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Digital Image Watermarking based on Multiband Wavelet Transform

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***Abstract*- Digital image watermarking is an important tool for protecting the secret information. In this paper a Multiband based watermarking technique is proposed. The proposed scheme is based on, to decompose the image and get multiple sub-bands in one level decomposition. It will improve the quality of watermarked image and robustness of the watermark. This method is more secure and robust to attacks. The experimental results are observed with the proposed work in terms of PSNR.**

Keywords: Digital watermarking, Multiband wavelet Transform, PSNR.

I.INTRODUCTION

Digital Image watermarking is the process of embedding the secret information into the digital image. It is the one of the solution for copyright protection and data authentication. It is inserted invisibly in another image so it can be extracted at later times for the evidence of authentic owner[1]. It having many other features like Robustness, Imperceptibility, Security and Hiding capacity.

Watermarking can be classified into various types[3]. In the basis of human Perception, it can be visible or Invisible. In detection and extraction basis, blind and non-blind watermarking. The ability of watermark to resist attack, it can be Fragile and semi-fragile, and using the key basis the other two types are public and private. Next one is the domain based classification.

The main embedding domain basis classification is, spatial and frequency domain watermarking. In the spatial domain, we can embed the watermark directly by modify the pixels of image. but in the case of frequency domain based watermarking we have to apply some transformation, and finding the transform coefficients then embed watermark into the sub-band[6]. By using this transform modification is imposed on those positions which are less sensitive to human eye. This causes effective achievement in the fidelity and robustness requirements. Applying the transformation get the coefficients.

In this paper, we present a modified watermarking method using multiband decomposition. It is more secure than other transform and stable, also having high PSNR values.

II.IMAGE TRANSFORMATION

The normal transformations are basically applied in the watermarking like, DFT (Discrete Fourier Transform), DCT (Discrete Cosine Transform) and DWT (Discrete Wavelet Transform). In the DFT, transforming the view of the signal from time based to frequency based domain, and in the case of DCT the block based transformation has to be carried, it express a sequence of finitely many data points in terms of a sum of cosine functions oscillating at different frequency. The above two transformations are having some more drawbacks. so we go for DWT (Discrete Wavelet Transform).

In DWT, it analyse the signal at different frequency bands with different resolutions by decomposing the signal into a approximation and detail information. It transform the signal from time into time-frequency domain. It employs scaling and wavelet function, which are associated with Low pass and High pass filters respectively. Here the approximation coefficients are the high scale low frequency components and the detail coefficients are low scale high frequency components.

$$Y_{high}(n)=\sum_n x(n) * g(2k-n)$$
$$Y_{low}(n)=\sum_n x(n) * h(2k-n)$$

where $Y_{high}(n)$ and $Y_{low}(n)$are the outputs of the highpass and lowpass filters respectively after subsampling by2.

The fig 1 represent the single level decomposition using DWT. Input image is given to both high pass and low pass filter respectively. The highpass only allow the high frequency and the low pass allow the low frequency.

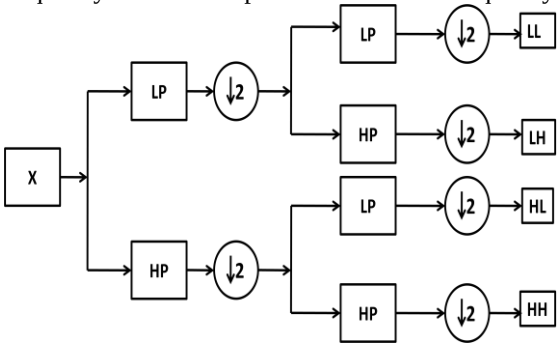

Fig 1: decomposition using DWT

In order to avoid the doubling of data, downsampling will be used. In the first stage row wise downsampling conducted. Again the same process repeated. In the next stage column wise downsampling presented. Finally it produce 4 sub-bands respectively as shown above.The LL represent the approximation coefficient, LH is the Horizontal detail, HL indicate the Vertical detail and finally the HH is the Diagonal detail.

Multiband wavelet transform (MWT) that is better able to represent high -frequency information. Multiband wavelet is very similar to wavelet, but has some important differences. Multiband wavelet has two or more scaling and wavelet functions, while wavelet has only an associated scaling function $\phi(t)$ and wavelet function w(t) [2].

$$\phi(t) = [\phi_1(t), \phi_2(t), \ldots \phi_r(t)]^T$$

$$w(t) = [w_1(t), w_2(t), \ldots w_{r(t)}]^T$$

. In multiband wavelet analysis, multiband scaling function and $\phi(t)$ multiband wavelet function w(t) should satisfy the following two-scale matrix dilation equations.

$$\phi(t) = \sum_k C[k]\, \phi(2t-k)$$

$$W(t) = \sum_k D[k]\, \phi(2t-k)$$

Here, C[k] and D[k] are matrix filters, i.e., H[k] and D[k] are r x r matrixes for each

integer k. Multiband wavelets can achieve better level of performance and higher degree of freedom than scalar wavelets with approximately similar computational complexity. In multiband $0 - \pi$ is splitted into numerous tiny frequency

Here we apply the MWT, in one level decomposion we can get 16 sub-bands . It shows all multiband wavelet subbands of an image under one level decomposition. Here, each subband corresponds to low-pass and high-pass filters used in vertical and horizontal directions. For examples, sub-band labeled by L_1H_2 corresponds to data obtained by applying high-pass filter on horizontal direction and taking its second channel, then applying lowpass filter on vertical direction and

L_1L_1	L_2L_1	L_1H_1	L_2H_1
L_1L_2	L_2L_2	L_1H_2	L_2H_2
H_1L_1	H_2L_1	H_1H_1	H_2H_1
H_1L_2	H_2L_2	H_1H_2	H_2H_2

Fig2 : multiband decomposition

taking its first channel. In multiband wavelet sub-bands, L_1L_1; L_1L_2; L_2L_1 and L_2L_2 are ‘‘low-low-pass” sub-bands, which represent an approximation of original image.

all sub-bands of image under single-level decomposition by using scalar wavelet, while Fig. 2 shows all sub-bands of image under single-level decomposition by using multiband wavelet. we see that image in multiband wavelet domain has different structure of frequency band compared with that in wavelet domain. Besides, four ‘‘low-low-pass” sub-bands in multiband wavelet domain concentrate more energy of an image[7]. The special structure and property will be used to design a new watermark embedding algorithm. In this paper, we will randomly select thr appropriate sub-bands, which having high PSNR and employ a relationship of their multiband wavelet coefficients in order to embed watermark information. The proposed work is given below.

III.PROPOSED WORK

In our Proposed work, we implement the watermarking scheme based on Multiband wavelet transform.

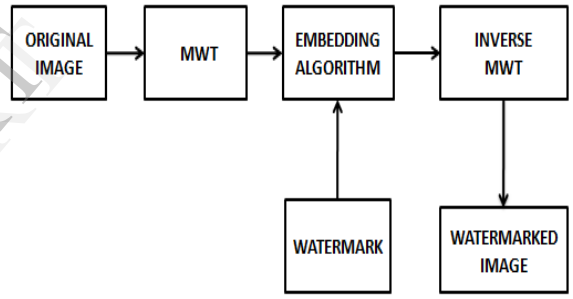

fig 3: Watermarking scheme based on MWT

The input image decomposed in one level, by applying the Multiband Wavelet Transform and we get 16 sub-bands. As per the literature of wavelet transform, we consider the middle frequency bands.

It represent the watermarking approach, in the middle frequency range totally we get 8 sub-bands. The embedding sub-band can be selected with the help of PSNR Values, which having high compared to all[8]. Here the, watermark is embedded into the particular sub-band with the help of embedding equation. After the completion of embedding procedure, we reconstruct the image with the help applying Inverse Multiband Wavelet Transform (IMWT), it produce the Watermarked Image.

The embedding equation is given as,

$$I_w(x.y) = I(x.y) + alpha * w(x.y)$$

w(x,y) is the watermark, I(x,y) is the middle frequency sub-band. Alpha is the embedding factor. In the case of Multiband based watermarking scheme, the degree of freedom increase normally we get 8 sub-bands in the

intermediate frequency range. so that the hiding capacity also increase, also more stable compared with DWT.

IV.SIMULATION RESULTS

Here, the lena image is taken as the input and Fish image is watermark.

Fig 4: lena image

Fig 5 : watermark image

Fig 4 & 5 represent the original image and watermark image. By apply the Multiband Wavelet Transform into the input image in the single level decomposition.

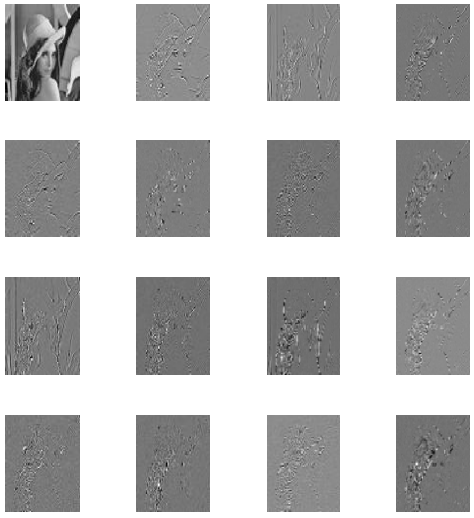

Fig 6: 1 level decomposition using MWT

Fig 6, indicates the one level decomposition using Multiband Wavelet transform under the input image of lena. In the 16 sub-bands we consider only the middle frequency sub-bands. Compared to all the middle frequency sub-bands, the 7^{th} sub-band having the high PSNR (Peak Signal to Noise Ratio)Value. So the Watermark image is embedded into that Particular band.

Fig 7 : watermarked image

Fig 7 indicates the watermarked image by using MWT**.** To apply the embedding procedure in the all the 16 sub-bands we can get the output model given in Fig 8 as follows

Fig 8: watermarked images using MWT

Calculate the PSNR values in all the sub-bands and it is tabulated in table1. In the case of discrete wavelet transform, four sub-bands are to be determined. The robustness is to be validated by implementing various attacks.

DWT	MWT
24.9585	24.9585 40.3623 37.1539 42.1207
40.3625	44.9079 45.6560 **47.6722** 45.4190
37.1539	41.3978 47.3034 42.0969 44.5588
42.1206	50.7717 49.3068 49.5404 47.1254

Table 1 : PSNR values (dB) for DWT and MWT

We list out the PSNR values for all the bands, the 7th band give the high rate, and better performance also that having good resistive ability. So the embedding procedure are implemented in the particular two bands respectively. The various attacks include Gaussian noise, salt and pepper noise, median filtering and cropping are to implemented for the particular band using multiband wavelet transform as shown Fig 9.

Fig 9: watermarked image for various Attacks

CONCLUSION

In this paper, an image watermarking based on multiband wavelet transform have been presented[4]. The quality of the watermarked image is good in terms of perceptibility and PSNR. Robustness and fidelity are the two major requirements in image watermarking.

The aim of our work was to improve the robustness against attacks (Gaussian noise, Salt and Pepper noise, Median Filtering and Cropping).To show the superiority of our method to that of [5], we compared the experimental results obtained by both DWT and MWT. Digital Image Watermarking is performed using Discrete Wavelet Transform and Multiband Wavelet Transform .

binary watermark is embedded in the middle frequency sub-band and Inverse Wavelet and Multiband wavelet Transform is performed to obtain watermarked image. Further, Quality of the watermarked image is justified through PSNR values. From the results, the PSNR value get increased and better picture result in Multiband Wavelet Transform when compared to Discrete Wavelet Transform.

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