Experiment No : 9

Discrete Wavelet Transform

Aim : To implement Discrete Wavelet Transform on an image and anlayze the LL, LH, HL and HH coefficeints.

Theory: Wavelet transform has recently become a very popular when it comes to analysis, de-noising and compression of signals and images. This section describes functions used to perform single- and multilevel Discrete Wavelet Transforms.
pywt.dwt2 computes the single-level 2-D discrete wavelet transform (DWT) of the input data X using the wname wavelet. dwt2 returns the approximation coefficients matrix cA and detail coefficients matrices cH, cV, and cD (horizontal, vertical, and diagonal, respectively).

```
# Import Libraries
import cv2
import matplotlib.pyplot as plt
import pywt

```

Image - l low

h high

1) blur approx =LL

2) V edges = LH

3) HE = HL

4) DE = HH

image(100 bits) -> LPF -> LPF = LL (approx)

image -> LPF -> HPF = LH (vertical edge)

image -> HPF -> LPF = HL (horizontal egde)

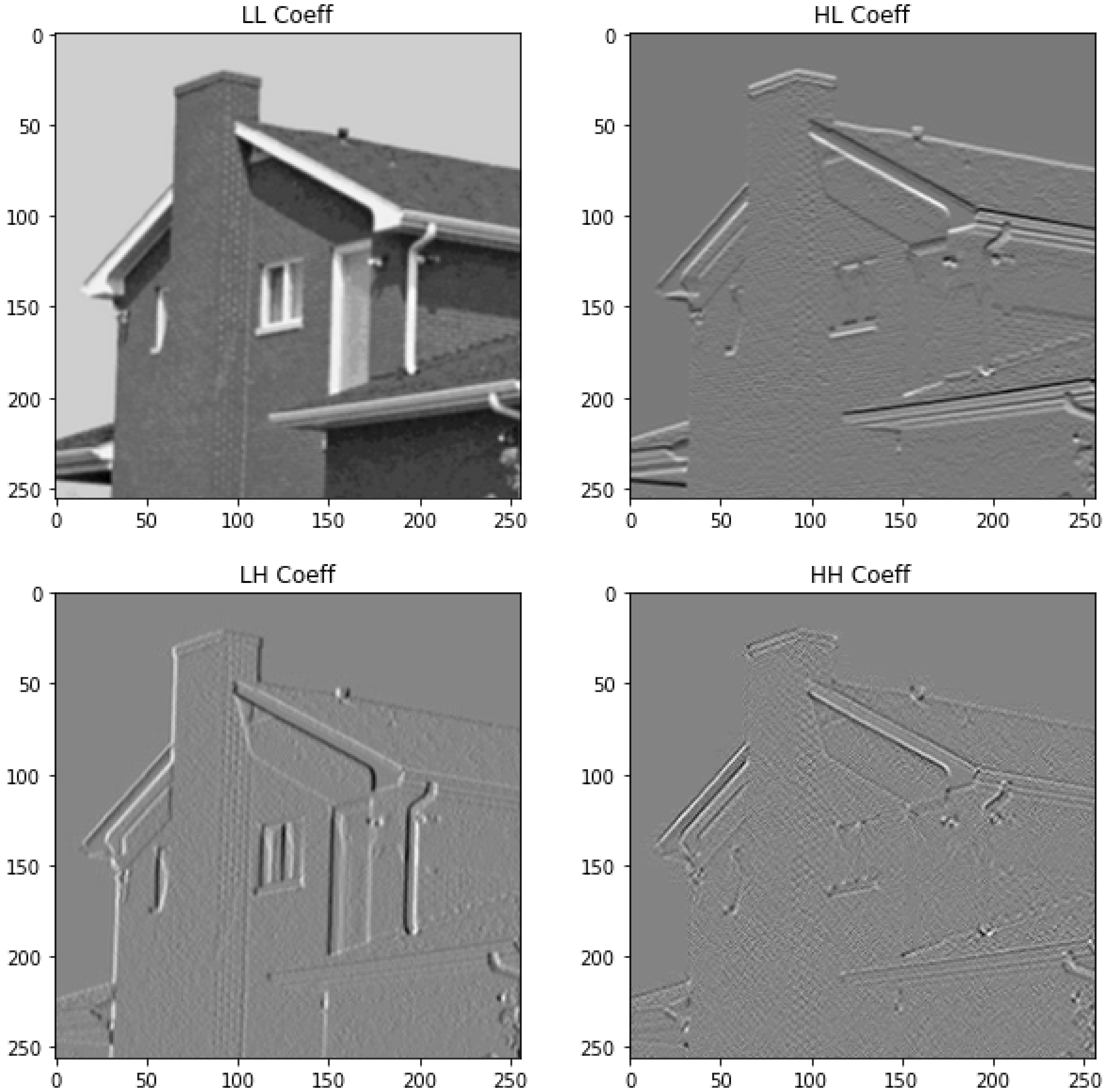
image -> HPF -> HPF = HH (diagonal edge)

Perform DWT image decomposition and view the LL, LH, HL and HH coefficeints

```
# Load image
img = cv2.imread("house.tif",0)

# Wavelet transform of image, and plot approximation and details
LL,(HL,LH,HH) = pywt.dwt2(img,"Haar")
```

```python

# Plot the coefficients
plt.figure(figsize = (10,10))

plt.subplot(221)
plt.imshow(LL,cmap='gray')
plt.title("LL Coeff")
plt.subplot(222)
plt.imshow(HL,cmap='gray')
plt.title("HL Coeff")
plt.subplot(223)
plt.imshow(LH,cmap='gray')
plt.title("LH Coeff")
plt.subplot(224)
plt.imshow(HH,cmap='gray')
plt.title("HH Coeff")
```

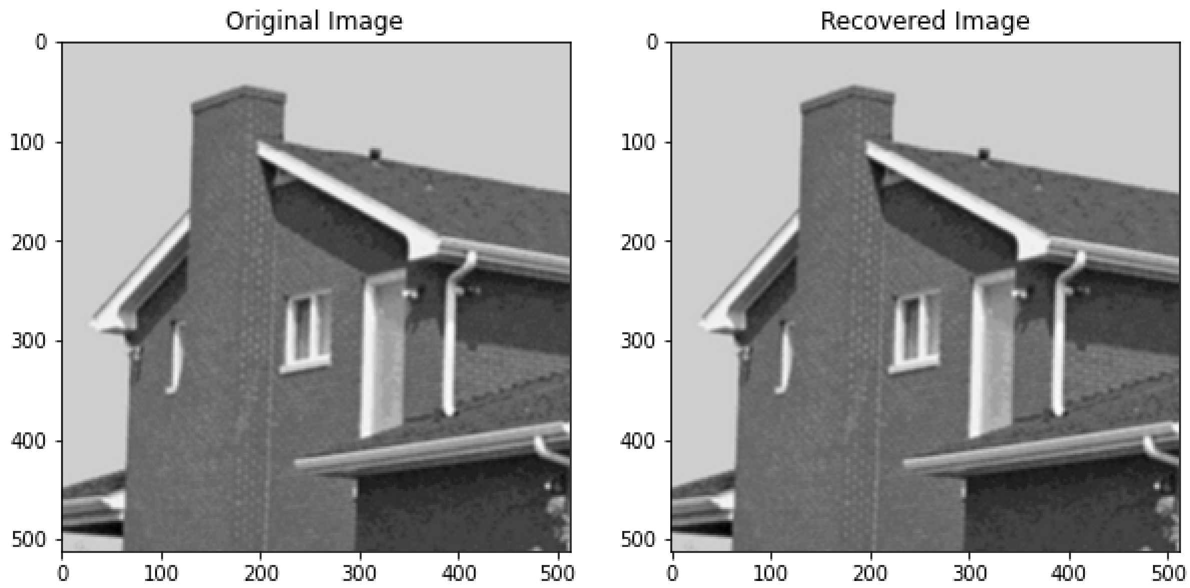
```
Text(0.5, 1.0, 'HH Coeff')
```



Compute the DWT of a image and reconstruct the image

```
# Load image
img2 = cv2.imread("house.tif",0)

# Wavelet transform of image, and plot approximation and details
X = pywt.dwt2(img2,"Haar")
recovered_img2 = pywt.idwt2(X,"Haar")

plt.figure(figsize = (10,10))
plt.subplot(121)
plt.imshow(img2,cmap='gray')
plt.title("Original Image")
plt.subplot(122)
plt.imshow(recovered_img2,cmap='gray')
plt.title("Recovered Image")


```

```
Text(0.5, 1.0, 'Recovered Image')
```



Conclusion :

1. Fourier transform is used to do stationary signal however, all real life signals r non stationary (frequency varies with respect to time.
2. DFT provides only Frequency and not time information. This limitation is overcome by using short time fourier transform. However stft uses a constant window size to enalyze high frequency we need small window and low frquency we need wider window.
3. Limitation is stft of fixed window size is overcome by using DWT(Wavelength transform).
4. Wavelenght transforms extracts the frequency and time, information, using scaling and translation property on mother wavelength.
5. Wavelenght transform is also used for frequency analysis and multi resolution analysis using wavelength decomposition or subband coding LL,HL,LH,HH.

6. LH- provides vertical, HL- Horizontal, HH-diagona, LL- approx.
7. We implemented the code for wavelenth composition using haar transform and observed the 4 subbands.
8. Incverse dft we also deconstructed the orignal image using the Inverse DWT and coefficient.