illegal transfer and duplication of images it becomes necessary to provide valid security to digital images. Moreover, protection against unauthorized copy and distribution is increased which leads the strongest technique to prohibit the distribution and modification of digital images and provides authentication of the owner of the images. As a solution of this, digital watermarking techniques are applied on digital images by using some biometrics parameters such as fingerprint, speech and iris etc. The biometric parameters are "unique" to an individual and no one can be easily altered the digital media[1]–[3]. Digital watermarking technology plays a vital role in avoiding copyright violation and distribution of the images. Digital watermarking is the process of embedding information into digital images. While the embedded information is known as a watermark that can be extracted or detected whenever it is required. A watermark may be a digital signal or pattern or logo which is inserted into digital images [4], [5].

A. Classification of Watermarking Techniques

The watermarking techniques are classified into three major categories which are shown in figure 1.

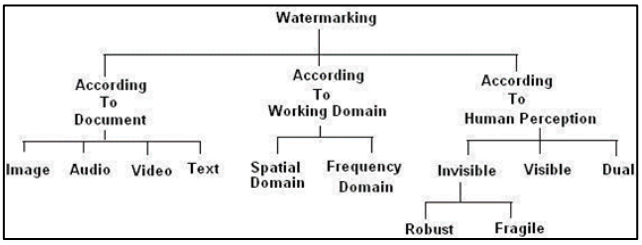


Fig. 1: Classification of watermarking techniques

II. DCT BASED DIGITAL WATERMARKING FOR IMAGES

DCT describes the cover image as coefficients of different cosines frequencies. The different frequency bands of DCT are shown in figure 3.2. By taking 8x8 blocks of input image, the DCT of that is calculated and each block is distorted independently. The DCT transforms a signal from a time domain representation to frequency domain representation. The imperceptibility problems will occur, if watermark embedding is performed into lower frequency coefficients. While watermark is embedded into higher frequency coefficients then watermark algorithm will not resist against image processing attacks (Jagadeesh and Kumar 2014b; Lande, Talbar, and Shinde 2010; Monika Patel and Sajja 2015). Figure 2 Model of DCT based Image Watermarking.

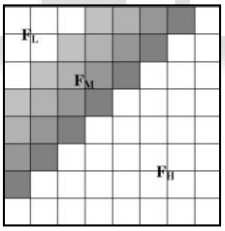


Fig. 2: Different Frequency Band

To embed the watermark in an original image, user has to input cover and watermark images. Before performing embedding procedure, DCT blocks of cover image are generated. During embedding process the watermark bits are added into cover image. After that inverse DCT is applied. As the result of the given model watermarked image is generated. During watermark extraction, user has to provide watermarked image as input for the extracting watermark. Before passing watermarked image into the extracting process DCT blocks are generated for watermarked image. Then watermark bits are extracted from the watermarked image. By getting all extracted watermark bits are the resultant watermark.

III. DWT BASED DIGITAL WATERMARKING FOR IMAGES

Discrete Wavelet transform (DWT) is a mathematical apparatus for hierarchically decomposing an image. Wavelet Transform technique is broadly used in areas such as digital image processing, compression, watermarking etc. This transform proposes the time-frequency representation of a

given signal. Small waves, called wavelets which contain varying frequency and limited duration, are the basis of the transform. The wavelet transform decomposes the image into three spatial directions - horizontal, vertical and diagonal. Hence, wavelets replicate the anisotropic properties of HVS more precisely. At each level of decomposition, the magnitude of DWT coefficients is larger in the lowest bands (LL) and is smaller for other bands (HH, LH, and HL). DWT based techniques set analogy with theoretical model of Human Visual System (HVS).

Here, an image is passed through series of low pass and high pass filters which decompose the image into sub bands of different resolutions. Most of the energy being concentrated in the approximate (LL) sub band having low frequency sub bands; any change in these low frequency sub bands might cause a severe degradation of image. As the human eyes are not sensitive to high frequency sub bands, secret information is embedded in either vertical, horizontal or diagonal (LH, HL or HH respectively) sub bands. Ultimately, we can split the image into four bands denoted by LL, HL, LH and HH. Figure 3.3 and 3.4 shows one level and second level decomposition (Monika Patel, Sajja, and Sheth 2013; Potdar, Song, and Elizabeth 2005).

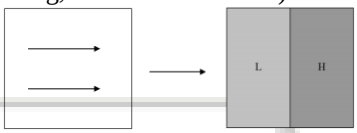


Fig. 3: Horizontal Transform-2 subbands

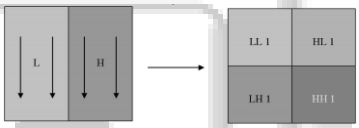


Fig. 4: Vertical Transform-4 subbands

In this model user has to provide original image, watermark image and scaling factor (α) as input for the embedding process. After that find out the wavelet transforms of original image and choose 'haar' wavelet in the high frequency band. During embedding process, embed the watermark coefficient with the highest value wavelet coefficient of original image. Apply inverse DWT to the image and get watermarked image as the result of the given model.

Here value of α must be chosen very carefully. If this value is not proper then it may create the distorted watermarked image, which is easily noticed by everybody. So to keep the invisibility of the watermark in the cover image the value of α is chosen as lower as possible. Therefore it is necessary to choose proper value of α which creates the watermarked image robust and also not create any type of visual effects.

For watermark extraction, user has to provide watermarked image. After that find out the wavelet transforms of watermark as well as watermarked image. After that retrieve the coefficients of the watermark image. Then after apply DWT to retrieve watermark from the watermarked image which is the result of the given model.

IV. SINGULAR VALUE DECOMPOSITION

The singular value decomposition matrix is very useful in computer vision as a decomposition matrix and it is matrix and it is an efficient tool for image transformations. The SVD of given image I in the form of a matrix is defined as

$$I = USV^T \quad \ldots\ldots\ldots (1)$$

Where S is the diagonal matrix which is given as below:

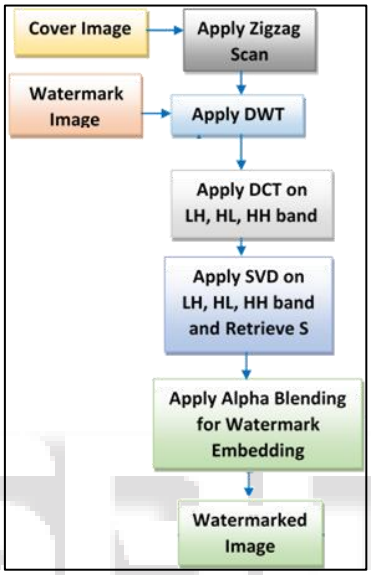
$$S = \begin{bmatrix} S_1 & 0 & . & 0 & 0 \\ 0 & S_2 & . & 0 & 0 \\ . & . & . & . & . \\ 0 & 0 & . & S_{n-1} & 0 \\ 0 & 0 & . & 0 & S_n \end{bmatrix}$$

While U and V are orthogonal matrices which are given as below:

$$U^TU = V^TV = 1 \quad \ldots\ldots\ldots\ldots (2)$$

V. GENERIC ARCHITECTURE OF THE PROPOSED SYSTEM

A. Proposed Watermark Embedding Algorithm



- Step 1: Take cover image and watermark as inputs.
- Step 2: After that convert the inputted cover image into zigzag pattern to get new cover image.
- Step 3: Apply first level DWT on the new cover image to decompose it into LL, HL, LH and HH sub bands.
- Step 4: Apply DCT on all high bands such as LH, HL and HH of new cover image.
- Step 5: Then perform SVD on all high bands such as LH, HL and HH of new cover image and retrieve S value from these bands.
- Step 6: Apply DWT on the watermark image to decompose it into LL, HL, LH and HH sub bands.
- Step 7: After that perform DCT on all high bands such as LH, HL and HH of watermark image.
- Step 8: Then SVD is performed on all high bands of watermark image to retrieve S value from these bands.
- Step 9: Now apply alpha blending technique using following equation to get new higher band of cover image

  $$WI = CI + (alpha * W)$$

  Where WI = is watermarked image
  CI = is diagonal matrix of cover image
  W = is diagonal matrix of watermark image
- Step 10: Then construct the new modified SVD value of all high bands such as LH, HL and HH.
- Step 11: Apply inverse DCT and DWT respectively on all high bands such as LH, HL and HH.
- Step 12: Apply inverse zigzag scan on watermarked image. So the resultant image is watermarked image.

B. Proposed Watermark Extraction Algorithm

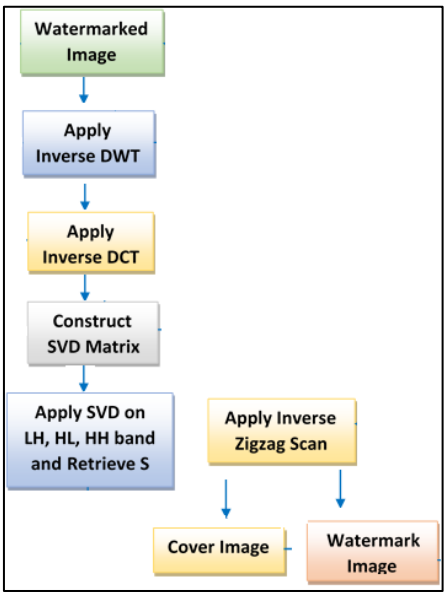


Fig. 5: Proposed Watermark Extraction Algorithm

- Step 1: Input watermarked image.
- Step 2: Apply first level DWT on the watermarked image to retrieve LL, HL, LH and HH sub bands.
- Step 3: Apply DCT on all high bands such as LH, HL and HH of watermarked image.
- Step 5: Then perform SVD on all high bands such as LH, HL and HH of watermarked image and retrieve S value from these bands.
- Step 6: Now apply alpha blending technique using following equation to get watermark.
- W = (WI – CI) / alpha
- Where WI = watermarked image
- CI = diagonal matrix of watermarked image
- W = extracted watermark
- Step 10: Then construct the new modified SVD value of all high bands such as LH, HL and HH.
- Step 11: Apply inverse DCT and DWT respectively on all high bands such as LH, HL and HH of watermarked image to retrieve watermark.

VI. RESULTS

Here these watermarking techniques are implemented by using standard images such as 'Lena.bmp' and 'house.tif' which are taken from the Internet. In DWT, value of scaling factor is taken between 0.2 To 0.9. Here 0.8 is taken as an alpha for retrieving the results. By using this value, user will gain more robust result. The obtained results by considering the several well-known attack are shown in table 1.

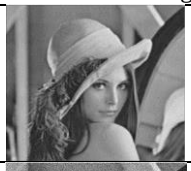
Attack	Watermarked Image	Result
Blurred		PSNR: 29.9405 CC: 0.9312
Gaussian		PSNR: 32.7742 CC: 0.9516
Median		PSNR: 32.6212 CC: 0.9499
Motion blurred		PSNR: 34.0404 CC: 0.958
Rotation		PSNR: 31.795 CC: 0.9459
Salt and pepper		PSNR: 29.2361 CC: 0.9254
Attack	Watermarked Image	Result
Blurred		PSNR: 25.1409 CC: 0.8768
Gaussian		PSNR: 33.4187 CC: 0.9558
Median		PSNR: 36.1184 CC: 0.9674
Motion blurred		PSNR: 30.4457 CC: 0.935
Rotation		PSNR: 25.5884 CC: 0.8833
Salt and pepper		PSNR: 29.255 CC: 0.9258

Table 1: Well-Known Attack

VII. CONCLUSION

This research paper shows the comparison of different attack on watermarking techniques for images. To provide security of digital images, fingerprint is taken as watermark. This paper also demonstrated that frequency domain is a better

way for watermarking. Here alpha blending formula is used to embed and extract watermark which provides more robustness as well as higher visual impact. Moreover, DCT and DWT watermarking are developed for gray scale images. Compare to DCT, Discrete Wavelet transform understands the HVS (Human Visual System) more closely than the DCT. By observing the results it has been concluded that alpha blending technique provides higher PSNR value. Also the watermarked image obtained by alpha blending technique is more robust compare to all other methods.

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