Digital Signal Processing I
Purdue University
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Lab 2 Report

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1 Power Spectral Density of an Image

1. The gray scale image *img04g.tif*

Figure 1: Grey Scale Image of Input

2. The power spectral density plots for block sizes of 64x64, 128x128, and 256x256.

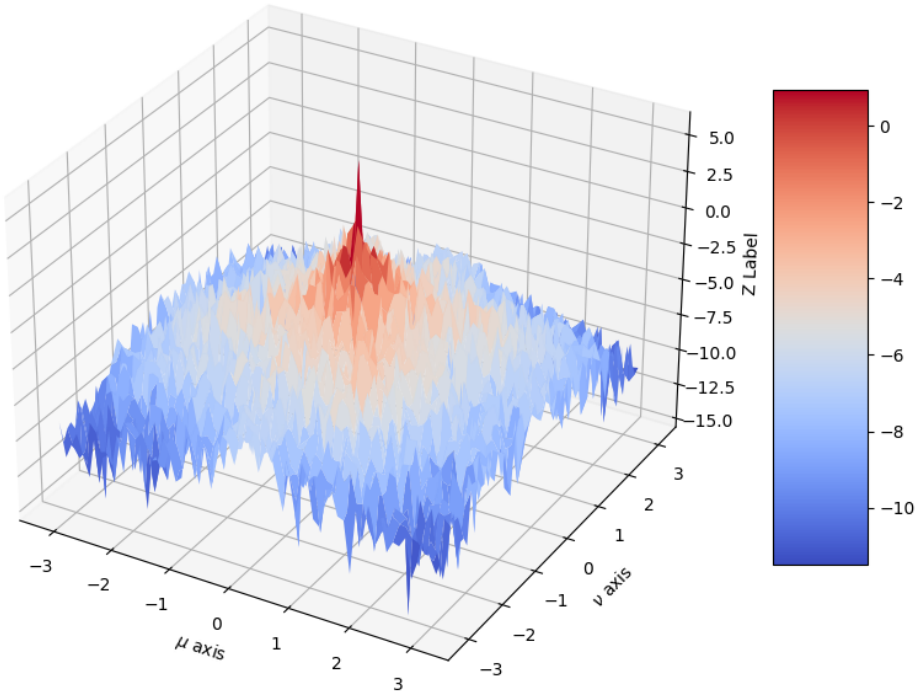

Figure 2: Power Spectral Density for 64x64 Block Size

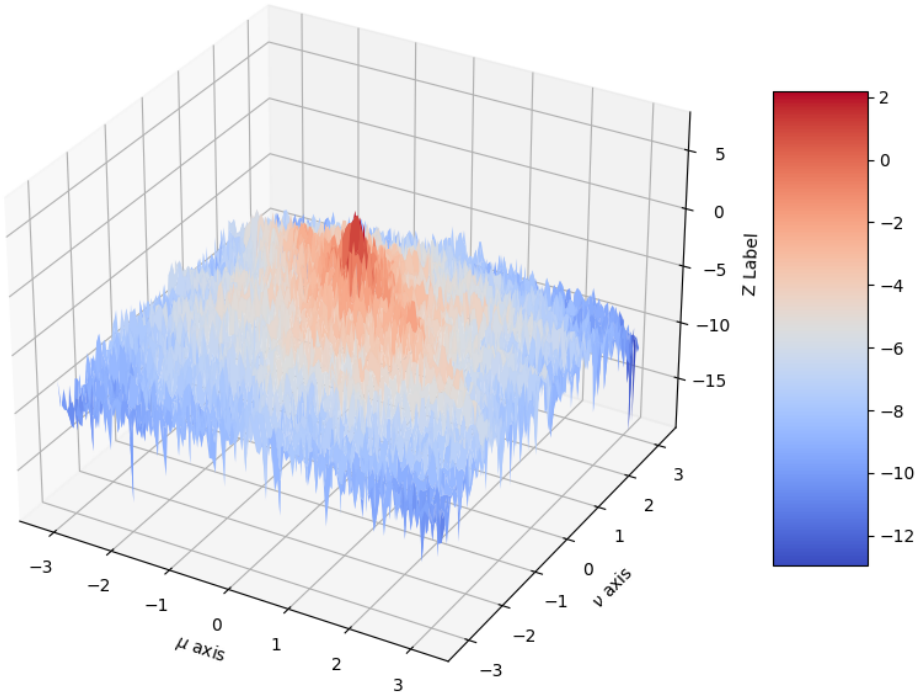

Figure 3: Power Spectral Density for 128x128 Block Size

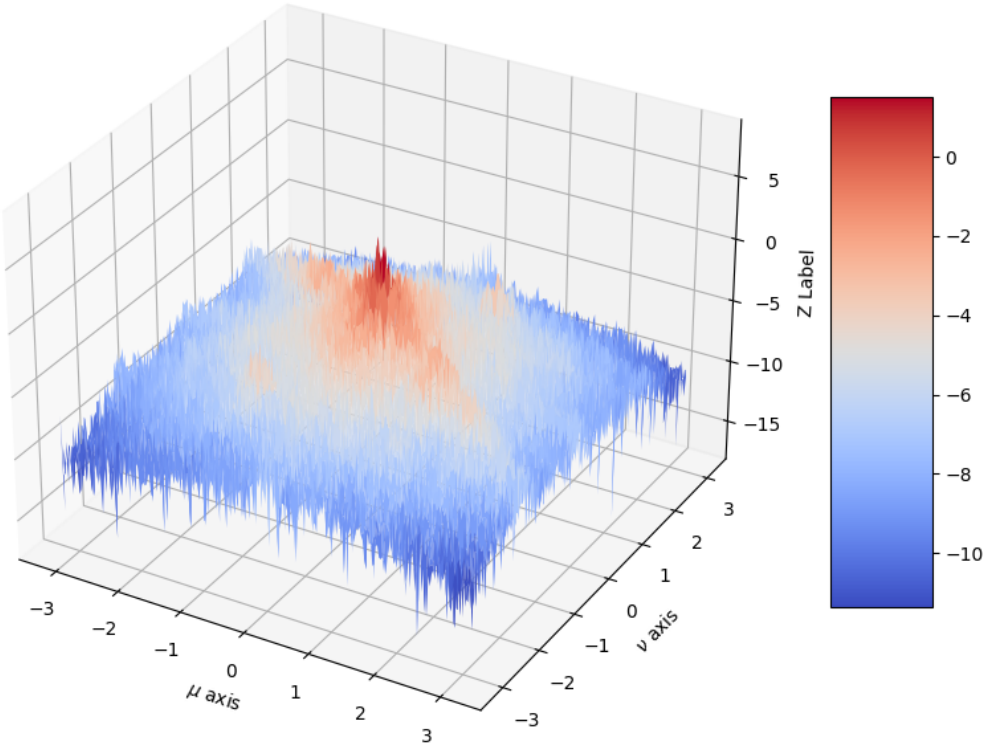

Figure 4: Power Spectral Density for 256x256 Block Size

3. The improved power spectral density estimate.

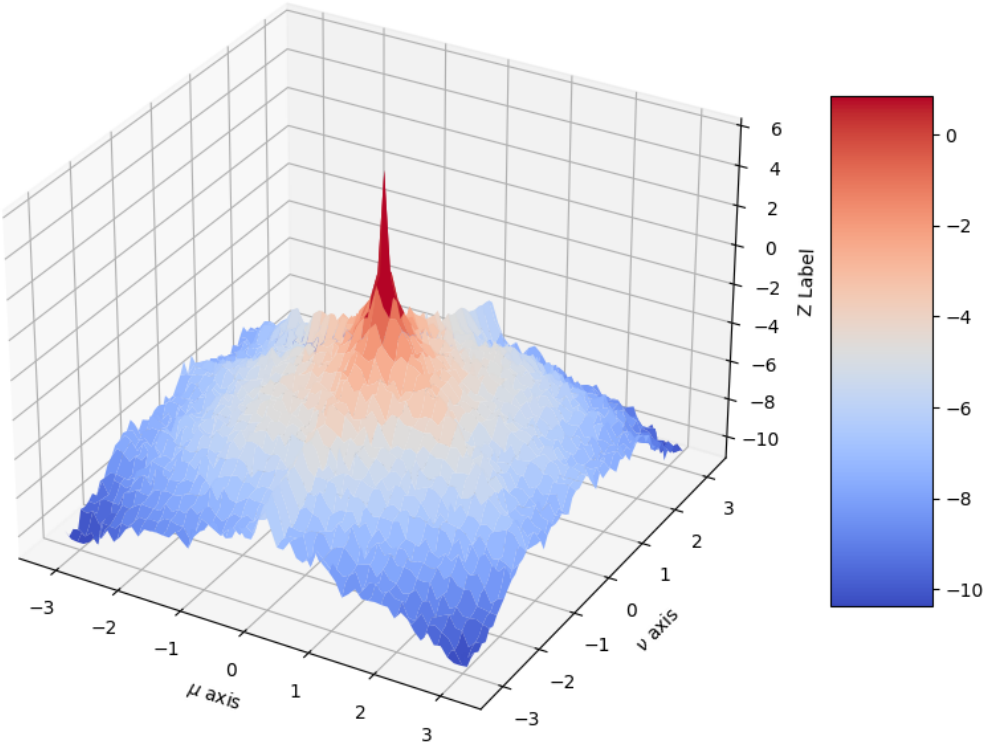

Figure 5: Better Estimation of Power Spectral Density with 64x64 Block Size

4. The for *BetterSpecAnal(x)* function.

```
def BetterSpecAnal(x):
    W = np.hamming(64).reshape((64,1))*np.hamming(64).reshape((1,64))
    i_c = x.shape[0] / 2
    j_c = x.shape[1] / 2
    loc_i = np.zeros((25,))
    loc_j = np.zeros((25,))
    # Calculate Location of all windows
    for i in range(-2,3):
        for j in range(-2,3):
            loc_i[(i+2)*5+(j+2)] = i_c + i * 64
            loc_j[(i+2)*5+(j+2)] = j_c + j * 64

    loc_i = loc_i.astype(int)
    loc_j = loc_j.astype(int)
    Z = np.zeros((64,64))
    for ind in range(25):
        i = loc_i[ind]
        j = loc_j[ind]
        z = x[i-32:i+32, j-32:j+32]
        Z_temp = (1/64**2) * np.abs(np.fft.fft2(z))**2
        Z = Z + np.log(np.fft.fftshift(Z_temp))
    Z = Z / 25
    # Plot the result using a 3-D mesh plot
    fig = plt.figure(figsize=(10,8))
    ax = fig.add_subplot(111, projection='3d')
    a = b = np.linspace(-np.pi, np.pi, num = 64)
    X, Y = np.meshgrid(a, b)

    surf = ax.plot_surface(X, Y, Z, cmap=plt.cm.coolwarm)

    ax.set_xlabel('$\mu$ axis')
    ax.set_ylabel('$\\nu$ axis')
    ax.set_zlabel('Z Label')

    fig.colorbar(surf, shrink=0.5, aspect=5)

    plt.show()
```

2 Power Spectral Density of a 2-D AR Process

1. The image $255 * (x + 0.5)$.

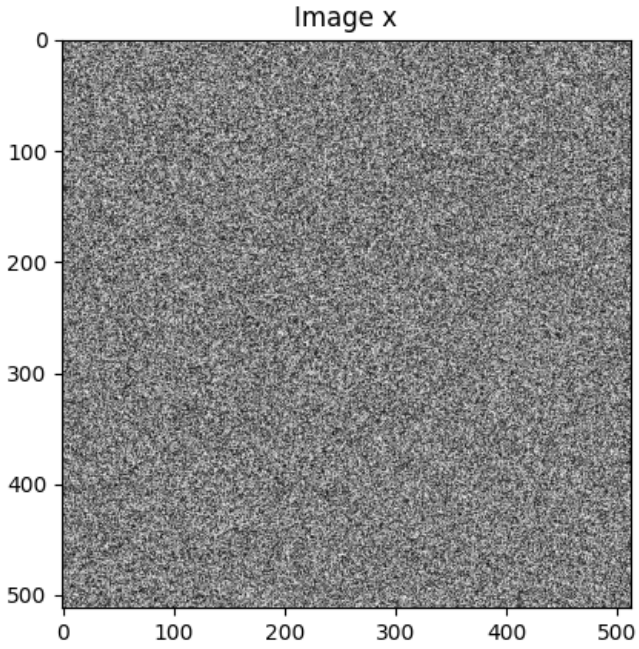

Figure 6: Image x

2. The image $y + 127$.

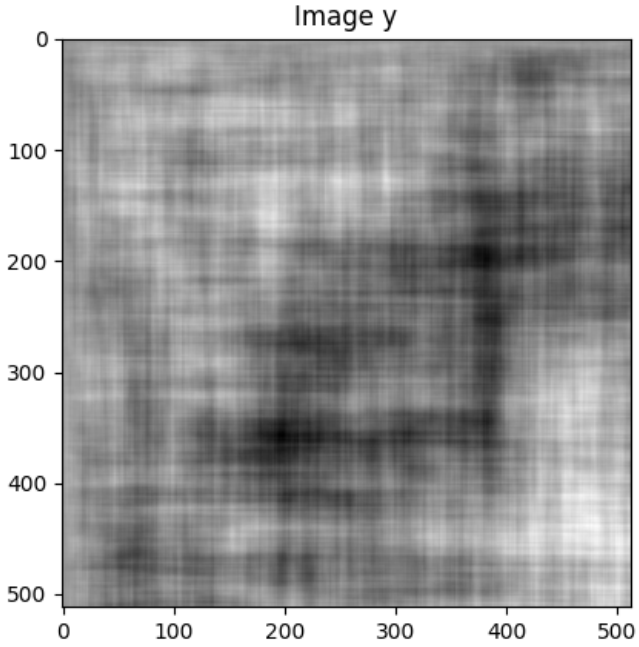

Figure 7: Image y

3. A mesh plot of the function $\log S_y(e^{j\mu}, e^{j\nu})$.

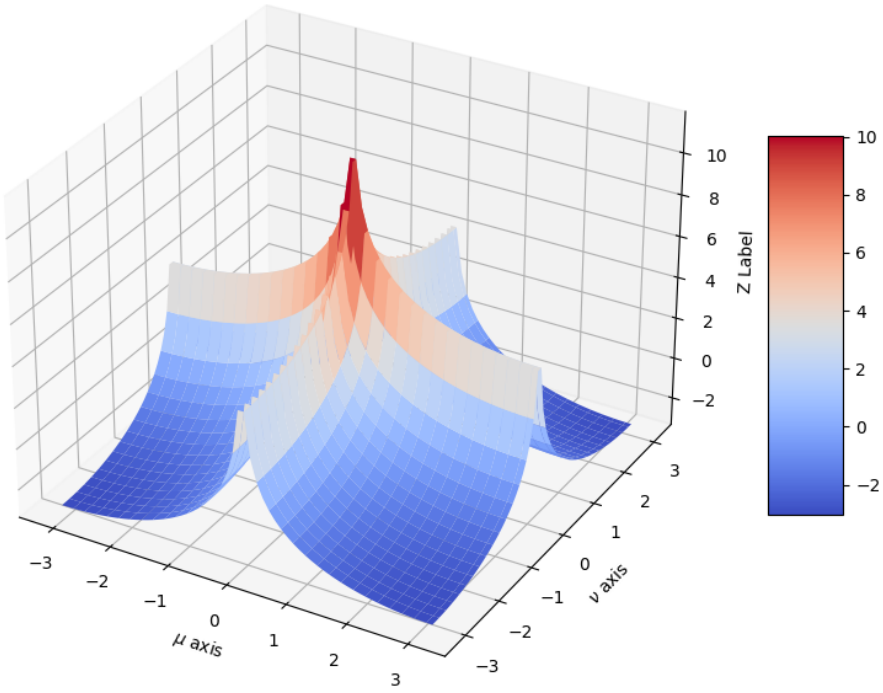

Figure 8: Mesh plot of the theoretical power spectral density of y

4. A mesh plot of the log of the estimated power spectral density of y using *BetterSpecAnal(y)*.

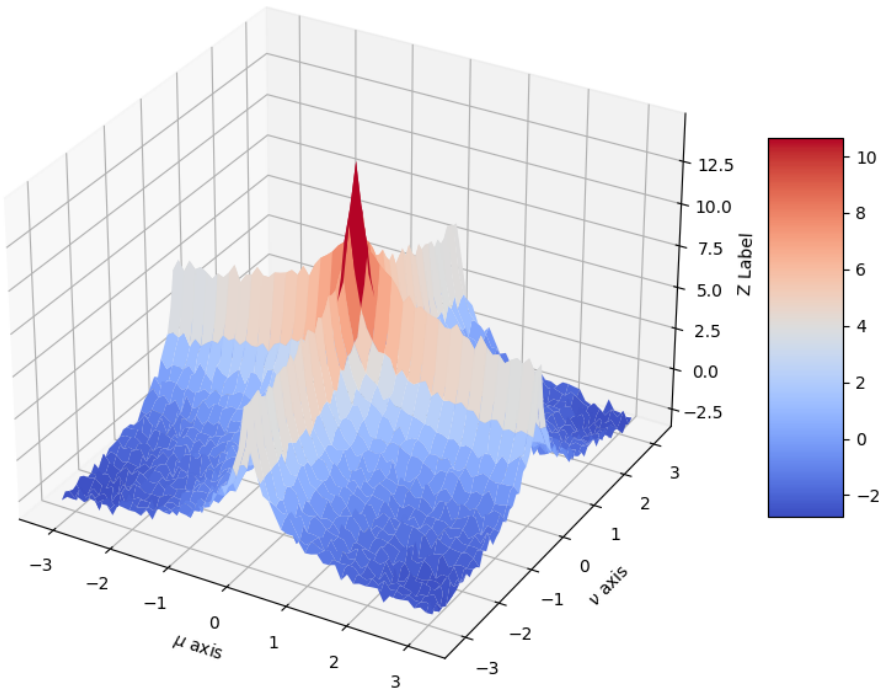

Figure 9: Mesh plot of the power spectral density of y using *BetterSpecAnal(y)*