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Image Water Marking Using Cryptography

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Abstract— A digital watermark is a kind of marker convertly embedded in a noise tolerant signal such as audio or image data. It is typically used to identify ownership of the copyright of such signal. Watermarking is a process of hiding digital information in a carrier signal, the hidden information should but doesnot need to contain a relation to the carrier signal. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners. It is prominently used for tracing copyright infringements and for bank note authentication. Traditional watermarks may be applied to visible media such as images or video, whereas in digital watermarking, the signal may be audio, pictures, video, texts or 3D models. A signal may carry several different watermarks at the same time.

Keywords-*Digital*watermarks,Cryptography,Matlab

I. INTRODUCTION

The digital watermarking is a process of information hiding. There are various techniques for hiding the information in the form of digital contents like image, text, audio and video. Basically digital watermarking is a method for embedding some secret information and additional information in the cover image which can later be extracted or detected for various purposes like authentication, owner identification, content protection and copyright protection, *etc.* Sometimes the scaling factor is also used for embedding the watermark in the cover image. The digital watermarking is used for the security of the digital content and to protect the data from illegal users and provides the ownership right for the digital data. An important characteristic of digital watermarking is robustness and imperceptibility against various types of attacks or common image manipulation like rotation, filtering, scaling, cropping and compression. The efficiency of digital watermarking algorithms is totally based on the robustness of the embedded watermark against various types of attacks. Digital watermarking is a method used to improve the ownership over image by replacing low level signal directly into image. Digital watermarking method is also used for the tamper proofing and authentication

II. METHODOLOGY

WATERMARKING TECHNIQUES

In the field of digital watermarking, digital image watermarking has attracted a lot of awareness in the research community for two reasons: one is its easy availability and the other is it convey enough redundant information that could be used to embed watermarks. Digital watermarking contains various techniques for protecting the digital content. The entire digital image watermarking techniques always works in two domains either spatial domain or transform domain. The spatial domain techniques works directly on pixels. It embeds the watermark by modifying the pixels value. Most commonly used spatial domain techniques are LSB. Transform domain techniques embed the watermark by modifying the transform domain coefficients. Most commonly used transform domain techniques is DCT,

DWT and DFT. For achieving the robustness and imperceptibility, the transform domain techniques are more effective as compare to the spatial domain. We further elaborated these two domains and its techniques.

Spatial Domain Watermarking

The spatial domain represents the image in the form of pixels. The spatial domain watermarking embeds the watermark by modifying the intensity and the colour value of some selected pixels . The strength of the spatial domain watermarking is

- Simplicity.
- Very low computational complexity.
- Less time consuming.

The spatial domain watermarking is easier and its computing speed is high than transform domain but it is less robust against attacks. The spatial domain techniques can be

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easily applied to any image. The most important method of spatial domain is LSB.

Limitations of spatial domain watermarking:

The spatial domain watermarking is simple as compared to the transform domain watermarking. The robustness is the main limitation of the spatial domain watermarking. It can survive simple operations like cropping and addition of noise.

Another limitation of spatial domain technique is that they do not allow for the subsequent processing in order to increase the robustness of watermark.

Transform Domain Watermarking

The transform domain watermarking is achieving very much success as compared to the spatial domain watermarking. In the transform domain watermarking, the image is represented in the form of frequency. In the transform domain watermarking techniques, firstly the original image is converted by a predefined transformation. Then the watermark is embedded in the transform image or in the transformation coefficients. Finally, the inverse transform is performed to obtain the watermarked image [14]. Most commonly used transform domain methods is Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) and Discrete Fourier Transform (DFT).

Discrete Cosine Transform: Discrete Cosine Transform (DCT) used for the signal processing. It transforms a signal from the spatial domain to the frequency domain. DCT is applied in many fields like data compression, pattern recognition and every field of image processing. DCT watermarking is more robust as compared to the spatial domain

The main steps which used in DCT :

1) Segment the image into non-overlapping blocks of 8x8.
2) Apply forward DCT to each of these blocks.
3) Apply some block selection criteria (e.g. HVS).
4) Apply coefficient selection criteria (e.g. highest).
5) Embedded watermark by modifying the selected Co-efficient.
6) Apply inverse DCT transform on each block

Discrete Wavelet Transform: Discrete wavelet transform (DWT) of the image produces multi resolution representation of an image. The multi resolution representation provides a simple framework for interpreting the image information. The DWT analyses the signal at multiple resolution. DWT divides the image into high frequency quadrants and low frequency quadrants. The low frequency quadrant is again split into two more parts of high and low frequencies and this process is repeated until the signal has been entirely decomposed.

The single DWT transformed two dimensional image into four parts: one part is the low frequency of the original image, the top right contains horizontal details of the image, the one bottom left contains vertical details of the original image, the bottom right contains high frequency of the original image. The low frequency coefficients are more robust to embed watermark because it contains more information of the original image . The reconstruct of the original image from the decomposed image is performed by IDWT .

The digital wavelet transform are scalable in nature. DWT more frequently used in digital image watermarking because of its excellent spatial localization and multi resolution techniques. The excellent spatial localization property is very convenient to recognize the area in the cover image in which the watermark is embedded efficiently.

Merits of DWT over DCT:

- DWT gives better visual image quality as compared to the DCT.
- In DWT, dividing the input coding into non overlapping 2-D block is not necessary; its higher compression ratios avoid blocking artefacts.
- DWT allows better localization as compared to the DCT.
- The watermarking method is robust to wavelet transform based image compression as well as to other common image distortions like rescaling half toning, additive noise etc. This is also an advantage over DCT .
- The DWT understands the working of HVS more clearly than the DCT.
- DWT defines the multi resolution description of the image. So, the image can be shown in different levels of resolution and proceed from low resolution to high resolution.

Demerits of DWT over DCT:

The main disadvantage of DWT is that the DWT is more complex than the DCT. When DCT is used it takes 54 multiplications to compute for a block of 8x8, distinct wavelet calculation depends upon the length of the filter used, whom at least one multiplication per coefficient. The other drawback is that computation cost is higher and its computation time is longer.

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DCT

DCT separates images into parts of different frequencies where less important frequencies are discarded through quantization and important frequencies are used to retrieve the image during decompression. Compared to other input dependent transforms, DCT has many advantages: (1) It has been implemented in single integrated circuit; (2) It has the ability to pack most information in fewest coefficients; (3) It minimizes the block like appearance called blocking artifact that results when boundaries between subimages become visible [15]. The 1D_DCT transformation is given by the following equation:

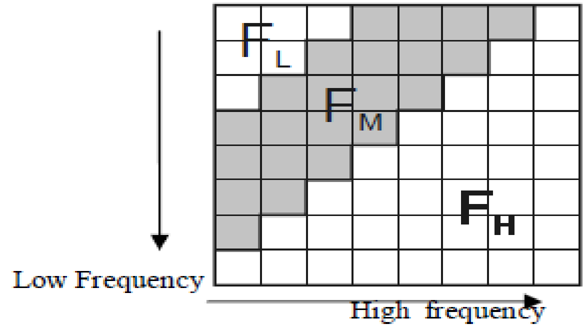
$$F(u,v) = \frac{C_u}{2}\frac{C_v}{2}\sum_{y=0}^{7}\sum_{x=0}^{7} f(x,y)\cos\left[\frac{(2x+1)u\pi}{16}\right]\cos\left[\frac{(2y+1)v\pi}{16}\right]$$

with:

$$C_u = \begin{cases} \frac{1}{\sqrt{2}} & \text{if } u = 0, \\ 1 & \text{if } u > 0 \end{cases} ; C_v = \begin{cases} \frac{1}{\sqrt{2}} & \text{if } v = 0, \\ 1 & \text{if } v > 0 \end{cases}$$

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 similar to the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain. A discrete cosine transform (DCT) expresses a sequence of finitely many data points in terms of a sum of cosine functions oscillating at different frequencies. DCTs are important to numerous applications in science and engineering, from lossy compression of audio (e.g. MP3) and images (e.g. JPEG) (where small high-frequency components can be discarded), to spectral for the numerical solution of partial differential equations. The use of cosine rather than sine functions is critical in these applications: for compression, it turns out that cosine functions are much more efficient (as described below, fewer are needed to approximate a typical signal), whereas for differential equations the cosines express a particular choice of boundary conditions. In particular, a DCT is a Fourierrelated transform similar to the discrete Fourier transform (DFT), but using only real numbers

In DCT, for embedding the watermark information, we divide the image into different frequency bands. In Figure 4 FL denotes the lowest frequency component of the block, while FH denotes the higher frequency component and FM denotes the middle frequency component which is chosen as the embedding region. The Discrete cosine transform achieves good robustness against various signal processing attacks because of the selection of perceptually significant frequency domain coefficients.



The block diagram of DCT watermarking is as shown below

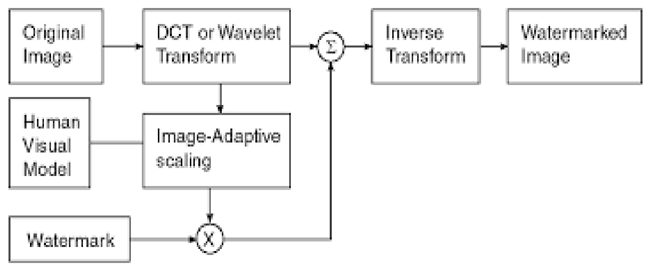


Fig 2.4 The block diagram of DCT watermarking

PROPOSED METHOD

Here we describe the systematic block diffusion method. A block diagram of the embedding is shown in Figure 2.1 and a flowchart in Figure 2.2 Furthermore, a flowchart of the detection is shown in Figure 2.3. Note that the basic configurations of the systematic diffusion scheme are given elsewhere (Ohzeki, 2012 1,2). However, because the block sizes in these configurations are small and the Chirp transform has been used in the literature, the scheme did not exhibit the best performance. In this study, we have used a sufficiently large block size and DCT for verification of the above mentioned diffusion method.

First, this method reduces the size of a luminance image after colour space conversion. The image formed by this process is referred to as a reduced image. Let the width of the reduced image be M and the height be N. Let , be the size ratio of the horizontal and vertical dimensions, respectively. Then, let the width of the luminance image be M and the height be N. Next, DCT is performed on the reduced image in order to convert it into the frequency domain. Then, by quantizing the DCT coefficients, we embed the watermark information. Next, after carrying out the inverse DCT, a reduced image in which the

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watermark information is embedded is generated. This reduced image is then expanded to the image of luminance with a quantized watermark having the size of M × N. The image thus expanded is called the expanded image.

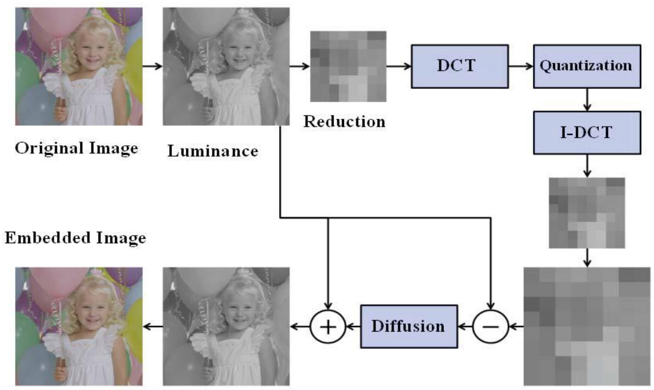

Fig 2.6 Embedding block diagram of proposed method

Next, in this method, we calculate the difference of each pixel between the luminance image and the expanded image with a quantized watermark and then calculate the average value from the difference for each expanded range × , which is referred to as an average block. In the final stage, we add the average value to the luminance image. After the above processing, a single watermark embedded in the reduced image is diffused in a block with × pixels.

This method involves the following procedure for watermark detection. First, we perform colour space conversion from the RGB system into the YCbCr system in order to create a luminance image composed of only the luminance component. Then, we perform a reduction with the same ratio as making the reduced image in orderto expand the watermark. Through this reduction, we retrieve the information diffused in the block of × . Thereafter, we perform the DCT on the reduced image. Finally, we extract the DCT coefficients from the positions at which they were embedded in the embedding process. We detect whether the quantized value is 0 or 1.

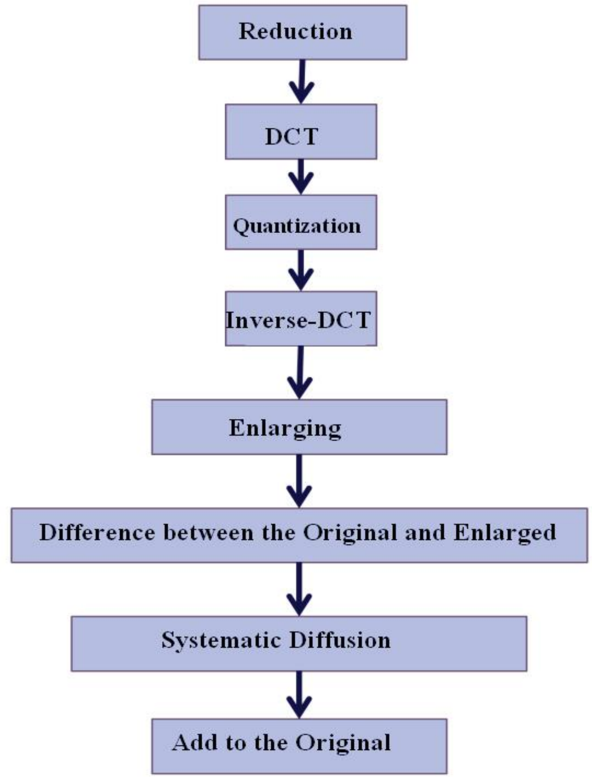

Fig 2.7 Embedding flowchart of proposed watermarking system

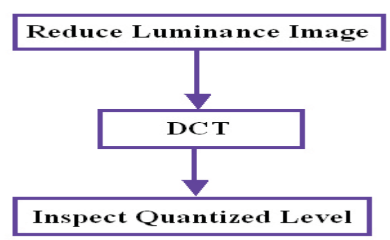

Fig 2.8 Detection Block Diagram of Proposed System

In order to avoid truncating the fractional component of the difference, errors are allocated to the original image so as not to increase the errors and to keep them to less than the least significant bit (LSB).

2.4 DWT

Discrete Wavelet transform (DWT) is a mathematical tool for hierarchically decomposing an image. It gained widespread acceptance in signal processing, image compression & watermarking. It decomposes a signal into a set of basis functions, called wavelets. Wavelets are created by translations and dilations of a fixed function called mother wavelet.

Wavelet transform provides both frequency and spatial description of an image. Unlike conventional Fourier

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transform, temporal information is retained in this transformation process. Its multi-resolution analysis (MRA) analyzes the signal at different frequencies giving different resolutions. Discrete Wavelet Transformation is very suitable to identify the areas in the cover image where a secret image can be embedded effectively. This property allows the exploitation of the masking effect of the human visual system such that if a DWT co-efficient is modified, it modifies only the region corresponding to that coefficient. The embedding watermark in the lower frequency sub-bands may degrade the image as generally most of the Image energy is stored in these sub-bands. However it is more robust. The high frequency part contains information about the edge of the image so this frequency sub-bands are usually used for watermarking since the human eye is less sensitive to changes in edges so this frequency sub-bands.
The DWT splits the signal into high and low frequency parts. The low frequency part contains coarse information of signal while high frequency part contains information about the edge components. The high frequency components are usually used for watermarking since the human eye is less sensitive to changes in edges .

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Fig 2.9 DWT representation

Proposed Technique
Digital image Watermarking consist of two process embedding & extraction.

Watermark Embedding
For this process firstly we apply 3 level DWT on host image decomposes the image into sub-images, 3 details and 1 approximation. The approximation looks just like the original. The same manner 3 level DWT is also applied to the watermark image .For this Haar wavelet is uesd. Then technique alpha blending is used to insert the watermark in the host image. In this technique the decomposed components of the host image and the watermark are multiplied by a scaling factor and are added. Since the watermark embedded in low frequency approximation Component of the host image So it is perceptible in nature or visible.

Watermark Extraction For this firstly we applied 3 level DWT to watermarked image and cover image which decomposed the image in sub-bands. After this we apply alpha blending on low frequency components. *Alpha blending***:** Formula of the alpha blending extraction for Recover watermark is given by RW = (WMI - k*LL3) /q RW= Low frequency approximation of Recovered watermark, LL3=Low frequency approximation of the original image, and WMI= Low frequency approximation of watermarked image. After extraction process, Inverse discrete wavelet transform is applied to the watermark image coefficient to generate the final watermark extracted image

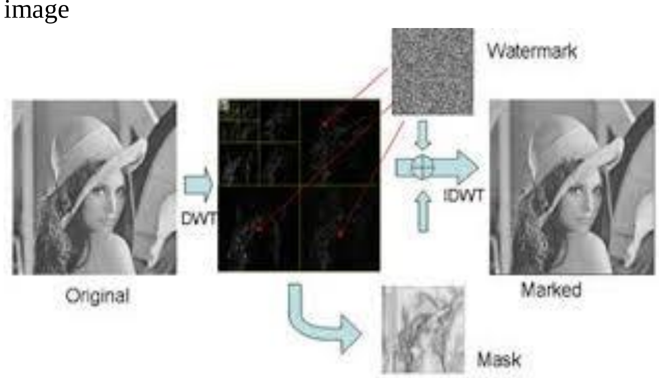

Fig 2.10 watermarking using DWT

2.5 SINGULAR VALUE DECOMPOSITION

SVD is an optimal matrix decomposition in a least square sense packing the maximum signal energy into a few coefficients as possible The SVD theorem decomposes a digital image A of size $M \times N$, as:

$A = USVT$, (1)

where U and V are of size$M \times M$, and $N \times N$ respectively. S is a diagonal matrix containing the singular values. Inwatermarking trial, SVD is applied to the image matrix; thenwatermark resides by altering singular values (*SVs*).

In this paper, we present a new blind algorithm that inserts the watermark in all the SVD components (U, S and V) matrix of singular values. In the same time, we present our proposed approach for achieving watermarking in the different components of the SVD decomposition. The fundamentals of SVD are first recalled, the method is then detailed and the experimental results discussed. Our approach shows more resistance against several attacks like rotation, noising, Filtering, Compression, etc ... compared to the proposed approaches using SVD [15, 17]. When embedding a watermark w into a host image i, we use one of the two methods: either iw = i + t w, where t is close to 0 or iw = (1−t)w+t, i, where t is close to 1. However, we prefer using the second embedding function (linear interpolation) [20], since in this case, i and w play the same role allowing choosing in the tests any t [, so that visualization is more accurate in the sense that if t is close to 1 (resp. 0) then iw is close to i (resp. w). For robustness, the images are watermarked after transforming them into other spaces like YUV, DCT or DWT. The watermark is often embedded into Y component (YUV), Blue channel (RGB), high frequencies (DCT, DWT) and singular values matrix (SVD). Suppose I is any RGB-color image. Without loss of generality, we use the red component i of I. Many papers adopt the following embedding process. The image i is transformed using one of YUV, DCT, DWT getting a matrix which is then decomposed using SVD into the triple [Ui , Si , Vi]. The same transformation is applied to the watermark W and leads to the triple [Uw, Sw, Vw]. Note that the watermark may be Sw itself. Now, let Sw ∗ = Si + t Sw, where t is a parameter ≠ 0, so that iw = Ui Sw ∗ Vi T is the red component of the watermarked image IW (Fig.1). The extraction process is the inverse embedding process. There are many techniques to measure the robustness of any watermarking scheme. The most used are the Mean Square Error (MSE)[19], the fractal dimensions [20], correlation coefficient [19]. In reality, these techniques measure the degree of resemblance between the original watermark and that extracted in order to decide the quality of the embedding/extraction.

Proposed method. We present in this paper, a blind algorithm that inserts by linear interpolation the watermark in the SVD matrices U, S and V of each image component (red, green or blue, say red hereafter).

Convention. Fig.2 shows the way of designing mark and unmark functions in the watermarking schemes. In Fig.2(a), we use linear interpolation to embed the *w* in *i* getting

$$iw = (1-t)w+ti.$$

This implies the inverse process in Fig.2(b), that is 1=t

$$iw-(1\text{-}t)=t\,w.$$

Watermark embedding. Let us consider RGB-color images *I* and *W*, with size 128 × 128 × 3 and recall that without loss of generality *i* and *w* are respectively the red components of *I* and *W*.

2.6 LEAST SIGNIFICANT BIT (LSB):

The LSB is the simplest spatial domain watermarking technique to embed a watermark in the least significant bits of some randomly selected pixels of the cover image.
Example of least significant bit watermarking :
Image:
10010101 00111011 1100110 1 01010101….
Watermark:
1 0 1 0…..
Watermarked Image:
1001010**1** 0011101**0** 1100110**1** 0101010**0**…..
The steps used to embed the watermark in the original image by using the LSB []:
1) Convert RGB image to grey scale image.
2) Make double precision for image.
3) Shift most significant bits to low significant bits of watermark image.
4) Make least significant bits of host image zero.
5) Add shifted version (step 3) of watermarked image to modified (step 4) host image.

The main advantage of this method is that it is easily performed on images. And it provides high perceptual transparency. When we embed the watermark by using LSB the quality of the image will not degrade. The main drawback of LSB technique is its poor robustness to common signal processing operations because by using this technique watermark can easily be destroyed by any signal processing attacks. It is not vulnerable to attacks and noise but it is very much imperceptible.

Proposed Method
Fig. 1 shows the 1-bit LSB. In Fig. 1, the pixel value of the cover image is 141(10001101)2 and the secret data is 0. It applies to LSB-1 that the changed pixel value of the cover is 140(10001100)2. LSB can store 1-bit in each pixel. If the cover image size is 256 x 256 pixel image, it can thus store a total amount of 65,536 bits or 8,192 bytes of embedded data.

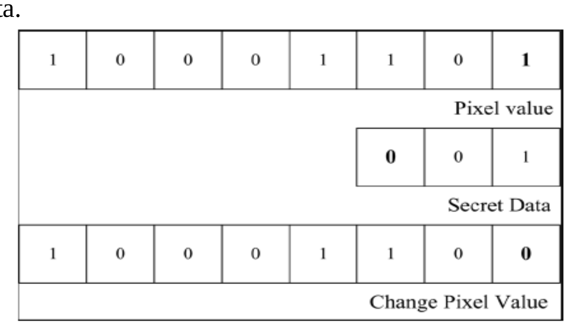

Fig. 2.12 Example of LSB

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Proposed method based on LSB technique, we propose a new watermarking algorithm. Most of researchers have proposed the first LSB and the third and forth LSB for hiding the data but our proposed watermarking algorithm is using the third and fourth LSB for hiding the data. And using the RGB watermark image embedding in blue component of original image because of less sensitivity. This is because of the security reason. So, no one will expect that the hidden data in the third and the forth LSB. Fig. 2 shows the framework of the proposed method. First, we select the image which is a colour image and we will transfer the data to binary value after typing it. Then, we hide the data in the image using the proposed algorithm. Fig. 3 shows the embedding algorithm in MATLAB. Then, we will get the watermarked image. Then, the receiver will retrieve the data back. Scramble applying before the process of embedding extraction and then descramble we received the output this is PSNR and MSE value. Fig. 4 shows the extracting algorithm in MATLAB. The data will be extracted from the watermarked image.

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Fig. 2.13: The framework of the proposed method.

Watermark embedding: The proposed watermark embedding scheme is shown in Fig.2. In the proposed method, the watermark image is a binary image where as the host image is an 8 bit color image. The watermark is embedded four times as shown in Fig.3 in different positions. The four embedded positions are chosen to hide the watermarks in order to be robust against cropping attack from the bottom, the top or the left or the right side of the watermarked image. The blue component is chosen to hide the watermark because it is less sensitive to human eyes. Suppose the original color image H with size of 512*512 pixels, which to be protected by the binary watermark W of size pixels 32*32, the original image H is divided into a non-overlapping blocks of 8*8 and each bit of the encoded watermark is embedded in a block, therefore one watermark is required 1024 blocks. The embedding process is described as follows:

Step 1: The original image H is decomposed into R, G, and B components and then the B component is divided into a non-overlapping blocks with size of 8*8 pixels.

Step 2: A private key is used to determine the positions of embedding the watermark

Step 3: scramble on private image or secret image.

Step 4: The encoded watermark W'' is embedded in the Blue component B. For each encoded watermark bit, a block of 8*8 is modified as follows:

If W''=1; for all the pixels of the 8*8 blocks, {I'=I+ λ}

If W''=0; For all the pixels of the 8*8 blocks,{I'=I- λ}

Where I' is the modified pixel intensity and I is the original intensity and λ is a constant.

Step5: The modified block of pixels is then positioned in its original location of the host image and then step 3 and 4 is repeated until all encoded watermark bits W'' are embedded.

Step6: After embedding the all encoded watermark bits four times, the R, G, and B' components are composed to obtain the watermarked image.

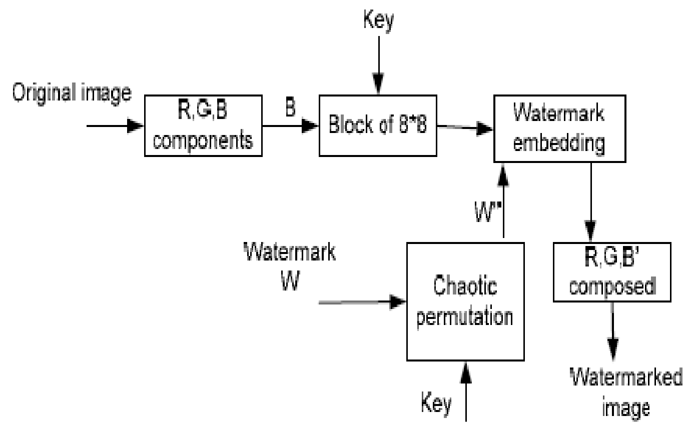

Fig. 2.14: Proposed embedding process.

required the original host image and the original watermark, therefore, it is a non blind watermarking scheme. The proposed extraction is based on the probability (P1, P0) of detecting '1' or '0' bit, which can be obtained by comparing each pixel (I') in a block of 8*8 of the watermarked image with the corresponding pixel (I) in the original image and then the probability of detecting '1' or '0' bit is calculated as follows:

P1=P1+1/64 if I' > I

P0=P0+1/64 if I' $\leq$ I, According to the probability (P1, P0), the extracted watermark bits W'' can be decoded as follows:

$W'' = 1$ if P1 $\geq$ P0

$W'' = 0$ if P1< P0

The extracted watermark bits for the four watermarks are decoded using Gray code and then, the decoded bits are XOR with random bits, which generated using the same secret key that was used during the watermark embedding.

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fig. 2.15: Proposed extraction process.

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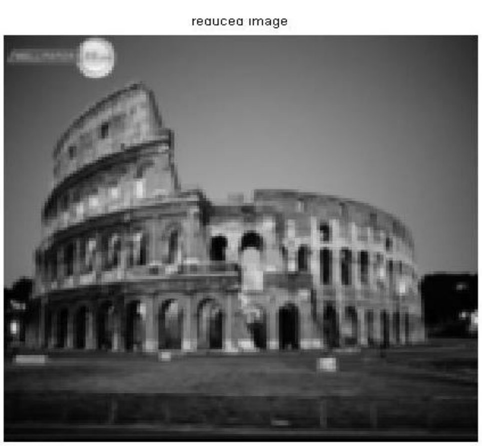
III. RESULTS AND EXAMPLES

WATERMARKING *USING DCT*

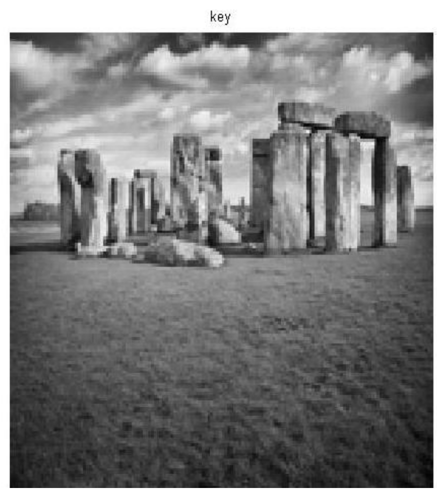
Original Image

Luminance image



Reduced image

Resized image



Key Watermarked image

Degraded image

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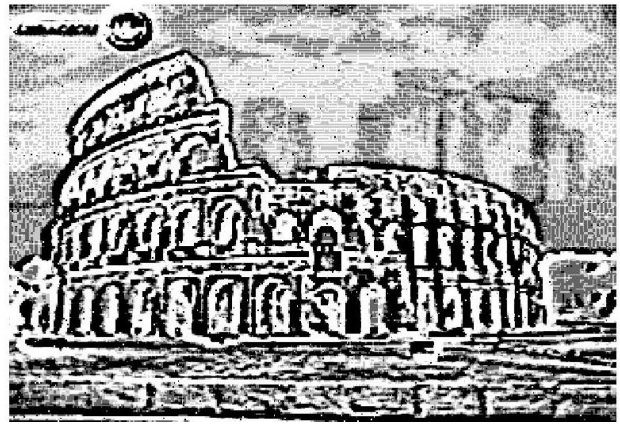
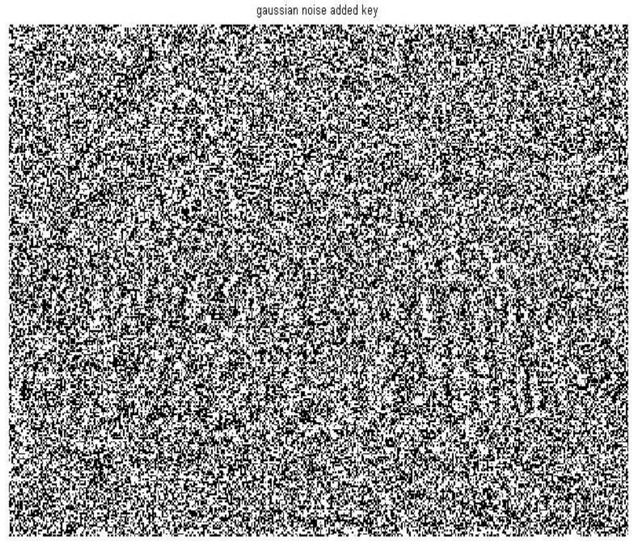
Image reduced



Salt and pepper noise added key

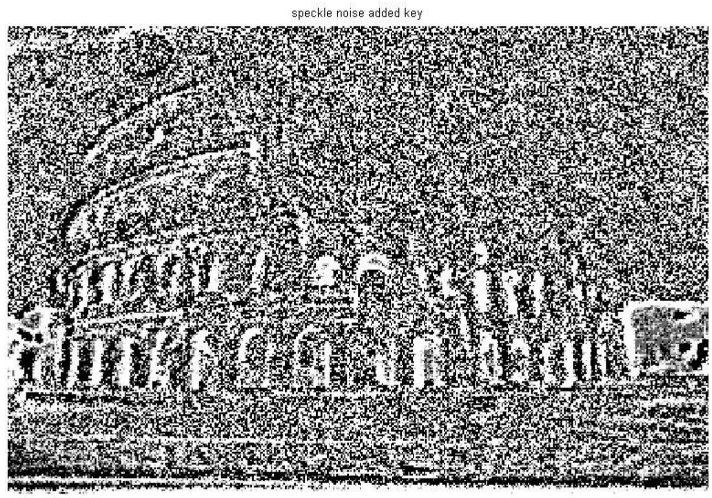
Watermarked image with Gaussian noise



Gaussian noise added key

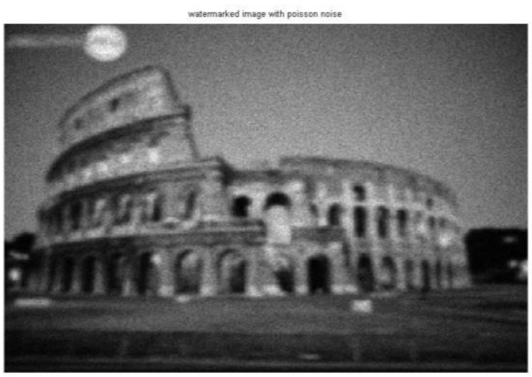
Watermarked image with salt and pepper noise

Watermarked image with speckle noise



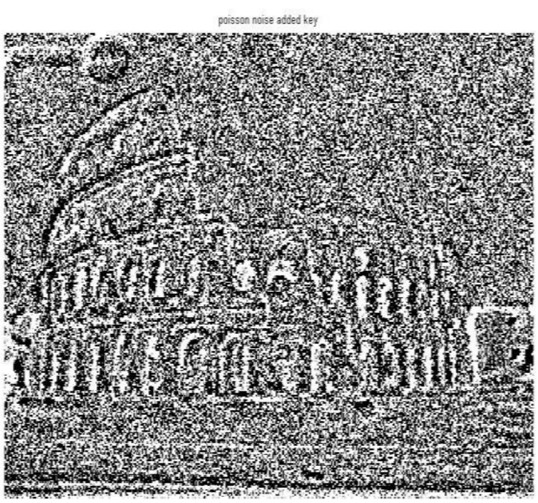
Speckle noise added key

Histogram equialization of watermarked image

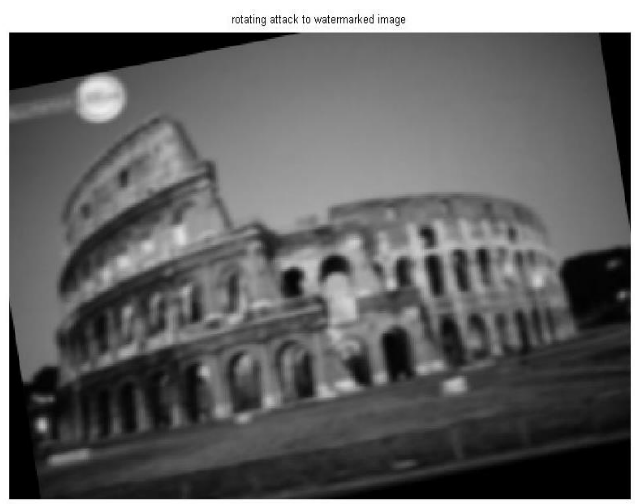


Watermarked image with poission noise

Extracted key



Possion noise key



Rotating effect to watermarked image

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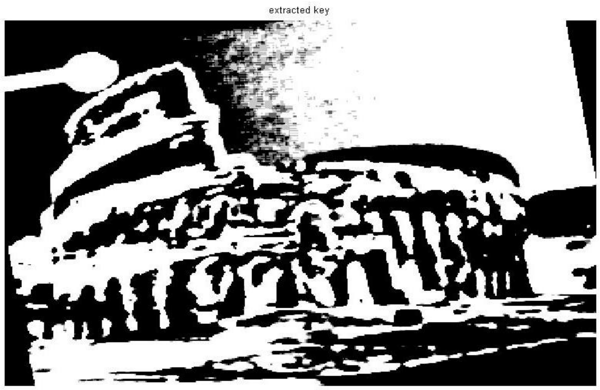
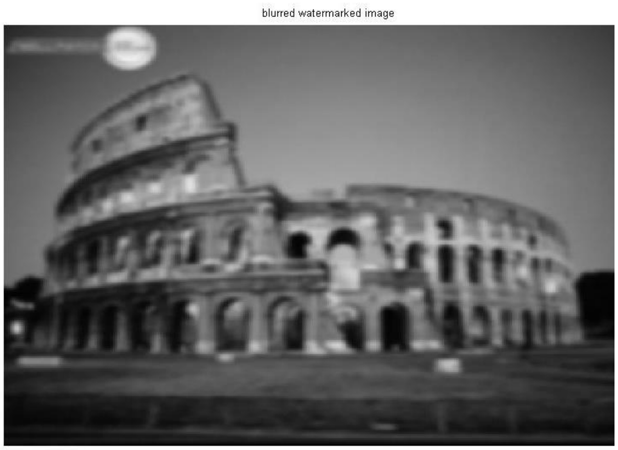
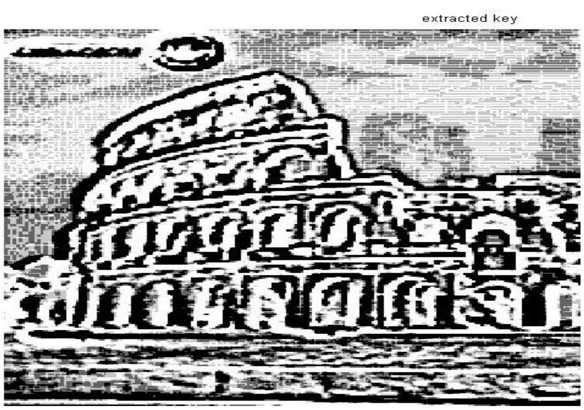


Extracted key



Blurred watermarked image



Extracted key

IV. CONCLUSION

Digital watermarking is very useful method for providing security to the digital media on the internet technology. In this project, survey of different watermarking techniques based on spatial domain (LSB) and the transform domain (DCT, DWT) and SVD has been carried out. This survey analyses the limitations and strengths of the watermarking methods.

Digital watermarking is still a challenging research field with many interesting problems, like it does not prevent copying or distribution and also cannot survive in every possible attack. One future research pointer is the development of truly robust, transparent and secure watermarking technique for different digital media including images, video and audio.

Another key problem is the development of semi-fragile authentication techniques. The solution to these problem will require application of known results and development of new results in the fields of information and coding theory, adaptive signal processing, game theory, statistical decision theory, and cryptography. Although a lot of progress has already been made, there still remain many open issues that need attention before this area becomes mature.

V. References All incomplete references

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