Part 2, Lab #4: Image Denoising

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Due April 20th, 2023 11:59 PM CST

Logistics and Lab Submission

See the **BlackBoard**.

What You Will Need To Know For This Lab

This lab covers:

- Learning Image Desoising.

The submission procedure is provided below:

- You will be provided with a Jupyter Notebook for this lab where you need to implement the provided functions as needed for each question. Follow the instructions provided in this Jupyter Notebook (.ipynb) to implement the required functions.
- Upload the **PDF** (screen shot) file of your Jupyter Notebook (.ipynb file).
- Your grades and feedbacks will appear on BlackBoard. You will have a chance to re-submit your code, only if you have *reasonable* submissions before the deadline (i.e. not an empty script).

Problem 1: Mean filter

1. import packages, read the origin image and noised image.

In [8]:
```
!pip install scikit-image
```

```
Requirement already satisfied: scikit-image in /opt/anaconda3/lib/python3.8
/site-packages (0.18.1)
Requirement already satisfied: numpy>=1.16.5 in /opt/anaconda3/lib/python3.
8/site-packages (from scikit-image) (1.20.1)
Requirement already satisfied: scipy>=1.0.1 in /opt/anaconda3/lib/python3.8
/site-packages (from scikit-image) (1.6.2)
Requirement already satisfied: matplotlib!=3.0.0,>=2.0.0 in /opt/anaconda3/
lib/python3.8/site-packages (from scikit-image) (3.3.4)
Requirement already satisfied: networkx>=2.0 in /opt/anaconda3/lib/python3.
8/site-packages (from scikit-image) (2.8.2)
Requirement already satisfied: pillow!=7.1.0,!=7.1.1,>=4.3.0 in /opt/anacon
da3/lib/python3.8/site-packages (from scikit-image) (8.2.0)
Requirement already satisfied: imageio>=2.3.0 in /opt/anaconda3/lib/python3
.8/site-packages (from scikit-image) (2.9.0)
Requirement already satisfied: tifffile>=2019.7.26 in /opt/anaconda3/lib/py
thon3.8/site-packages (from scikit-image) (2020.10.1)
Requirement already satisfied: PyWavelets>=1.1.1 in /opt/anaconda3/lib/pyth
on3.8/site-packages (from scikit-image) (1.1.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.3 in
/opt/anaconda3/lib/python3.8/site-packages (from matplotlib!=3.0.0,>=2.0.0-
>scikit-image) (2.4.7)
Requirement already satisfied: cycler>=0.10 in /opt/anaconda3/lib/python3.8
/site-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image) (0.10.0)
Requirement already satisfied: python-dateutil>=2.1 in /opt/anaconda3/lib/p
ython3.8/site-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image) (2.8.
1)
Requirement already satisfied: kiwisolver>=1.0.1 in /opt/anaconda3/lib/pyth
on3.8/site-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image) (1.3.1)
Requirement already satisfied: six in /opt/anaconda3/lib/python3.8/site-pac
kages (from cycler>=0.10->matplotlib!=3.0.0,>=2.0.0->scikit-image) (1.15.0)
```

In [9]:

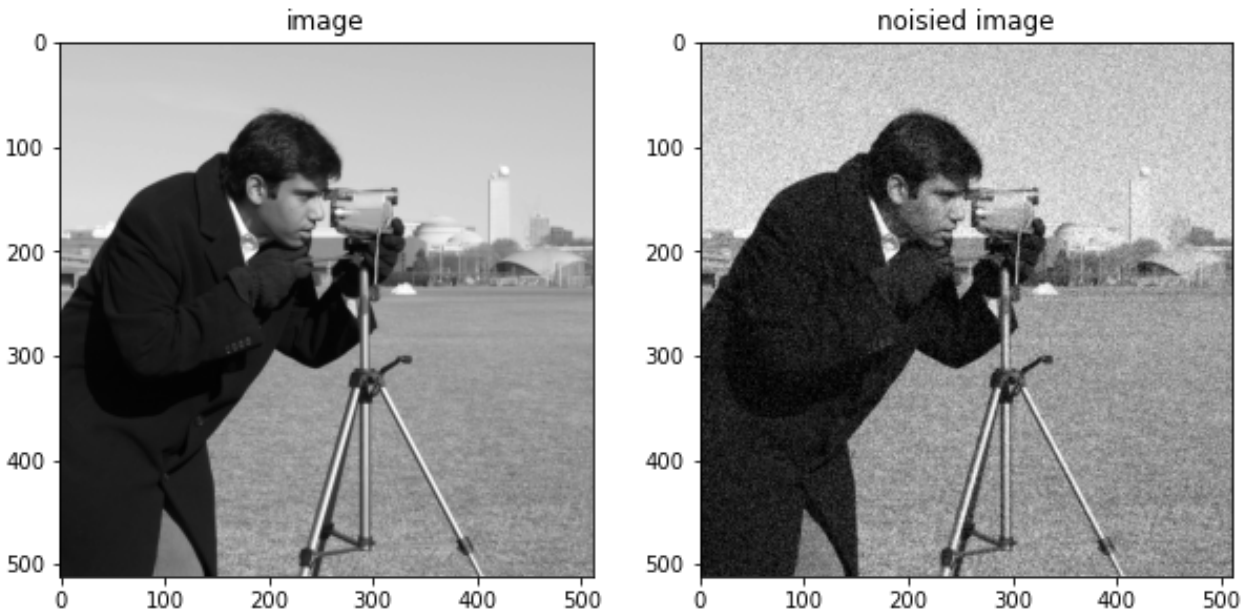
```
import skimage
from skimage import data, img_as_float
import matplotlib.pyplot as plt
import numpy as np
import math
from skimage import filters
from skimage.morphology import disk

plt.rcParams['image.cmap'] = 'gray'
def imshow_all(*images, titles=None):
    images = [img_as_float(img) for img in images]

    if titles is None:
        titles = [''] * len(images)
    vmin = min(map(np.min, images))
    vmax = max(map(np.max, images))
    ncols = len(images)
    height = 5
    width = height * len(images)
    fig, axes = plt.subplots(nrows=1, ncols=ncols,
                             figsize=(width, height))
    for ax, img, label in zip(axes.ravel(), images, titles):
        ax.imshow(img, vmin=vmin, vmax=vmax)
        ax.set_title(label)

image = data.camera()
noisy = skimage.util.random_noise(image, mode='gaussian', var=0.01)
imshow_all(image, noisy, titles=['image', 'noisied image'])
mse = np.mean((image-noisy*255)**2)
psnr=20*math.log10(255/math.sqrt(mse))
print('PSNR: ',psnr);
```

```
PSNR:  20.43172867671977
```

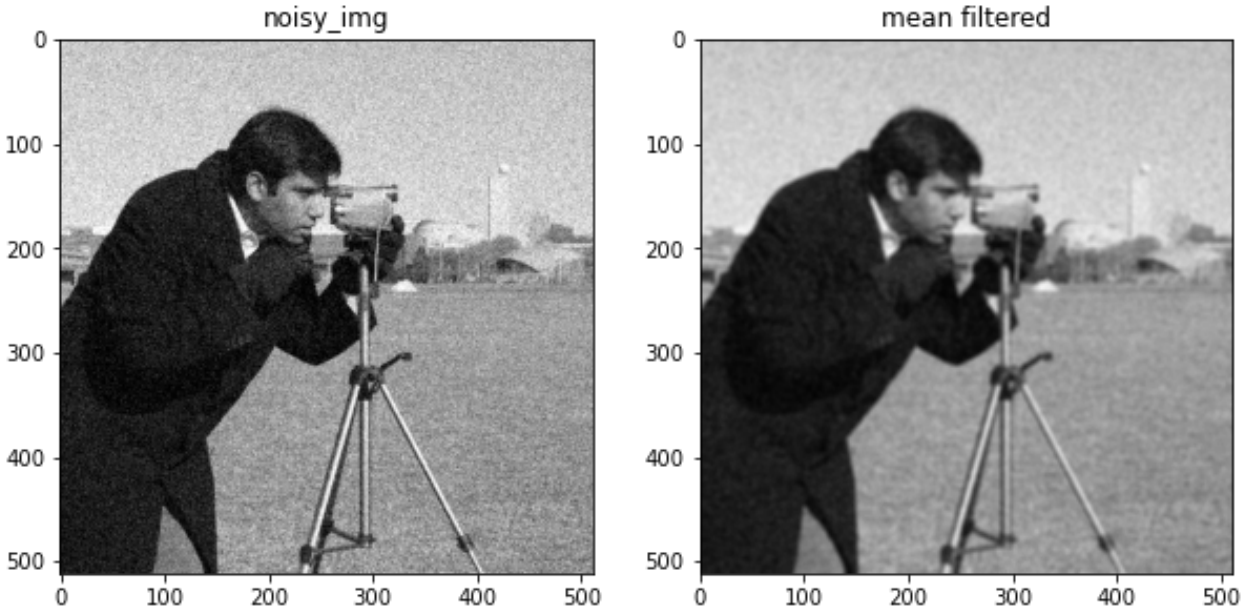


1. Please design a 3* 3 mean filter for denoising, you can refer from this link

In [10]:
```
mean_filter = filters.rank.mean(noisy, disk(3))
# skimage.filters.rank.mean(image, footprint, out=None, mask=None, shift_x=

imshow_all(noisy, mean_filter, titles=['noisy_img', 'mean filtered'])
mse = np.mean((image-mean_filter*255)**2)
psnr=20*math.log10(255/math.sqrt(mse))
print('PSNR: ',psnr)
```

```
PSNR:  27.708839404755775
```



Problem 2: Median filter

Please design a 3*3 median filter, you can refer from this link.

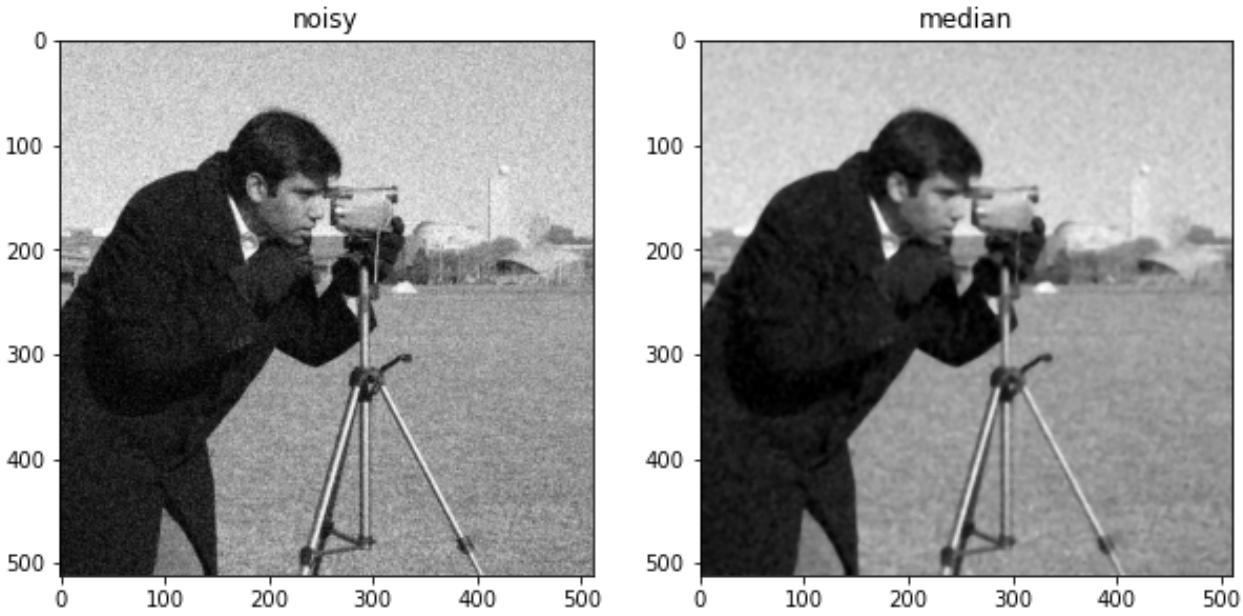
In [11]:
```
from skimage.filters import median

median_filter = median(noisy,disk(3))
# skimage.filters.median(image, footprint=None, out=None, mode='nearest', c

titles = ['noisy', 'median']
imshow_all(noisy, median_filter, titles=titles)

mse = np.mean((image-median_filter*255)**2)
psnr=20*math.log10(255/math.sqrt(mse))
print('PSNR: ',psnr)
```

```
PSNR:  26.29821312189769
```



Problem 3: Gaussian filter

Please design a 3*3 gaussian filter, standard deviation is 1, you can refer from this link.

In [12]:

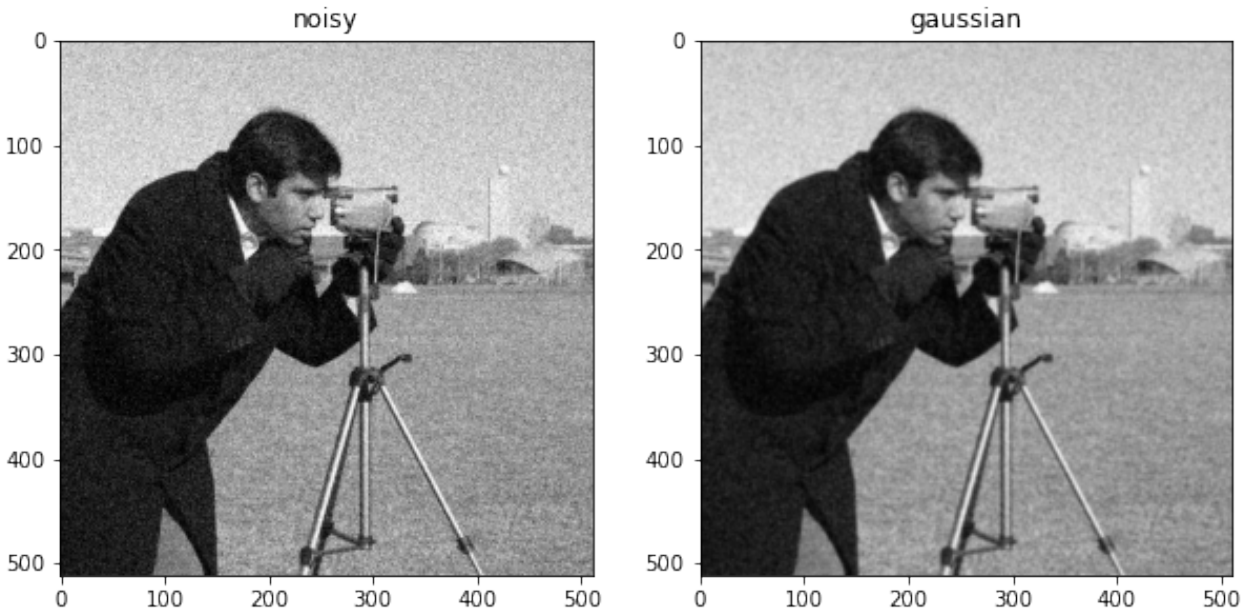
```
from skimage.filters import gaussian

gaussian_filter = gaussian(noisy,sigma=1)
# skimage.filters.gaussian(image, sigma=1, output=None, mode='nearest', cv

titles = ['noisy', 'gaussian']
imshow_all(noisy, gaussian_filter, titles=titles)

mse = np.mean((image-gaussian_filter*255)**2)
psnr=20*math.log10(255/math.sqrt(mse))
print('PSNR: ',psnr)
```

```
PSNR:  27.174972955193738
```



Problem 4: Bilateral filter

Please design a bilateral filter, the standard deviation of range is 0.1, the standard deviation of range is 10. You can refer from this link.

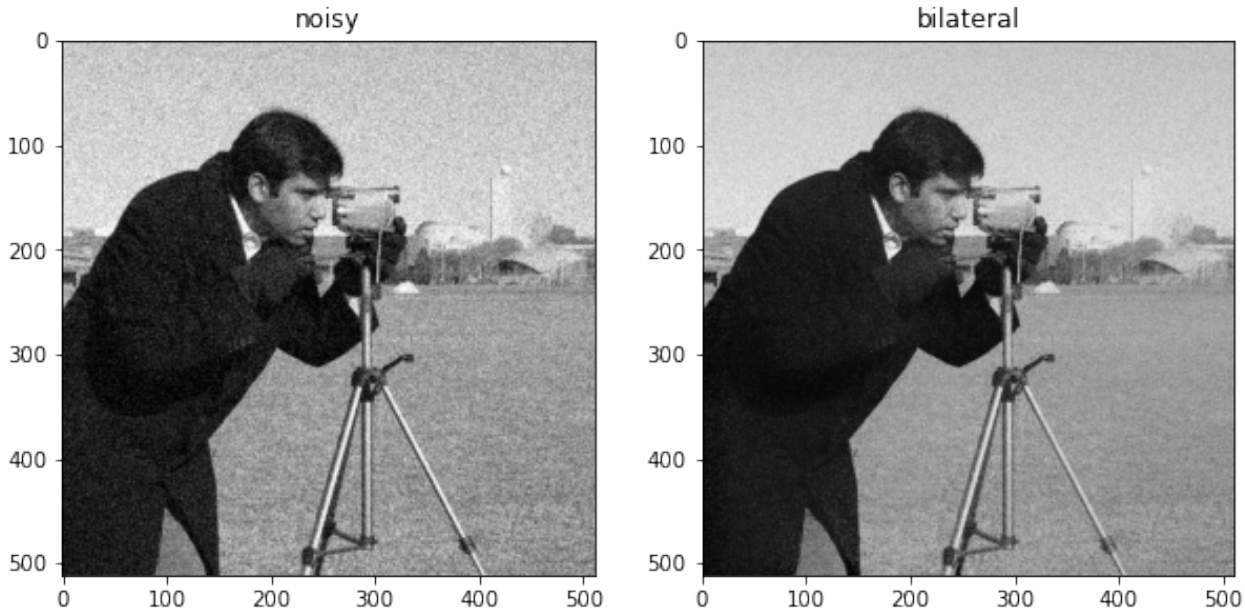
In [13]:

```
from skimage.restoration import denoise_bilateral
bilateral_filter = denoise_bilateral(noisy,sigma_color=0.1, sigma_spatial=
# skimage.restoration.denoise_bilateral(image, win_size=None, sigma_color=

titles = ['noisy', 'bilateral']
imshow_all(noisy, bilateral_filter, titles=titles)

mse = np.mean((image-bilateral_filter*255)**2)
psnr=20*math.log10(255/math.sqrt(mse))
print('PSNR: ',psnr)
```

```
PSNR:  23.967035548333662
```



Problem 5: Custom the filter

Please design a filter so that the PSNR is greater than 22 (except 4 filters above). You can refer from this link.

In [14]:

```
from scipy import ndimage
# 1.custom your kernal by numpy
k = 1/18*np.array([[1,2,3],[3,2,1],[2,3,1]])
# 2.input the noisied image, kernel and other parameters.
filtered = ndimage.convolve(noisy, k)
# scipy.ndimage.convolve(input, weights, output=None, mode='reflect', cval=

titles = ['image', 'noisy', 'custom']
imshow_all(image, noisy, filtered, titles=titles)

mse = np.mean((image-filtered*255)**2)
psnr=20*math.log10(255/math.sqrt(mse))
print('PSNR: ',psnr)
```

```
PSNR:  26.285364030808246
```