ECE 63700 Laboratory:

2-D Random Processes

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1 Power Spectral Density of an Image
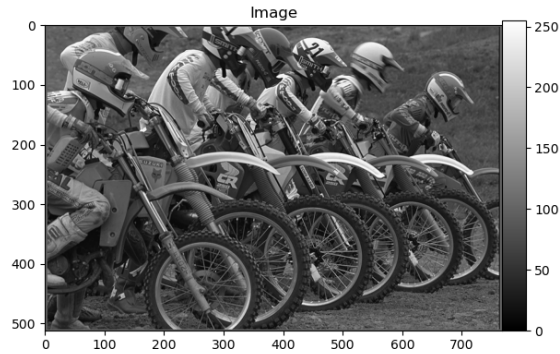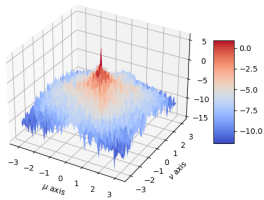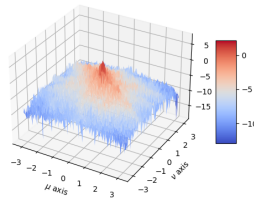
1.1 The gray scale image

Figure 1: img04.tif
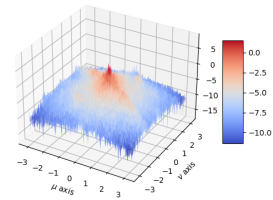
1.2 Power spectral density plots

The power spectrum estimates remain noisy even when the block size is increased.

(a) PSD plot for block size 64 x 64

(b) PSD plot for block size 128 x 128

(c) PSD plot for block size 256 x 256

Figure 2: PSD plot for different block sizes

1.3 The improved power spectral density plot

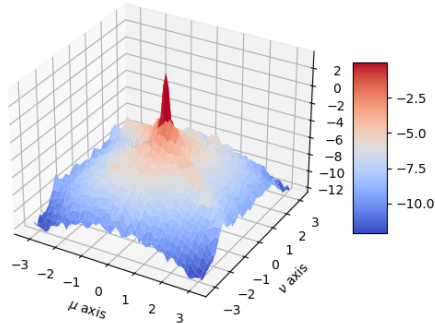The noise has been reduced after computing the power spectrum with *BetterSpecAnal(x)*

Figure 3: The improved PSD

1.4 Code for BetterSpecAnal(x)

```python
def BetterSpecAnal(x):
    rows, cols = x.shape

    # Starting points
    start_row = (rows - (5 * 64)) // 2
    start_col = (cols - (5 * 64)) // 2

    # 2D Hamming window
    W = np.outer(np.hamming(64), np.hamming(64))

    better_psd = np.zeros((64, 64))
    for i in range(5):
        for j in range(5):
            # Extract window
            row_start = start_row + i * 64
            col_start = start_col + j * 64
            window = x[row_start:row_start + 64, col_start:col_start + 64]

            # Apply Hamming window
            window = window * W

            # Compute squared DFT magnitude
            window = (1/64**2)*np.abs(np.fft.fft2(window))**2
            window = np.fft.fftshift(window)

            # Sum the averaged window
            better_psd += window/25

    return better_psd
```

2 Power Spectral Density of a 2-D AR Process
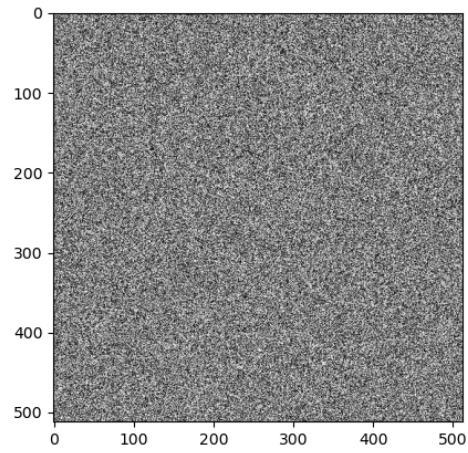
2.1 The image $255 * (x + 0.5)$

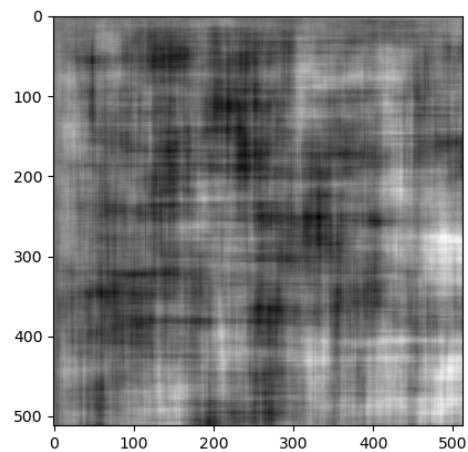Figure 4: Image of $255 * (x + 0.5)$

2.2 The image $y + 127$

Figure 5: Image of $y + 127$
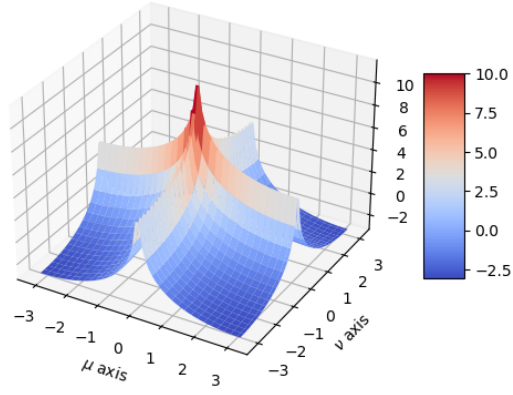
2.3 Mesh plot of $logS_y(e^{j\mu}, e^{j\nu})$

Figure 6: PSD of $logS_y(e^{j\mu}, e^{j\nu})$
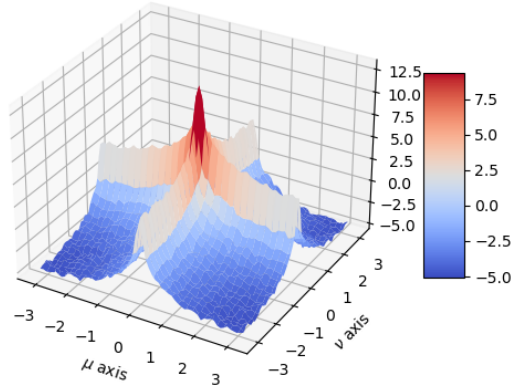
2.4 Mesh plot of $log(BetterSpecAnal(y))$

Figure 7: Estimated PSD plot of y using $BetterSpecAnal(y)$