ECE-178 Homework #4

Due on Wednesday, November 6, 2024, 11:59 PM

Name:

2D Fourier Transform Intuition (8 points)

1. Compute the (Discrete) Fourier Transform for each of the following signals, assuming that each signal has a length of 8 samples. Sketch a plot of the resulting Fourier Transform including axis labels.
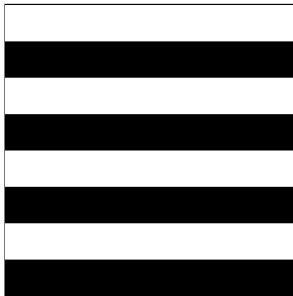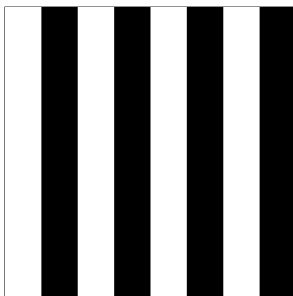
    a. $p[n] = n \bmod 2$

    b. $c[n] = 1$

    c. $c[n] = 0$

2. Sketch the 2D Fourier Transform of each of the following 8x8 images. For your convenience, you may report each pixel as being "dark" or "light" (white/black). *Hint: you shouldn't have to do any computations if you use the result from the previous question!*
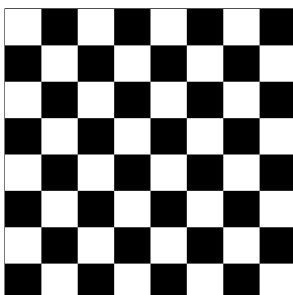
    a.

    b.

    c.

3. Explain the intuition behind the light pixels for 2a. What does a lit-up pixel represent? Create a general rule which applies to larger images.

[PROGRAMMING] Fast Convolution (4 points)

Unless otherwise stated, you may not use any library functions which compute convolution for this problem.

1. Implement a function called `conv(x[n], y[n])` which returns the convolution of two 1D signals of identical length `x[n]` and `y[n]` using the formula from class.

2. Recall the relationship between convolution and the FFT. Use any `np.fft` to implement a faster `fastconv(x[n], y[n])` in numpy. Briefly explain why this implementation is faster.

[PROGRAMMING] Basic Filtering (3 points)

Apply each of the three transformations to the `basic_filtering.png` image. Use the kernels provided in lecture/discussion. Save each of the output images.

1. Trace edges using a 3x3 gradient operator of your choice.

2. Sharpen the image using Laplacian Sharpening.