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Advanced Watermarking of Digital Images Showing Robust, Semi-Fragile and Fragile Behaviour

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Abstract: ***Digital Image Watermarking plays an important role when it comes to maintaining digital color picture authentication information. The proposed paper consists mainly of a digital watermarking scheme consisting of discrete wavelet transformation and involving the generation of pn sequence number to embed the watermark and also to extract the watermark from the host image. The technique suggested includes both embedding the watermark and removing it from the host file. Both the method of embedding and extraction consists of generating the pn sequence number values using the random numbers. The technique for all three of the RGB signal sources is included. The watermark symbol is located independently within the RGB image's red, green, and blue channels. The suggested technique further reveals the improved mode of digital watermarking of images through fragile watermarking of images and semi-fragile digital watermarking of images.***

Keywords: ***Digital Watermarking, Discrete Wavelet Transformation (DWT), pn_sequence (pseudo-noise sequence), PSNR(Peak Signal to Noise Ratio), Fragile Digital Image watermarking, NCC(Normalized Cross-Correlation).***

I. INTRODUCTION

The developments within the modern age have contributed in the present years to the particular application of the amount of multimedia materials. This type of advancement in digital technology has led to a number of distributing issues and unauthorized access to multimedia content. To overcome these problems a technique was introduced known as digital watermarking. The watermarking is a method of integrating established knowledge into the multimedia data. A general digital picture watermarking block-diagram can be seen in Figure.1. Therefore the identified data contained in the cover image is considered the details about the watermark, and the image in which the watermark is stored is identified as the picture cover. In general, embedding a watermark in a cover image causes the image quality to degrade into which the watermark is embedded. The deterioration of the cover image caused by the inclusion of a watermark within the cover image is thus imperceptible to the human eye. Therefore the watermarked images are targeted causing the distortions either by the use of aggressive attacks or by the use of passive attacks. It is also possible to merge several different operations and either change the secret watermark or delete the watermark or erase the watermark on the watermark picture. The watermark methodology capable of embedding the watermark must be resilient to all manner of (active and passive) threats. A watermarking technique's level of robustness implies the notion of how much the embedded watermark image can be removed. The number of current watermarking techniques deals mainly with the perceptibility of the embedding phase of a given watermark and the robustness of the extraction. Watermarking techniques are divided into several due to the various characteristics that the watermarking techniques have. The watermarking techniques are divided into the transparent watermarking and invisible watermarking techniques, based on the illumination. The clear watermarking method is one in which the author of the digital content can be clearly detected, in other words the watermark

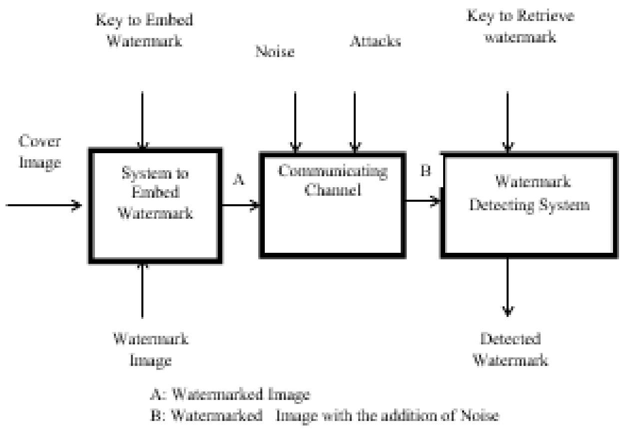

Fig: 1 General block diagram for digital watermarking system

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can be easily noticed by the human eye and is inserted in the cover image using a watermarking process. The invisible watermarking is the one that is imperceptible inside the cover image. The watermarking strategies are categorized into spatial domain watermarking and the frequency domain watermarking according to the domain chosen for the watermarking. The watermarking strategies in the spatial domain are the one that requires direct alteration of the pixel values of the cover image onto which the watermark is to be inserted. The watermarking spatial domain technique is called the oldest method, and the continuum method and LSB approach are still the widely used watermarking spatial domain techniques. The key benefits of the spatial domain techniques are the simple execution of these methods, with low computing costs and the key disadvantages associated with the spatial domain techniques are resilient to just a few attacks. The techniques of the frequency domain include converting the original cover image into a shape more appropriate for embedding the watermark image, this transformation takes the original image directly from its spatial domain to its transform domain. Many of these include Discrete Wavelet Transformation (DWT), Discrete Cosine Transformation (DCT), Walsh-Hadamard Transformation (WHT), discrete Fourier Transformation, Ridgelet Transformation, etc. The processing methods of embedding the watermark inside the cover image include first converting the image into a new shape and then embedding the watermark into it. The picture watermarking transformation domain strategies have a greater quality of imperceptibility involved to the watermark along with a high degree of robustness against all kinds of attacks. Based on the permanence, the invisible watermarking strategies are further categorized into various groups such as delicate watermarking of images, semi-fragile watermarking of images and solid watermarking of images. Fragile watermarking strategies are the ones that are capable of distinguishing the tampers in the watermarked images. The delicate methods of watermarking photographs are responsible for maintaining the image accuracy and data validity. The theory behind the delicate watermark is that as the host image is changed in a linear and non-linear transition the watermark may be quickly altered or lost. Further the fragile digital image watermarking techniques are broadly classified into two categories mainly:

1) Block wise fragile watermarking
2) Pixel wise fragile watermarking.

Fragile watermarking in block-wise terms includes adding and removing the watermark from the host image using the watermark information given by each of the blocks. Whereas the watermark information is derived directly from each of the pixels in the case of a pixel-wise approach of fragile image watermarking, either to embed the watermark into the cover image or to extract the watermark from the cover image. Semi-fragile watermarking approach is the one that combines fragile digital image watermarking with robust digital image watermarking. Semi-fragile digital image watermarking techniques display robustness feature only to a number of attacks while showing fragility to a number of attacks, hence the technique is called semi-fragile. Robust watermarking methods for the image are the ones that have the potential to withstand all the attacks responsible for modifying the watermarked images. Frequent attacks in the watermarked images are image compression, noise addition, filtering geometric transformations, etc. Robust image watermarking techniques are responsible for providing the images with a high degree of authenticity and verification. The approach involves the specifics of the separation and application of the watermark, and the process involved. The suggested technique is used in specific situations to produce the findings, and in all the situations examined. A decision is drawn on the basis of the different findings obtained and finally the sources are mentioned in the last section based on these a protocol is developed for the insertion and extraction of watermarks.

II. LITERATURE SURVEY

[1] have introduced a secure image authentication scheme based on the double fragile watermark. The proposed algorithm focuses mainly on the security along with the localization of the tamper. These safety aspects concern primarily the fragility of the scheme. The double fragile watermark is specifically notified as watermark for diffusion and watermark for authentication. The cover image determines the diffusion watermark with the use of the secret key along with the two random numbers via non-linear transformations in addition it is also notified that the watermark for authenticity is generated mainly with the use of the cover image. The suggested scheme primarily demonstrates the diffusion watermark and the authentication watermark has a higher degree of sensitivity to the cover images and at the same time it is the duty of the authentication watermark to check the validity of the photographs and find the corrupted photographs. The scrambled authentication watermark and diffusion watermark are randomly inserted in a random sequence managed by a hidden key in the two lowest significant bit layers of the cover file. The concept aims to strengthen the reliability of vulnerable watermarking and the statistical findings and performance review demonstrate that this scheme can withstand selected cover-image attacks. [2] have mainly proposed a review report on the digital image watermarking techniques. Digital image identification is an increasingly critical issue for the digital revolution, since any image can be quickly manipulated. The authenticity of digital images has been a pressing concern for researchers over the past few decades. Several suitable watermarking techniques were developed to mitigate this concern, based on the desired applications. It is tough though to achieve a watermarking system that is both robust and safe at the same time. This paper provides details of standard watermarking system frameworks and lists some standard requirements which are used to design watermarking techniques for several different applications. In order to determine the state-of-the-art approaches and their drawbacks, the latest developments in digital image watermarking strategies are also studied. Some traditional attacks are discussed, and directions for future research are given. [3]have established an watermarking algorithm that is reversible and is based upon the quadratic difference expansion.

A reversible image watermarking algorithm based on quadratic difference extension is proposed to boost the visual consistency and embedding performance of existing reversible image watermarking algorithms. First, the pixel points with grayscale values 0 and 255 are replaced in the original image and the half-scrambled watermark detail is inserted into the original image using expansion of linear differences. Finally, the remaining half of the watermark information is embedded in the previously generated watermarked image by the expansion of the quadratic difference, while the pixel points with gray scale values 0 are removed the image is merged with 255, and the final watermarked image is created accordingly. + e experimental results show that the algorithm has both a high embedding rate and a high visual quality capable of recovering the original image completely. Compared to other watermarking algorithms for differential expansion, it has certain advantages without having to consider the smoothness of the embedded image region. [4] have presented a paper comprising of the digital image watermarking technique that is carried out at the various levels of the DWT with the utilization of the RGB channels. This paper proposes a watermarking scheme for digital image, consisting of DWT transformation. Thanks to the normal method of making the replica, the data replication of the original version is transferred and diffused. Digital picture watermarking has the potential to offer a solution to the issue of unintended replication. The scheme developed and discussed in this paper consists primarily of two modules one for embedding the watermark within the cover image and another one for removing the watermark from the watermarked picture. The process is conducted within different sub-bands of the DWT transformation at different levels of the DWT transformation. The extraction method involves removing the watermark image from different RGB signal sources mostly red, green , and blue. There are checks on robustness and imperceptibility. The related PSNR and correlation values are noted in each case and the findings obtained infer the scheme as the stable, semi-delicate and delicate digital image watermarking at different stages of the DWT transformation.

[5]have presented a colored image watermarking technique with the usage of the singular value decomposition for the sake of the data protection. Data is inserted for a range of reasons, including copyright enforcement, source tracing, piracy prevention, tamper proofing etc. It shall therefore be embedded in a manner that makes it difficult to visualize with the human eye and difficult to remove. When machines become gradually connected across the network, automated data sharing is getting cheaper, simpler and requires less effort to produce exact copies. One of the current areas of research is to protect the digital watermark within the information, so that third parties cannot claim ownership of the information. In this paper, we propose a colored digital image watermarking algorithm based on singular value decomposition. This paper covers the embedding, watermark extraction algorithm and some robustness tests while coloring images of both the host and watermark. The quality of the watermarked image is tested against most common attacks, such as image compression, filtering, cropping, noise injection, blurring and sharpening, by experiment. The robustness of the proposed watermarking algorithm was tested using standard benchmark. Experimental results show the algorithm to be strong against geometric attacks. [6] have proposed an watermarking technique that is invisible with the usage of the hybrid scheme. Proposed hybrid technique is transparent watermarking system composed of blind and non-blind watermarking strategies. First, the blind scheme is used as an internal watermarking scheme and then as an outer watermarking scheme, the non-blind watermarking scheme. A binary hidden image is taken as a watermark, and using the blind watermarking scheme in conjunction with a predefined binary digit sequence block, embedded in an inner cover image using discrete wavelet transformation (DWT) and obtaining factor α to get an inner watermarked picture. Then, using DWT and singular value decomposition by non-blind watermarking technique, this inner watermarked image is embedded into an outer cover image to get hybrid watermarked image. On the contrary, techniques for extracting the secret binary image are used first to extract non-blind watermark, and then to extract blind watermark. From the experimental findings, this hybrid watermarking method is demonstrated to be resilient against distortion, JPEG fragmentation, salt and pepper noise, Gaussian noise, sparkling noise and Poisson noise. [7] have proposed a methodology known as Blind Digital Image Watermarking for hadmard-based copyright turn protection. The proposed approach uses the technique of breadth-first scan to alert the productive position for embedding the watermark within the cover file. The average system output for embedding the watermark is measured and told using the values PSNR and NCC. Experiments were performed using the recommended methods such as JPEG compression, cropping, sharpening, and filtration. The paper involves a comparison test, showing the best findings with the robustness and imperceptibility. The image extraction approach does not include the host image or the original watermark image which rendered the proposed method a blind watermarking technique. The program's methodology is based on the MATLAB environment, and the simulation process only takes place on gray scale images. [8]have Proposed a text-based text-image watermarking technique known as Integer Wavelet Transform and Discrete Cosine Transform(DCT) that involves the protection of text images using digital watermarking. The method involves the combination of the two mainly Integer Wavelet Transformation (IWT) and Discrete Cosine Transformation (DCT) Transformations. The watermark embedding process involves applying the entire wavelet transition to the cover picture as the Discrete cosine transition is applied to the LL sub-bands of the lower frequency. To order to achieve a high degree of robustness and imperceptibility, the watermark is often located within the lower to medium DCT coefficients. The final findings obtained revealed that the approach suggested is more imperceptible than the current methodologies applied to the Arabic text-images. Also, the proposed approach achieves a greater degree of robustness particularly against compression and additive noise. The experiments performed using the suggested technique primarily use four values for calculating the correct DCT coefficients, namely 9, 16, 25 and 36. In this way, the results are obtained too close in case of imperceptibility and robustness but still differ in efficiency.

The technique has the lower PSNR values when checking its robustness against the equalization checks on rotation and histogram. [9] have shown a new watermarking scheme called fragile watermarking for copyright authentication and modification of medical photographs using compressive sensing, a hybrid fragile watermarking technique based on non-blind approach, was introduced. The method is specifically intended to exploit image recognition and also to protect the copyrights of protected images. The technique consists mainly of integrating the compressive sensing principle, Discrete Wavelet Transformation along with the non-sampled contour enabling transformation to achieve a high degree of protection, high degree of embedding efficiency, and authenticity. The specifications of the technique are met primarily by placing the encrypted watermark into the contour of the lower frequency let coefficients of the cover images. Finally , the experimental findings suggest that the proposed technique is capable of withstanding a high degree of protection, a higher rate of imperceptibility, validity and identification of manipulations for a variety of specific image processing and geometric assaults. The experimental results show that the average PSNR values obtained are equal to 92.22dB and the value varies with the various types of cover images used or with the watermarked images used or with the different values defining the gain factor. The suggested technique can be used for authentication purposes as well as for exploiting the identification of sensitive color images against a variety of malicious attacks. [10]have Proposed a new scheme known as Secure and Robust Fragile Watermarking Scheme for medical images which is concerned primarily with fragile watermarking to authenticate images and also with the process of self-recovery, particularly with medical applications. The key solution to this picture protection is largely important in order to meet the criteria of medical facilities, both in the case of safety and non-safety. The proposed scheme is largely responsible for the image manipulation along with the initial image recovery. The suggested scheme primarily uses two authentication bits known as the block authentication bit and the self-recovery bit which are responsible for surviving the attack on vector quantization. The scheme uses Arnold transformation to evaluate self-recovery bits inclusion and then restores the original image even after a higher tampering rate. The proposed scheme illustrates the use of SVD approach to watermark the images, and improves the image accuracy quality. Several different types of attacks are introduced to better test the new system. The attacks are mainly text delete attacks, text injection attacks, and copying and pasting copies. The experimental findings showed that the scheme is very accurate and able to identify the blocks that were targeted. [11]have proposed a digital watermarking strategy called An improved delicate watermarking system for digital image security and self-recovery. The technique is based primarily on the approach to source-channel coding, which is mainly used to protect and self-recover digital images. The suggested scheme is based primarily on the set partitioning in case encoding in hierarchical trees (SPIHT) and Reed-Solomon (RS) code. The technique consists of watermark bit-budget and further involves three parts, the first part consists of source encoder output bits used for self-recovery of image information, the second part consists of channel code parity bits used to correct source encoder output bits errors, and the last part consists of test bits used to detect corrupted image region. As a consequence of the developed source and channel codes, the proposed technique is successful for the image recovery efficiency. The suggested scheme is already shown to be unsuccessful under circumstances such as abuse of channel parity bits. The experimental results for the proposed scheme are calculated on the basis of a) Ability of tampering discrimination b) Robustness against parity bits modification attack. [12]have Presented an algorithm known as digital image protection using digital watermarking and the description is linked to the various principles and research works in the area of digital image watermarking for image authentication. The proposed research work also involves the comparative study of various watermarking techniques and also involves the advantages and drawbacks involved with each of the techniques. The paper ends with a detailed review of the various facets of automated watermarking strategies and their implementations. The paper also provides watermarking algorithms for the classification process primarily focused on the spatial domain and the domain of transformation. [13]have proposed a technique known as a robust watermarking image technique with an optimal DCT-Psychovisual threshold related to a reliable digital watermarking technique with a degree of imperceptibility and robustness for copyright protection using an optimal psychovisual threshold of DCT. The embedding method within the suggested watermarking methodology requires a variety of DCT frequency zones, in which case the addition of the watermark bits produces the least distortion of picture. The embedding process often includes deciding the optimum psychovisual level to achieve the best image quality after the watermark has been embedded in the host image. The method of embedding involves changing the other coefficients to create the images of the watermark. This method demonstrates that during the embedding phase of the watermark bits in a few chosen image frequencies the watermark is not specifically incorporated into the coefficients. The technique uses a process known as the adjusted entropy, to evaluate the embedding frequencies. The protection for the watermarked images is established by scrambling the watermark to be placed within the picture cover. Data from the tests demonstrate that the new methods gain greater invisibility and robustness than the current schemes. The testing evaluation of the suggested scheme is further carried out by applying the various different image recognition and geometric attacks. [14]have proposed a visual watermarking methodology known as the accuracy assessment of a database image watermarking approach with improved tamper detection, mainly responsible for assessing a non-blind reliable watermarking approach with linear interpolation to track, identify and recover. The performance of the proposed scheme is investigated along with its resistance to paint-based and stirmark-based assaults on sensitive documents. The proposed scheme specifically uses a sensitive Arabic script as a case study to provide a sensitive image of a document, and the specified operations were performed on the selected sensitive image. Therefore, in contrast to other versions, the new implementation is considered the superior implementation of tamper detection and recovery capabilities.

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The simulation results showed that the proposed approach was resistant to numerous malicious attacks and has the high degree of precision against the potential to find and correct distorted regions. Finally, it is recognized that in its wide applicability to other sensitive digital images, the proposed solution has another advantage. The experimental and the outcome section primarily contain two separate types of attacks conducted on the scheme: first, the attacks generated using the windows paint framework and the attacks created during the Stir-Mark test suite. The experiments carried out on the grayscale images with a fixed size of 256x256 were primarily carried out. The proposed scheme is contrasted with the previous schemes and thereby asserts dominance of the proposed scheme over other algorithms for processing and recovery of the chosen set of images. [15]have proposed an image authentication scheme based on reversible delicate watermarking with two images and capable of achieving adequate precision in the identification of manipulations and also the consistency of watermarking images. The suggested solution includes applying the reversible data hiding strategy consisting of the two equivalent host images where one image is concealed in the sensitive information to be stored, while the skewed information is encoded in another image. The suggested approach involves the process of matching information derived from the image with the original verification information in order to measure the effects by notifying the interference within the data extracted. The experimental findings obtained indicate that the proposed algorithm is capable of achieving a high degree of accuracy in the identification of manipulations and also ensuring the consistency of the image to integrate adequate authentication knowledge. [16] have suggested technique known as entropy-based texture watermarking using discrete wavelet transform which is a novel image watermarking approach that utilizes host entropy to watermark layer texture. The coefficients of the host image's discrete wavelet transition are measured with the entropy. Then, the scheme chooses the sub-band with the maximum entropy to add the watermark texture. The watermark texturization is done using the Arnold process, and a texture is randomly chosen. The security level of the scheme is increased by embedding a texture in place of the watermark itself. To analyze the proposed entropy-based sub-band selection, a number of experiments are established, such as linear weight evaluation, watermark embedding, and watermark host extraction. Ultimately, based on the experimental results obtained, it is demonstrated that the proposed approach efficiently removes the watermark along with improved imperceptibility of the host images. The proposed scheme builds on a novel DWT domain approach. The conclusion part states that the method proposed when analyzing the metrics is capable of providing better watermark embedding and extraction with the advanced security that is possible due to the Arnold transformation's periodicity property. [17]have proposed a study of many vulnerable watermarking systems known as vulnerable image authentication watermarking schemes proposed over the past decade for image authentication purposes. The primary objective of conducting the survey over fragile watermarking is due to the restricted capability of embedding, and the degree of tampering is the aim that draws primarily in this field of study. The findings of the survey that region out are based primarily on the different types of attacks and criteria that are used to test the schemes. Definitions of the various separate types of fragile watermarking strategies are described such as self-embedding based fragile watermarking scheme and the changes to watermark generation are carefully discussed along with block mapping and variable payload. Fragile watermarking systems are explored based on the pixel-grouping and probability distribution functions. Often explored in depth are the hamming language and the converted contexts and miscellaneous strategies. In each of these sections the descriptive and quantitative analysis with a short overview of all the schemes was noted. [18]have proposed a robust digital image watermarking algorithm known as a robust digital image watermarking algorithm based on DCT domain for copyright protection and is based upon DCT domain for copyright protection. The scheme embeds a binary watermark image into the cover image. A toral automorphism system is used by the proposed watermarking algorithm to scramble the watermark image that is used as a watermark. The scheme uses the discrete cosine transform over the blocks of a gray scale image which is used as a carrier image and a quantization table is noted down by the side. Further the results are used when an image needs a relatively higher compression rate and is used to quantize the coefficients of the DCT. After the process of the quantization some of the statistical characteristics of the coefficients which are either greater or smaller to the value zero will be utilized to implement the embedding of the watermark. It is noted that the watermarking algorithm that is proposed is expected to gain great robustness that to with respect to the JPEG compressing. The results obtained through the simulation experiment also prove the strength of the proposed algorithm. [19]have proposed a methodology known as intelligent multiple watermarking schemes for the authentication and tamper recovery of information in document image. The methodology involves division of the source document into a number of blocks which are of the same dimensions. For each of the divided block appropriate type of watermarking technique is decided the process is carried mainly by notifying the type of the block which is determined automatically using gradient binarized technique. Further the blocks having regeneratable information are protected using semi-fragile watermarking and the blocks which do not have regeneratable information are protected with the fragile watermarking technique. The experiments results out of this methodology clearly shows the accurate identification of the type of the block and the performance results shows that multiple watermarking schemes have also been reduced the capacity of embedding and by the side improving the perceptual quality of the watermarked image. The methodology shows the classification of the blocks of the cover image automatically with greater accuracy. The proposed methodology has the maximum accuracy towards the tamper detection and recovery capabilities. Finally improvement within the accuracy of identification of the type of block is the task of enhancement of the proposed methodology. [20]have proposed a methodology known as an evolutionary programming approach for securing medical images using watermarking scheme in invariant discrete wavelet transformation. The purpose of the methodology is to mainly achieve the high imperceptibility.

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The proposed methodology mainly considers the low frequency blocks to embed the watermark image into the cover image. Further entropy is employed to notify the suitable blocks to embed the watermark. Hence the combination of IDWT using the singular value decomposition (SVD) and particle swarm optimization (PSO) are used to construct the methodology and to attain the criteria. Thus the improved IDWT is applied over the medical images to retrieve the invariant wavelet domain and then the watermark is inserted within the selected region by continuously modifying the values of the coefficient within the image using the threshold function. The proposed method optimizes the scaling factors during the process using the PSO algorithm. Finally the performance of the proposed methodology is evaluated using the existing schemes which are much similar to the properties of the proposed model. The similarities between the watermarked medical image and the medical image are calculated using the normalized coefficient (NC) and peak signal to noise ratio (PSNR) and thus based upon the values obtained the proposed methodology is declared to have improved performance in terms of the imperceptibility and robustness. [21]have proposed a watermarking technique known as selective bit embedding scheme for robust blind color image watermarking which is called a novel robust color image watermarking method which involves embedding of a gray-scale image as an watermark into the cover image within the wavelet domain. The proposed method involves decomposition of the gray-scale image watermark image into its component binary images in the ordering of digits specified from least significant bit (LSB) to the most significant bit (MSB) then the binary bits those are retrieved are then embedded within the wavelet blocks having two optimal color channels with th usage of an efficient quantization technique. Further the wavelet coefficient difference within each of the block is quantized either two pre-defined thresholds for the corresponding 0-bits and to the 1-bits. The proposed method consists of splitting the coefficients modified quantity equally on two on two middle-frequency sub-bands instead of having single one as in the case of existing approaches this is due to optimize the watermark imperceptibility. This embedding rule implementation technique within the proposed methodology increases approximately 3 dB of the watermarked image quality. Further the minimum trade-off between the imperceptibility and robustness is mainly controlled by a factor that represents the embedding strength. The proposed methodology utilizes 2D Otsu algorithm within the extraction process for its high accuracy of the watermark detection rather using the 1D Otsu. The experimental results derived prove that the robustness achieved by the proposed watermarking model against common image processing operations is efficient along with the imperceptibility of the watermark within the host image. [22]have proposed a scheme known as self-embedding fragile watermarking scheme to restoration of a tampered image using AMBTC using the digital forgery. The scheme includes an absolute moment block truncation coding image used as an watermark, in which case the image was a compressed version of the original cover image and also contained the content features of the original cover image hence the scheme involves the perfect possible way to perform self-embedding process. Further the scheme involves the embedding process of watermark using the LSB and 2LSB technique for the pixels concerned to the cover image. Thus the procedure opted in the scheme allowed to recover the possible original watermarked image from a tampered watermarked image. Further it is claimed that, the scheme is more efficient for the reconstruction of the watermarked image even it is tampered more than 80%. The proposed self-embedding scheme is verified through an experiment and the results of the experiment are declared to get the recovered image which has good perceptual quality as compared to those with the previous schemes. The proposed scheme program is implemented using the Matlab tool and the results of the experiment are noted down. The chosen cover images for the experiment were of the type gray scale images having sizes equal to the 512x512. Further photo shop tools were included to make a tampered image. The experiment and result section also includes a comparison test with the various restoration capabilities among different schemes. It is declared that main purpose to propose the scheme is to implement a fragile watermarking scheme. [23]have proposed a technique on a feature based semi-fragile Watermarking algorithm for digital color image authentication using hybrid transform semi-fragile watermarking that is based on using feature extraction. The technique includes mainly canny edge detection trough which features of original image are extracted and is utilized further as a watermark. The proposed technique involves a strategy of providing security through scrambling the watermark. The technique is comprised mainly by the combination of DCT, DWT, and SVD. The experimental results thus obtained clarifies that, the proposed technique is robust against a number of attacks consisting of sufficient hiding capacity and imperceptibility as compared to the existing systems. The experimental results showed the maximum value of the PSNR obtained is about 93dB and the robustness achieved is maximum with the jpeg compression that is noted to be around 90% compressed. The experiment involves the Gaussian noise which is up to the 0.03 variance with the salt and pepper up to 0.03 density further sharpen image and motion blur processes are also carried out. Based upon the experimental results obtained the proposed semi-fragile watermarking technique is acceptable for image authentication. The proposed technique is highlighted as a non-blind watermarking technique and in future this technique is improved as blind system along with the implementation of the tamper detection technique from the watermarked image. [24]have proposed a new fragile watermarking methodology known as fragile image watermarking with pixel-wise recovery based based on overlapping embedding strategy signal processing that consists of high-quality recovery capability composed on overlapping embedding strategy. The proposed scheme is comprised mainly of block-wise mechanism for tampering localization along with the pixel-wise mechanism for the sake of content recovery. Reference bits are generated from the man value of each overlapping block, which are then are dispersedly embedded within the 1 LSB or 2 LSB layers of the image which are corresponding to the horizontal-vertical mode and also the diagonal mode. Further the authentication bits are hidden within the adaptive LSB layers of the central pixel for each block according to the block complexity.

The scheme mainly exploits three pixel-wise manners for tampering recovery that are based on different neighboring blocks the process is carried at the receiver side after locating tampered blocks and also reconstructing mean-value bits according to the different types of tampered pixels in each of the overlapping block. The experimental results are derived over number of images to check the superiority of the proposed scheme. The software and the hardware tools that are used to implement the scheme are mainly 2.50 GHz Intel i5 processor, 4.00 GB memory, and Windows 7 operating system and programming environment being the MATLAB 2010b. Selected number of test images of size 512x512 is mainly used serving as the cover image and the scheme notifies the PSNR values of the watermarked images. The scheme concludes that the overlapping block-wise mechanism for the tampering detection along with the pixel-wise mechanism for content recovery is both proposed. The Proposed scheme is compared finally with some reported schemes and declared that the proposed scheme achieve superior performance of tampering recovery even for larger tampering rates. [25]have proposed a technique known as a robust digital image watermarking algorithm using DWT and SVD. The method is restricted to the size of the cover image having the value 256x256 which is further decomposed using the DWT transformation into the third level using Haar wavelet which produces four different sub-bands. Further diagonal matrices of the singular values are obtained by the application of the SVD onto these sub-bands. The watermark image that has to be embedded is embedded into these singular values of the four sub-bands. The algorithm proposed is simulated using the tool MATLAB v.2013 and the results thus obtained showed that the PSNR value is equal to the 84.25 which lies within the range 0.1-0.11 of the scale factor. The proposed scheme also shows that the process of extracting the watermark image is quite easy even when the watermarked image is under the influence of several different attacks like rotation, motion blur, Gaussian noise, gamma correction, rescaling, cropping, Gaussian blur, contrast adjustment, histogram equalization etc.

[26]have proposed a technique of Performance Evaluation of Digital Color Image Watermarking Using Column Walsh Wavelet Transform which is a robust image watermarking technique comprising of wavelet transform that is generated from a known orthogonal transform walsh. The proposed methodology involves embedding of the watermark image into the middle frequency band of the column wavelet transformed of the cover image. Further the performance of the proposed methodology is evaluated under the influence of the many of the image processing attacks such as compression, cropping, addition of run length noise with the usage of binary and Gaussian distribution and also image resizing is performed. The paper also involves a comparison test on the basis of the robustness to the various attacks using MSE which is termed as a metric for robustness. It is concluded that the column wavelet is found to be preferable over all of the wavelet and also column wavelet is preferable over DCT wavelet for robustness. Walsh transform is more dominant than walsh wavelet transform against many of th attacks such as compression in the range of 69-100% and against cropping attack in the range of 90-98% and against noise addition fom 28 to 30% and against resizing attack by 40% hence proving the required robustness. The experimental results obtained further showed that the column walsh wavelet is also found to have more robustness as compared to the column DCT wavelet for the attacks like compression have a range of 19-51%, against cropping by 15-47% and against the resizing attack by 6-20%.

III. METHODOLOGY

The proposed methodology for digital image watermarking consists of both watermark embedding scheme and watermark extraction scheme. The watermark embedding scheme uses the discrete wavelet transformation along with the usage of pseudo-noise sequences. This section deals with the discrete wavelet transformation in detail.

Discrete wavelet transformation: The acceptance of the DWT has gained a lot of attention within the signal processing as well as within the image compression technique. The JPEG committee recently has released a new image coding standard which is mainly based upon the DWT transformation. The wavelet transforms decomposes an image into a set of its basis functions. The base functions thus established after the decomposition process are known as the wavelets. The wavelets thus obtained mainly are from a single prototype which is referred as the mother wavelet and thus is subjected to dilations and shifting process. The DWT transformation is referred to be as the highly efficient and flexible method of sub-band decomposition for an image. Nowadays the 2-DWT is situated as a key operation in case of the image processing which further is referred as the multi-resolution analysis and it is about to decompose the images into wavelet coefficients and scaling functions. In case of the DWT the image energy concentrates more to the specific wavelet coefficients. This characteristic feature of the DWT transformation is much useful for the compression of the digital images.

The proposed methodology uses haar wavelet transformation for the sake of decomposition. It is observed that, the Haar wavelet is discontinuous and it resembles a step function. The technique of haar wavelet is observed to be a discrete form were haar wavelets are related to a mathematical operation called the haar transform. The haar transform obtained thus serves as a prototype for all of the other wavelet transforms.

The term wavelet is referred as a small wave; hence wavelet analysis can also be stated as, the analysis of a complete signal or a complete image having short duration of finite energy functions. The main applications in which wavelets are extremely involved are mainly in image processing and in compression techniques because of its less computational complexity of separable transforms. Further Wavelets are known to be the special functions which, in a form resembles to sines and cosines mainly in case of Fourier analysis that are used as basal functions. The process of applying DWT for the 2D-images is considered to be as the processing of the images using 2-D filters within each of the dimension. The application of DWT leads to the division of the input image into four non-overlapping multi-resolution sub-bands in general known as the LL1, LH1, HL1, and HH1 were in this case ‘L’ stands for the lower frequency towards the rows and ‘H’ stands for the higher frequency towards the columns and each of the sub-bands has got its own unique identity.

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Sub-band LL1 constitutes the coarse-scale discrete wavelet transformation coefficients while the sub-bands LH1, HL1, and HH1 constitute the fine-scale of discrete wavelet coefficients. To determine the next fine-scale of wavelet coefficients, the sub-band HL1 is further divided into its four non-overlapping sub-bands until some fine-scale N is attained. Wavelets transform the image which is under the influence into the form which has got a high range of meaning than before. The choice of a particular wavelet mainly depends on the type of the application that is built. Wavelet transformation has the capability to provide both the temporal as well as the frequency information of an image, further, it has the high range of capability to show the multi-resolution characteristic features of an image, and wavelet transformations are mainly utilized in the cases of transients. Wavelets are further known as the mathematical functions that are responsible to define certain criteria's as a zero mean and are utilized for analyzing and representing the images or other functions. The important characteristic feature of the DWT is the, it exhibits the property known as the spatio-frequency localization that represents the DWT which is appropriate to identify the areas within the cover image where a watermark can be embedded effectively. In general it is termed to be, most of the energy of an image lies within the lower frequency sub-bands mentioned as the LLx where x=1,2,3,… thus embedding a given watermark image within these sub-bands leads to the degradation of the cover image significantly. The HHx sub-bands are declared as the high-frequency sub-bands that consist of both the edges and the textures of the cover image and further any of the changes made to these sub-bands will remain insensitive to the human eyes. Based upon these considerations thus the conclusion drawn by many of the DWT-based watermarking algorithms is to embed the watermark image within the middle frequency sub-bands LHx and HLx that further corresponds to the acceptable performance with respect to the imperceptibility and robustness. Fig.2 show's all of the sub-bands related to the wavelet transform in the frequency domain.

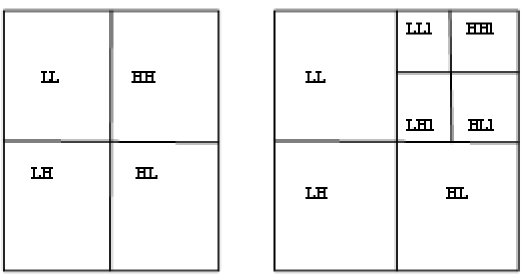

Fig: 2 Sub-bands Of DWT

PN-Sequence generator: PN-Sequence generator is a block that is responsible to generate a sequence of pseudorandom binary numbers with the usage of a linear-feedback shift register (LFSR). This block is implemented mainly with the LFSR that uses a simple shift register generator configuration. The obtained pseudo noise sequences thus can be used within a pseudorandom scrambler and descrambler. It is possible to use the same within a direct-sequence spread-spectrum system.

The registers thus mentioned within the generator blocks are 'r' in number and are capable to update their values at each of the time step, with the basis to the value of the incoming arrow to the shift registers. The main function of the adders is to perform addition modulo 2. The shift register is declared by the generator polynomial parameters which is referred to as the primitive binary polynomial in z and is represented as the grZr+gr-1Zr-1+gr-2Zr-2+…….+g0. The coefficient gk is referred to as 1 if there exists a connection for the kth register.

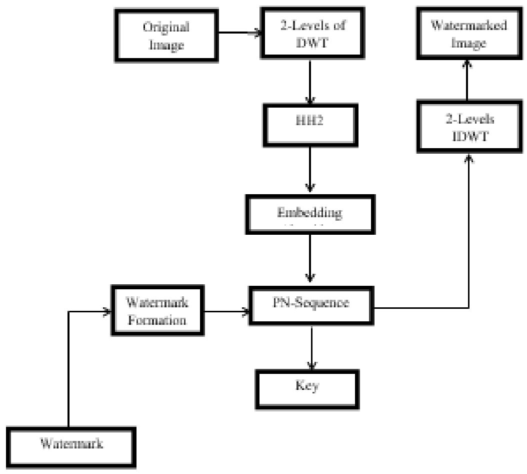

Fig: 3 Watermark Embedding Procedure

Based upon the above discussions mentioned a methodology for the digital image watermark method is proposed. The methodology comprises of the 2-level DWT transformation along with the pn-sequence generator.

Method for embedding a watermark image into the cover image

Algorithm1:Watermark Embedding

Start

Step 1: Read cover image

Step 2: Read watermark image

Step 3: Set the gain factor constant k=1 for embedding the watermark image

Step 4: Determine the size of the cover image and notify the values within the variables

Step 5: Determine the size of the watermark image and notify the values within the variables

Step 6: Reshape the watermarked image into a message vector by rounding the values into its nearest values

Step 7: Generate the random numbers by mentioning the state seed so that to obtain same repeated number of the random numbers

Step 8: Apply 2-level DWT to the cover image

Step 9: Apply 2-level DWT to the CD band

Step 10: Perform the operation by specifying the loop from first element of the message vector till the last element of the message vector

Step 11: Generate pn_sequence using the random numbers by specifying the dimensions quarter to the size of the cover image

Step 12: Apply the control statement if and else by specifying the condition

If (message1 (kk)==0)

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cD2=cD2+k*pn_sequnce_v;
end

Step 13: Apply2-idwt to retain the cD11 component

Step 14: Apply 2-idwt to cD11 again to obtain watermarked image

Step 15: Write the same retrieved watermark image into another image

Step 16: Calculate the PSNR value by comparing the original cover image and the watermarked image

Step 17: Insert various noises into the Watermarked image like Gaussian noise, poison noise, salt and pepper noise and speckle noise and apply the cropping effects to the inserted watermark and note down the correlation value obtained in all of the cases by comparing the extracted watermark image and original watermark image

Step 18: Display the same watermarked image

End

The proposed methodology involves reading of the original cover image and the determination of the size of the original image and storing the dimension values within the variables. The step is followed by reading the watermark image and determining the size. The methodology involves generation of the random numbers with the seed being the state. Apply two levels of DWT to the cover image. Generate the pn-sequence values with the usage of the random numbers dimensions being equal to the quarter size of the cover size. Embed the watermark with the usage of the pn-sequence numbers. Finally apply two dimensional idwt to obtain the watermarked image and write the image into another image.

Method for extracting a watermark image from the cover image

Algorithm 2: Watermark Extraction

Step 1: Read the watermarked image into the variable

Step 2: Determine the size of the watermarked image

Step 3: Read the original watermark image

Step 4: Determine the size of the original watermark image

Step 5: Generate random numbers

Step 6: Create a message vector of ones having the dimensions equal to the size of the original watermark image

Step 7: Apply 2-DWT to the watermarked image to obtain the four sub-bands

Step 8: Apply 2-DWT to the cD1 sub-band to obtain the set of sub-bands

Step 9: Apply for conditional loop by specifying the condition for
(kk=1:length(message_vector))
pn_sequence_v=round(2*(rand(Mw/4,Nw/4)-0.5))
correlation_h1(kk)=corr2(cD2(:,:,1),pn_sequence_v)
Correlation (kk)= (correlation_h1(kk))

Step 10: Repeat step 9 by changing the condition for
correlation_h2(kk)=corr2(cD2(:,:,2),pn_sequence_v)
correlation_h2(kk)=corr2(cD2(:,:,3),pn_sequence_v)

Step 11: Apply for conditional loop again by specifying the condition
(kk=1:length(message_vector))

Step 12: Apply if conditional statement by specifying the condition
if (correlation(kk) > mean (correlation)*4)
message_vector(kk)=0;
else
message_vector(kk)=1;

Step 13: Repeat the step 12 by changing the multiple value 4 to 3, 2 and 1 and obtain the results

Step14: Calculate the PSNR values and obtain the correlation values in all of the cases

End

The extraction procedure within the proposed scheme involves reading of the watermarked image into a variable and finding the dimensions of the watermarked image. The proposed scheme also involves reading the original image and notifying its dimensions too. The extraction process involves generation of the message vector consisting of ones which is of the size equal to the original watermark image. Further application of the two dimensional DWT is carried-out to the watermarked image followed by generation of the pn-sequence. Then correlating method is established between the values of the HH2 sub-bands and pn-sequence for each of the planes within the watermarked image. Finally a conditional statement is established i.e if the correlated values of the message_vector is greater than the mean (correlation) then values of the message_vector is set to zero else it will be set to 1.

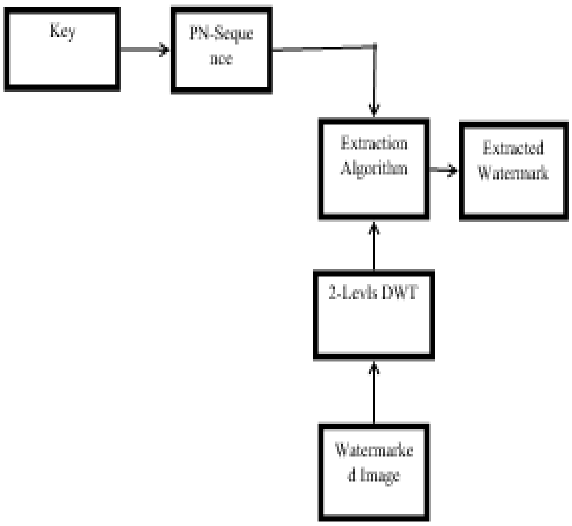
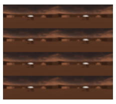


Fig: 4, Watermark Extraction Procedure

IV. RESULTS AND DISCUSSION

The experiments were carried on various aspects of the digital image watermarking for the proposed algorithm and the results of each of the output of the digital image watermarking are noted. The experiments are mainly carried on the selected images having the format of bitmap and the watermark image being the same in all of the cases. The selected cover images mainly used for the experiments are shown below within the table.1 along with the watermark image used to embed into all of the cover images.

Table.1 Cover Images Used in the Experiments

Cover Images				
	1.bmp	2.bmp	3.bmp	4.bmp

The only watermark image that is used to embed within each of the cover image is shown below in the table.2 which is of the binary format.

Table.2 Watermark Image

Watermark image	Copyright

The experiment involved the selected cover images and the selected watermark image. The experiment is mainly conducted on the RGB images by the usage of the discrete wavelet transformation along with the pn_sequence number. The watermark is embedded into the red channel, green channel and into the blue channel of the RGB cover image. Table.3 shows the embedding of the watermark image into the red channel of the cover image using the proposed methodology and analyzing the PSNR values obtained along with the correlation values.

Further there exists a experiment with the extraction procedure of the proposed methodology. The extraction procedure involves multiplication of an integer value with the mean (correlation) obtained and checking out the result weather it is greater than the values obtained for the generated message_vector. The integer value multiplied is decreased from 4 to 1 and the corresponding PSNR values and the correlation values are noted. Table.3 shows the watermark image and the cover images used along with the corresponding watermarked images obtained for the respective cover image which are watermarked within the red channel of the cover images. In this case of watermarked images of table.3 the mean (correlation) values are multiplied with an integer factor having the value equal to 4 and checked weather the value is greater than the values obtained by correlating the values of the red channel with the pn_sequence.

The PSNR values and the correlation values are notified for the respective Watermarked image. Similarly the embedding process is repeated and the extraction process is performed for the red channel of the RGB watermarked image by multiplying with an integer factor equal to 3, 2 and 1 and notifying the PSNR values and correlation values.

Table.4 shows the correlated values of the red channel of the watermarked image with the pn_ sequence when the correlation value is greater than the mean (correlation) multiplied with an integer factor equal to 3. Table.5 shows the correlated values of the red channel of the watermarked image with the pn_ sequence when the correlation value is greater than the mean (correlation) multiplied with an integer factor equal to 2. Table.6 shows the correlated values of the red channel of the watermarked image with the pn_ sequence when the correlation value is greater than the mean (correlation) multiplied with an integer factor equal to 1. From table.3,4,5 and 6 it can be concluded that the multiplying integer factor as reduced from 4 to 1 the obtained correlation values and the PSNR values are decreased simultaneously the extracted watermark form each of the cover images gets distorted as the multiplying factor gets reduced. This results obtained thus concludes that the procedure of digital image watermark extraction process leads from the robust procedure to the semi-fragile and further to the fragile digital image watermarking.

Table.3 Correlation and PSNR for selected set of images in the red channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 4

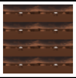
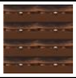
Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	1
	Copyright		26.3043	Copyright	0.9645
	Copyright		27.4817	Copyright	0.9947
	Copyright		34.2479	Copyright	1

Table.4 Correlation and PSNR for selected set of images in the red channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 3

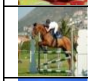
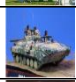
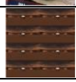
Cover image	Watermark image	Water marked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	1
	Copyright		26.3043	Copyright	0.8745
	Copyright		27.4817	Copyright	0.9645
	Copyright		34.2479	Copyright	1

Table.5 Correlation and PSNR for selected set of images in the red channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 2

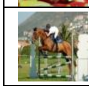
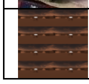
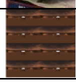
Cover image	Watermark image	Water marked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	0.9645
	Copyright		26.3043	Copyright	0.6644
	Copyright		27.4817	Copyright	0.8154
	Copyright		34.2479	Copyright	0.9743

Table.6 Correlation and PSNR for selected set of images in the red channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 1

Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	0.6526
	Copyright		26.3043	Copyright	0.4751
	Copyright		27.4817	Copyright	0.5506
	Copyright		34.2479	Copyright	0.7044

Similarly table.7, 8, 9 and 10 shows the watermarked images along with the extracted watermark images from the green channel of the RGB images. The PSNR values and the correlation values are noted in all of the cases and the results are analyzed. By comparing the extraction process from the red channel of the watermarked image and the extraction process involved from the green channel of the RGB image it can be declared again as the multiplying factor decreases then the corresponding PSNR values and also the correlation values gets decreased. Hence it can also be noted that the extracted watermark image gets distorted from its normal form to the corrupted. This kind of application is mainly used in preserving the quality of the images and also for the authentication purposes and for copyright protection.

Table.7 Correlation and PSNR for selected set of cover images in the green channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 4

Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	1
	Copyright		26.3043	Copyright	0.9693
	Copyright		27.4817	Copyright	0.9947
	Copyright		34.2479	Copyright	1

Table.8 Correlation and PSNR for selected set of cover images in the green channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 3

Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	1
	Copyright		26.3043	Copyright	0.8707
	Copyright		27.4817	Copyright	0.9502
	Copyright		34.2479	Copyright	1

Table.9 Correlation and PSNR for selected set of cover images in the green channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 2

Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	0.9693
	Copyright		26.3043	Copyright	0.6584
	Copyright		27.4817	Copyright	0.7997
	Copyright		34.2479	Copyright	0.9693

Table.10 Correlation and PSNR for selected set of cover images in the green channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 1

Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	0.6526
	Copyright		26.3043	Copyright	0.4699
	Copyright		27.4817	Copyright	0.5439
	Copyright		34.2479	Copyright	0.7026

Similarly table.11, 12, 13 and 14 shows the watermarked images along with the extracted watermark images from the blue channel of the selected RGB images. The PSNR values and the correlation values are notified in all of the cases and the results are analyzed. By comparing the extraction process from the red channel and green channel of the watermarked image and the extraction process involved from the blue channel of the RGB image it can be declared again as the multiplying factor decreases then the corresponding PSNR values and also the correlation values gets decreased. Hence it can also be stated that the extracted watermark image gets distorted from its normal form to abrupt. This kind of application is mainly used in preserving the quality of the images and also for the authentication purposes and for the copyright protection.

Table.11 Correlation and PSNR for selected set of cover images in the blue channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 4

Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	1
	Copyright		26.3043	Copyright	0.9596
	Copyright		27.4817	Copyright	1
	Copyright		34.2479	Copyright	1

Table.12 Correlation and PSNR for selected set of cover images in the blue channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 3

Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	1
	Copyright		26.3043	Copyright	0.8861
	Copyright		27.4817	Copyright	0.9596
	Copyright		34.2479	Copyright	1

Table.13 Correlation and PSNR for selected set of cover images in the blue channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 2

Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315	Copyright	0.9743
	Copyright		26.3043		0.6704
	Copyright		27.4817	Copyright	0.7937

Table.14 Correlation and PSNR for selected set of cover images in the blue channel of the watermarked image when the mean (correlation) is multiplied with an integer factor equal to 1

Cover image	Watermark image	Watermarked image	PSNR	Watermark retrieved	Correlation
	Copyright		30.8315		0.6431
	Copyright		26.3043		0.4709
	Copyright		27.4817		0.5458
	Copyright		34.2479		0.6982

Table.15 shows the experiment results obtained by correlating the values of the red channel of the watermarked image with the pn_sequence when the correlation value is greater than the mean (correlation) multiplied with an integer factor equal to 4 by the application of the gaussian noise. Table. 15 establish the correlation values for each of the respective watermarked image. It can be noted that by analyzing both the correlation values obtained along with the extracted watermark image from the tables 15, 16,17 and 18 when multiplied with an integer factor equal to 4, 3, 2 and 1 for the mean (correlation) values the quality of the extracted watermark image gets distorted. Hence it can be stated that the methodology of extracting the watermark image from any of the cover image in the proposed methodology does not require any of the disturbances during the recovery of the watermark image else the extraction procedure reaches from its normal robust method to the semi-fragile and fragile method. Similarly it is noted that the the table numbered 19, 20, 21 and 22 which shows the watermarked image added with Gaussian noise and also the extracted watermark image from the green channel of the watermarked image along with the correlation values between the extracted watermark image and the original watermark image. By examining the correlation values obtained and the extracted watermark image it can be easily deduced again the methodology turns to robust digital image watermarking to fragile digital image watermarking as the multiplication factor is reduced. Table 23, 24, 25 and 26 shows the watermarked images distorted with the addition of the Gaussian noise along with the extracted watermark images from the blue channel of the watermarked RGB images again the correlation values are notified declaring the same conclusion.

Table.15 Correlation obtained with the addition of Gaussian noise to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 4

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright			Copyright	0.7326
	Copyright				0.5184
	Copyright			Copyright	0.6483
	Copyright			Copyright	0.7668

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Table.16 Correlation obtained with the addition of Gaussian noise to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 3

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.4807
	Copyright				0.5917
	Copyright				0.6465
	Copyright				0.6052

Table.17 Correlation obtained with the addition of Gaussian noise to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 2

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.5051
	Copyright				0.4620
	Copyright				0.4775
	Copyright				0.4859

Table.18 Correlation obtained with the addition of Gaussian noise to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 1

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.3976
	Copyright				0.3711
	Copyright				0.3817
	Copyright				0.4126

Table.19 Correlation obtained with the addition of Gaussian noise to the watermarked image within the green channel when the mean (correlation) is multiplied with an integer factor equal to 4

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright			Copyright	1
	Copyright			Copyright	0.9693
	Copyright			Copyright	0.9947
	Copyright			Copyright	1

Table.20 Correlation obtained with the addition of Gaussian noise to the watermarked image within the green channel when the mean (correlation) is multiplied with an integer factor equal to 3

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright			Copyright	1
	Copyright			Copyright	0.8707
	Copyright			Copyright	0.9502
	Copyright			Copyright	1

Table.21 Correlation obtained with the addition of Gaussian noise to the watermarked image within the green channel when the mean (correlation) is multiplied with an integer factor equal to 2

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright			Copyright	0.9693
	Copyright			Copyright	0.6584
	Copyright			Copyright	0.7997
	Copyright			Copyright	0.9693

Table.22 Correlation obtained with the addition of Gaussian noise to the watermarked image within the green channel when the mean (correlation) is multiplied with an integer factor equal to 1

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright			Copyright	0.6526
	Copyright			Copyright	0.4699
	Copyright			Copyright	0.5439
	Copyright			Copyright	0.7026

Table.23 Correlation obtained with the addition of Gaussian noise to the watermarked image within the blue channel when the mean (correlation) is multiplied with an integer factor equal to 4

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
					1
					0.9596
					1
					1

Table.24 Correlation obtained with the addition of Gaussian noise to the watermarked image within the blue channel when the mean (correlation) is multiplied with an integer factor equal to 3

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
					1
					0.8861
					0.9596
					1

Table.25 Correlation obtained with the addition of Gaussian noise to the watermarked image within the blue channel when the mean (correlation) is multiplied with an integer factor equal to 2

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
					0.9743
					0.6704
					0.7937
					0.9743

Table.26 Correlation obtained with the addition of Gaussian noise to the watermarked image within the blue channel when the mean (correlation) is multiplied with an integer factor equal to 1

Cover image	Watermark image	Water marked image	Noise added watermark	Watermark retrieved	Correlation
					0.6431
					0.4709
					0.5452
					0.6982

The procedure is carried out by the application of the poison noise for the watermarked image and analyzing the correlation values for the selected set of the cover images. Table 27, 28, 29 and 30 shows the watermarked images added with the poison noise along with the extracted watermark image from the red channel of the watermarked image each time again reducing the multiplication value from 4 to 1 to the mean (correlation) values. The methodology again declares the extracted watermark image is corrupted as the multiplication value is reduced.

Table.27 Correlation obtained with the addition of Poison noise to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 4

Cover image	Watermark image	Water marked image	Noise added watermark	Watermark retrieved	Correlation
					0.9844
					0.8538
					0.9947
					1

Table.28 Correlation obtained with the addition of Poison noise to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 3.

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
					0.9146
					0.7226
					0.8745
					0.9596

Table.29 Correlation obtained with the addition of Poison noise to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 2

Cover image	Watermark image	Water marked image	Noise added watermark	Watermark retrieved	Correlation
					0.6937

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	Copyright				0.5661
	Copyright				0.6982
	Copyright				0.7762

Table.30 Correlation obtained with the addition of Poison noise to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 1

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.4751
	Copyright				0.4126
	Copyright				0.4947
	Copyright				0.5399

The procedure is carried out by the application of the salt and pepper noise for the watermarked image and analyzing the correlation values for the selected set of the cover images. Table 31, 32, 33 and 34 shows the watermarked images added with the salt and pepper noise along with the extracted watermark image from the red channel of the watermarked image each time again reducing the multiplication value from 4 to 1 to the mean (correlation) values. The methodology again declares the extracted watermark image is corrupted in all of the cases.

Table.31 Correlation obtained with the addition of Salt and Pepper to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 4

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.5806
	Copyright				0.5095
	Copyright				0.6740
	Copyright				0.6067

Table.32 Correlation obtained with the addition of Salt and Pepper to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 3

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.5114
	Copyright				0.4443
	Copyright				0.5451
	Copyright				0.5248

Table.33 Correlation obtained with the addition of Salt and Pepper to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 2

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.4411
	Copyright				0.3969
	Copyright				0.4579
	Copyright				0.4440

Table.34 Correlation obtained with the addition of Salt and Pepper to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 1

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.3856
	Copyright				0.3588
	Copyright				0.3594
	Copyright				0.3787

The procedure is carried out by the application of the speckle noise for the watermarked image and analyzing the correlation values for the selected set of the cover images. Table 35, 36, 37 and 38 shows the watermarked images added with the salt and pepper noise along with the extracted watermark image from the red channel of the watermarked image each time again reducing the multiplication value from 4 to 1 to the mean (correlation) values. The methodology again declares the extracted watermark image is corrupted in all of the cases.

Table.35 Correlation obtained with the addition of Speckle to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 4

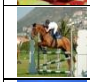
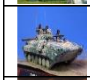
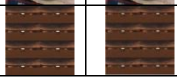
Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.5556
	Copyright				0.5077
	Copyright				0.7705
	Copyright				0.8516

Table.36 Correlation obtained with the addition of Speckle to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 3

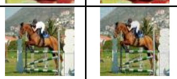
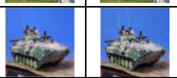
Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.4887
	Copyright				0.4655
	Copyright				0.6584
	Copyright				0.7049

Table.37 Correlation obtained with the addition of Speckle to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 2

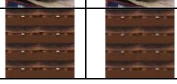
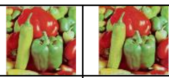
Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.4101
	Copyright				0.4083
	Copyright				0.5346
	Copyright				0.5690

Table.38 Correlation obtained with the addition of Speckle to the watermarked image within the red channel when the mean (correlation) is multiplied with an integer factor equal to 1

Cover image	Watermark image	Watermarked image	Noise added watermark	Watermark retrieved	Correlation
	Copyright				0.3625
	Copyright				0.3588
	Copyright				0.4195
	Copyright				0.4311

V. CONCLUSION

By examining the experimental results in all of the cases and verifying the mean of correlation values obtained by multiplying with an integer factor from 4 to 1 in all of the cases of the RGB images with the correlation values it is declared that the methodology changes to robust digital image watermarking to the semi-fragile digital image watermarking and then to the fragile digital image watermarking technique. Further it can be noticed that the any kind of attack caused on the watermarked image also leads to the fragile watermark. The process is repeated for the entire red, green and blue channel and the results PSNR and correlation values are analyzed and are expected to be the same. Hence the experiments carried over the selected set of images using the proposed methodology proves the robust methodology for digital image watermarking can also be enhanced to semi-fragile digital image watermarking and to the fragile digital image watermarking. Further it can be noticed the enhancement of the embedding capacity of cover image to accommodate equal size watermark without losing quality of the cover image is obtained.

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