Digital Image Watermarking

March 18, 2017

Introduction

- Digital watermarking is the process by which an image is coded(embedded) with an owner's watermark.
- A digital watermark is a pattern of bits inserted into a digital image, audio or video file that identifies the file's copyright information.
- Watermark should be detectable even after manipulation of image.

Techniques used-

In Spatial Domain

We can divide pixels of any image (say Grayscale) into bits. The MSB bits contribute maximally to the image as seen in the image while having the least contribution from the LSB bits. We can use these LSB bits for watermarking.

In Frequency Domain

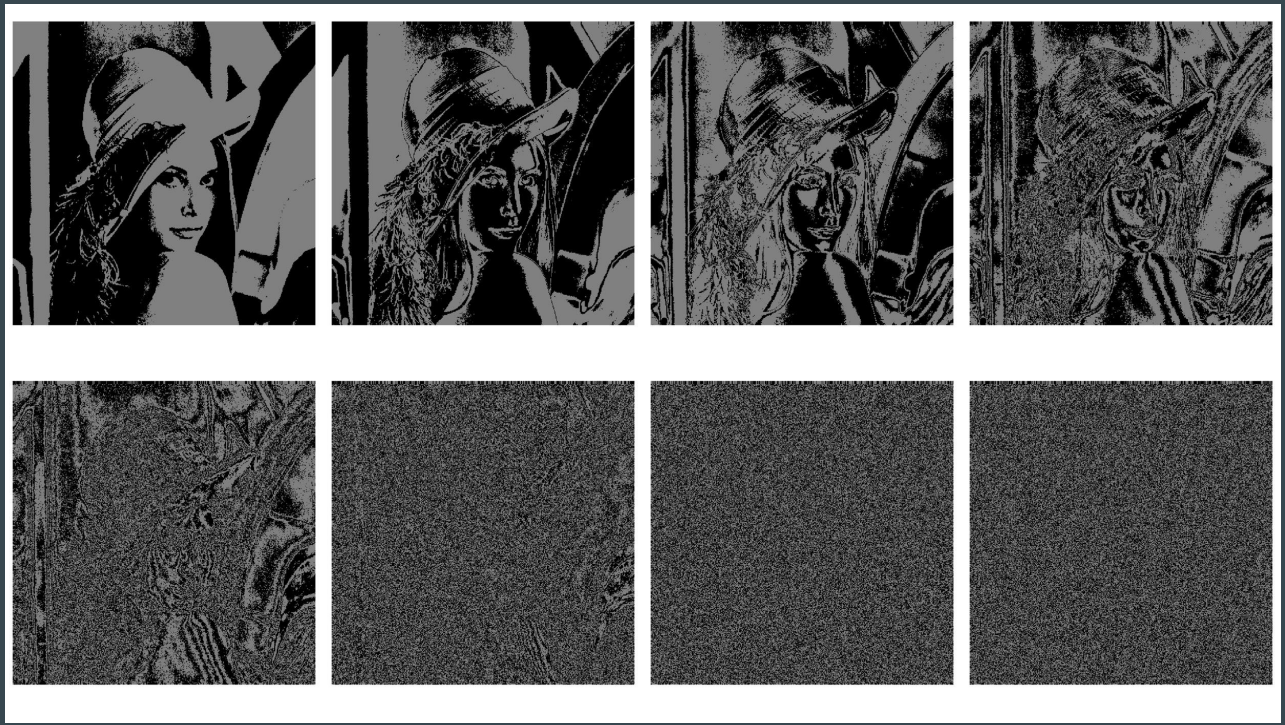
Transforming the image in frequency domain using transforms namely Discrete Cosine Transform and Discrete Fourier Transform and modifying coefficients slightly resulting in unnoticeable changes in image.

In Hybrid Domain

Modification of image can be done by combination of changes in both spatial and spectral domain by use of the Discrete Wavelet Transform (DWT). Better model of Human Visual System than DCT.

The Spatial Domain

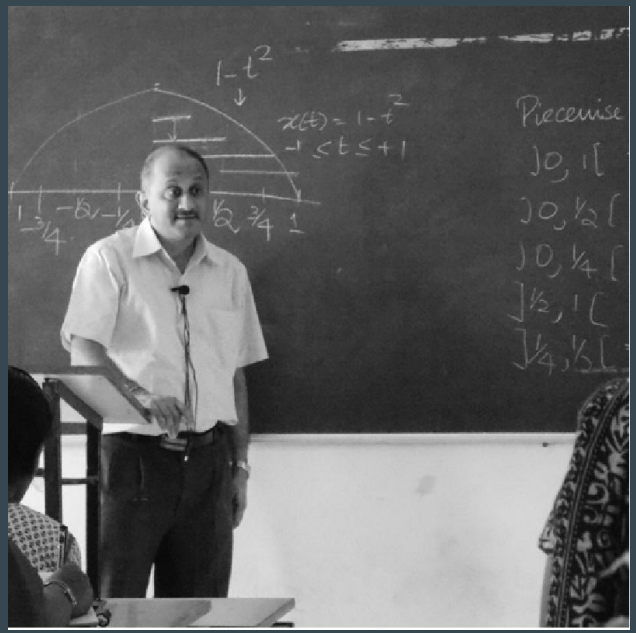
Dividing original image into bit planes



Original Image and Watermarking image

Original Image

Watermarking Image



Dividing Watermarked image into bit planes

Watermarked Image

Problems with Spatial Domain

- Easy to attack - not robust
- Ineffective when compressed (JPEG or PNG formats)

The Frequency Domain

Techniques used in Frequency Domain

Using DCT

Watermark embedded in the DCT domain

Advantages :

- Real output
- Resistance against JPEG compression
- Fast transform, specially when it is used in compressed images

Disadvantages :

- Not robust against geometric attacks

Using DFT

Watermark embedded in the DFT domain

Advantages :

- Resistance against frequency attacks
- Properties that accelerate the detection of geometrically distorted image

Disadvantages :

- Complex output

Discrete Cosine Transform (DCT)

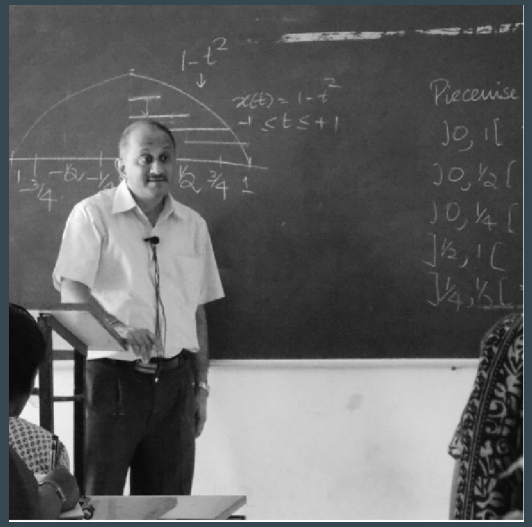
DCT converts images from spatial-domain to frequency-domain to decorrelate pixels. It helps to separate the image into parts of differing importance(w.r.t. the image's visual quality).

Discrete Fourier Transform (DFT)

The DFT is the sampled Fourier Transform and therefore does not contain all frequencies forming an image, but only a set of samples which is large enough to fully describe the spatial domain image. The number of frequencies corresponds to the number of pixels in the spatial domain image, *i.e.* the image in the spatial and Fourier domain are of the same size.

Original Image and Watermarked Image

Original Image



Watermarking image

Watermarked image

The Hybrid Domain

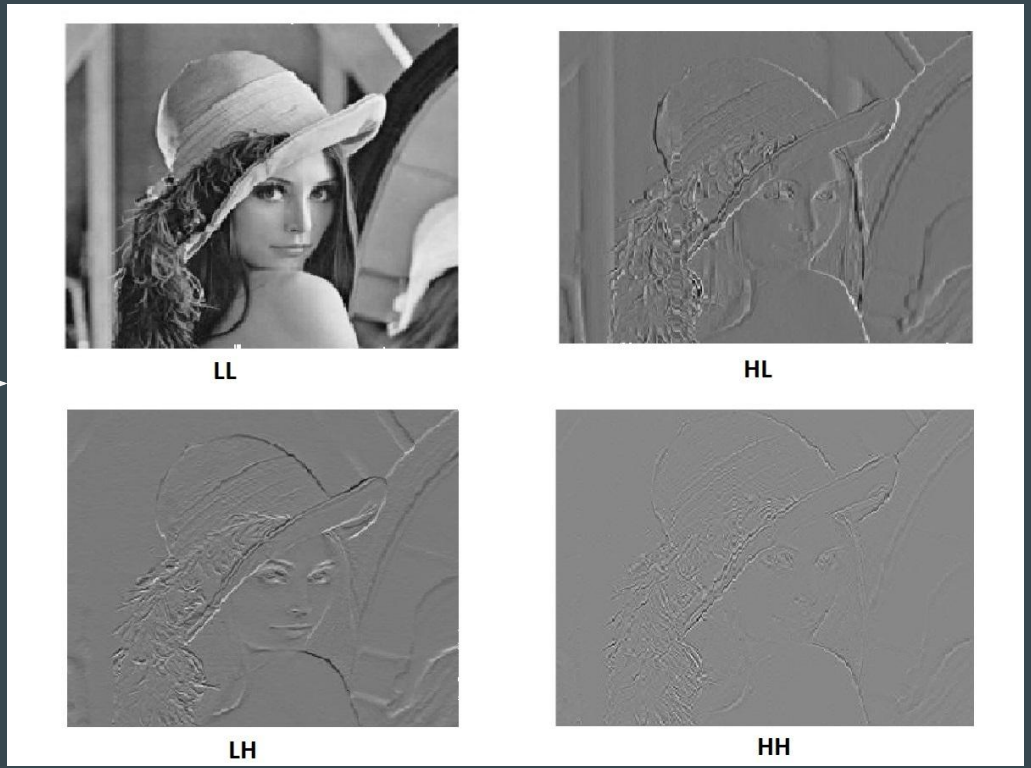
Overview of the Hybrid domain

- Level 3 DWT transformation is used to form watermarked image.
- DWT divides image into four non-overlapping multi-resolution sub bands.
- DWT has been used in digital image watermarking more frequently due to its excellent spatial localization and multi-resolution characteristics.
- Better model of Human Visual System than DCT
- Becoming more common in compression techniques

Discrete Wavelet Transform (DWT)

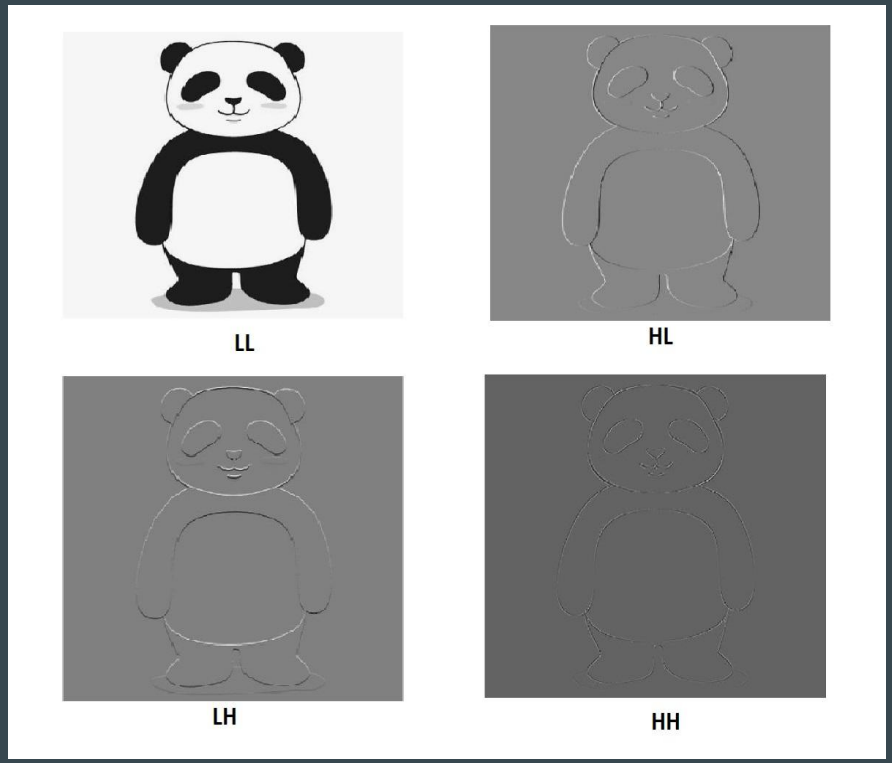
- Discrete wavelet transform (DWT) is any wavelet transform for which the wavelets are discretely sampled.
- A main advantage it has over Fourier transforms is - it captures both frequency and time information.
- Can be used for non-stationary signals (with time-varying frequency signals.)

Original Image



Level-1 Discrete Wavelet Decomposition

Original Image



Level-1 Discrete Wavelet Decomposition

For varying values of scaling/blending factors

K=0.2
Q=0.01

K=0.5
Q=0.01

K=0.97
Q=0.01

K=1.5
Q=0.01

K=0.1
Q=0.5

K=0.1
Q=0.7

K=0.1
Q=1.1

K=0.1
Q=1.5

Applications-

- Copyright -
  - The objective is to permanently and without alternately mark the image so that the credit is beyond dispute.
- Digital Rights -
  - A file may only be used by a users with a license which matches with the watermarked signature.
- Broadcast Monitoring -
  - Digital watermarking is an obvious alternative method of hiding identification information.
- Transaction tracking -
  - Visible watermarking is often used in this application, but Invisible watermark is even better.

The Team

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