HW 1 – ASSIGNMENT

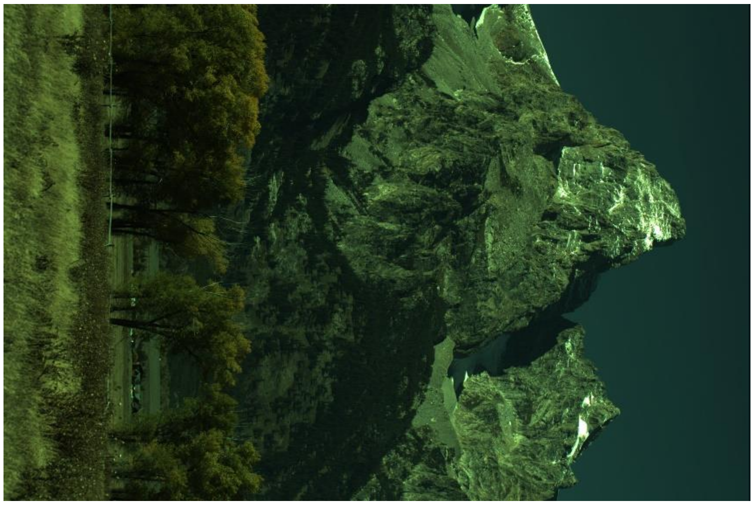
1) Demosaicing

```
import rawpy
import imageio
import cv2
from PIL import Image
import numpy as np
import math
import matplotlib.pyplot as plt
#########1a.reading and saving the image in png format and subsampling ##############################################
path = 'tetons.nef'
raw = rawpy.imread(path)
rgb = raw.postprocess()
imageio.imsave('tetons_original.png', rgb)

k=cv2.imread('tetons_original.png');
cvuint8 = cv2.convertScaleAbs(k)
print(cvuint8.dtype)

bayer = raw.raw_image
print(bayer.shape[1])
print(bayer.shape[0])

rr=bayer[::2, ::2]
gg=(bayer[1::2, ::2]+bayer[::2, 1::2])*0.5
bb=bayer[1::2, 1::2]
```

```
r1=(rr/float(np.max(rr)))*255

g1=(gg/float(np.max(gg)))*255

b1=(bb/float(np.max(bb)))*255


im=cv2.merge((b1,g1,r1))

cv2.imwrite("tetons_subsample.png",im)

print(im.shape[1])

print(im.shape[0])

##########################################################################
```

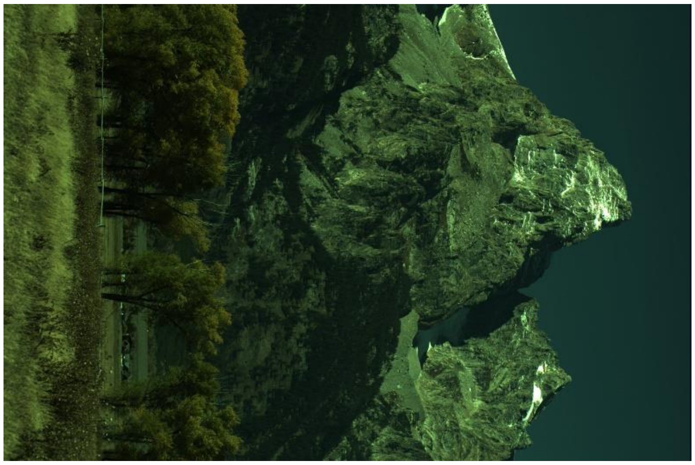
```
#########1b. nearest neighbour demosaicing ####################################################

img_scaled2 = cv2.resize(im,None,fx=2, fy=2, interpolation = cv2.INTER_NEAREST)

cv2.imwrite('tetons_nn.png', img_scaled2)

##############################################################################
```

```
#########1c. Bilinear demosaicing ###############################################

img_scaled3 = cv2.resize(im,None,fx=2, fy=2, interpolation = cv2.INTER_LINEAR)

cv2.imwrite('tetons_bl.png', img_scaled3)

######################################################################
```



```
#########1d. Gunturk demosaicing ###############################################

rn=bayer[::2, ::2]

gn=np.zeros([int(bayer.shape[0]/2),int(bayer.shape[1]/2)])

bn=bayer[1::2, 1::2]


for x in range(0,bayer.shape[0],2):

   for y in range(0,bayer.shape[1],2):

      dh=np.abs(((bayer[x,0]+bayer[x,bayer.shape[1]-1])/2)-bayer[x,y])
```

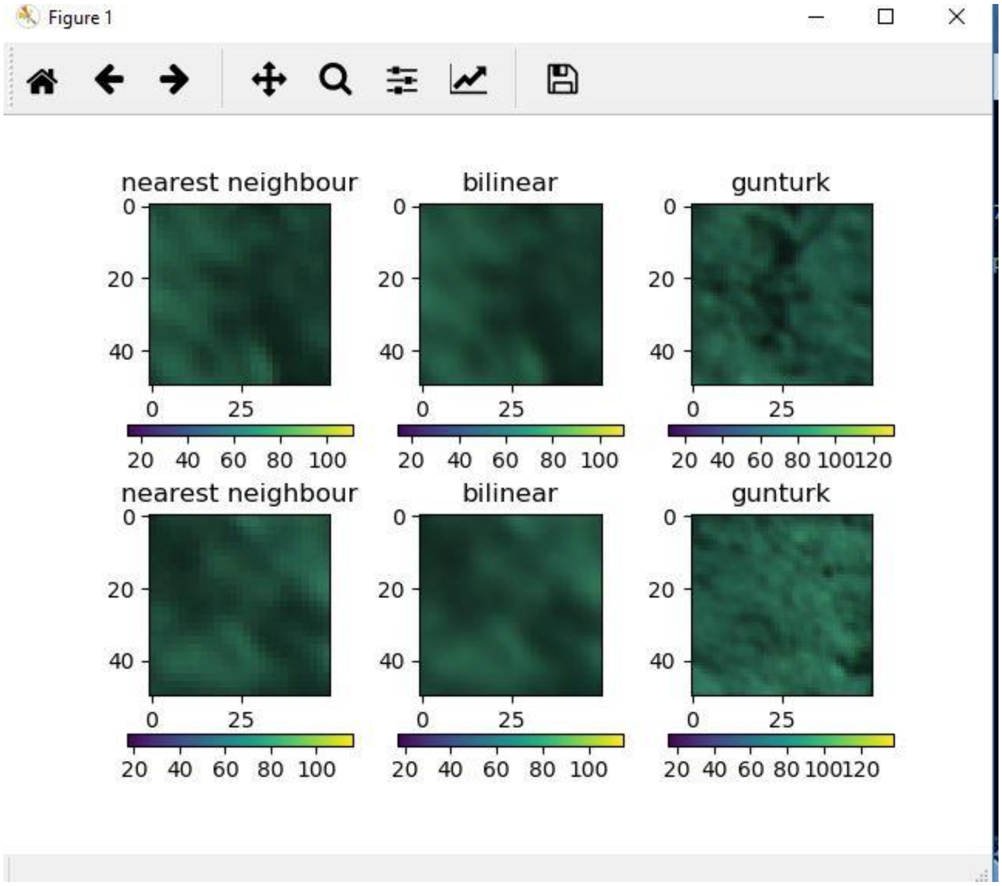
```
        dv=np.abs(((bayer[0,y]+bayer[bayer.shape[0]-1,y])/2)-bayer[x,y])
        if dh>dv:
            gn[int(x/2),int(y/2)]=(bayer[x-1,y]+bayer[x+1,y])/2
        elif dh<dv:
            gn[int(x/2),int(y/2)]=(bayer[x,y-1]+bayer[x,y+1])/2
        else:
            gn[int(x/2),int(y/2)]=(bayer[x-1,y]+bayer[x,y-1]+bayer[x+1,y]+bayer[x,y+1])/4

rk=(rn/float(np.max(rn)))*255
gk=(gn/float(np.max(gn)))*255
bk=(bn/float(np.max(bn)))*255

imk = cv2.merge((bk,gk,rk))
cv2.imwrite('tetons_dm.png',imk)
#########################################################################
```



```
#########1e. Comparision of NN, Bilinear and Gunturk methods ##########################
img = cv2.imread('tetons_nn.png')
img1 = cv2.imread('tetons_bl.png')
img2 = cv2.imread('tetons_dm.png')

fig = plt.figure()
```

```
a=fig.add_subplot(2,3,1)

az = img[100:150,100:150]

imgk = plt.imshow(az)

a.set_title('nearest neighbour')

plt.colorbar(orientation='horizontal')


a1=fig.add_subplot(2,3,2)

az1 = img1[100:150,100:150]

imgk = plt.imshow(az1)

a1.set_title('bilinear')

plt.colorbar(orientation='horizontal')


a2=fig.add_subplot(2,3,3)

az2 = img2[100:150,100:150]

imgk = plt.imshow(az2)

a2.set_title('gunturk')

plt.colorbar(orientation='horizontal')


a3=fig.add_subplot(2,3,4)

az3 = img[150:200,150:200]

imgk = plt.imshow(az3)

a3.set_title('nearest neighbour')

plt.colorbar(orientation='horizontal')


a4=fig.add_subplot(2,3,5)

az4 = img1[150:200,150:200]

imgk = plt.imshow(az4)

a4.set_title('bilinear')
```

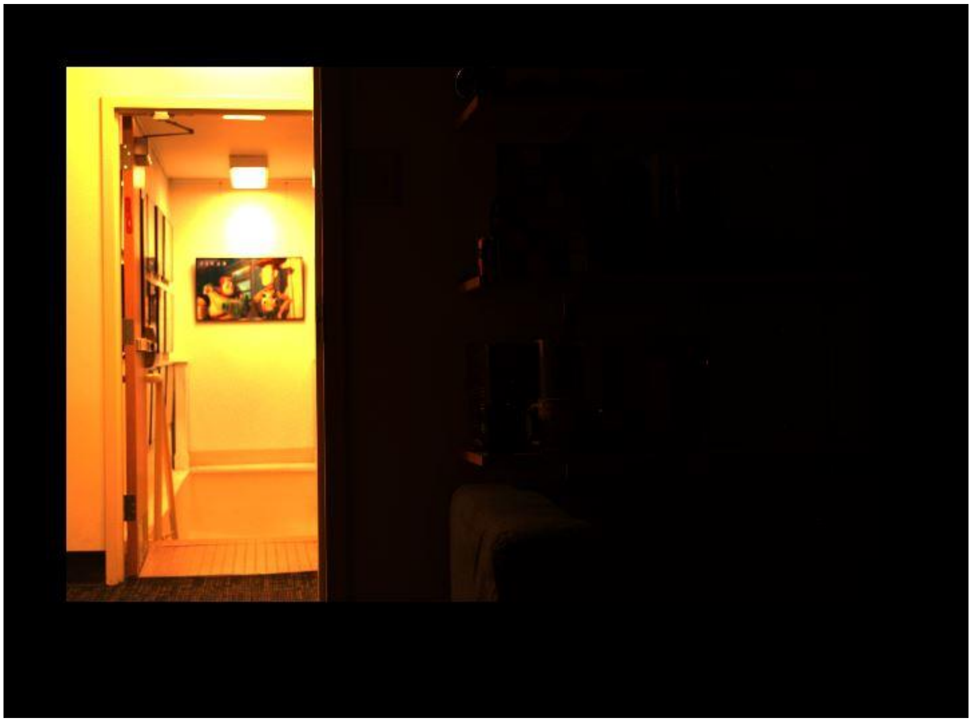
```
plt.colorbar(orientation='horizontal')

a5=fig.add_subplot(2,3,6)
az5 = img2[150:200,150:200]
imgk = plt.imshow(az5)
a5.set_title('gunturk')
plt.colorbar(orientation='horizontal')

plt.show()
#########################################################################
```



2)HDR imaging

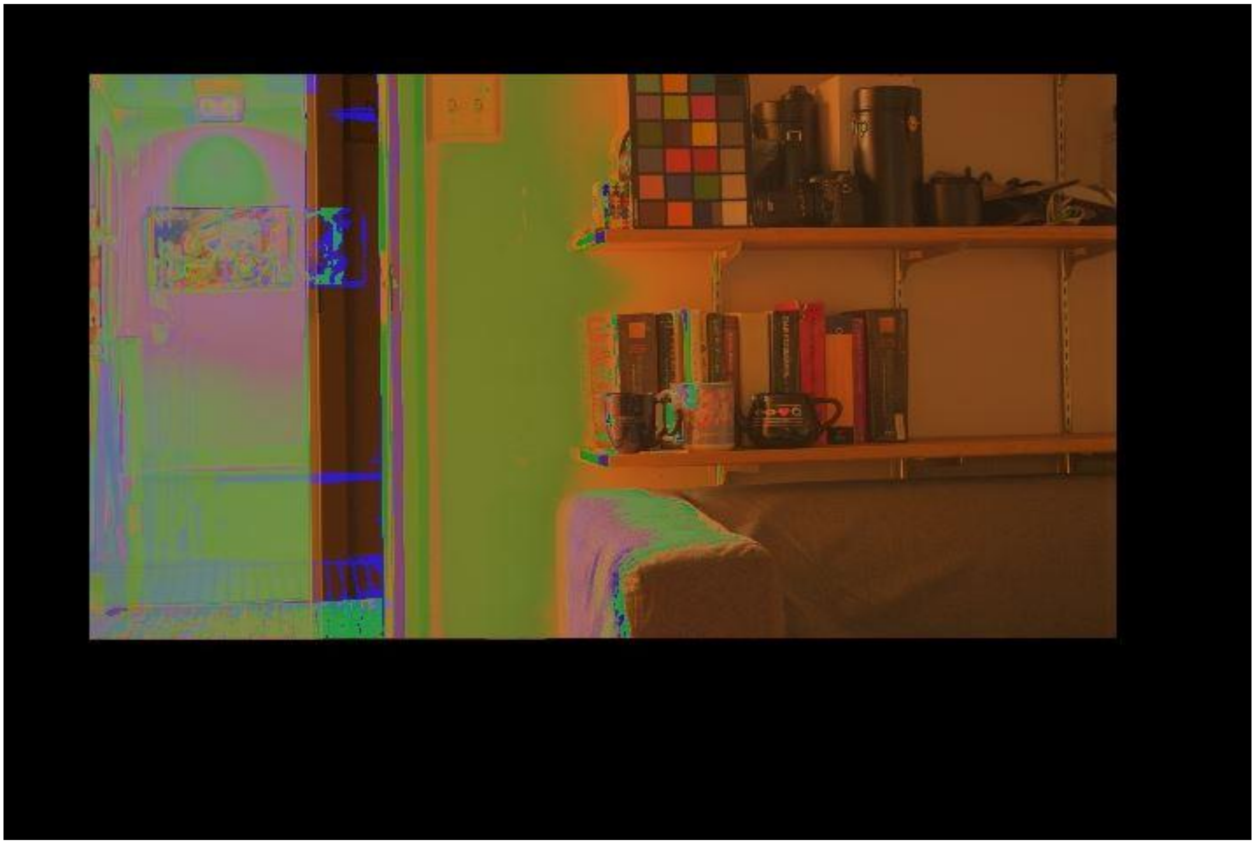
```
import cv2
import numpy as np
import matplotlib.pyplot as plt
import rawpy
import imageio
from PIL import Image
import tifffile as tiff
import math

paths = [ ]
tk = []
for k in range(1,17):
    paths.append('exposure%d.nef' % k )
    tk.append(2**(k-12))
#print(k)
#print(paths)
#print(tk)
i = 0;
########## section 3.a <processing raw images and resizing the images >#######################
for path in paths:
    i= i +1
    with rawpy.imread(path) as raw:
        rgb = raw.postprocess(gamma=(1,1), no_auto_bright=True, output_bps=16)
    xnew,ynew=rgb.shape[1]/10,rgb.shape[0]/10
    xnew = int(xnew)
    ynew = int(ynew)
    #print (xnew)
```

```
        rgb=cv2.resize(rgb,(xnew,ynew))
        imageio.imsave('processed_exposure%d.tiff' % i,rgb)
####################################
########## section 3.b <calculating hdr image using the formula >#######################
Ihdr=np.zeros((400,600,3))
Ihdr1=0
Ihdr11=0

for i in range(0,400):
        for j in range(0,600):
                for c in range(0,3):
                        for k in range(1,17):
                                img=cv2.imread('processed_exposure'+str(k)+'.tiff')
                                norm=img[i,j][c]/(255.0)
                                Ihdr1=Ihdr1+math.exp((-4*(norm-0.5)**2)/(0.5**2))*((Pex[i,j][c])/((1.0/2048)*(2**(k-1))))
                                Ihdr11=Ihdr11+math.exp((-4*(norm-0.5)**2)/(0.5**2))
                        Ihdr[i,j][c]=Ihdr1/Ihdr11
                        Ihdr1=0
                        Ihdr11=0
        #print( i )
####################################
########## section 3.c <displaying and saving the tonemapped image >#######################
cv2.imshow('image',Ihdr)
cv2.waitKey(0)
cv2.destroyAllWindows()
cv2.imwrite('HDR_phototonemap.png',Ihdr)
####################################
```



```
########## section 3. d<built In tonemapping  >######################

ps =[]

for k in range(1,17):

            ps.append('processed_exposure%d.tiff' % k )

img_list = [cv2.imread(fn) for fn in ps]

ks = np.array(tk)

#print(type(ks))

# images alignment

alignMTB = cv2.createAlignMTB()

alignMTB.process(img_list, img_list)


merge_robertson = cv2.createMergeRobertson()

hdr_robertson = merge_robertson.process(img_list, times=ks)


#Tonemap HDR image with gamma and saturation parameters
```

```
tonemap2 = cv2.createTonemapDrago(1.2,0.7)

res_robertson = tonemap2.process(hdr_robertson.copy())


# Convert datatype to 8-bit and save

res_robertson_8bit = np.clip(res_robertson*255, 0, 255).astype('uint8')

cv2.imshow('image',res_robertson_8bit)

cv2.waitKey(0)

cv2.destroyAllWindows()

cv2.imwrite("ldr_robertson_builtintonemap.jpg", res_robertson_8bit)

#####################################
```



3Bilateral filtering

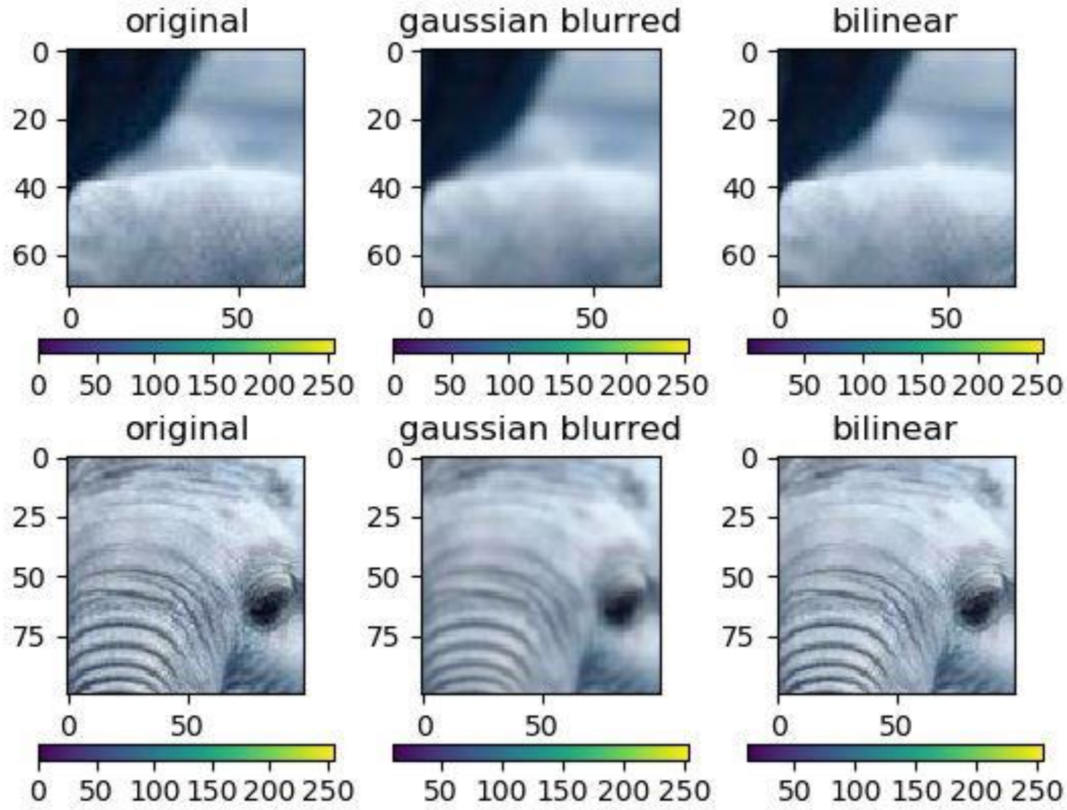
```
import cv2

import numpy as np
import matplotlib.pyplot as plt

import rawpy

import imageio

from PIL import Image

import tifffile as tiff

import math


##########distance function#######################

def distance(x, y, i, j):

    return np.sqrt((x-i)**2 + (y-j)**2)

#################################


########## gaussain function#######################

def gaussian(x, sigma):

    return (1.0 / np.sqrt((2 * math.pi * (sigma ** 2)))) * np.exp(- (x ** 2) / (2 * sigma ** 2))

#################################


########## section 3.b <bilateral filtering function >#######################

def bilateral_filter_own(source, x, y, diameter, sigma_i, sigma_s):

    #print(type(source))

    hl = int(diameter/2)

    i_filtered = 0

    Wp = 0

    i = 0

    while i < diameter:

        j = 0

        while j < diameter:

            neighbour_x = x - (hl - i)

            neighbour_y = y - (hl - j)
            if neighbour_x >= len(source):
                neighbour_x -= len(source)
            if neighbour_y >= len(source[0]):
                neighbour_y -= len(source[0])
            gi = gaussian(source[neighbour_x][neighbour_y] - source[x][y], sigma_i)
            gs = gaussian(distance(neighbour_x, neighbour_y, x, y), sigma_s)
            w = gi * gs
            i_filtered += source[neighbour_x][neighbour_y] * w
            Wp += w
            j += 1
        i += 1
    return (i_filtered / Wp)
###################################################


########## section 3.b <calling bilateral filtering function with following parameters>#######################
if __name__ == "__main__":
    imh= cv2.imread('babyelephant.jpg')
    diam = 5
    ele_new = np.zeros([imh.shape[0], imh.shape[1],3])
    for c in range(0,3):
        #print(src.shape[0])
        #print(src.shape[1])
        for l in range(0, imh.shape[0]):
            for m in range(0, imh.shape[1]):

                imh[l,m,c] = bilateral_filter_own(imh[:,:,c],l,m,diam,15,30)

cv2.imwrite('bilateral_bl_elephant.jpg', np.uint8(imh))
```

```
#################################################################
```

```
########## section 3.a <Loading and displaying the image >#######################

#load image

img = cv2.imread('babyelephant.jpg')

#display image

cv2.imshow('image',img)

cv2.waitKey(0)

cv2.destroyAllWindows()

#####################################


########## section 3.a <displaying the image after applying gaussian blur >#######################

#display image

dst = cv2.GaussianBlur(img, (5,5),0)

cv2.imshow('gaussian blurred image',dst)

cv2.waitKey(0)

cv2.destroyAllWindows()

cv2.imwrite("gaussianblurred.jpg", dst)

#####################################
```

```
###################3.b comparision of original, gaussian blurred and bilateral images#######################
img = cv2.imread('original_image_grayscale.png')
img1 = cv2.imread('gaussianblurred.jpg')
img2 = cv2.imread('bilateral_bl_elephant.jpg')

fig = plt.figure()

a=fig.add_subplot(2,3,1)
az = img[180:250,180:250]
imgk = plt.imshow(az)
a.set_title('original')
plt.colorbar(orientation='horizontal')

a1=fig.add_subplot(2,3,2)
az1 = img1[180:250,180:250]
imgk = plt.imshow(az1)
a1.set_title('gaussian blurred')
```

```
plt.colorbar(orientation='horizontal')

a2=fig.add_subplot(2,3,3)
az2 = img2[180:250,180:250]
imgk = plt.imshow(az2)
a2.set_title('bilinear')
plt.colorbar(orientation='horizontal')

a3=fig.add_subplot(2,3,4)
az3 = img[250:350,250:350]
imgk = plt.imshow(az3)
a3.set_title('original')
plt.colorbar(orientation='horizontal')

a4=fig.add_subplot(2,3,5)
az4 = img1[250:350,250:350]
imgk = plt.imshow(az4)
a4.set_title('gaussian blurred')
plt.colorbar(orientation='horizontal')

a5=fig.add_subplot(2,3,6)
az5 = img2[250:350,250:350]
imgk = plt.imshow(az5)
a5.set_title('bilinear')
plt.colorbar(orientation='horizontal')

plt.show()
###################################################################
```


original
gaussian blurred
bilinear
0
20
40
60
0
50
0
50
100
150
200
250
original
gaussian blurred
bilinear
0
25
50
75
0
50
0
50
100
150
200
250