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Image Watermarking withHybrid approach using Discrete Wavelet Transform(DWT)–Discrete Cosine Transform (DCT)

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***Abstract*—Thispaper presents a robust water-marking technique for the copyright protection based onwavelet transform (DWT) and discrete cosine transform (DCT). In this a secrete watermark image is embedded into a low frequency band of a cover image. The comparison is based on statistical parameters such as peak-signal-to-noise-ratio (PSNR), mean square error (MSE) and normalized cross-correlation (NCC).**

Keywords-image watermark, DWT,MSE ,PSNR.

I. INTRODUCTION

The watermark is a signal that is embedded into the host media to be protected, such as an image or audio or video. It contains useful information for the owner of the host media such as logo, text, etc. The watermark can be detected or extracted.

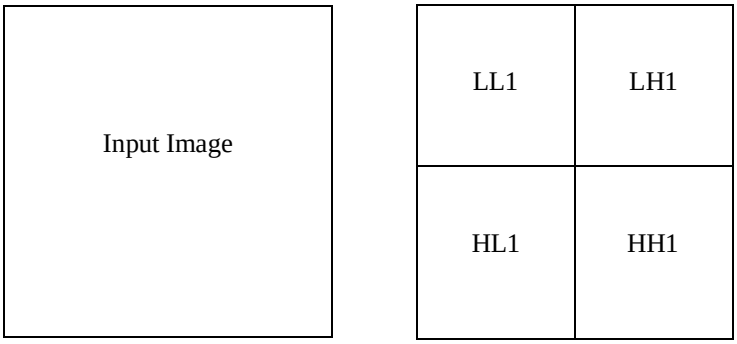
In order for a digital watermarking method to be effective it should be imperceptible and robust todifferent type noise attacks. Currently digital image watermarking is divided into two major classes: Spatial domain and Frequency domain watermarking.

In comparison with spatial domain, frequency domain is more robust domain in terms of achieving the imperceptibility and noise attack. So Discrete Wavelet Transform (DWT), the Discrete Cosine Transform (DCT) and Discrete Fourier Transform (DFT) are the better option for frequency domain processing.The reason of applying two transform is based on the fact that jointed transform could make up for the disadvantages of each other, so that effective watermarking approaches could acquire.

In this technique cover image is divided into four sub-bands. So watermark should be inserted into high frequency band for better imperceptibility of the watermark into the final watermarked image.Next session contains DWT in details.

II. DWT*(DISCRETE WAVELET TRANSFORM)*

Wavelet transform decomposes an image into a set of band limited components which can be reassembled to reconstruct the original image without error. For 2-D images, applying DWT corresponds to processing the image by 2-D filters in each dimension. The filters divide the input image into four non-overlapping multi-resolution coefficient sets, a lower resolution approximation image (LL1) as well as horizontal (HL1), vertical (LH1) and diagonal (HH1) detail components. The sub-band LL1 represents the coarse-scale DWT coefficients while the coefficient sets LH1, HL1 and HH1 represent the fine-scale of DWT coefficients.So DWT is very effective to find out the areas where watermark can be inserted efficiently. Human eyes are low sensitive to high frequency and with DWT all the entropy is concentrated in the LL band so embedding watermark into high frequency band (HH) is more efficient.The high frequency coefficient sets HH include the edges and textures of the image and the human eye is not generally sensitive to changes in such coefficient sets. This allows the watermark to be embedded without being perceived by the human eye.



III. PROPOSEDALOGORITHM

The proposed watermarking algorithm is described as follows:

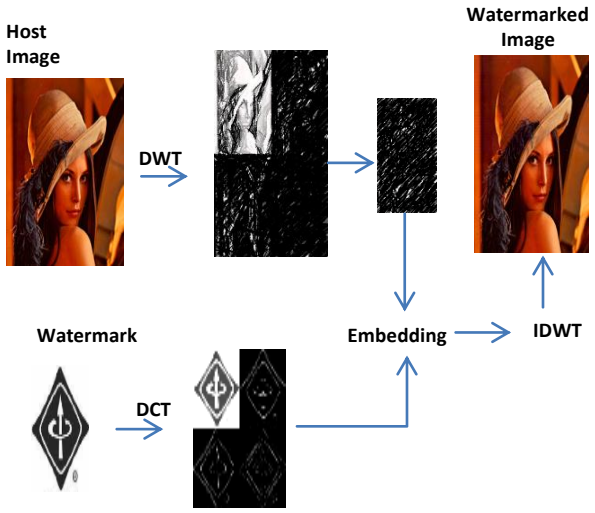
A. Watermark Embbeding

Step1. Take blue component (b) of Host image(H) and take its DWT because blue color is insensitive to human eyes.

Step2. Divide HH band into blocks of size multiple of watermark (w) size.

Step3. Add eachpixel intensity of DCT of watermark(w) to first element of respected block of HH band.(means add first pixel intensity to first element of first block,add second pixel intensity to first element of second block and so on…)

Step4. Take inverse DWT of modified image of H which gives final watermarked image(H1).



B.Extraction of watermark

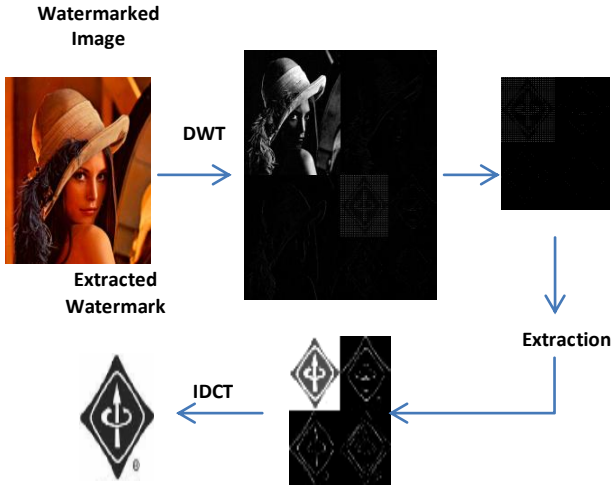
Step1. Separate blue component of water-marked image(H1) and Take DWT of both H and H1.

Step2. Subtract HHband of Host image from the HH band of watermarked image.

Step3. Divide resulting image into blocks of size multiple of watermark (w) size.

Step4. Take first element of each block and rearrange into an image(w1).

Step5. Take IDCT of w1 which will give original watermark (w2).



IV. EXPERIMENTAL RESULTS

For testing of the algorithm following parameters are calculated and compared with other methods.

1. PSNR(Peak Signal to Noise Ratio)
2. MSE(Mean Square Error)
3. NCC(Normalized Cross-correlation)

- PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation.
- MSE is mean square error between Host image(H) and watermarked image(H1).
- NCC is Cross-correlation between original watermark (w) and extracted watermark (w2).

$$MSE = \frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}[H(i,j) - H1(i,j)]^2$$

$$PSNR = 10 * \log_{10}\left[\frac{max^2}{MSE}\right]$$

$$NCC = \frac{\sum_{i,j}[w1 * w2]}{\sqrt{w1^2} * \sqrt{w2^2}}$$

- SimulationResults with hybrid approach

Above figures shows simulation result of hybrid aproach. We can find that there is hardly recognized difference between Host and Watermarked Image and watermark is recovered efficiently
Parameters are as below:

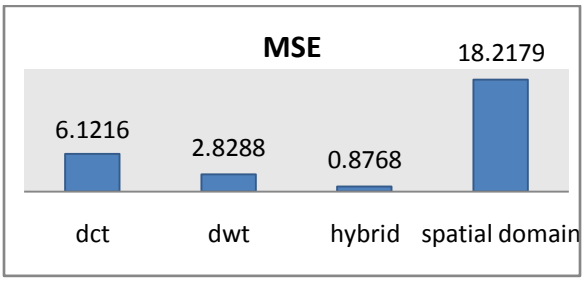
MSE = 0.8768
PSNR = 48.7017db
NCC = 1.0000

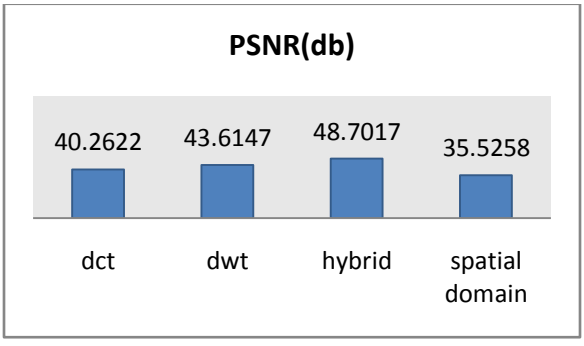
- Results with adding Noise in Watermarked image

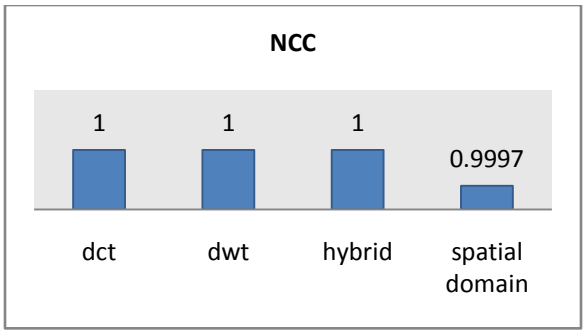
MSE = 1.1657E+03
PSNR = 17.4651db
NCC = 1.0000

Above image show that with adding noise in watermarked image there is a rise in MSE and decrement in PSNR but still watermark is recovered efficiently.

Simulation result comparison of this hybrid approach with traditional spatial domain, DWT and DCT approach is shown below with charts:







These results shows that using traditional method of DCT and DWT separately is better than spatial domain but there is always reconstruction error with DWT due to rounding operation which can be eliminated with using instead DCT of watermark at the time of embedding. So hybrid approach will give better results.

- Results for other images:

Image	MSE	PSNR
House	9.5844	38.3151
Baboon	1.3091	46.9611

V. CONCLUSION

To make-over the disadvantages of both DWT and DCT, hybrid approach can be used, which is seen more effective than individual DWT and DCT. It eliminates reconstruction error problem of DWT. Hybrid approach is also robust to noise as compared to DWT alone. It gives better PSNR.

This algorithm can be expanded by taking any other wavelet function rather than Haar Wavelet like bi-orthogonal wavelet or db1 or db4 etc. For the watermark security change may be done in the algorithm of Embedding process.

For checking and improvement of the robustness of algorithm more attacks can be added along with noise attacks like cropping and rotating watermarked image.

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