

HOMEWORK ASSIGNMENT 4

Digital Halftoning, Frequency Domain

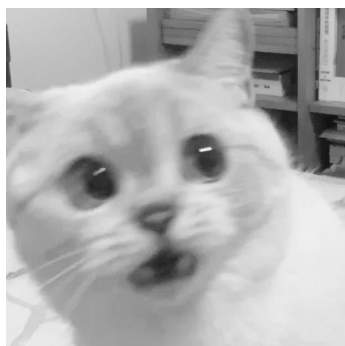
Due Date: 11:59 pm on May. 10, 2023

Please read the **submission guideline** carefully before getting started. All images in this homework are in PNG format and can be downloaded from our NTU COOL website. Details of all files offered are listed in the appendix. You are **NOT** allowed to use other functions except I/O, plotting and basic functions.

Problem 1: DIGITAL HALFTONING

A gray-scale image **sample1.png** and a dither matrix I_2 are shown in Fig. 1.(a) and (b), respectively.

- (a) (10 pt) According to the dither matrix I_2 , please perform dithering to obtain a binary image **result1.png**.
- (b) (15 pt) Expand the dither matrix I_2 to I_{256} (256×256) and use it to perform dithering. Output the result as **result2.png**. Compare **result1.png** and **result2.png** along with some discussions.
- (c) (25 pt) Perform error diffusion with Floyd-Steinberg and Jarvis' patterns on **sample1.png**. Output the results as **result3.png** and **result4.png**, respectively. You may also try more patterns and show the results in your report. Discuss these patterns based on the results. You can find some masks [here](#) (from lecture slide 06. p21)



(a) sample1.png

1	2
3	0

(b) Dither Matrix I_2

Figure 1: The image and dither matrix for digital halftoning.

Problem 2: Frequency Domain

- (a) (10 pt) By analyzing **sample2.png**, please explain how to perform image sampling on it to avoid aliasing. Please also perform 'inappropriate' image sampling which results in aliasing in the sampled image. Output the result as **result5.png**, specify the sampling rate you choose and discuss how it affects the resultant image.
- (b) (20 pt) Please perform the Gaussian high-pass filter in the frequency domain on **sample2.png** and transform the result back to the pixel domain by inverse Fourier transform. Save the resultant image as **result6.png**.
- (c) (20 pt) Try to remove the undesired pattern on **sample3.png** with Fourier transform and output it as **result7.png**. Please also describe how you accomplished the task.



sample2.png



sample3.png

Figure 2: Images for Fourier transform.

Appendix

Problem 1: DIGITAL HALFTONING

sample1.png:	622×622	gray-scale
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Problem 2: IMAGE SAMPLING

sample2.png:	2048×1639	gray-scale
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sample3.png:	874×726	gray-scale
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Recommended tools for Fourier transform

- scipy.fftpack.fft2
- scipy.fftpack.ifft2
- scipy.fftpack.fftshift
- scipy.fftpack.ifftshift
- numpy.fft.fft2
- numpy.fft.ifft2
- numpy.fft.fftshift
- numpy.fft.ifftshift