Assignment 2

COMP 478 Image Processing

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Assignment 2

1.

Given that binary strings are broken strings of 1s with gaps of 0s for 1 to 5 pixels, a 5x5 kernel size would cover the largest gap of 0s that represents 5 pixels. Therefore, to ensure there are no gaps, the minimum kernel size is 5x5. For the threshold function to return a sharper version of the blurred image, the threshold value depends on the average value returned by the averaging filter. Its smallest average is found when a certain neighborhood of pixels from the blurred image contains only 2 pixels. This value r represents a gray level, which serves as an input for the thresholding function that should return a value s. For the blurred pixel to be sharp, r must be lower than s. Therefore, the threshold value must be set lower than r (or the smallest average given by the averaging mask).

2.

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} => [1\ 1 - 4\ 1\ 1] + [1\ 1 - 4\ 1\ 1]^T = [0\ 0\ 1\ 0\ 0$$

$$0\ 0\ 1\ 0\ 0$$

$$1\ 1 - 8\ 1\ 1$$

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This 5x5 mask must be built with uniform response in all directions: horizontal, vertical, and diagonal. The sum of all values in the filter must be equal to 0. This filter should yield a sharper image as there is more differentiation (more values in the matrix) in all directions unlike the aforementioned filters due to their smaller size.

01 110 10 101] 3.

a)

$$F(\mu) = \int_{-\infty}^{\infty} f(t)e^{-j2\pi\mu t}dt = \int_{0}^{W} Ae^{-j2\pi\mu t}dt$$
$$= \frac{-A}{j2\pi\mu} \Big[e^{-j2\pi\mu t} \Big]_{0}^{W} = \frac{-A}{j2\pi\mu} \Big[e^{-j2\pi\mu W} - 1 \Big]$$
$$= \frac{-A}{j2\pi\mu} [\cos(2\pi\mu W) - j\sin(2\pi\mu W) - 1]$$

Unlike the result from example 4.1, the main difference is that the result found from $0 \le t \le W$ contains an imaginary part as well as a cosine function that came from the identity: $e^{-j\theta} = \cos(\theta) - j\sin(\theta)$

$$\int_{0}^{1} e^{-j2\pi\mu t} dt$$

$$= \frac{-1}{j2\pi\mu} \left[e^{-j2\pi\mu t} \right]_{0}^{1} = \frac{-1}{j2\pi\mu} \left[e^{-j2\pi\mu} - 1 \right]$$

$$= \frac{-1}{j2\pi\mu} \left[\cos(2\pi\mu) - j\sin(2\pi\mu) - 1 \right]$$

b)

$$\begin{split} Fourier\big((f*g)(t)\big) &= H(\mu)F(\mu) \\ &= \left(\frac{AW}{\pi\mu W}[sin(\pi\mu W)]\right)^2 = \frac{A^2}{\pi^2\mu^2}[sin(\pi\mu W)]^2 \end{split}$$

Programming

import cv2

import numpy as np

#reading and blurring image using averaging filter of size 5x5

current_image = cv2.imread('Doc.tiff',0)

new_img = cv2.blur(current_image, (5,5))

cv2.imshow('image using avg filter',new_img)

cv2.waitKey(0);

```
cv2.destroyAllWindows();
print('done showing image')
#threshold implementation and application
def get_threshold_value_on_pixel(c, weighted_avg):
  return weighted_avg - c
for col in range(len(new_img)):
  for row in range(len(new_img[col])):
    thresh_arr = get_threshold_value_on_pixel(3, new_img[col][row])
    new_img[col][row] = 0
    if current_image[col][row] > thresh_arr:
      new_img[col][row] = 255
print('threshold calculation done')
cv2.imshow('image using my threshold',new_img)
cv2.waitKey(0);
cv2.destroyAllWindows();
print('threshold image done')
#using built-in threshold function
img_2 = cv2.blur(current_image, (5,5))
img_from_builtin_adapt = cv2.adaptiveThreshold(img_2, 255, cv2.ADAPTIVE_THRESH_MEAN_C,
cv2.THRESH_BINARY, 5, 3)
#displaying the 2 images side-by-side
side_by_side_imgs = np.hstack((new_img, img_from_builtin_adapt))
cv2.imshow('my threshold vs real threshold',side_by_side_imgs)
cv2.waitKey(0);
cv2.destroyAllWindows()
```

my threshold vs real threshold X Sonnet for Lena Sonnet for Lena O dear Lenn, your beauty is so vast Chaffe an Conferent Mercent fin ein warell It is hard sometimes to describe it fast. Recht fin mellermeiten mit merrieten mit fieren bar all weiter unt fieren है ब्युवन्त्योग परेस अमृत्यान कालपेरी है क्यापनि संस्कृतन I thought the entire world I would impress क्षि व्यक्तिक एक्स्पुत्र पुरावक्षण है अवस्थित एक्सप्युक्त स्थान If only your portrait I could compress. Alasi First when I tried to use VQ Diene There & design and the second Section (A.) I found that your cheeks belong to only you. # Brances State group alleathe Bulling Secretic grate Your sliky hair contains a thousand lines de error afeld y Regell wortet geben de Albertreiterfe Urjanu Hard to match with sums of discrete cosines. देवीत्रक द्वी कार प्रदानक हो। कार्याहों कार्याहों के विकास स्वर्ध कार्याहों के And for your lips, sensual and tactual க் விரின் நடிக் பிழக, மையுக்கி விரிச்சாங்கி Plus com Chang flomiff mid bir gengun flembaff Thirteen Crays found not the proper fractal. And while these setbacks are all quite sovere And while Chest set have not all signed moved I might have fixed them with backs here or there 2 magle flavor flavof *loop * PJaffard Chies or *look Hut when filters took sparkle from your eyes 1968 william Millam Sambangan Wit Barrin, yang sejeri I said, 'Dann all this, I'll just digitize.' County Charge all eller 218 freit Sie eine ? Thomas Colthurst Lightening & officer in

Custom threshold: filter size = 5x5, parameter c = 3

Built-in threshold: filter size = 5x5, parameter c = 3

Reason: tested various values, but those 2 were close in terms of desirable results when comparing the output images side by side.

Result: the custom threshold implementation with the same values used by the built-in one seems to yield a sharper image, with a little bit a noise in the background, whereas the built-in has no noise but is a bit blurry.