Lab2 Report

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Contents

1 Spatial Filtering

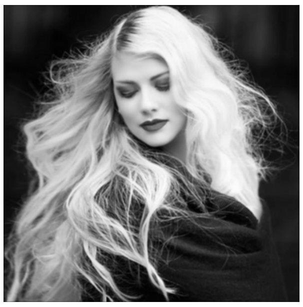
1.1 Integrated Function including linear and nonlinear filter

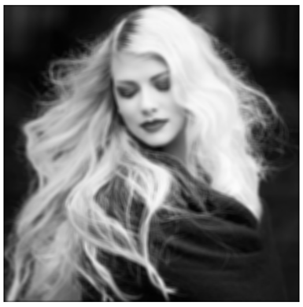
```python
import cv2
import numpy as np

#gaussian kernel generator
def gkern(l, sig):
    ax = np.linspace(-(l - 1) / 2., (l - 1) / 2., l)
    xx, yy = np.meshgrid(ax, ax)
    kernel = np.exp(-0.5 * (np.square(xx) + np.square(yy)) / np.square(sig))
    return kernel / np.sum(kernel)

#kernel generator
'''
type='average'|'gaussian'|'sobel_h'|'sobel_v'|'laplacian'|'median'
size=odd number like 3,5,7...
sigma >=0
'''
def knl_generator(type, size, sigma):
    if type=='average':
        return np.ones([size,size],dtype=int)/(size*size)
    if type=='gaussian':
        return gkern(size, sigma)
    if type=='sobel_v':
        return np.array([[-1,0,1],[-2,0,2],[-1,0,1]])
    if type=='sobel_h':
        return np.array([[-1,-2,-1],[0,0,0],[1,2,1]])
    if type=='laplacian':
        return np.array([[0.4038, 0.8021,   0.4038],
                        [0.8021,  -4.8233,   0.8021],
                        [0.4038,   0.8021,   0.4038]])
    if type=='median':
        return np.zeros([size,size])

#pad image border with 0
#size denote kernel size
def pad_img(img,size):
    m,n=img.shape
    pad_len=int((size-1)/2)#padding length for each edge
    padded_img=np.zeros([m+size-1,n+size-1])
    for i in range(pad_len, pad_len+m):
        for j in range(pad_len, pad_len+n):
            padded_img[i,j]=img[i-pad_len,j-pad_len]
    return padded_img

'''
function: spatial filter including linear and non-linear filter
input:img--np.array|type--'linear' or 'nonlinear'--median filter
output:filtered image--np.array
'''
def filter(img, type, kx):
    m,n=img.shape
    size=kx.shape[0]
    pad_len=int((size-1)/2)
    new_img=np.zeros([m,n],dtype=np.uint8)
    padded_img=pad_img(img, size)
    for i in range(pad_len,m+pad_len):
        for j in range(pad_len,n+pad_len):
            sum_prod=0
            for s in range(0,size):
               for t in range(0,size):
                   p=i-pad_len+s
                   q=j-pad_len+t
                   if type=='linear':
                       sum_prod=sum_prod+padded_img[p,q]*kx[s,t]
                   if type=='nonlinear':
                       kx[s,t]=padded_img[p, q]
            if type=='linear':
                new_img[i-pad_len,j-pad_len]=sum_prod
            if type=='nonlinear':
                sorted_kx=np.sort(kx,axis=None,kind='quicksort')
                med=sorted_kx[int((size*size-1)/2)]
                new_img[i-pad_len, j-pad_len]=med
    return new_img

#linear filter
img1=cv2.imread('img1.png',0)
img2=cv2.imread('img2.png',0)
k1=knl_generator('average', 3, 0)
img_one3=filter(img1, 'linear', k1)
cv2.imwrite('ones3.png', img_one3)
cv2.imshow('ones3',img_one3)
cv2.imwrite('ones3.png',img_one3)

k2=knl_generator('average', 7, 0)
img_one7=filter(img1,'linear',k2)
cv2.imwrite('ones7.png', img_one7)
cv2.imshow('ones7',img_one7)
cv2.imwrite('ones7.png',img_one7)

k3=knl_generator('gaussian', 3, 0.5)
img_g3=filter(img1,'linear',k3)
cv2.imshow('g3',img_g3)
cv2.imwrite('g3.png',img_g3)

k4=knl_generator('gaussian', 7, 1.2)
img_g7=filter(img1,'linear',k4)
cv2.imshow('g7',img_g7)
cv2.imwrite('g7.png',img_g7)

k6=knl_generator('sobel_h', 0, 0)
img_k6=filter(img2,'linear',k6)
cv2.imshow('k6',img_k6)
cv2.imwrite('k6.png',img_k6)

k7=knl_generator('sobel_v', 0, 0)
img_k7=filter(img2,'linear',k7)
cv2.imshow('k7',img_k7)
cv2.imwrite('k7.png',img_k7)

k8=knl_generator('laplacian', 0, 0)
img_k8=filter(img2,'linear',k8)
print(img_k8.max(), img_k8.min())
```

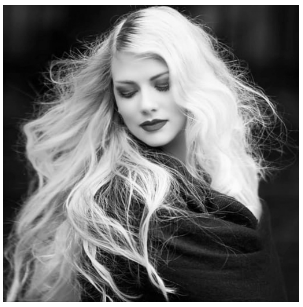
```
cv2.imshow('k8',img_k8)
cv2.imwrite('k8.png',img_k8)

#perform median filter
m3=knl_generator('median', 3, 0)
img_m3=filter(img1, 'nonlinear', m3)
cv2.imwrite('m3.png',img_m3)
cv2.imshow('m3',img_m3)

m5=knl_generator('median', 5, 0)
img_m5=filter(img1, 'nonlinear', m5)
cv2.imwrite('m5.png',img_m5)
cv2.imshow('m5',img_m5)

cv2.imwrite('origin1.png',img1)
cv2.imshow('originImg1',img1)

cv2.imwrite('origin2.png',img2)
cv2.imshow('originImg2',img2)

cv2.waitKey(0)
cv2.destroyAllWindows()
```

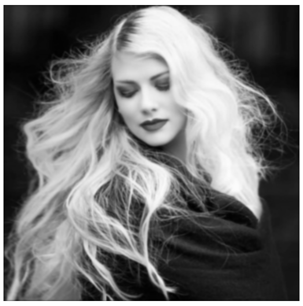
1.2 Outcome Collections I

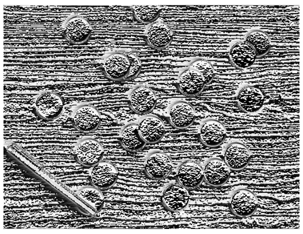
(a) Img1 Original Image.

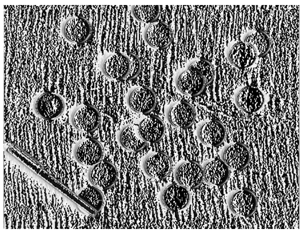

(b) Ones(3)

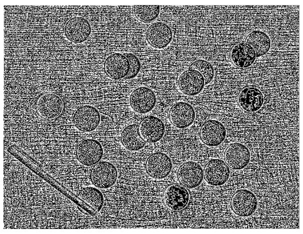

(c) ones(7)


(d) Gaussian3

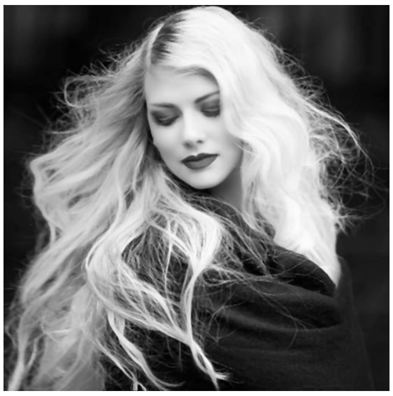

(e) Gaussian7

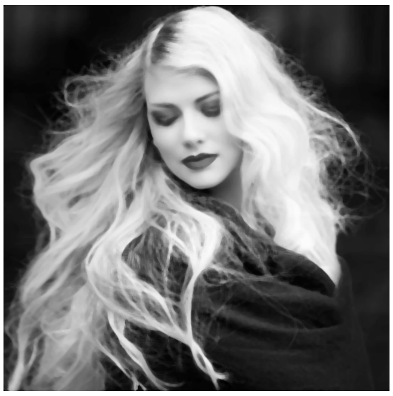

(f) Sobel-x


(g) Sobel-y


(h) log3

1.3 Median Filter Outcome


(a) Median3X3

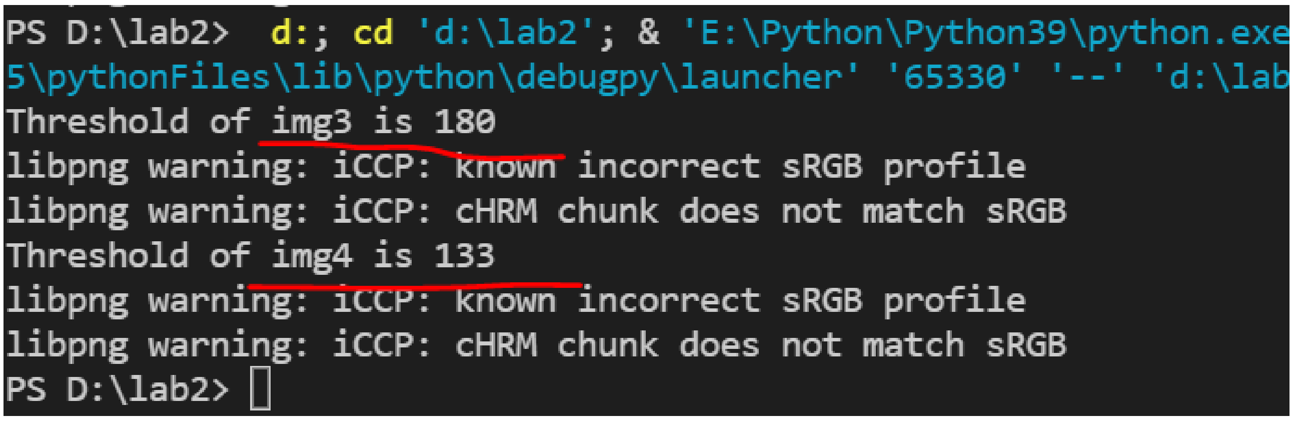

(b) Median5X5

2 Thresholding

2.1 Code for fingding threshold

```
import cv2
import numpy as np

def find_th(fig):
    img=cv2.imread(fig,0)
    global L
    L=img.max()
    m, n=img.shape
        #cnt is the number of intensity, pt is the probability accordingly
    cnt=np.zeros(L+1)
    pt=np.zeros(L+1)
    for i in range(0,m):
        for j in range(0,n):
            cnt[img[i,j]]=cnt[img[i,j]]+1
            pt[img[i,j]]=cnt[img[i,j]]/(m*n)

    def sigma(t):
        wt0=wt1=0
        ut0=ut1=0
        for x in range(0,t):
            wt0=wt0+pt[x]
        for y in range(t,L+1):
            wt1=wt1+pt[y]
        for p in range(0,t):
            ut0=ut0+p*pt[p]/wt0
        for q in range(t,L+1):
            ut1=ut1+q*pt[q]/wt1
        sigmaSqr=wt0*wt1*(ut0-ut1)**2
        return sigmaSqr

    maxInit=0
    for k in range(1,L+1):
        s=sigma(k)
        if s>maxInit:
            maxInit=s
            th=k
    return th

#binarize the iamge using threshold found by above function
def biImag(fig,th):
    img=cv2.imread(fig,0)
    L=img.max()
    m,n=img.shape
    for x in range(0,m):
        for y in range(0,n):
            if img[x,y]<th:
                img[x,y]=0
            else:
                img[x,y]=L
    return img

th3=find_th('img3.png')
print('Threshold of img3 is', th3)
th4=find_th('img4.png')
print('Threshold of img4 is', th4)

I3=biImag('img3.png',th3)
I4=biImag('img4.png',th4)
cv2.imshow('img3',I3)
cv2.imshow('img4',I4)
cv2.waitKey(0)
cv2.destroyAllWindows

cv2.imwrite('img3bi.png',I3)
cv2.imwrite('img4bi.png',I4)
```

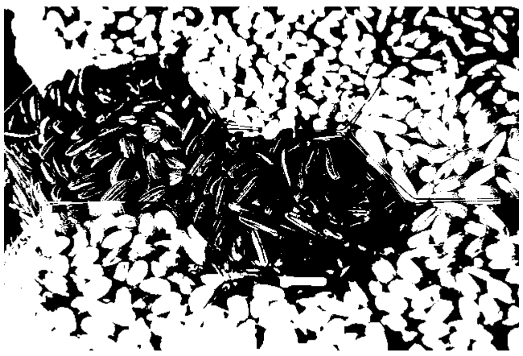
2.2 Outcome



```
PS D:\lab2>  d:; cd 'd:\lab2'; & 'E:\Python\Python39\python.exe
5\pythonFiles\lib\python\debugpy\launcher' '65330' '--' 'd:\lab
Threshold of img3 is 180
libpng warning: iCCP: known incorrect sRGB profile
libpng warning: iCCP: cHRM chunk does not match sRGB
Threshold of img4 is 133
libpng warning: iCCP: known incorrect sRGB profile
libpng warning: iCCP: cHRM chunk does not match sRGB
PS D:\lab2> 
```

Figure 3: Threshold of img3 and img4 executed from function.

(a) Binarized img3



(b) Binarized img4

3 Discussion

1.Kernel1 and kerne5 are avaraging filter and gaussian filter. Compared to averaging filter, guassian filter weighs the pixel within the kernel which give higher weight to the closer pixel. So Gaussian highlight more importance for the colse pixel.
2. The bigger the kernel size is, the vaguer the image is. Becasue with a bigger size kernel, more pixels far from the origin which are less relevant to the origin pixel will be convolved.
3.Kernel6 is sobel filter for x axis, which sharpens the x direction edge. Kernel7 is a rotationally symmetric Laplacian of Gaussian filter, which sharpens the edge without direction feature.
4. Edges in an image represents a swift change in the intensity of an image and noise in an image also signifies the same. so when noise is abundant in an image, it can interfere the edge detection.
5.Adaptive thresholding typically takes a grayscale or color image as input and, in the simplest implementation, outputs a binary image representing the segmentation. For each pixel in the image, a threshold has to be calculated. If the pixel value is below the threshold it is set to the background value, otherwise it assumes the foreground value.