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A SURVEY ON THE COMPARISON ON DCT, DWT AND SVD WATERMARKING TECHNIQUES

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ABSTRACT
Watermarking is a technique that is used in copyright–protection for valuable medias and it belongs to the information hiding field. The main aim of developing watermarking techniques is to protect the copyright of digital media and to maintain the extents of the secret key. Watermarking is measured by four quantities: capacity, security, robustness, and imperceptibility Robustness is one of the crucial important issues in watermarking.This paper aims to present the survey of the comparisonof the techniques in watermarking, which shows that singular value decomposition provides high security and successful recovery of watermark image.

INTRODUCTION
Watermarking is a branch of information hiding which provides a powerful solution for intellectual protection. Digital watermarking is the process that embedding the information in the multimedia files. The information may be an image or audio or video or text. Watermarking is used as a proof of ownership of digital data by embedding copyright statements into the digital media Traditional watermarking techniques often treat the image as a set of pixels rather than a set of objects In order to protect the interest of the content providers, these digital contents can be watermarked. The paper is organized in the following sections. In Section II we describe digital watermarking process. In Section III we identify the main requirements of image watermarking. In Section IV we discuss the main application of watermarking. In Section V we provide a detailed survey of image watermarking techniques. We conclude this paper in section VI where we give some guidelines on developing robust watermarking algorithms.

DIGITAL WATERMARKING TECHNIQUE:
The process of embedding a watermark in a multimedia object is termed as watermarking. Content providers want to embed watermarks in their multimedia objects (digital content) for several reasons like copyright protection, content authentication, tamper detection etc. A digital watermark can be *visible* or *invisible*. A visible watermark typically consists of a conspicuously visible message or a company logo indicating the ownership of the image. A visible watermark typically consists of a conspicuously visible message or a company logo indicating the ownership of the image. Here, the watermark may be a logo or an image which can be proved who is right owner.

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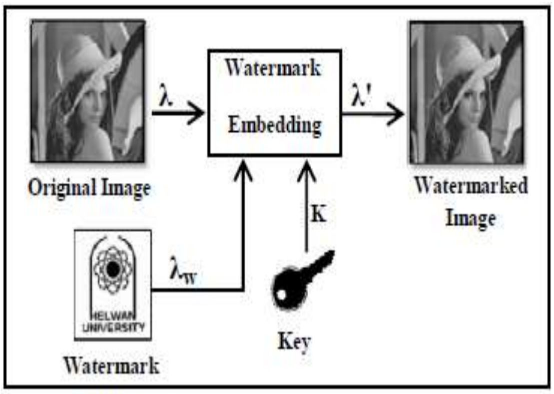

Figure1: Watermark embedding

The digital image watermarking system consist two functions, embedding function, and extracting/detecting function. The embedding function embeds the secret message called watermark into the original image and then the watermarked image is passed onto the internet where it may be passed through general processing functions or attacked by an attacker either to remove or destroy the watermark. The extracting/ detecting function is used to extract the watermark for verification purposes or to check the presence of watermark for monitoring purposes.

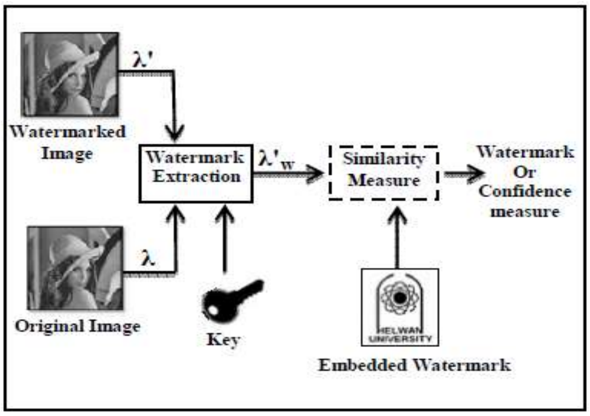

Figure2: Watermark extraction and detection.

Researchers are interested in the field of watermarking because of its significance. These kinds of work in this field have led to several watermarking techniques such as spatial domain and transform domain. In transform domain it may discrete cosine transform (DCT), discrete wavelet transform (DWT), singular value decomposition (SVD) and their cross relation.

PRELIMINARIES

As stated earlier that transform domain based watermarking scheme is always a better choice thanspatial domain based watermarking scheme. This can be done by using different transformationlike DCT, SVD and DWT. In this section, we will briefly describe the DCT, DWT and SVDtransformations in below.

Discrete Cosine Transform (DCT):

DCT like a Fourier Transform, it represents data in terms of frequency space rather than an amplitude space. This is useful because that corresponds more to the way humans perceive light, so that the part that are not perceived can be identified and thrown away. DCT based watermarking techniques are robust compared to spatial domain techniques. Such algorithms are robust against simple image processing operations like low pass filtering, brightness and contrast adjustment, blurring etc. However, they are difficult to implement and are computationally more expensive.DCT domain watermarking can be classified into Global DCT watermarking and Block based DCT watermarking. Embedding in the perceptually significant portion of the image has its own advantages because most compression schemes remove the perceptually insignificant portion of the image. The

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Discrete Cosine Transform (DCT) attempts to decor relate the image data. After décor relation each transform coefficient can be encoded independently without losing compression efficiency [23].The One dimensional DCT is defines as

$$c(u) = \alpha(u)\sum_{x=0}^{N-1} f(x)\cos[\pi(2x+1)u/2N]$$
$$\text{For } u = 0,1,2,\ldots N-1$$

And the inverse transform is given as

$$f(x) = \sum_{u=0}^{N-1} \alpha(u)c(u)\cos[\pi(2x+1)u/2N]$$
$$\text{For } x = 0,1,2,\ldots N-1$$

Where,

$$\alpha(u) = \sqrt{1/N} \quad \text{For } u = 0$$
$$= \sqrt{2/N} \quad \text{For } u \neq 0$$

Thus, the first transform coefficient is the average value ofthe sample sequence. In literature, this value is referred to asthe DC Coefficient. All other transform coefficients arecalled the AC Coefficients. The 2d DCT is an extension of 1.

$$C(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos\left[\frac{\pi(2x+1)u}{2N}\right]\cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

DCT plays a very important role in image compressing; coding and otherapplications. The watermarking algorithms based on DCT domain are compatible withthe existing international compression standards like JPEG and MPEG. Italso states thatDCT is the most widely used transform technique in image compression.

The watermark Embedding processes consists of following steps:
1. The original image is first resized into 256x256 pixels.
2. The watermark is resized into 32x32 pixels.
3. Then original resized image is block-processed into 8x8 blocks so as to completely embed the 32x32 watermark on 256x256 image.
4. After this, 2D- Discrete Cosine Transform is applied on these 8x8 sub-blocks individually to convert it from time domain to frequency domain.
5. The watermark image is embedded on the 8x8 blocks in the middle frequency band.
6. For embedding watermark, the value of frequency coefficient is changed in-accordance to watermark data.
7. Reversed 2D-DCT is performed afterward on the watermark embedded image to convert from frequency domain to time domain.

The watermark Extraction process consists of following steps:
1. Firstly the watermarked image is resized into 256x256 pixels if needed.
2. Then watermarked image is again block processed into 8x8 pixels.
3. Then Forward 2D-DCT is applied on the block processed image to have frequency separation.
4. After this, Extraction process is done in the same way as embedding was done in embedding process.
5. Depending upon the comparison done with particular pixels on which watermark data was embedded, decision is make which is stored in again 32x32 empty array.
6. Then this matrix is the extracted image which was original watermark image.

Discrete Wavelet Transformation (DWT)
The Discrete Wavelet Transform (DWT) is currently used in a wide variety of signal processing applications, such as in audio and video compression, removal of noise in audio, and the simulation of wireless antenna distribution. Wavelets have their energy concentrated in time and are well suited for the analysis of transient,

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time- varying signals. Since most of the real life signals encountered are time varying in nature, the Wavelet Transform suits many applications very well [11]. One of the main challenges of the watermarking problem is to achieve a better trade-off between robustness and perceptivity. Robustness can be achieved by increasing the strength of the embedded watermark, but the visible distortion would be increased as well [12]. However, DWT is much preferred because it provides both a simultaneous spatial localization and a frequency spread of the watermark within the host image [13]. The basic idea of discrete wavelet transform in image process is to multi-differentiated decompose the image into sub- image of different spatial domain and independent frequencies [14]. The information of low frequency district image is very close to the original image. The frequency district of LH, HL, and HH respectively represents the level detail, the upright detail and the diagonal detail.

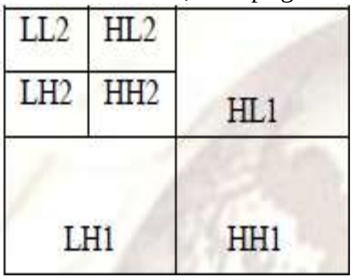

Figure3:2level DWT Decomposition

The human eye is sensitive to the change of smooth district of image, but not at the edges and peaks. So, it is not safe to putting watermark in coefficients of high frequency band of DWT image because it can be easily noticed. The brightness masking on human visual model shows that the larger the background brightness, the more the just noticeable difference of embeddable signal, which means low frequency approximate image can be embedded by more watermarking capacity is lower than JND, as human eyes cannot suspect the existence of signal. Some common attacking to low frequency coefficients, the host image is also destroyed. So it is good to embed watermark in medium and low frequency.

The Watermark embedding process consists of the following steps:

1. The original image is first resized into 512x512 pixels because after DWT decomposition, we will get only with 256x256 pixel size image.
2. As, the size of our watermark is 32x32, 256x256 is the exact dimension to embedded 32x32 pixels on 8x8 sub-blocks in complete image.
3. Then this is decomposed through 1-level Discrete Wavelet Transform which leads the image into four parts [1] as explained above.
4. After this, watermark is embedded into the Low-high frequency components.
5. Then again, 1-level IDWT is applied to this image to synthesize it to complete image.
6. The final image is watermarked image.

Watermark extraction process consists of following steps:

1. The watermarked image is resized into 512x512 pixels if needed.
2. The watermarked image is decomposed into 1-level DWT transform.
3. Then according to the embedding process, the comparison is done for extraction.
4. The generated image by comparison is the extracted watermark image.

3.3 Singular Value Decomposition(SVD)

3.3.1Embed watermarking:

SVD is a technology to make the matrix diagonal matrix. The singular values as one of valid features of matrix as many very good features. They have some stability against the little change of matrix and it can affect the relationship of element in image matrix. If one image is A. and AR^{NXN}, R is the real number field, the SVD of matrix A is

$$A=USV^{T}, UR^{NXN}, VR^{NXN}$$

$$S=\mathrm{diag}(\lambda_1 \ldots \lambda_L \ldots \lambda)$$

Elements of S diagonal lineare called as the singular value of A, V is the left singular vector, U is the right

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singular vector. The method for embedding,

1. To getthesequencenumberGofvideoframeatfirst,itgenerallyisgotbytheGOPofvideo.ThenthespacepositionDandsynchronyguidecodesarealsogot.Thesynchrony code is

$$Y=[S\ G\ D]$$

2. Fromthefirstblock,tocalculatetheSVDN=UMVT,M=diag(λm1…λmL…λ).Anddecidewhetherto embed the synchrony code signal

$L< n$
$\max(\Delta_\lambda) > \alpha_{max}$
$\Delta_\lambda=\{ \lambda_{m1}- \lambda_{m2},\ldots, \lambda_{mn-1}- \lambda_{mn}\}$

α_{max} is the maximum of the quantization value. If not, next block is decided to whether it can be embedded with watermark.

3. Embed the watermark in proper block according the following formula

$$\lambda_m = \lambda_m - \lambda_m{}^{\%\,\alpha} + y_m * \alpha$$

4. The embedded image block is got as follows

$$N = S\lambda_m V^T$$

3.3.2 Detection of watermarking

1. Firstly, get the SVD of the image block in the elected position.

$$N_w=U_w M_w V_w{}^T$$
$$M_w=\mathrm{diag}(\lambda_{w1} \ldots \lambda_{wn})$$

Then calculate

$$Dm=\lambda_m\%\alpha/\alpha pwoer$$

And get all the synchrony code D, then judge whether it hasthe valid watermark, if not, search the next until the validsynchrony code is found.

2. Get there frame sequences and space position of watermark to calculate

$$Dn=C_{xy}(\varphi,\theta)\%\ \alpha/\alpha power$$

Then one bit of D, repeat to get all the expanding frequency bits.

RESULT

Several experiments results are compared to find the best performance of the technique . The gray-level images “Lena” of size 256 ×256 and “Cameraman” of size 128 × 128 are used as the cover image and the watermark, respectively.

DCT Method:

The gray-level images “Lena” of size 256 ×256 is taken as the cover image for DCT technique.

(a) (b) (c)

Figure 4 (a) Cover image (b) Watermark image (c) Watermarked image

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The PSNR value of the watermarked images is 33.69.

TABLE I PERFORMANCE OF DCTMETHOD (PSNR)

Coefficient k	10	30	50	70	90
PSNR	42.8	37.3	33.6	31.2	29

TABLE I is representing the values of PSNR for watermarked images for different values of k, where k is a secret key for embedding watermark, called minimum coefficient difference which is difference of two DCT blocks.

DWT Method:
The gray-level images "Lena" of size 256 ×256 is taken as the cover image for DWT technique.

(a) (b) (c)

Figure 5 (a) Cover image(b) Watermark image (c) Wavelet subband image

Figure6 (a) Watermarked image (b) Extracted Watermark image

The watermarked image has the PSNR value=12.28 at SF=0.5 and the extracted image has the PSNR value = 13.02 at SF=0.5.

SVD Method:
SVD is a numerical technique used to diagonalize matrices in numerical analysis. It is an algorithm developed for a variety of applications

(a) (b)

Figure7 (a) Cover image (b) Watermark image

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International Journal OF Engineering Sciences & Management Research

(c) (d)

Figure7. (a) Watermarked image (b) Extracted Watermark image

The watermarked image has the PSNR value=16.64 at SF=0.5 and the extracted image has the PSNR value = 35.56 at SF=0.5.

TABLEII PERFORMANCE OF DWT

Process/SF	0.1	0.3	0.5	0.7	0.9
Embedding	25.25	16.16	12.28	9.91	8.34
Extracting	31.49	24.01	13.08	9.68	7.25

TABLEIII PERFORMANCE OF SVD

Process/SF	0.1	0.3	0.5	0.7	0.9
Embedding	37.68	22.34	16.99	14.4	13.0
Extracting	64.34	37.73	35.5	33.7	32.9

Table II and Table III are displaying the PSNR of embedding (Watermarked image) and extracted watermark image with differentvalues of scaling factors.*(SF-Scaling Factor).

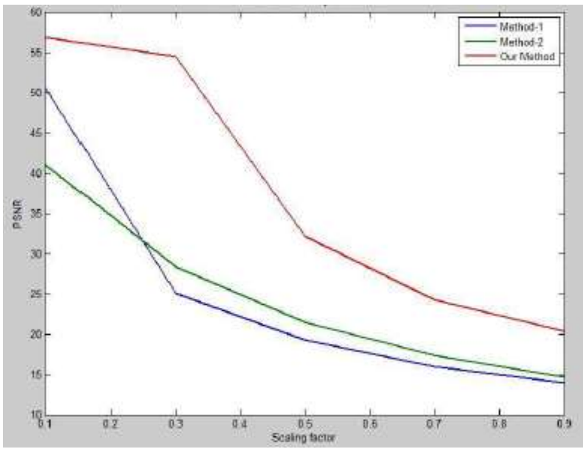

Figure12. Graph of PSNRs of different hybrid methods

In This paper we have discuss different type of techniques of embedding watermark and as per result shown based on SVD have higher PSNR of Extracted watermark image.

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IJESMR
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