HOMEWORK ASSIGNMENT 4

Digital Halftoning, Shape Analysis

Due Date: 11:59 pm on May. 8, 2024
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 Figure 1.

(a) (`10 pt`) According to the dither matrix I_2, please perform dithering on **sample1.png** 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 on **sample1.png**. 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: SHAPE ANALYSIS (50 pt)

Given a training set as shown in Figure 2, please deign a recognition system for license plates and perform it on **sample2.png**, **sample3.png** and **sample4.png** as shown in Figure 3, respectively. In other words, a license plate image serves as an input to the system, and the output is its corresponding characters. For example, if the input is **sample3.png**, your program is supposed to output "FAE681". Note that you don't have to recognize the special character, "-". Please provide the flow chart along with the detailed descriptions of your algorithm. Also show the results and discuss on both the successful and failure cases.

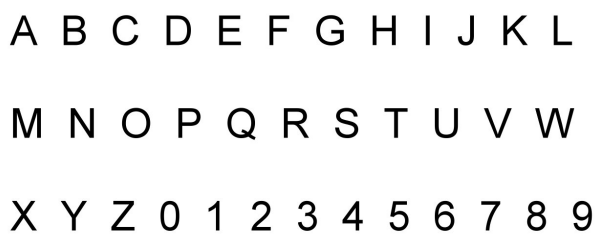


Figure 2: TrainingSet.png

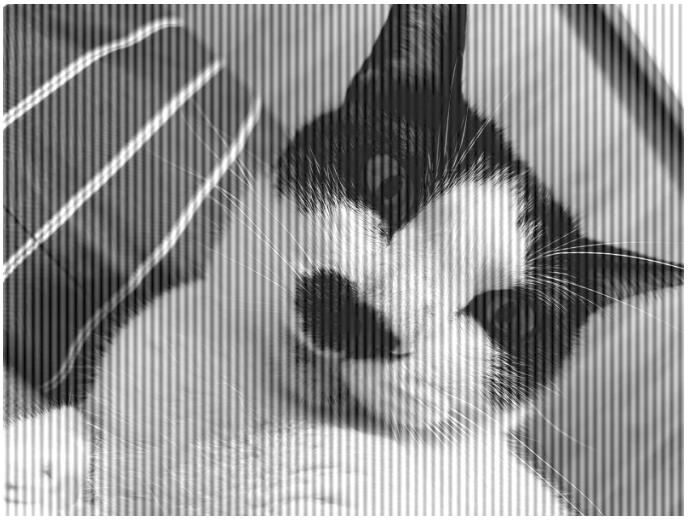
sample2.png sample3.png sample4.png

Figure 3: Three images of license plates

Problem 3: FREQUENCY DOMAIN

(`bonus`) Please remove the undesired pattern from **sample5.png** using a Fourier transform, and save the result as **result5.png**. Describe in detail how you accomplish this task. You may use the following external functions for ease:

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



sample5.png

Appendix

Problem 1: DIGITAL HALFTONING

sample1.png:	600×600	gray-scale

Problem 2: SHAPE ANALYSIS

sample2.png:	57×128	gray-scale
sample3.png:	80×250	gray-scale
sample4.png:	74×156	gray-scale
TrainingSet.png:	540×1240	gray-scale

Problem 2: FREQUENCY DOMAIN

sample5.png:	600×800	gray-scale

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