International Journal for Innovative Engineering and Management Research
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IJIEMR Transactions, online available on 06th Jan 2023. Link
:http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=ISSUE-1

DOI: 10.48047/IJIEMR/V12/ISSUE 01/34

Title **A Survey on Digital Watermarking Techniques**

Volume 12, Issue 1, Pages: 365-398

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A Survey on Digital Watermarking Techniques

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Abstract

Digital watermarking is an influential data embedding technique widely used to prevent the unauthorized access, altering, redistributing the digital information. In recent days, to assign the copy right privacy to the multimedia data, databases, and documents digital watermarking technology is widely used. By applying Conventional algorithms digital watermarking classified into frequency domain and transform domain based on these classification several digital watermarking techniques implemented and applied to the multimedia data. The extremity in image watermarking depends on quality of image after insertion and retrieval of the watermark. To examine the quality of image data signal processing operations and geometric attacks are performed. Evolution of artificial intelligence, machine learning, deep neural networks provides the advancements in this field. In this review paper several previous papers has been referred, discussed the various digital watermarking techniques and their robustness to various attacks that gives understanding about the different watermarking techniques in this research field.

Keywords: DCT, DWT, SVD, Neural Networks, Public, Fragile.

Introduction

Digital watermarking technology embed the watermark into the original image in order protect copy right information in various fields like cryptography, image signal processing, and communication. Digital watermarking technology mainly categorized into two different approaches namely spatial domain and transform domain. Spatial domain includes additive watermarking where it modifies the image intensity pixel values, least significant bit technique is one of the technique mainly used in spatial domain. Transform domain determines the coefficients of original image and embeds the watermark onto the cover image by modifying those coefficient values. DCT,

DWT, DFT, are the most commonly used transform domain techniques.

Extraction procedure in digital image water marking includes Non-blind and blind image watermarking procedures. Non-blind image watermarking requires cover image for extraction of the watermark and blind image watermarking do not require the cover image in retrieval of the watermark.

Singular value decomposition(SVD) is a linear algebraic model, digital image comprises of different matrices, so singular value decomposition method is effectively applied to secure the images. advantage of using the SVD based digital watermarking technique is singular values in image are less susceptible to the external distortion applied to the image.

Advancement of Deep neural network(DNN) in watermarking provides prominent outputs. Watermarking techniques in deep neural network fascinated to improve the robustness of the watermark and makes watermark retrieval procedure blind. It uses white box and black box techniques in digital watermarking.

Organization of the paper:

In the below sections our survey will cover recent Digital watermarking techniques, section2 gives classification of different watermarking techniques, section3 identifies challenges that are present watermarking, section4 discusses results of various papers in the literature survey and section5 concludes the paper.

Literature Survey

In this paper we discussed four different types watermarking techniques based on visibility and robustness of the watermark includes Visible watermarking, Invisible watermarking, Fragile watermarking and public watermarking. In visible watermarking intensity of watermark pixels are less and those are adjusted to a particular threshold and embedded onto the cover image. Invisible watermarking is not sensible to the Human visual system also it is more considerable than the visible watermarking system because the original image is not degraded after insertion of the watermark in most cases. In fragile watermarking any modifications that are made to the image effects the watermark so that it can be helpful for authentication and integrity of the images. Public watermarking technique includes two types of keys as public key and private key. By using the private key Owner of the image can embed the watermark to provide authentication to the original

image and applying the public key any one can access the original image but can't tamper the original information.

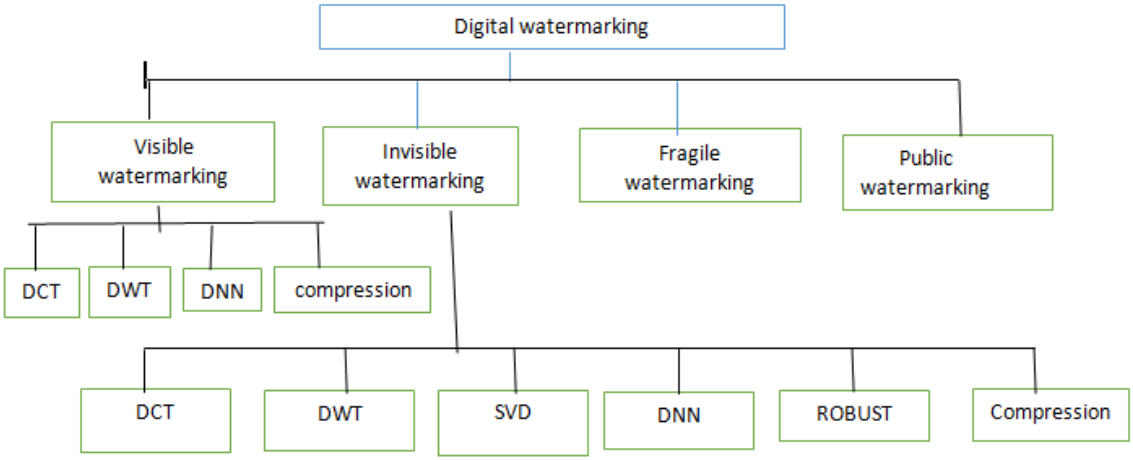

Fig1: Types of Watermarking

Visible Watermarking Techniques

DCT based Visible Watermarking Techniques

S.P.Mohanty.et.al[1] Introduced a discrete cosine transformation(DCT) to improve the visible watermarking in human visual system. To prevent the unwanted commercial use of digital images proposed scheme addresses feature selection of the several images having different portions to embed watermark in the images introduces sequence of changes in scaling factor and embedding factors values in the Gaussian random mean and the normalization methods. It is only a mathematical model procedure for visual watermarking Ying Yang.et.al.[2] Proposed a removable visible watermark scheme uses the DCT domain for copy secures the illegal removal of watermark from unknown users. Here the placed visible watermark preserves the media information and guarantees encrypted images with better quality to known users and low quality to unknown users. From an existing mathematical model adaptive scaling and embedding factors are calculated and viability of the proposed scheme enlarged to various other transform domains. Future work of this scheme extends to both visible and invisible watermarking

Yang.et.al[3] Proposed a scheme that performs operations on the watermark using a secret key before placing the watermark into the cover image so that it

restricts the placed visible watermark from unauthorized users who have the intentions to removal of watermark. Scaling and embedding factors are calculated from the mathematical model, uses the features of human visual system.the future work of this scheme applying proposed method to both visible and invisible watermarking

J. Abraham and V. Paul[4] Proposes watermark method capable of invisible watermark in to the monochrome images .The used gives a reasonable visual quality after the addition of watermark.

A block of pixels chosen for hiding the watermark. DCT transform fragmenting an image into three different frequency blocks low, medium and high frequency regions and the medium frequency regions are selected for watermark insertion because changes could not effect image perceptibility

In this proposed scheme Experimental results shows watermarked images of high signal noise ratio and Robustness of watermark is decreased when the attacks are performed on the watermark images. Also the quality of images remain intact after resetting four bits on the LSB side of all pixels.

Saxena.et.al.[5] Introduces a DCT with Genetic algorithm that optimizes problems of present watermarking schemes that uses wavelet transformation and an algorithm. Proposed methodology includes the analysis of various existing algorithms, introduces an algorithm using DCT, Z moments and Genetic algorithm these three algorithms jointly strengthen the present watermarking schemes based on wavelet transformations.

DWT based visible watermarking techniques

Biao-Bing Huang and Shao-Xian Tang, [6] proposes a scheme uses contrast sensitive function and region classification of DWT domain, by analyzing the image information, texture, smooth areas and edges. proposed wavelet coefficients and contrast sensitive function generates a visible watermarking scheme where the watermark of an image is obtained by changing the pixel values of an image so that the difference between the original and watermarked image is very small. It uses a mathematical model that modifies DWT coefficients of host image.calculated embedding and scaling factors of mathematical model determines visible weight masks of contrast sensitive function and the texture sensitivity of human visual

system, these weights protect against attacks of watermark removal. In its future work proposed scheme extends its copy right protection of images to videos.

M. Tsai and C. Lin,[7] In the Proposed model due to the combination of contrast sensitive function(CSF) and noise visibility function(NFV) for human visible system model is benefited with the noise reduction of visibility thresholds for human visible system in DWT domain. Noise visibility function(NFV) uses the local image properties as a replacement of textures edges and smooth areas to estimate the watermark areas and ensures watermark insertion. Weights associated with the inserted watermark gives the desired visibility performance that results in progress of watermarked images by CSF based algorithms in the image quality and robustness. Results shown in this visible watermark scheme reaches high PSNR values with superior visibility

M. Chandra and S. Pandey[8], Proposes a DWT based visible watermarking algorithm for copy right privacy to digital images based on concept of DWT. It divides the image into different resolutions, wavelet domain favorable to robust watermarking and algorithm used does not cause any problem to original image during insertion of watermark and the algorithm used is very simple available in wavelet domain.

The results shown strengthen the general belief in the wavelet domain as most desirable domain for watermarking this scheme provides desired results of visible watermarking and in its future work it is extended to applying for video images.

Malika Narang and Sharda Vashisth,[9] Proposes a technique that depends on one level discrete wavelet transform is used for embedding and extraction of watermark in the host image by using alphablending.in the proposed method cover image and watermark image divided into blocks based on different frequency sub bands. alpha blending technique is used for insertion and removal of watermark to and from the host image. gray scale images used as input to this scheme and obtain results. Scaling and embedding factors determined to estimate quality of watermark and host image.

Wavelet domain watermark decreases the problems of any misrepresentations including compression and low pass filtering that modifies the high frequency regions of an image. Also the wavelet watermark does not withstand to attacks

that damages the entire watermark by clipping.

A. Kumar and M. Gupta,[10] Proposes a scheme that aims to copyright privacy and authenticity of color image data, insertion and retrieval of watermark developed by two algorithms. based on the concept of DWT the cover image first divided into four different frequency sub bands after that principal component analysis is applied and then the color watermarked image is inserted into the cover image.In this DWT PCA based semi visible color image watermarking the two correlation parameters PSNR,NC values of HL, LH bands are more robust and invisible than the LL, HH.

Deep learning based visible watermarking techniques

Danni Cheng.et.al[11] proposes a deep learning based watermark detection and removal. A large scale visible watermark data set is used to train and process deep learning framework in watermark detection process. Watermark detection is done by common object detection schemes such as Faster RCNN, YOLO, and RetinaNet. After the watermark detection, watermark detected area send to the removal network to get watermark free area. Experimental results shows the framework provides better results for watermark detection and removal.

Pei Jiang.et.al[12],Proposes a method to address the issue of color watermark similar to the background, current methods unable to remove the watermark from the watermarked image, this method uses two step process of watermark extraction and image inpainting and also it uses conditional generative adversarial networks(CGANS) and least squares generative adversarial Networks (LSGANS) to remove the visible watermark. WW dataset and CW data set are used to analyze the proposed network architecture.

Experimental results shows the proposed method capable of removing the color watermarks which are similar to the back ground color. Here we also consider the fact of color watermarks that are matching to the background can't secure image copy right protection.

Y. Liu.et.al[13], proposes a method based on the problems of general watermark removal methods image to image conversion techniques that uses size, shape color and intensity levels of the

watermarks are unpredictable using image to image conversion techniques. To address the above issue Watermark-Decomposition Network for Visible Watermark Removal(WDNet),combines the conventional watermark image decomposition into two stages. In the first stage it estimates approximate positions from the whole watermarked image and in the second stage extracts the watermarked area and cleanse the removed positions. WDNet able to learn from huge datasets and distinguish the watermarks from host image using Deep neural network. However WDNet shows high quality results and also in some cases removal of watermarks very difficult and this method is not robust to several attacks.

R. S. Kavitha.et.al[45], Proposes a Neural network watermarking in frequency domain transformation. A combined DCT-DWT algorithm is used to insert watermark into the original image and the neural networks are used to extract the watermark. This method is used to create a secure watermark and the removal of the watermark does not use the host image. In this proposed method two types of watermarks are inserted at the same time into the host image. DCT watermark coefficients are implemented on the original image as a visible watermark, next the DWT coefficient are applied onto the DCT makes the watermark invisible. By using the DCT-DWT makes the watermark robust and TWO stage Neural networks are used to extract the watermark.

Multiple image based visible watermarking technique

Ruba.et.al[14], proposed a scheme that adds several watermarks on the same cover image by choosing various positions to embed the watermarks and eliminating the interventions among the watermarks. It embeds the watermarks of different shape, size, and positions using different transparency's and opacity levels. This scheme uses equation $K = n*A + (1-A)*B$ for different transparency levels.

Automatic Visible watermarking technique

C. Xu.et.al[15] Proposed method has the two common steps watermark detection and removal of the watermark. In the watermark detection process it takes all images from test data set having the same resolution, watermark regions and a statistical method to detect the watermark region. After detection of visible watermark takes the watermark place as the missing region and removes the watermarks from all the images in the test

dataset and performs any one of image inpainting technique on the missing region from where water mark is removed.

Santoyo-Garcia.et.al[17], In this paper for the automatic detection of visible watermarks this method takes support of traditional watermark removal method for an effective processing. Total variation (TV-L1) method divides the watermarked into structure image and texture image , by using canny edge operator and otsu threshold method watermarks are distinguished from the edges of cover image. This scheme provides robust visible watermarking to be used for future works.

K. Rangel-Espinoza.et.al[18], Proposed a visible watermarking scheme seam carving system involve two stages in the first stage it generates a different kinds of watermark patterns by using the pixel variations , in the second stage placing of visible watermark pattern. Generated watermark is robust to several inpainting attacks. In this method essential part is creating the different watermark images from the original image and information is not same in one other.Experimental results shows this method is robust against inpainting attacks because the generation of different watermarks. In future work this scheme extended to video images to stop the collusion attacks.

Compression based visible watermarking technique.

E. Fragoso-Navarro.et.al[35], Proposes compression based visible watermarking on the idea of just noticeable distortion(JND). Human visible system(HVS) can be imperceptible to the distortion. In JND threshold value of distortion is calculated using various responsiveness parameters of Human visual system. By using the basic value of JND perceptibility of watermark is controlled. Proposed algorithm carried through DCT domain so that it will perform operations on JPEG domain directly. Experimental result indicates using the JND threshold value watermark perceptibility is guided and it also shows enhanced image watermark quality.

Mohammad.et.al[16], Introduces a scheme to achieve visual quality of stego images and to obtain the cover images without any distortion. A new reversible visible watermarking Absolute moment block truncation coding scheme(AMBTC), uses adjustable pixel circular shift operation that adjust to confined properties of image to insert the visible water mark into two

level static quantization levels of AMBTC triple. From the parity of bit plane watermark can be retrieved and the obtained results shows the visual quality of stego images and cover images without any distortion.

To minimize the bits in watermarked host image, AMBTC is used to compress the images. AMBTC compressed image is extracted without any loss after removal of watermark from the cover image. This scheme is robust against the various attacks and it is used in present online environment.

Invisible Watermarking Techniques

Singular value decomposition based invisible watermarking techniques

J. Deng,[19]Proposes a method that classifies binary text images into various DCT classes, these classes are again divided into DCT sub classes based on the pixel degree ,texture difference between blocks. Experimental results shows LL , LH bands are robust to different individual attacks. Also proposed scheme withstand to the attacks of filtering and zooming.In the watermark insertion process to get the jumbled watermark image Arnold transformation is applied to binary images and Singular value decomposition transformations are applied to blocks of DCT coefficients acquired from the binary images. In extraction process DCT applied on watermarked image and perform Singular value decomposition on the blocks of DCT coefficients and get the original image by inverse Discrete cosine transform. Results obtained shows proposed watermarking gives the better transparency, watermark detection, less computation and increased robustness, with stand to various watermark attacks.

B. Jagadeesh[20]proposes a blind watermark method based on Singular value decomposition and Dither quantization, optimization of watermark carried out by Genetic algorithm. This scheme uses genetic algorithm in SVD domain and insertion of watermark done by dither quantization. Results indicates proposed method robust to various attacks like low pass filtering, median filtering, resizing, jpeg compression, cropping, salt & pepper noise etc.

Z. Chao-yang[21] Introduces a binary watermark algorithm that uses wavelet transform and scrambling technique on binary images. watermark insertion is carried out by the singular value decomposition at the low frequency values of wavelet coefficients in the host image. Scrambling technique ensures both the

robustness and security of the watermark. When the watermarked image is exposed to Gaussian noise, compression, salt & pepper noise it under goes to several attacks and interventions

Y. Zolotavkin.et.al[22] proposes a singular value decomposition based watermarking provides adaption feature. It uses private key for retrieval of the watermark. To insert the watermark into 4*4 block it utilizes the orthonormal vectors acquired by the SVD. Fragment size of 4*4 block to insert the watermark helps from various attacks like jpeg compression, median filtering etc. The two orthonormal vectors provides stable watermarking and it is least affected by the common image processes.

J. Liu.et.al[23], Introduces singular value decomposition using directionlet. Canny operate detection and houghline detection schemes are used to get the transform directions of directionlet. chooses a blue channel with respect to directionlet transform and SVD is performed on the subband images to embed the watermark. Retrieval of watermark includes the operations of selecting the coordinate system of detection and coset division. Advantages of proposed watermarking method includes it with stands to various geometric attacks like noise, rotation and cropping.

Y. Chen.et.al[24] proposes a robust dual color watermarking on the basis of quaternion singular value decomposition to secure the copy right privacy of color images. In the watermark insertion process color watermark image is separated into three R, G, B, channels and each channel is scrambled by Arnold scrambling with secret a key. Host image is also separated into non overlapping quaternion 4*4 blocks. To insert the watermark these blocks are selected in a random manner by using the secret key and performs the algorithm on it.

In the retrieval process original and watermark images are not needed because it uses blind retrieval process. On the analysis of results obtained shows watermark is invisible and robust to the geometric attacks.

DCT based invisible watermarking techniques

W. C. Chu[25], proposes a scheme in which the original image is distinguished into sub images, these sub images are converted into discrete cosine transform. Obtained DCT coefficients are tested in

pairs to determine they are appropriate for insertion. To keep away from the misrepresentations, the coefficients of two different amplitudes are not changed. Watermark sample is inserted into the pairs of DCT coefficients. proposed scheme shows good results to attacks of high pass filtering, collusion, noise. For low pass filtering, jpeg compression it does not gives the desired results.

J. Guo[26].et.al, Proposes a method uses DC values of adjacent regions to estimate the low frequency AC coefficients of middle block.low frequency AC coefficients are changed for watermark insertion. Intermediate filters from the Least mean squares(LMS) helps to estimate initial AC coefficients from adjacent DC coefficients. Based on idea of variance classified blocks two watermarking algorithms, Watermark Embedding in the Predicted AC Coefficient (WEPAC) and Watermark Embedding in the Original AC coefficient (WEOAC) are used. WEPAC inserts the watermark into the estimated AC coefficients and gives the reasonable robustness and WEOAC inserts the watermark into the initial AC coefficients and gives reasonable image quality.

To test the robustness of this scheme various attacks are conducted. In cropping middle area of watermarked image is removed it degrades the CDR results. WEPAC has the good robustness to jpeg compression than other methods.

Shuai Liu[27].et.al, Proposes a method that adds fractal encoding and DCT scheme for dual encryption to enhance the conventional DCT process. In the initial encryption process image is encoded using fractal encoding and DCT method uses obtained parameters from the fractal encoding as second encryption process. Proposed scheme performs white noise attack, Gaussian low pass filtering, jpeg compression, these attacks exposed with traditional PCA and 2DPCA schemes shows robustness of proposed method.

H. Mehra.et.al[28], proposes a frequency domain watermarking based on the concept of DCT with variable size of host and watermarked images. In DCT host image distinguished into low, middle, high frequency bands and middle frequency band is selected for insertion of watermark. After the experimentation two images are compared, PSNR values for both the host and watermarked images are high.so the watermark is not recognizable

by external user and also the watermark and watermarked images are compared it has various peaks to noise, so the collusion attacks are not possible on watermarked image. Exploiting the watermarked image to various attacks among the attacks watermarked image is good against the additive noise and gives the better results compared to other attacks.

A.Susanto.et.al[29], Proposes a method to enhance the watermarked image quality. This scheme uses unsystematic keys. Random embedding is done through unsystematic keys that has binary numbers and the keys having same size of watermark image. XOR operations performed on the watermark image and also used key enhance the robustness of the watermarked images. watermark extraction is carried out through Non blind methods that uses original image watermark retrieval process. On the analysis of experimental results against several attacks proposed method enhance the quality of the image output without decreasing the ability of copy right to image changes.

DWT based invisible watermarking techniques

M. Malonia.et.al[30], Proposes a scheme in which original image is divided into different frequencies using DWT and the watermark is inserted into the one level HH, LH, HL, frequency sub band of original image using Arthematic progression. Mean is calculated for each sub band, lowest mean among all is used for initial insertion of the watermark. Watermarked image is exposed to various attacks shows good robustness to the attacks, indicated by high PSNR values. In future work the proposed method developed for multiple attacks at a time and for video watermarking.

Maruturi Haribabu.et.al[31], Introduces Discrete wavelet watermarking on the concept of wavelet transform in HSI color space. Single level wavelets are determined to match the intensity values of HIS color space of original image. LL blocks of 8*8 are carried out for further processing. entropies of original image and wavelet blocks are compared. Scaling factor is calculated to insert the watermark. By using various resolutional images proposed algorithm is tested and retrieved watermark image quality noted to check the performance. Determined reasonable PSNR, MSE values indicates effectiveness of this method. Efficiency and robustness of this method verified by performing various attacks includes salt & pepper,

speckle, Gaussian and brightness of watermarked image.

Y. Yunawan.et.al[32], introduces a scheme that uses DWT and Spread spectrum for watermarking the image. Watermark data is processed by compression method, for some images compression method on image watermarking degrades the system performance due to the attacks. Spread spectrum technology is used to insert the watermark by scattering the watermark bits into different frequency components. The proposed method has better robustness to jpeg compression attack compared to other attacks.

Q. B. Dang.et.al[33], Proposes digital water marking to all types of document images by placing the QR code details in the document image imperceptibly. By using DWT, original document image is divided into different frequency bands. after that the QR code is inserted into the subbands of n^{th} level DWT. Experimental results indicates thismethod performs better for different types of document images and it also withstands to various attacks like compression, rotation, cropping, salt & pepper.

F. H. Pugar.et.al[34], Introduces a scheme of digital color image with available . M-ary Modulation based on the concept of spread spectrum and discrete wavelet transform. It translates the original image into YCbCrcolor space. Watermark is rearranged using logistic function map before inserting into the original image. This blind watermarking scheme uses two level DWT, M-ary Modulation and logistic function to scramble the data for color images. obtained experimental results shows better invisibility of watermarked image by using the high PSNR values and SSIM to 0.997. Different attacks performed on the watermarked image, results show it has good robustness to noise, filtering, histogram equalization, sharpening, cropping, cropping and jpeg compression.

Compression based invisible watermarking techniques

F. H. Yeh.et.al[36], Proposes a scheme in which the host image and watermark image are divided into non intersecting 8*8 blocks. In this scheme characteristics of watermark is categorized to frontend and back end colors. If the divided block does not contain front end color then that region does not provide any information. Back provides meaning full information. Coefficients of watermark and shifted to 12 gray levels. After this DCT coefficients of watermark image are inserted into the host image by doing this we get the

meaningful and unmeaningful blocks, scaling factor is used to provide the security to the watermark. Quantized DCT coefficients are encrypted by using Huffman encryptor to obtain a watermark compressed image. By using the secret key authorized user will remove the visible watermarked image. Logistic chaotic map is used to generate a secret key. Experimental result shows watermark insertion, retrieval is done by using the secret key.

Swamy.et.al[37], Proposes a compression based watermarking using Contourlet transform(CT) and scalar quantization used for watermark insertion. Laplacian pyramid(LP), Directional filter bank(DFB), used to find discontinuities and combine the discontinuities respectively. The coefficients of LP are divided and arranged in pre classified manner. Based on the level of frequency band values CT coefficients are quantized and a prediction algorithm is used to reduce the size of the pixels. The watermark is inserted into the low level contourlet image classification using different intensity values of CT classification, implementation of compression is enhances decreased regions jpeg compression results shows CT based image compression gives better performance than WT based watermarking. Retrieved watermark exposed to several attacks does not degrades the watermark quality, so that it can be applied to copy right privacy.

Badshah.et.al[38], Proposes a watermarking method to obtain a lossless compressed watermarks. Region of interest(ROI) and watermark private key together forms watermark in Lempel-Ziv-Welch (LZW) scheme in order to obtain the reduced lossless compressed watermark by decreasing the payload of watermark scheme gives the better improvement than other traditional methods. In this method each sample is divided into Region of interest(ROI) and Region of non interest(RONI), ROI contains actual information. ROI and secret key from the watermark. To watermark the image initially the compressed watermark is translated into binary format and the watermark is applied to RONI area bits at first and second least significant bits. Embedding the watermark at LSB gives better visibility of image. In the retrieval process LSB bits are changed to obtain the inserted watermark bits. Embedding the watermark into the first two bits of an image gives permanent solution to image degradation problem. Retrieved watermark image is

decompressed and authenticated to get the region of interest information

M. Talbi.et.al[39] Proposes a compression based image watermarking. In this scheme to get the four sub band image samples 2-D lifting wavelet is applied to the two dimensional matrix of RGB color images. compressed watermark signal from the speech wavelet form is embedded into the DCT coefficient values of LL sub band image. Inverse DCT and inverse LWT2 is applied on the sub band LL1, also perform the retrieval of compressed signal gives the original image. PSNR, MSE, SSIM values gives the better results for both the original image and watermarked image after extraction process.

S. Nithya.et.al[40] Proposes a scheme which uses SHA-256, AES, Arithmetic progression techniques. Medical images are divided into Region of interest(ROI) and Region of non interest(RONI), ROI contains critical information to take the decisions. SHA-256, AES is used to perform the encryption and decryption on medical image data sets.Arithmetic progression technique used to reduce the payload size and lossless compression the watermark image. In this scheme Experimental results shows the successful transformation of medical images.

Wang, L.; Ji, H. A[68] Proposed Algorithm uses techniques K-Level DWT, HMD(Hessenberg Decomposition), SVD and also to determine scaling factor it uses PSO(Particle swarm Optimiation) gives PSNR, NC Values 49.50 and 1.0 respectively, for achieving robustness and imperceptibility without attacks.

Deep neural network based invisible watermarking

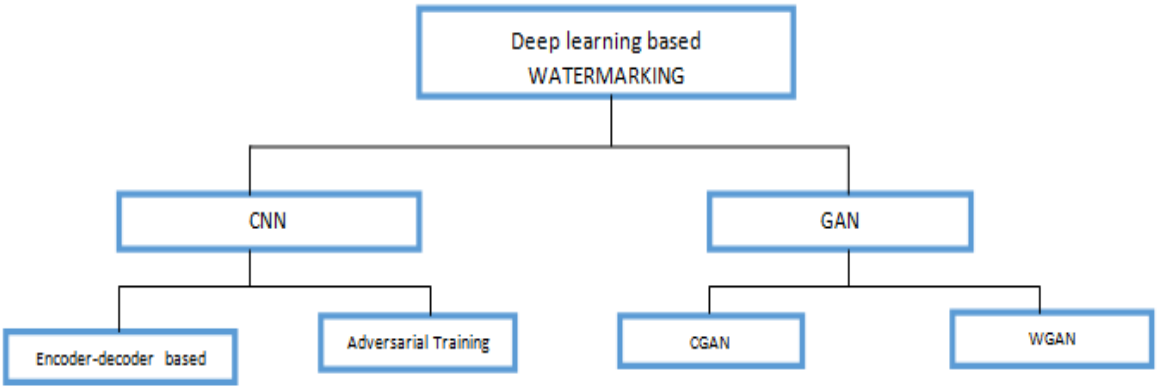

Fig2: Deep learning based watermarking types

Q. Yang.et.al[41], Proposes a scheme on the idea of super resolution and deep neural network(DNN) to reconstruction of the watermark image. It provides the solution to the watermarks disturbed by outside factors. This method mainly consists of feature extraction and image reconstruction. In the feature extraction phase it uses seven convolutional layers, 3*3 convolutional kernel and kip connections. In image reconstruction phase it uses multiple 1*1 convolutional layers, PRelu is considered as an activation function to convolutional layer.1CNN used in the the reconstruction model enhance the performance by reducing the dimensions and it also uses the less computing resources.

G. Wang.et.al[42] Proposes a visible Adversarial attack scheme it converts and inserts a watermark on the selected image to intruding the results from inceptionV3 model. Two types attacks on white box and black box are T-attack and S- attack are performed. In white box, T-attack gives the good results for adversarial samples of different levels, for S- attack it gives lower performance than the T-attack. In black box, adversarial samples onto residualNet and denseNet, S- attack gives the better results than the T-attack.

Jie Zhang.et.al[43] Proposes a watermarking frame work for preserving the image processing models by strengthening the spatial visible watermarking process. Imperceptible watermarking is embedded into the outputs of black box target model. For image processing tasks it uses two domains input domain(A), output domain(B) and a target model(M) consists of large scale image pairs and computational measures. In order to prevent the surrogate model(SM), it uses the pairs of (a_i, b_i) from the trained model(M) and develops an efficient DNN model which has capable to identify and restrict the surrogate model. Experimental results show the developed framework withstand to the various surrogate models trained with several network structures and loss functions.

Deeba.et.al[44], Proposes a deep neural network model for watermarking, which explore intellectual property of Deep neural network(DNN), Insertion of watermark and authentication. Also it provides resistance to several attacks by testing on the data sets. In DNN uses two types of watermarks includes white box

and black box watermarking. In white box model watermark is inserted into the weights, an insertion algorithm is used to insert the pre trained watermarks into the original data and it also robust to attacks. A decryption algorithm is used to extract the watermark.

Trained model gives the same error rate and accuracy for the multiple iterations so the model ensures to good against the several attacks. In this proposed model several frameworks of watermark are inserted into the DNN and also it does the ownership authentication based on the inserted watermark.

R.S. Kavitha.et.al[46], Proposes convolutional neural network model, it surpasses the present frequency domain techniques. This model introduces digital watermarking in Deep neural network through numerical modelling, algorithm shows the implementation of watermarking in neural networks. Proposed model uses the spatial domain watermarking where the LSB pixel values of host image are changed using the watermark image. It also utilizes the DNN to imperceptible watermark insertion and also uses binary signature to withstand to various attacks. Adversarial techniques disorder the decode signature, expectation maximization is used in training the decoder network, gradient descent utilized in the expectation over the transformation framework. Robustness of the watermark is evaluated by using hard, soft decision detectors. These detectors can be measured using the graphs of Receiver operating characteristics(ROC), Bit error rate(BER) helps for detector retrieval with bit sequence.

Overfit, underfit, goodfit of the training and testing results are performed. This model is invariable and estimated with other models shows the good results. The proposed scheme gives the low loss and better accuracy. By using this model we could not differentiate the original image and watermark image so that it can be used in copy right protection.

Robust invisible watermarking techniques

S. Hamad.et.al[47] Proposes a scheme based on the idea of DNA encoding and Haar Wavelet transformation process of proposed algorithm includes initially the binary watermark is converted into the DNA sequence. Next the watermark data inserted onto the third level coefficient of Haar Wavelet decomposition of the original image.

Evolution of proposed algorithm is processed using Hiding capacity, invisibility and robustness. experimental result shows high imperceptibility and also the good robustness against the jpeg compression. When compared with other existing algorithms proposed algorithm gives better performance and also it covers up to two bits in frequency band coefficient of third level DWT proposed scheme is non blind watermarking so that it uses cover image in the watermark removal process.

S. Rohith.et.al[48], Proposes a scheme which uses A5/1 cryptographic algorithm to encrypt the binary watermark image, it is encoded by repetition code and inserted into the initial host image using least significant bit[LSB] technique. In LSB embedding technique, image is represented in terms of bits and then the LSB bits are modified to insert the watermark. This model aims to provide robust and enhanced image watermarking to various densities of salt and pepper noise attack. In this scheme security is assured by A5/1 cryptographic technique and robustness is achieved by repetition code[n,1] for n = 3,5,7,9,11,13. For different salt and pepper noise densities [13,1] repetition code gives high normalized correlation[NC] for noise density 0.6 and minimum bit error rate[BER].

This scheme provides better results for the increased ‘n’ values of repetition code at the same time it takes the large size of host image and small size of watermark image.

K. R. Kakkirala.et.al[51] Proposes a blind watermarking scheme which uses the three different techniques such as Discrete wavelet transformation(DWT), Singular value decomposition(SVD), Torus automorphism. DWT technique decomposes the image into different frequency sub bands and it is basically time frequency representation. Watermark is is inserted onto any one of the frequency sub bands, SVD technique is a mathematical model which divides the original image into three singular value matrices such as USVT. Torus automorphism is a dynamic process it reorders the watermark bits into block of LL sub band of original image. Watermark embedding process of proposed method uses the logo image as a watermark, it is converted into the binary image which is embedded onto the 2D DWT, LL frequency sub band and SVD is applied onto each block. Binary watermark image is scattered by using the Torus automorphism also converted into 1D signal form then inserted onto the

processed image. Analysis from the obtained results proposed method is robust and withstand to the attacks of compression, resize, and filtering attacks, also this method is not robust against rotation attack, to overcome this attack they insert watermark into middle region of LL band and also uses the error correcting codes, in addition to this dilation, erosion methods are used remove the watermark errors.

R. Esgandari.et.al[49], Introduces a robust watermarking method based on the idea of discrete wavelet transform, proposed scheme uses the Haar wavelet transform and chaotic map function in the watermark embedding and retrieval process. Initially Haar wavelet transform is performed on the original image, different frequency sub bands are generated. Chaotic map function is performed on the watermark image with the secret key and so that we get the scattered watermark, this scattered watermark is appliedon to the Haar wavelet transform to get the watermarked image. Experimental results shows the enhanced performance compared with previous methods and it also provides the robustness against the attacks of rotation, gamma correction, Gaussian filtering, median filtering, histogram analysis, jpeg compression etc.

S. Singh.et.al[50], Proposes a method to increase the robustness and invisibility of the watermark in frequency domain. Proposed scheme uses the Deinterlacing method, which is applied on the frequency sub band of the host image, it divides the image into odd, even pixels, on which different watermarks are inserted using the additive method. It is a non blind water marking process which requires both the cover image and private key in its watermark extraction process. Experimental results shows the better visibility and resistance against the various attacks. It also shows the watermark embedding at the initial level of DWT gives more robustness and invisibility compared to the high level DWT. In future work proposed scheme can be developed by using the optimal scaling factor.

Saxena.et.al[52] Introduces a digital watermarking method which uses the concepts of image interpolation and entropy. In this scheme process of watermark embedding includes, at first binary interpolation is performed on the cover image and determines the entropy filtration on the cover image in different domains like Discrete wavelet

transformation(DWT), Discrete cosine transformation(DCT). Here the DWT has the more entropy value compared to other, so it is taken for insertion of the watermark and it is also robust to several attacks. After this Histogram equalization is performed on the interpolated image and then embed the watermark onto the decomposed watermark image. They also provided an alternative method in which it divides cover image and watermark image are divided into three different frequency channels (R, G, B) and watermark is embedded onto any one of these channels cover image and then merging the watermarked image, cover image gives the better imperceptibility of the watermark. Experiment shows the proposed method gives better PSNR values and improved security, also it uses the secret key that helps as only the known users can retrieve the watermark from the watermarked image.

Poonam.et.al[53], Proposes a watermark technique which combines DWT-SVD to solve the problem of copy right protection. In this method by using DWT the original image is decomposed into four different frequency sub bands gives the 1-D DWT and choose one of the frequency sub band among the four frequency sub bands also decompose it into different frequency sub bands gives 2-D DWT, this process is repeated for N-D DWT. Singular value decomposition(SVD) is a matrix translation process from which initial p*q size image is converted into 2-D p*q image matrix and then applies the SVD to obtain the USV^T matrices. Experimental result values of PSNR, MSE, SSIM shows proposed DWT-SVD based method can withstand to various image processing and geometric attacks.

Yahya AL-Nabhani.et.al[54], Proposes a blind watermarking method aims to generate the imperceptible watermarked images. To achieve this, proposed method uses DWT with Haar filters to insertion of the watermark and Probabilistic neural network(PNN) to retrieval of the watermark. Watermark insertion process includes, first it decomposes the cover image using wavelet transform and generate different frequency sub bands and embed the binary watermark image onto the selected wavelet coefficients. Next on the watermarked image by performing the PNN extracts the embedded watermark. Experimental results shows the superior imperceptibility of the watermarked image and better extraction of the watermarked image, also it withstand to various attacks

such as jpeg compression, rotation, Gaussian noise, cropping and median filter.

Fragile Watermarking

S. Taheri.et.al[55]Proposes a Hierarchical fragile watermarking method to process the localization problem. In hierarchical watermarking an image is decomposed into several blocks, at the top level of hierarchy blocks are created by joining the group of pixels. For authentication of data singular value decomposition is performed on each level of block. In the watermark embedding process the singular values are converted into binary bits and inserted into LSBs of arbitrarily selected pixels gives the watermarked image. In watermark retrieval process LSB pixels are compared with authenticated data and perform the XOR operation between them gives watermark image. By using the proposed method provides the location where changes are made to the watermarked image

Z. Xingyang.et.al[56],Proposes a extended fragile watermarking on the idea of secret key sharing. Proposed scheme combines all the extended channels in order to get the original image. Capability of watermark insertion is improved because of enlarged channels. Improved watermark capability resolves the problems of authentication, cropping, and tamper localization, scrambling technique is used to prevent vector quantification attack. Enlarged channels can improve the watermark embedding capacity and all the users access the original image by performing simple mathematical operation. Experimental result shows proposed fragile watermarking using ECFM method gives the better performance to tamper location, cropping, shifting and patching attacks.

Mohammad.et.al[57], Proposes a fragile watermarking scheme in spatial domain so that the computational problems are reduced, it also provides authentication and verification of images. Hamming code is used to find any modifications done to the image. By using the parity bits Hamming code can perform error correction and detection of bits in images and parity bits are combined with binary image data while encoding and these can be detached while decoding. In this two keys are used in watermark embedding process to increase the security. Initially original image is divided into blocks, by using the hamming code several rounds of parity bit placing is performed to improve

the robustness of verification. Experimental result shows this scheme provides improved localization property leads to better image authentication.

P. Patil .et.al[58], Proposes a fragile watermarking method to identify any modifications to the images. In this method watermark is acquired from the cover image, which incorporates the reference bits and check bits. These reference bits and check bits are inserted into the blocks of cover image using differential expansion algorithm. Experimental result shows a PSNR value that does not greatly improve the quality of watermarked image and it also detects tampered regions.

R. Eswaraiah.et.al[59], Proposes a block based fragile watermarking scheme which can identify any changes that are made to the original finger print image. In this scheme for authentication of data image is decomposed into 10*10 blocks and 100bit watermark is created from all the blocks, divide them 10 equal parts insert into other blocks at LSB positions. Experimental result shows, for several noise attacks the proposed algorithm reduces the SF value it confirms proposed scheme is fit to fragile watermarking. Drawback of this this scheme is it doesn't withstand to tampering. In future work by using efficient techniques can improve the result.

Q. Qian.et.al[60], Proposes a fragile watermarking for voice authentication by changing the least significant bits. this scheme has two step process, in the first step it creates the watermark and inserts, next it performs the authentication and revival of original speech signal. Proposed scheme, initially compresses the original voice signal, frame number, check bits are inserted into the least significant digits of original signal. In retrieval process by using the retrieved frame number and check bits data can detect the modified signal. Experimental result shows proposed scheme is fragile and the inserted watermark is not audible.

Public Watermarking

P. W. Wong[61], Proposes a secure invisible watermarking scheme and also it applies to visible watermarking to preserve the visible watermarks. Proposed method uses secret key to check the integrity and authentication of the original image. Authentication procedure determines any modifications that are made to pixel values by calculating its size. In this method it decomposes the original image into different blocks and the watermark is inserted onto each of these blocks along

with the user key. Proposed scheme notices if any modifications done to watermarked image. Exact user key is used in the watermark removal process. Unwatermarked image, incorrect user key, cropped watermark image gives the random noise image in its extracted output. This scheme also executes secure visible watermark by providing all the invisible watermark features into the visible watermark process

Ping Wah Wong[62], Introduces a public key watermarking scheme which expands the secret key authentication process to public key process that provides integrity and ownership to the watermarked image. In this scheme owner can insert the private key into the watermarked image, in watermark removal process public key is used to retrieve the watermark by all users. In this watermark embedding is procedure, initially it divides the original image into different blocks and watermark is inserted onto all of those blocks along with the public key.

S. C. Byun.et.al[63], Introduces a cryptographic concept to color images for image authentication. To increase security proposed model uses two keys, one key is used to change the input of hash function and other key is used for encryption and decryption of watermark. In the watermark insertion and retrieval process, proposed system can identify where the modifications done to the watermarked image and also specify the location, in watermark insertion process original color image is decomposed into R, G, B channels, blue channel is used for watermark insertion and R, G channels used to authentication purpose. The result of MD5 hash function is combined with watermark using XOR operation and it is encrypted by using the encryption algorithm. Proposed scheme requires the proper key to retrieve the watermark, it can detect altered location from the watermark using blue channel.

Y. Ding.et.al[64], Proposes a public key based multipurpose watermarking method in which the authenticated and secured watermark is inserted into the DCT transform domain. This method uses the RSA cryptosystem, Hamming code techniques. Error correcting code is used to decrease the Bit error rate(BER) and encryption is performed on the encoded watermark using RSA algorithm, also the scrambling technique used to improve the error correction rate. Experimental results shows proposed scheme has reasonable performance against different attacks like

Gaussian noise, salt and pepper, jpeg compression.

H. Cui.et.al[65], Proposes a public key cryptographic algorithm for insertion watermarks in relational data bases. Public watermarks are used for insertion and identification database watermarks. Proposed system uses third party IPR for detection of the watermark using public key and the system does not provide any information about the private key, algorithm is used to generate public and private keys by which the watermark insertion into relational databases are performed.

H. Wang.et.al[66], Proposes public watermark identification method by using secure multiparty computation. It uses integer comparison process in order to identify the watermarks with the use of secure multi party computation. Also it does not reveal any information about the watermark, provides better security to various attacks. This process eliminates the third party and uses different proxies so that it can withstand to particular instance problem.

C. T. Luyen.et.al[67], Proposes public key watermarking method in which by using normalization process public key is generated and mean, variance of public keys are 0 and 1 respectively. Watermark is grouped with the public and private key using straight line relationship of mathematical model. In the watermark embedding process initially it performs discrete wavelet transform on the original image and it selects LL frequency sub band, next LL frequency sub band is decomposed into non intersecting frequency blocks, discrete cosine transform is performed on each of these blocks and middle frequency values are considered to insert the watermark. Experimental result shows proposed method has very good robustness as compared to munir's method to various attacks such as jpeg compression, Gaussian noise, cropping, rotation and resizing.

Challenges

In public key[62] watermarking system loss of private key leads to remove the watermark from images and makes the system vulnerable to various attacks. [25]In frequency domain watermarking Discrete wavelet transform has high computational cost and increased compression time, Discrete cosine transform prone to blocking effect and also it can't resist to, compression cropping

attack. [21]In digital watermarking to attain high quality of images normally watermark is inserted on to the high frequency regions, it can decrease the robustness of watermarking, for effective robustness of watermarking low frequency regions are selected to insertion of the watermarking that effects the quality of the image.

In spatial domain watermarking[46] modifications to intensity values of pixels vulnerable to various attacks such as low pass filtering, high pass filtering, salt and pepper noise, jpeg compression. Execution time and computational cost of different models are very high needs be minimized.

Results

Table1: Analyzing performances after attacks

Ref.no.	Noise Attack	PSNR	SSIM	BER	NCC
[28]	Salt and pepper	5.59			
	Gaussian noise	5.59			
[29]	Salt and pepper				0.9805
	Gaussian noise				0.9540
[30]	Salt and pepper	53.8769	0.8745		
	Gaussian noise	75.9492	0.5903		
[49]	Salt and pepper				0.99
	Gaussian noise				0.97
[50]	Salt and pepper	23.4376	0.5417		
	Gaussian noise	34.8044	0.9980		
	JPEG	41.7035	0.8984		

[51]	Gaussian noise			0.29	
	JPEG			9.03	
[53]	Salt and pepper	30.57	0.9434		
	Gaussian noise	34.12	0.9417		
[64]	Histogram Equalization		0.992		
	Gaussian noise		0.964		
	JPEG		0.976		
	Salt and pepper		0.9473		
[68]	Gaussian Filter	38.1024			0.9999
	Salt and pepper	31.6935			0.9999
	JPEG	34.74			0.9999
	Crop	17.2629			0.9949

From the above table [24] In the watermark insertion process color watermark image is separated into three R, G, B, channels and each channel is scrambled by Arnold scrambling with secret key. On the analysis of results obtained shows watermark is invisible and robust to the geometric attacks. [23] Proposed watermarking method with stands to various geometric attacks like noise, rotation and cropping. [28] Exploiting the watermarked image to various attacks among the attacks watermarked image is good against the additive noise and gives the better results compared to other attacks. [29] . XOR operations performed on the watermark image and also used key enhance the robustness of the watermarked images, On the analysis of experimental results against several attacks proposed method enhance the quality of the image output without decreasing the ability of copy right to image changes. [47] Evolution of proposed

DNA encoding and Haar Wavelet transformation algorithm is processed using Hiding capacity, invisibility and robustness. experimental result shows high imperceptibility and also the good robustness against the jpeg compression. [30] Watermarked image is exposed to various attacks shows good robustness to the attacks, indicated by high PSNR values. [33] Experimental results indicates this method performs better for different types of document images and it also withstands to various attacks like compression, rotation, cropping, salt & pepper. [44] Trained model gives the same error rate and accuracy for the multiple iterations so the model ensures to good against the several attacks. In this proposed model several frameworks of watermark are inserted into the DNN and also it does the ownership authentication based on the inserted watermark. [49]Proposed discrete wavelet transform, proposed scheme uses the Haar wavelet transform and chaotic map function in the watermark embedding and retrieval process provides the robustness against the attacks of rotation, gamma correction, Gaussian filtering, median filtering, histogram analysis, jpeg compression etc. [51]By Applying Techniques like Discrete wavelet transformation(DWT), Singular value decomposition(SVD), Torus automorphism and and Analysis from the obtained results of proposed method is robust and withstand to the attacks of compression, resize, and filtering attacks, also this method is not robust against rotation attack, to overcome this attack they inserted watermark into middle region of LL band and also uses the error correcting codes, in addition to this dilation, erosion methods are used remove the watermark errors. [59] Proposed Fragile watermarking scheme identifies changes to watermarked image but doesn't stand firm against tampering.

Conclusion

In Digital Watermarking Robustness, Imperceptibility, embedded capacity are the major challenges and they are interrelated and influencing each other when payload capacity increases chances of detecting watermark data is easier, that will effect invisibility of watermark, After Achieving high Robustness in various methods will effect on Payload capacity and imperceptibility. Deep learning models like Auto Encoder based Convolutional Neural Networks, Generated Adversarial Networks(GAN), Fast-RCNN, Provides balance between Robustness, Invisibility, and payload

Capacity. In this paper various techniques are discussed and identified among all some techniques resist to some attacks and vulnerable to other attacks and there is a need to build a robust global watermarking technique that can resist to all types of attacks.

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