A Robust Image Watermarking Technique using Gram SCHMIDT Orthogonalization

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Abstract: ***In this thesis, an innovative idea of watermarking technique is proposed based on Gram Schmidt orthogonalization. This technique can provide robust and improved imperceptible images for safeguarding the copyrights. Implanting process in this watermarking system uses certain recurrence locales of DCT to such an extent that inclusion of watermark bits causes the least picture contortion. In this way, the Gram-Schmidt orthogonalization is resolved to insert the watermark in the original picture for obtaining excellent picture quality. During the amendment of watermark into the bits having the specific frequency of the picture, bits involved in watermarking are not straightforwardly embedded into the recurrence coefficient; preferably, there is need to adjust the specific coefficients of the picture that depends on certain principles that builds the watermarking picture. The frequencies which are inserted are controlled by utilizing changed entropy discovering substantial excess territories. Moreover, the watermark is mixed before inserting to give an extra security. So as to confirm the proposed procedure, our strategy is tried. The trial results demonstrate that our procedure accomplishes higher imperceptibility and strength than the existing techniques. The watermark extraction gives more expected results to picture quality after various variety of attacks.***

Keywords : Embedding technique, Image watermarking, Extraction method,DCT.

I. INTRODUCTION

Nowadays, the usage of the net generation is in rapid volume with this unlawful copy, broadcasting of digital multimedia leads to critical protection problem. Illegal copy has drawn good quantity of attention to prevent this virtual watermarking taken into consideration as an alternative solution. The hastily emerging field of digitised images, video and audio signal transmission has urged the need of copyright safety, which may be used to provide proof against any illegal attempt to either reproduce or influence them as a way to change their identity. Digital watermarking is a technique which can provide embedded copyright information within images. The technique called as digital watermarking, gives information in the watermark which is encapsulated in an original image. Either the transmission or storage of the watermarked image is performed. And then the process of decoding is carried out by the receiver so as to obtain original image. The purpose of action of watermarking is not to confine access to the actual image, but to ensure that embedded data can be obtained again.

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II. LITERATURE SURVEY

1. According to [2], we formulated an idea about the dependable virtual watermarking technique for protection of copyright using a best quality Discrete Cosine Transform (DCT) with psychovisual threshold limits. The responsiveness of the human visual notion at each frequency order to the image reconstruction is represented by the psychovisual threshold. A best improvement of the transform at each and every frequency order will be the essential for the psychovisual threshold in the image compression. This technique provides a advanced method of embedding by means to recognise the positive DCT coefficients with respect to center frequency which is primarily based on a psychovisual threshold. The embedding area are resolved that is based on the bottom converted entropy values of the image blocks. The highest redundant image data is suggested by the lowest modified entropy values.
2. According to [9] gives the Watermarking technique which can be executed in the spatial domain where watermarks are encrypted in the image pixels at once or else in the frequency domain in which the watermark is inserted in the frequency coefficients of an image received by using frequency transformation of the picture. This paper gives a blocked-Singular Value Decomposition (SVD) based on totally colour photo watermarking technique and is proposed in [5][6] which, to embed the shade watermark, where two stages of SVD are implemented on Y channel of the transformed host photograph. Moreover, to provide extra safety, imperceptibility and robustness, the watermark insertion is completed by the usage of zigzag approach on non-overlapping blocks. In given novel YCoCg, similarity of colour spaces usually used as a part of shade picture pipeline in structures of video and digital images is putforth. In this colour area, the Y factor indicates the luminance or brightness, while Co and Cg respectively provide an explanation for blue-distinction and red-difference. An effective colour photograph watermarking scheme has proposed wherein to embed the colour watermark photograph, the host image, after changing to YCoCg channels, is decomposed to two stages using SVD. Moreover, to archive extra safety, imperceptibility and robustness of the watermark, non-overlapping blocks are decided on to insertion the watermark for the usage of zigzag scanning method.

3. According to [7] introduces the watermarking scheme which based on Discrete Wavelet Transform (DWT) and SVD and rough set based image modified reference is included. This attempt is made to clear up the hassle of image uncertainty and to remove statistically unnecessary wavelet coefficients like LH,HL and HH subbands. Reference watermarking routines has been introduced which is the graphical example of relative overall performance. In the spatial domain the robustness is a prime problem because it is straightforward to perceive the watermark which is embedded in the pixel values of an image. This approach is primarily based on inserting the singular values of watermark image into the singular values of difficult units which are based totally on the original photograph. This introduced original photo watermarking algorithm presents good-pleasant watermarked picture. In these techniques the singular values of watermark sign is encrypted within the singular values of the original picture that are generated after hard set which is the type of sub bands coefficients of DWT. Due to its capability of appropriate the statistical redundancies among wavelet coefficients the idea of Rough set has been used.
4. According to [4] gives to intensify the imperceptibility and robustness of the watermarking snap shots, the watermarking strategies which is hybrid that is based on matrix decomposition and frequency. This paper proposes an advanced watermarking based on four DCT-SVD blocks and the usage of modified entropy in photograph watermarking. A modified entropy is used to select unnoticeable blocks. The proposed watermarking scheme makes use of the lowest entropy values to determine unnoticeable regions of the watermarked image. The distinct watermark sizes are embedded into four host photos. The imperceptibility and robustness are determined through the quantization step, it measures the alternate-off between them. The proposed watermarking scheme produces a super level of the imperceptibility and essence of the watermarked picture against distinctive attacks.
5. According to [6], a strong virtual photo watermarking technique is introduced which is primarily based on the mixture of the SVD and the Lifting Wavelet Transform (LWT). To obtain the good correlation among the authentic and extracted watermark, the binary type which is SVM-based that introduced is included in the extraction of watermark. In the given method, the correction based geometric distortion totally approaches that integrates with the binary watermark detection which is based on SVM to reap advanced robustness towards de-synchronization attacks. Three-level LWT is carried out on the cover photo in which horizontal (HL) sub-band is selected for binary watermark encryption. The schooling and trying out methods have fashioned the usage of an advanced set of functions with the side singular values of corresponding blocks. Geometrical distortion correction is necessary before applying the watermark extraction in the case of de-synchronization attacks. In the unmasking technique, the distortion in geometric parameters of the affected watermarked image are approximated by using the geometric correction technique. This algorithm gives large amount of robustness towards each of the non-geometrical and geometrical attacks.

III. GRAM-SCHMIDT ORTHOGONALIZATION PROCESS

In the mathematical terms especially the numerical analysis and linear algebra, the Gram Schmidt is a technique for which the ortho-normalization of a set of vectors in an inner product space, most frequently the Euclidean space Rn assembled with the prescribed inner product. A linearly independent and finite set are given by Gram-Schmidt method.

$S = \{v_1, ..., v_k\}$ for $k \leq n$

And generates an orthogonal set,

$S' = \{u_1, ..., u_k\}$

This technique spans the same k-dimensional subspace of Rn as S. The method which is known after Erhard Schmidt and Jorgen Pedersen Gram and Pierre-Simon Laplace. Iwasawa decomposition is established in the theory of Lie group decompositions.The operation of the Gram-Schmidt method to the column vectors of a full column rank matrix earns the QR decomposition.

Gram-schmidt algorithm

The gram-schmidt algorithm starts with n independent vectors $a_1, \dots, a_n$(the columns of A). It produces orthonormal vectors $q_1, \dots., q_n$(the columns of Q). To find q_j starts with a_j and substract off its projections onto the previous q's and then divide by the length of that vector v to produce a unit vector.

The inner products $q_i{}^T a_j$ go into a square matrix R that satisfies A=QR. This R is upper triangular, because $q_i{}^T a_j = 0$ when i is larger than j (later q's are orthogonal to earlier a's, that is the point of the algorithm).

Here is MATLAB code to build Q and R from A. Start with [m,n]=size(A); Q=zeros(m,n); R=zeros(m,n); to get correct results.

For j=1:n %Gram-schmidt orthogonalization

v=A(: ,j); %v begins as column j of A

for i=1: j-1

R(i , j)= Q (:, i)'*A(:, j); %modify A(:, j) to v for more accuracy

v=v-R(i, j)* Q(:,i); %substract the projection $(q_i{}^T a_j)q_i = (q_i{}^T v)q_i$

end %v is now perpendicular to all of $q_1 \dots\dots q_{j-1}$

R(j, j)= norm(v);

Q(:, j)= v/R(j, j);   % normalize v to be the next unit vector q_j

end

If you undo the last step and the middle steps, you find column j;

$$R(j,j)q_j = (v\ minus\ projections)$$

$$= (column\ j\ of\ A) - \sum_{i-1}^{j-1} R(i,j)q_i$$

Moving the sum of far left, this is column j in the multiplication A=QR.

That crucial change from $a_j\ to\ v$ in line 4 gives 'modified gram-schmidt'. In exact arithmetic, the number $R(i,j) = qiTaj$ is the same as $qiTv$. (The current v has substracted from a_j its projections onto earlier $q_1 \ldots\ldots q_{i-1}$. But the new q_1 is orthogonal to those directions). In real arithmetic this orthogonality is not perfect, and computations show a difference in Q.

Implementation of watermarking using Gram-Schmidt orthogonalization with Discrete Cosine Transform

First read an image, then divide into 8*8 matrix and apply gram-schmidt orthogonalization on that matrix. After this process we will get new matrix values using Gram-Schmidt orthogonalization. Then store that new value of this image in a variable, assign the matrix of all zeroes which are dependent on the size of image. Assigned the rectangle in the image with respect to Y and X axis and then save the output image as data file. Assign RGB components to variables, apply DCT on these RGB components and store the values in other variables. Load the previous rectangular image data file that was created. This is binary mask for watermarking, assign the coefficient of watermarking strength and also assign the rows and columns for the size of the image. Again assign the red component of the image right from rows and columns, add with the watermark strength and then multiply with image data. Repeat the similar procedure for green and blue components of the image. Then RGB components of the image are changed. Subsequently perform the inverse DCT on the RGB components, and then divide it by 255. To recognise the difference substract the value from absolute value which we obtained and multiply by 100. For Dewatermarking, first take watermarked image. Perform the DCT on again the RGB components of Y image which we have created in the watermark. Substract the respective values from the RGB channel separately and store them. After that perform the inverse DCT on respective image and get back the original image and then assign the given so, that red component, green component and the blue component are now assigned to the inverse discrete cosine transformation of each channels. Again divide by 255, to see values have actually changed from the original image. Subtract each and every values of the scale by last factor to see any difference which is occurring after dewater marking. We get an image with black colour that shows everything is zero so, no difference after performing the dewater marking in the image. After that we can change the strength coefficient of watermarking then the image is changed, if it increases by large value then image will be distorted and we can observe the watermark which is evident.

Fig.1

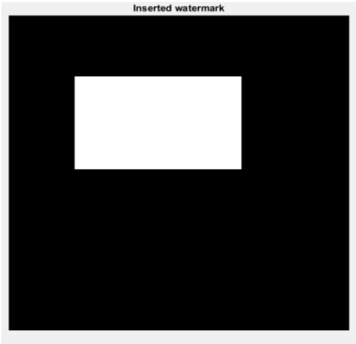

Fig.2

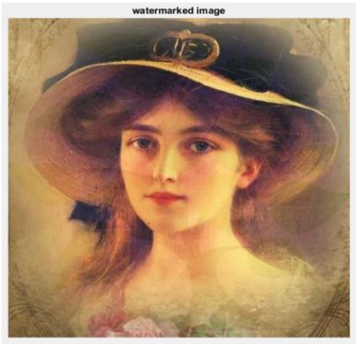

Fig.3

IV. EXPERIMENTAL RESULTS

The proposed watermarking technique gives better results under certain image processing techniques with Gaussian filter, speckle noise, salt and pepper noise. In addition it will produce the good result for histogram equalisation and PSNR ratio.

Signal processing attacks on proposed watermark

Gaussian filter

Gaussian filters are a variety of linear smoothening filters with the weights assigned according to the shape of a Gaussian function. The Gaussian kernel is widely used for smoothing purpose. The Gaussian smoothing filter is an appropriate filter for removing noise drawn from a normal distribution. Gaussian smoothening is a class of averaging, in which the kernel is a 2D Gaussian.

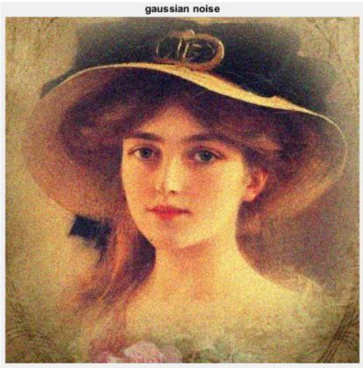

Fig.4

Salt and pepper noise

Salt and pepper is a one of the types of the noise which reflects on the picture. Because of this noise, image can have sharp and sudden disturbances. It is in the form of black pixels. To reduce this noise from the picture, an effective noise reduction method, median filter or a morphological filter can be used. To reduce one of the noises either salt noise or pepper noise contra-harmonic mean filter can be used.

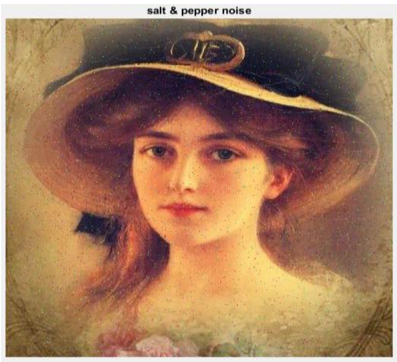

Fig.5

Speckle noise

Reduction of Speckle Noise in image enhancement for medical images and satellite images etc. is a great challenge for the researchers in digital image processing. Speckle is a granular 'noise' that inherently prevails in and degrades the quality of the active radar, Synthetic Aperture Radar (SAR), medical ultrasound and optical coherence tomography images. The extensive majority of surfaces, synthetic or natural, are truly rough on the scale of the wavelength. Images obtained from these surfaces by coherent imaging systems such as laser, SAR, and ultrasound suffer from a common phenomenon called speckle. Speckle, in these cases, is primarily due to the acquisition process which occurs due to interference of the returning wave at the transducer aperture.

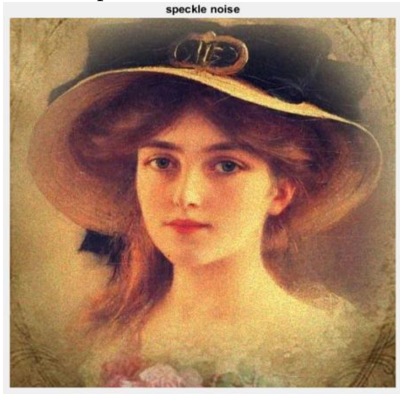

Fig.6

PSNR

The Peak Signal to Noise Ratio(PSNR) is expressed in dB's. This parameter is determined which is exceptional to other parameters like SNR because it uses a consistent measure that correlate the noise against that of data as in SNR. When significantly comparing various image-coding algorithms the PSNR values play a major dominant role. Due to this purpose, PSNR is used for complete coding image circles as a conclusive method to analyse the algorithms which are used in image-coding. Here we have applied the conventional watermarking technique as well as proposed watermarking technique on various images and then calculated the PSNR ratio.

Different images	PSNR(dB)
Cartoon	45.3
Dreamgirl	45.92
Flower	45.94
Greens	45.49
Lena	45.68
Monkey	44.54
Peppers	45.53
Tiger	45.74
TinyHome	45.46
Wolf	45.3

PSNR (dB)

Here we applied the Gram-schmidt method on various images. And then we calculated various signal processing parameters on respective images.

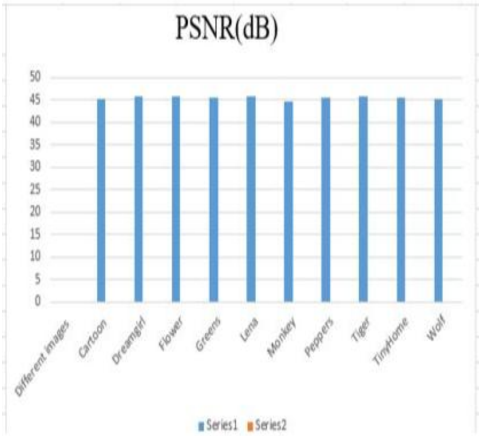

Fig.7 PSNR ratio of different images

Histogram Equalisation

Histogram equalisation is a technique that is used to spread out the gray levels in an image because of which these are intended to uniformly distribute across the range. The histogram equalisation changes the values of brightness of pixels which are based on the histogram image. Histogram equalisation is an improved method in which the histogram of the output image can be visualised as flat as possible. Visually 46 more suitable output across a wider range of images are given by this method. The frequency appearance of the gray level is also given by the histogram. This gives the number of times a certain gray level occurs in an image. The histogram is to calculate to give the number of times a certain colour has occurred in the image which generally happens in the example of a colour image. The histogram equalisation of a colour image is performed by first converting RGB image into the YIQ (NTSC) format. Then histogram equalisation is performed only for the Y component. The I and Q components are unaltered. Then in the histogram, the equalised Y, unaltered I and Q components are converted back to the RGB format.

NC values against signal processing attacks	
Salt & Pepper noise	0.812
Gaussian noise	0.942
speckle noise	0.793
Histogram equalization	0.965

NC values against signal processing attacks.

V. CONCLUSION

This paper confers a new embedding method for image watermarking based on the Gram-schmidt orthogonalization along with Discrete Cosine Transform. A watermark image is not directly embedded into a base image where, we have to apply Gram-schmidt algorithm on the image then we have encrypt the given gram-schmidt output image with the discrete cosine transform. Then the final output is subjected to various signal processing attacks such as Gaussian noise, speckle noise and salt & pepper noise on the given output image. The PSNR ratio and histogram equalization are computed for the output image. In this way the proposed technique gives the good results in terms of robustness under various combinations of attacks. And this work can be extended with advanced Wavelet Transform techniques in a future research.

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