CS517: Digital Image Processing & Analysis

Semester I, 2021 – 2022

Programming Assignment 2: Fourier Domain

(*Due Date/Time: Monday, 18th Oct 2021, Midnight*)

**Question 1: Discrete Fourier Transform [10 Points]**

- **Step 1:** Create an empty 512×512 pixel image

- **Step 2:** Assume that X and Y are the coordinates of pixels in the above image. Calculate the value of each pixel intensity using the following equation:

$$I(x,y) = \sin(0.1x) + \sin(0.2x) + \cos(0.4x) + \sin\left(\sqrt{x^2 + y^2}\times0.15\right) + \sin\left(\sqrt{x^2 + y^2}\times0.35\right)$$

- **Step 3:** Compute the Discrete Fourier Transform of this image. You should rearrange the result to show the zero frequency in the center of the image (*Hint:* `fftshift`)

- **Step 4:** Display the original image along with the magnitude and phase of DFT for this image (with proper titles)

- **Step 5:** Now, multiply the magnitude of DFT by 2.0 and calculate the inverse Discrete Fourier Transform of it.

- **Step 6:** Show the result alongside the original image (add proper titles)

- **Step 7:** Explain the difference between the first image that you created in step 2 with this image.

Question 2: Notch Filter [15 Points]

A band-stop filter is a filter that passes most frequencies, but attenuates those in a specific range to very low levels. A notch filter is a band-stop filter with a narrow stopband. These filters are used to remove periodic noise that can be approximated as two dimensional sinusoidal functions from the image. Below is the example we discussed class.
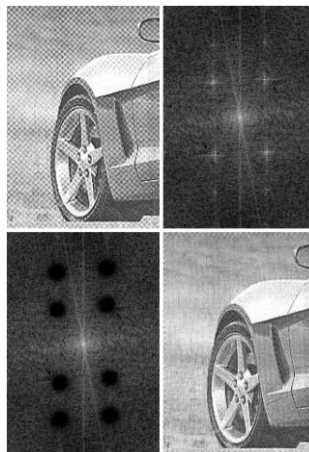
For each of the sample images provided (**NoiseBall.png** & **HalftoneCar.png**) that contain periodic noise:

- **Step 1:** Compute the DFT with appropriate shifting

- **Step 2:** Analyze the Fourier Spectrum and identify the components that represent the period noise

- **Step 3:** Design and implement a notch filter to remove the period noise components

- **Step 4:** Filter the DFT from Step 1 using the filter in Step 3

- **Step 5:** Calculate the inverse DFT of the filtered DFT from Step 4

- **Step 6:** In an image grid of 2 x 2, display the original image, original DFT, filtered DFT and filtered image as shown above

ASSIGNMENT SUBMISISON GUIDELINES

The assignment submission guidelines are very important for this course. Improper submissions will not be graded.

1. Rename your notebook file (ipnyb) accordingly. It should have both your Student Entry Number and the corresponding assignment number. For example, if your entry number is 2008CS1001, then the file should be named **2008CSB1001-PA2.ipnyb**

2. Use / add text sections to clarify the question number, provide detailed comments, etc.

3. Submit your assignment on Google Classroom.

4. Plagiarism is strongly prohibited!

5. Try to submit before the announced deadline or 25% penalty will be applied for the next day.

6. Assignments submitted later than one day will not be graded!