Session 3

Matrix of Orthogonal Basis Functions

1. A matrix (dictionary) containing all DCT basis vectors was created.

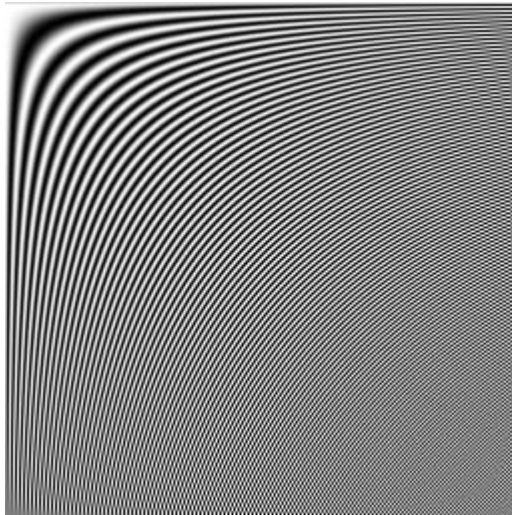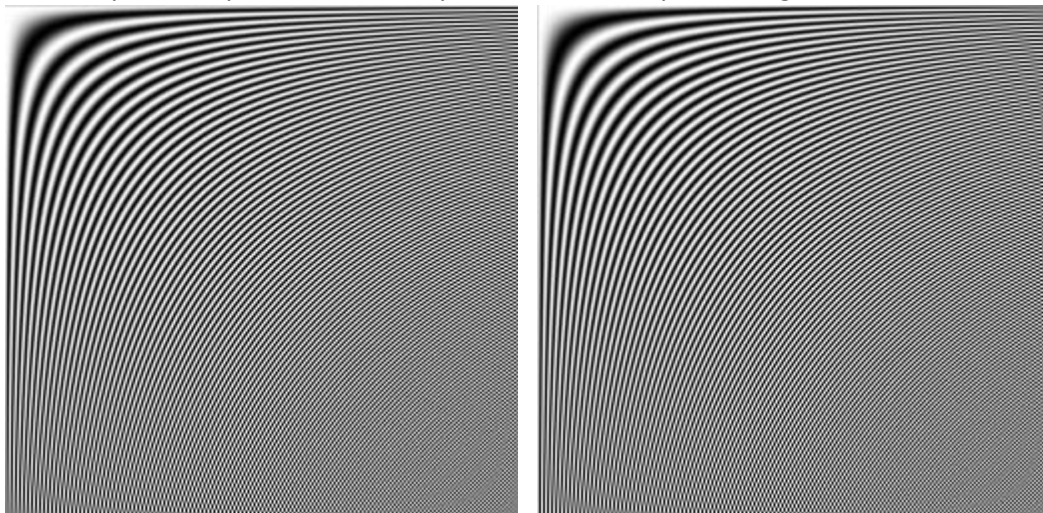2. An analysis DCT dictionary is displayed in figure 1 below.

Figure 1: Analysis Dictionary

3. A transpose function was written to produce the inverse synthesis IDCT dictionary.
   The Analysis and Synthesis Dictionary are shown side by side in figure 2.
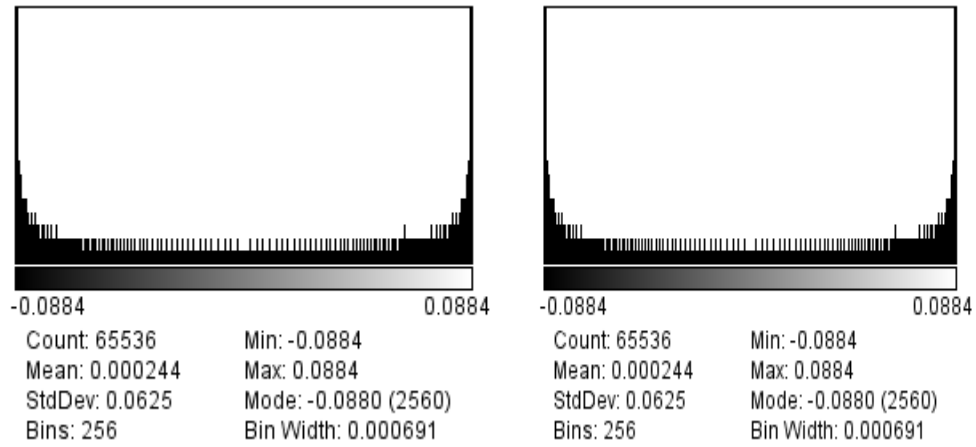

Analysis   Synthesis

Figure 2: Analysis and Synthesis Dictionary

I do not spot any difference between the Analysis and Synthesis Dictionary. Their histogram values are identical as shown in figure 3 below.

Count: 65536	Min: -0.0884
Mean: 0.000244	Max: 0.0884
StdDev: 0.0625	Mode: -0.0880 (2560)
Bins: 256	Bin Width: 0.000691

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Analysis Histogram   Synthesis Histogram

Figure 3: Histogram of Analysis and Synthesis dictionaries

The multiplication of the DCT matrix with its transpose results in an identity matrix as shown in figure 4 below.
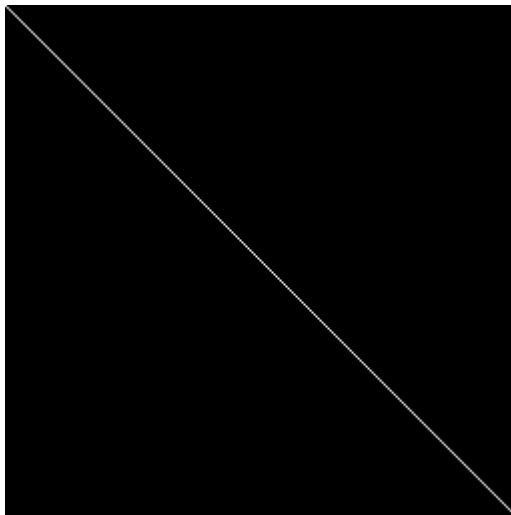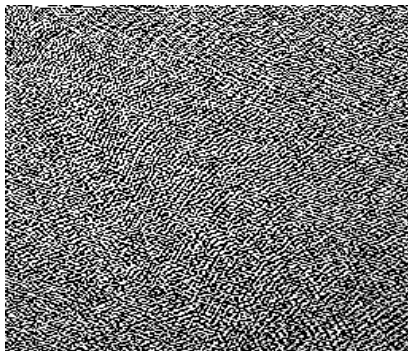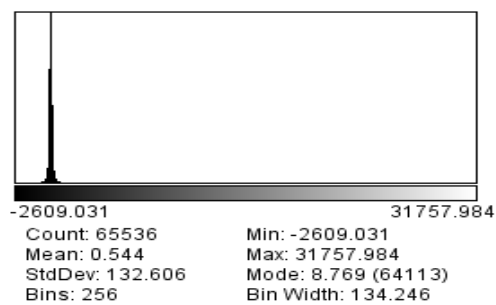

Figure 4: Identity Matrix

Discrete Cosine Transform

1. A transform function was written to produce DCT coefficients from the image of "Lena".

Count: 65536	Min: -2609.031
Mean: 0.544	Max: 31757.984
StdDev: 132.606	Mode: 8.769 (64113)
Bins: 256	Bin Width: 134.246

DCT coefficient from "Lena"   Histogram of DCT coefficient from "Lena"

Figure 5

2. A threshold function was written to zero out small DCT coefficients.
    Seven different matrices were gotten after using a threshold of 0, 1, 5,10, 50,100 and
    255 to remove coefficients lesser than 0, 1, 5, 10, 50, 100 and 255 respectively.

3. Image Reconstruction and PSNR:
    Comparing the original "Lena" image with the different reconstructed images, the PSNR
    were calculated as shown in figure 6.

PSNR Original "Lena": Infinity   PSNR threshold of 0: 86.0335

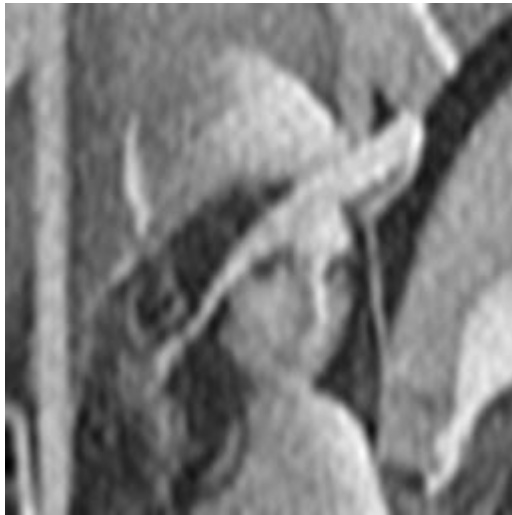PSNR threshold of 1: 53.8033   PSNR threshold of 5: 45.5378

PSNR threshold of 10: 42.8984   PSNR threshold of 50: 38.2719

PSNR threshold of 100: 36.8091   PSNR threshold of 255: 35.1094

Figure 6: PSNR of different thresholds

The PSNR reduces as the threshold increases. The image starts getting worse with a threshold of 50 and above.