HOMEWORK ASSIGNMENT #4
Digital Halftoning, Frequency Domain

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1 Problem 1: DIGITAL HALFTONING

sample1.png is given in Figure 1.(a) Please apply several halftoning methods to the given image and provide discussions about the detail of the results.

Original image **sample1.jpg** for question Problem 1: DIGITAL HALFTONING.

1.1 (a)

Perform dithering using the dither matrix I_2 in Figure 1.(b) and output the result as **result1.png**

Motivation

Approach

Performance of results In the end, I choose the **settings**...

Result of problem 1(a): **result1.jpg** Dithering with I_2.

Discussion

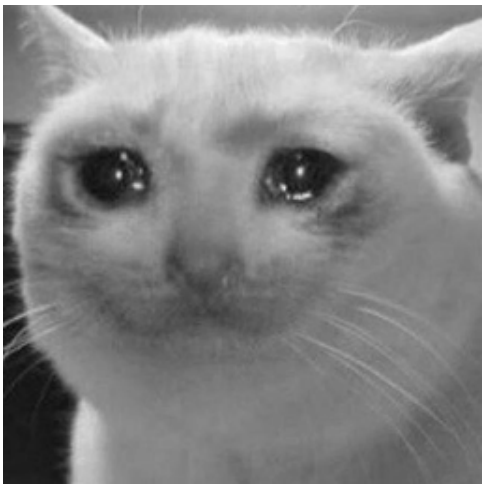

Figure 1: **sample1.jpg**

Figure 2: **result1.jpg** Dithering with I_2

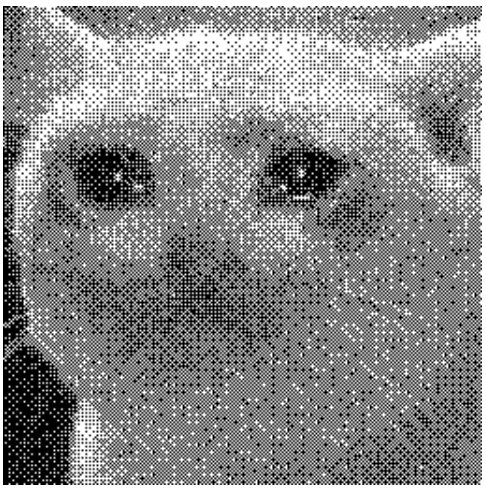

Figure 3: **result2.jpg** Dithering with I_{256}

1.2 (b)

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.

Motivation

Approach

Performance of results In the end, I choose the **settings**...

Result of problem 1(b): **result2.jpg** Dithering with I_{256}.

Discussion Compare **result1.png** and **result2.png**... **result2.jpg** Dithering with I_{256} sketch fine and smooth on the *face of the cat*.

1.3 (c)

Perform error diffusion with two different filter masks. Output the results as **result3.png**, and **result4.png**, respectively. Discuss these two masks based on the results.
You can find some masks **here** (from lecture slide 06. p23)

Motivation

Approach

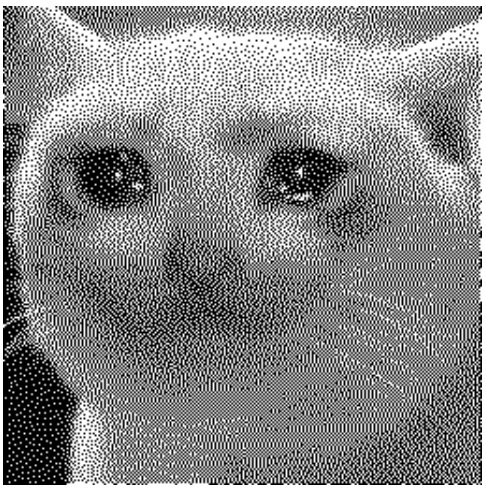

Figure 4: **result3.jpg** Error diffusion with mask Floyd Steinberg

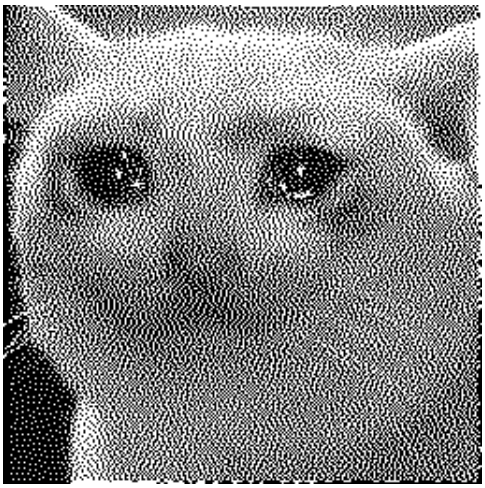

Figure 5: **result4.jpg** Error diffusion with mask Jarvis

Performance of results In the end, I choose the **settings**...

Result of problem 1(c): **result3.jpg** Error diffusion with mask Floyd Steinberg.

Result of problem 1(c): **result4.jpg** Error diffusion with mask Jarvis.

Discussion Discuss these two masks based on the results.

Other masks.

1.4 (d)

Try to transfer **result1.png** to a dotted halftone/manga style binary image such as **sample1_dotted.png** in Figure 1.(c). Describe the steps in detail and show the result. You may need to utilize a function like **cv2.circle** to draw a circle.

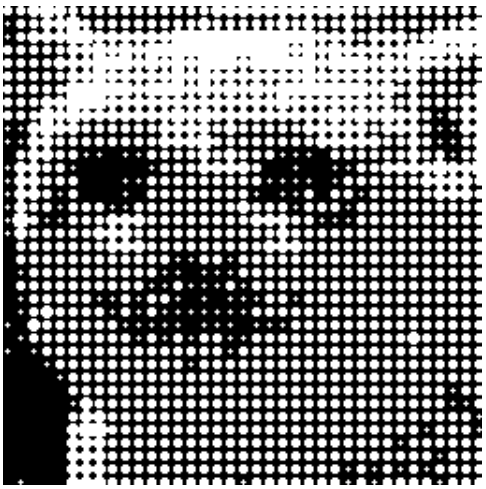

Figure 6: **sample1_dotted.png** Dotted halftone style transfer

Motivation

Approach

Performance of results In the end, I choose the **settings**...

Result of problem 1(d): **sample1_dotted.png** Dotted halftone style transfer.

Discussion Interesting style transfer methods.

Figure 7: **sample2.jpg**

2 Problem 2: FREQUENCY DOMAIN

In this problem, please perform Fourier transform and observe the relation between the spatial domain and the frequency spectrum. You may adopt tools for Fourier transform. The recommended tools are listed in the Appendix.

Original image **sample2.jpg** for question (a) (b), (c).

2.1 (a)

Perform Fourier transform on **sample2.png** to obtain its frequency spectrum and output it as **result5.png**. (Please take the log magnitude of the absolute value and center the low frequency part at the origin for visualization.)

Motivation

Approach

Performance of results In the end, I choose the **settings**...

Result of problem 2(a): **result5.jpg** Log axis of frequency domain.

Discussion

Figure 8: **result5.jpg** Log axis of frequency domain

2.2 (b)

Based on the result of part (a), design and apply a low-pass filter in the frequency domain and transform the result back to the pixel domain by inverse Fourier transform. The resultant image is saved as **result6.png**. Please also design a low-pass filter in the pixel domain which behaves similarly to the one you design in the frequency domain. Output the result as **result7.png** and provide some discussions.

Motivation

Approach

Performance of results In the end, I choose the **settings**...

Result of problem 2(b): **result6.jpg** Low-pass filter in frequency domain.

Result of problem 2(b): **result7.jpg** Low-pass filter in spatial domain.

Discussion Compare **result6.jpg** Low-pass filter in frequency domain with **result7.jpg** Low-pass filter in spatial domain.

Figure 9: **result6.jpg** Low-pass filter in frequency domain

Figure 10: **result7.jpg** Low-pass filter in spatial domain

Figure 11: **result8.jpg** High-pass filter in frequency domain

2.3 (c)

Based on the result of part (a), design and apply a high-pass filter in the frequency domain and transform the result back to the pixel domain by inverse Fourier transform. The resultant image is saved as **result8.png**. Please also design a high-pass filter in the pixel domain which behaves similarly to the one you design in the frequency domain. Output the result as **result9.png** and provide some discussions.

Motivation

Approach

Performance of results In the end, I choose the **settings**...

Result of problem 2(c): **result8.jpg** High-pass filter in frequency domain.

Result of problem 2(c): **result7.jpg** High-pass filter in spatial domain.

Discussion Compare **result8.jpg** High-pass filter in frequency domain with **result7.jpg** High-pass filter in spatial domain.

Original image **sample3.jpg** for question (d) (e).

Figure 12: **result7.jpg** High-pass filter in spatial domain

Figure 13: **sample3.jpg**

Figure 14: **result10.jpg** Fourier Transform on **sample3.jpg**

2.4 (d)

Perform Fourier Transform on **sample3.png** and output it as **result10.png**. Please discuss what you observe in **sample3.png** and **result10.png**.

Motivation

Approach

Performance of results In the end, I choose the **settings**...

Result of problem 2(d): **result10.jpg** Fourier Transform on **sample3.jpg**.

Discussion Observe in **sample3.jpg** and **result10.jpg** Fourier Transform on **sample3.jpg**.

2.5 (e)

Try to remove the undesired pattern on **sample3.png** and output it as **result11.png**.

Motivation

Approach

Figure 15: **result11.jpg** Noise cleaning of **sample3.jpg**

Performance of results In the end, I choose the **settings**...

Result of problem 2(e): **result11.jpg** Noise cleaning of **sample3.jpg**.

Discussion