Secure Data Transmission using DWT Based Image Watermarking Scheme

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Abstract- *We have implemented the watermarking technique for the copyright protection based on 3-level discrete wavelet transform (DWT). In this technique a multi-bit watermark is embedded into the low frequency sub-band of a cover image by using alpha blending technique. Digital Watermarking is a kind of process of embedding unnoticeable signal in an image in the form of text or image in such a way that intruder is not able to trace the signal to enhance Copyright Protection. This Paper presents an efficient Watermarking Technique for Digital Media Content Protection and Copyright Protection. Watermarking is a technique to embed hidden and unnoticeable signal into digital media in such a way that if an intruder wants to copy it, he can be caught on the basis of Copyright protection. This paper embraces invisible Image Watermarking that uses Discrete Wavelet Transformation (DWT) for embedding the secret message or logo into the target image, the work has been performed using MATLAB.*

Keywords—*Image watermarking, 2-D DWT, Digital watermarking, Wavelet transform, LSB, MSE, PSNR. RMSE.*

I. INTRODUCTION

Digital watermarking is used for protection of digital images. Digital Watermark is a visible or invisible identification code that is permanently embedded in the host media. Now a days, in each and every sectors the use of digital contents are gradually rising. Information handled using internet and multimedia network system is also in digital form. The copying of digital content without quality loss is not so difficult. For this reason, there are more chances of copying of such digital information. So, the requirement of prohibiting such illegal copyright of digital media are very much increasing today. Digital watermarking is the important solution of this problem. Digital watermarking is nothing but the technology in which there is embedding of various information in digital format which we have to protect from illegal copying of data. This added information for protecting the data is embedded as watermark. Digital watermarking came as a procedure to overcome shortcomings of current copyright laws for digital data. Current digital image watermarking techniques can be grouped into two major classes: Spatial Domain Watermarking and Frequency Domain Watermarking. Compared to spatial domain techniques [4], frequency-domain watermarking techniques proved to be more effective with respect to achieving the imperceptibility and robustness requirements of digital watermarking algorithms. However, DWT has been used in digital image watermarking more frequently due to its excellent spatial localization and multi-resolution characteristics, which are similar to the theoretical models of the human visual system. Further performance improvements in DWT-based digital image watermarking algorithms could be obtained by increasing the level of DWT.

II. DIGITAL WATERMARKING

Digital watermarking is defined as "the practice of imperceptibly altering a Work to embed a message about that Work." Watermarking works in two phases, the watermark embedding phase and the detection phase. In the embedding phase a message and an image, called as cover work, is passing to watermark embedded algorithm. When Watermark is added to digital data such as images even if any intruder tries to damage or manipulate it, he can be caught after the retrieval of watermark on the basis of Copyright Protection. In transform domain the watermark is embedded by modifying the frequency coefficients of the transformed image. The common methods in the transform domain are Fourier Transform (DFT), Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), etc. The main procedure of Watermarking is followed in 2 parts: Watermark addition and embedding and Watermark Retrieval and extraction. Embedding can be done in an image in the form of Text or Image and can be done in many formats. Watermark Extraction can be done to recover the watermark used for copyright protection.

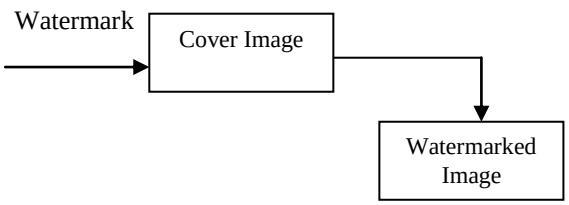

Figure1: Watermark Embeding Technique

III. Classification Of Watermark

There are different types of watermark. So, We have demonstrated some kind of them in below:-

A. Visible watermarks

Visible watermarks are an extensive version of the concept of logos. Such watermarks applicable to images only. Although these images are inlaid but they are more transparent. Such watermarks cannot be removed after cropping the different section of the image. The drawbacks of these visible watermarks are degrading the quality of image and detection by visual means only. Thus, it is not possible to detect them by dedicated programs or devices. Such watermarks have applications in the field of graphics and software user interface.

B. Invisible watermark

Invisible watermark is hidden in the content. It can be detected by an authorized agency only. Such watermarks are used for content and /or author authentication and for detecting unauthorized copier.

C. Robust watermark

- Embedded invisible watermarks.
- Resist to image processing or different attacks.
- Used for copyright protection or to verify the ownership properly.

D. Fragile watermark

Fragile watermarks are those watermarks which can be easily destroyed by any attempt to tamper with them. Fragile watermarks are destroyed by data manipulation. In the following figure an example of fragile watermarking the first one represent the original image, the second is the modified image and the third the detected modification.

IV. Requirements Of Watermark

Different requirement of watermark are given below.

A. Transparency

The most important requirement for any kind of Watermarking technique shall be such that it should be transparent to the end user. The watermarked content should be consumable at the intended user device without giving annoyance to the user. Watermark is shown by the watermark-detector device.

B. Security

Watermark information shall only be accessible to the authorized parties. Only authorized parties shall be able to alter the Watermark content. Encryption can be used to prevent unauthorized access of the watermarked data.

C. Robustness

Watermarking must be robust enough to withstand all kinds for signal processing operations, "attacks" or unauthorized access. Any attempt, whether intentional or not, or other third parties that has an ability to alter the data content is considered as an attack. Robustness against attack is an important requirement for Watermarking and the success of this technology for copyright protection depends on this.

D. Effect on bandwidth

It should be done in such a way that it doesn't increase the allotted bandwidth required for transmission. If Watermarking becomes a burden for the available bandwidth, then the method will be rejected immediately. So, the bandwidth is basically very much related for image watermarking.

E. Interoperability

Digitally watermarked content shall still be interoperable so that it can be seamlessly accessed through heterogeneous networks and can be played on various plays out devices that may be watermark aware or unaware.

V. Discrete Wavelet Transform(DWT)

Discrete Wavelet transform (DWT) is a mathematical tool for hierarchically decomposing an image. It is useful for processing of non-stationary signals. The transform is based on small waves, called wavelets, of varying frequency and limited duration. Wavelet transform provides both frequency and spatial description of an image. Unlike conventional Fourier transform, temporal information is retained in this transformation process.

In two dimensional applications, for each level of decomposition, we first perform the DWT in the vertical direction, followed by the DWT in the horizontal direction. After the first level of decomposition, there are 4 sub-bands: LL1, LH1, HL1, and HH1. For each successive level of decomposition, the LL subband of the previous level is used as the input. To perform second level decomposition, the DWT is applied to LL1. band which decomposes the LL1 band into the four sub-bands LL2, LH2, HL2, and HH2. To perform third level decomposition, the DWT is applied to LL2 band which decompose this band into the four sub-bands – LL3, LH3, HL3, HH3. This results in 10 sub-bands per component. LH1, HL1, and HH1 contain the highest frequency bands present in the image tile, while LL3 contains the lowest frequency band. The three-level DWT decomposition is shown in Figure below.

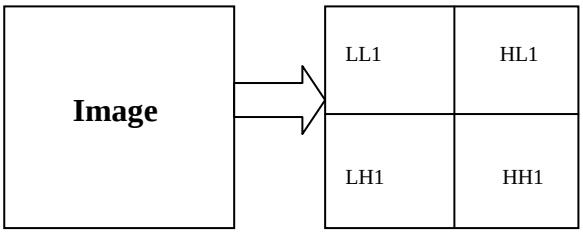

Figure2: 1-level DWT Transform

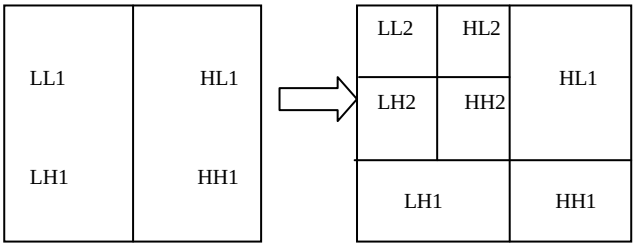

Figure3: 2-level DWT Transform

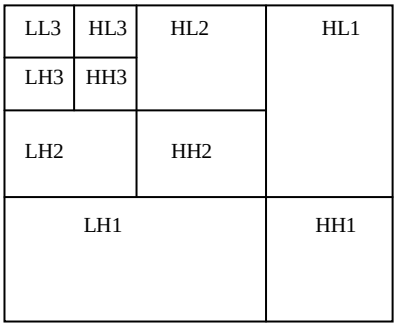

Figure4: 3-level DWT

VI. Least Significant Bit(LSB) Technique

The most common method of watermark embedding is to to embed the watermark into the least significant- bits of the cover object [21]. Despite being a simple method, LSB substitution suffers from many drawbacks. Although it can survive transformations like cropping, any addition of undesirable noise or lossy compression but a more sophisticated attack that could simply set the LSB bits of each pixel to one can fully defeat the Watermark with negligible impact on the cover object. [21]Once the algorithm is known to the intruder, the embedded watermark could be easily modified by him without any difficulty.

The simplest algorithm is Least Significant Bit(LSB) Insertion, in which each 8-bit pixel's least significant bit is over written with a bit from the watermark.[22] In a digital image, information can be inserted directly into every bit of image information or the more busy areas of an image can be calculated so as to hide such messages in less perceptible parts of an image. This method is based on the pixel value's Least Significant Bit (LSB) modifications.

The main principle of embedding message is very simple and effective. If we use a gray scale bitmap 8- bit image, we might require to read in the file and then embed data to the least significant bits of each pixel, in every 8-bit pixel. In a gray scale image each pixel is represented by 1byte consist of 8 bits. It can represent 256 gray colors between the black which is 0 to the white which is 255. The principle of encoding uses the Least Significant Bit of each of these bytes, the bit on the far right side.[22] If data is encoded to only the last two significant bits (which are the first and second LSB) of each color component it is most likely undetectable.

VII. Proposed Watermarking Technique

This algorithm is based on DWT Technique and is divided into 2 phases.

A. Watermark Embedding

B. Watermark Retrieval

A. Watermark Embedding

Watermark Embedding steps are given below.

Input : Cover image, Watermark Image
Output : Watermarked Image
Step1. Take cover image. and perform first level 2D-DWT on the image to decompose image and obtain approximation 1 coefficient (LL 1),horizontal 1 coefficient (HL 1), vertical 1coefficient (LH 1), diagonal 1 coefficient (HH1) respectively.
Step2. Perform second level DWT on LL1 to get 4 coefficients: LL2, HL2, LH2 and HH2.
Step3. Repeat decomposition for LL2 to give next level components: LL3, HL3, LH3 and HH3 as previous step.
Step4. Take the Watermark image and then convert it into black and white image.
Step5. Select HH3 Band For Embedding of Watermark.
Step6.Key is then added to provide Encryption method .
Step7. Thus Values of HH3 Band are modified and Now apply the Inverse Transformation .
Step8. After applying this method we get watermarked image.
Step9. Calculate the PSNR, MSE, CR in order to check for the visual quality of the Watermarked image by using below mentioned mathematical formula.
Step10. End.

Figure5: Steps For Embedding of Watermark in an image

B. Watermark Extraction

Watermark Extraction steps are given below.

Input: Watermarked Image
Output: Cover image, Watermark Image

Step1. Perform three level 2D- DWT decomposition on the Watermarked image as well the cover image as we did in the embedding procedure.
Step2. Perform DWT based transform on Watermarked Image.
Step3. Perform the similar process in reverse notation.
Step4 Perform inverse DWT after applying this step.
Step5. Extract Original Cover Image and Watermark Image from the Watermarked Image.
Step6. End.

Figure6: Steps For Extraction of Watermark in an image

VIII. PERFORMANCE ANALYSIS

In this section we have presented the experimental result and evaluated the performance of the proposed method. The proposed method is implemented in the MATLAB and the operating system used is windows 7.

A. Measure of imperceptibility

In the experimental phase we have used the parameter PSNR(Peak Signal to Noise Ratio) for calculating the difference between the cover image and stego-image. The PSNR for an image of size NxN is given as follows:

PSNR = 10 log10 (N^2 / MSE) (dB)
where MSE=(1/N*N) **ΣΣ** (xij – x'ij)2
RMSE= √ MSE

To evaluate the performance of the proposed data hiding algorithm, we have used different gray scale and color images . These images are used for our work. Simulations were done using MATLAB 8.0.

 **RABINDRANATH**	 **SWAMI VIVEKANANDA**	 **NETAJI**
 **LENA**	 **SAILBOAT**	 **Watermark Image**

Figure 7. Used Cover Images

IX. RESULTS

This work is done using MATLAB to evaluate this work. The performance Evaluation is done by two performance evaluation metrics: Perceptual transparency and Robustness. Perceptual transparency means perceived quality of image should not be destroyed by presence of watermark. The quality of watermarked image is measured by PSNR. Bigger is PSNR, better is quality of watermarked image. PSNR for image with size M x N is given by:-

Here the Watermark image is used is given below. It is the image which is embedded to the original image.

Result

Figure8: a.Original Image b. 3-level dwt Of Original image c. Watermarked Image d. Extracted Watermark

In table 1, we give the results of PSNR obtained from the proposed algorithms in the Haar domain. Eight images have been taken and these methods are applied to obtain results as shown in figure.After taking some images for calculating the PSNR and MSE values for measuring quality of the images. These are shown here. For these experiment, the first image has higher PSNR and lower MSE values rather than other, so it is better quality image than other.

TABLE1: COMPARATIVE RESULTS OF PSNR VALUES

Image	LSB Watermarking PSNR	Proposed DWT Based Watermarking PSNR
Rabindranath	41.4876	56.4676
Swami Vivekananda	41.5866	57.4456
Netaji	42.0274	57.6889
Lena	44.6684	59.8096
SailBoat	43.6908	58.0976

In table2 . the comparative results of MSE valurs are given. The proposed technique have achieved more

better MSE values rather than the LSB Watermarking scheme.

TABLE2: COMPARATIVE RESULTS OF MSE VALUES

Image	LSB Watermarking MSE	Proposed DWT Based Watermarking MSE
Rabindranath	11.6889	9.7889
Swami Vivekananda	11.3988	9.4708
Netaji	11.0665	9.1318
Lena	10.0888	8.0288
Sail Boat	10.6854	8.4878

In table3 . the comparative results of achieved more better RMSE values rather than the LSB Watermarking scheme.

TABLE3: COMPARATIVE RESULTS OF RMSE VALUES

Image	LSB Watermarking RMSE	Proposed DWT Based Watermarking RMSE
Rabindranath	3.4189	3.1287
Swami Vivekananda	3.376	3.0774
Netaji	3.3266	3.0218
Lena	3.1762	2.8335
Sail Boat	3.2688	2.9133

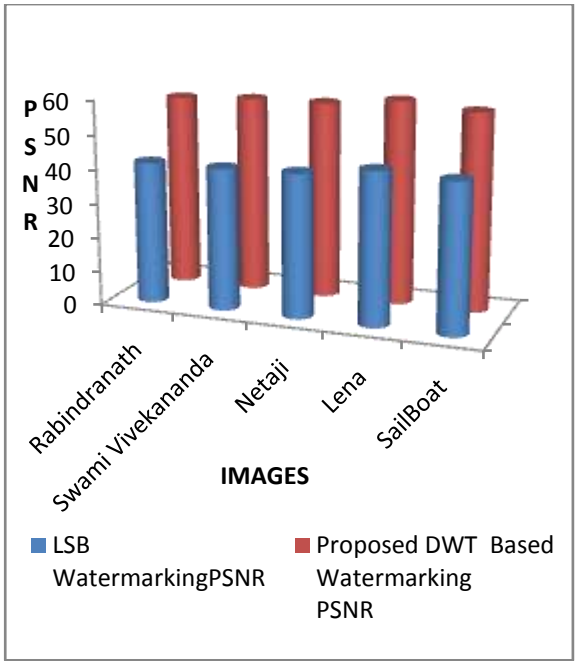

Figure 9. Graphical representation of PSNR values

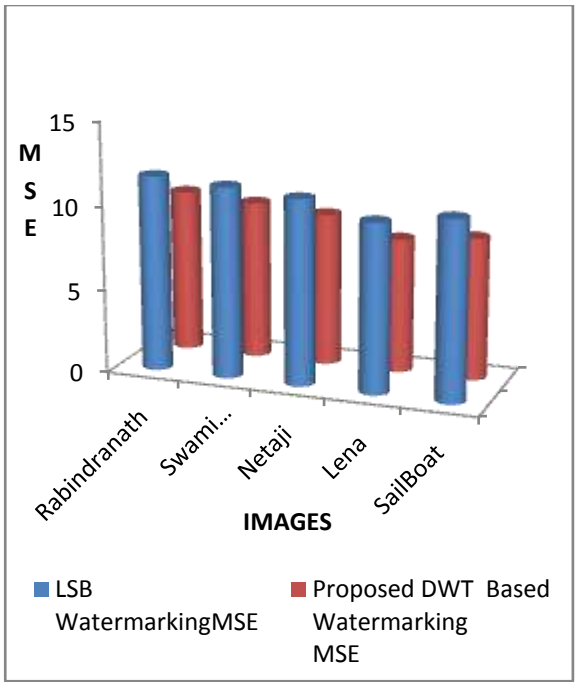

Figure 10. Graphical representation of MSE values

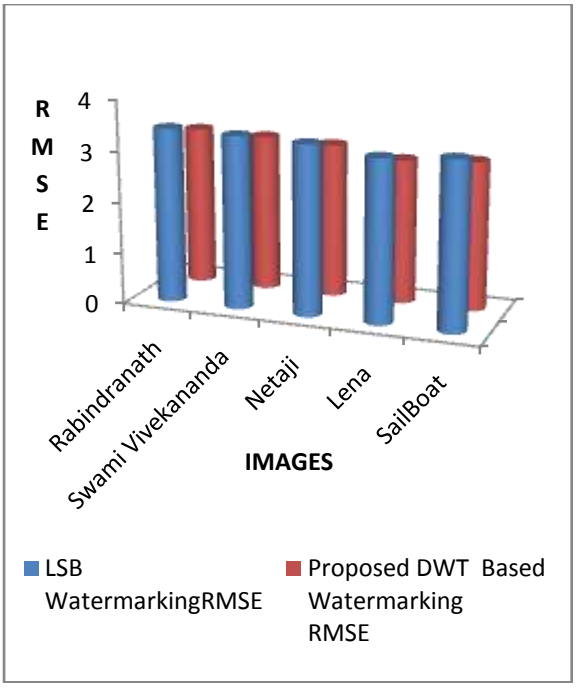

Figure 11. Graphical representation of MSE values

So , these figures of Graphical representation of PSNR, MSE, RMSE values are used for comparative analysis of image quality for these two techniques.

X. Conclusions

In this paper, an image watermarking technique based on a 3-level discrete wavelet transform has been implemented. In this paper, we have presented an efficient image watermarking technique to protect the copyright protection of digital images with watermark embedding and watermark extraction. Digital watermarking is a tool that could be effectively used for multimedia copyright protection, authentication and tamper proofing. In this paper, we have presented an efficient imaging watermarking technique to protect the copyright protection of digital images with watermark embedding and watermark extraction. So, after doing this work we get higher PSNR value for different images.

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