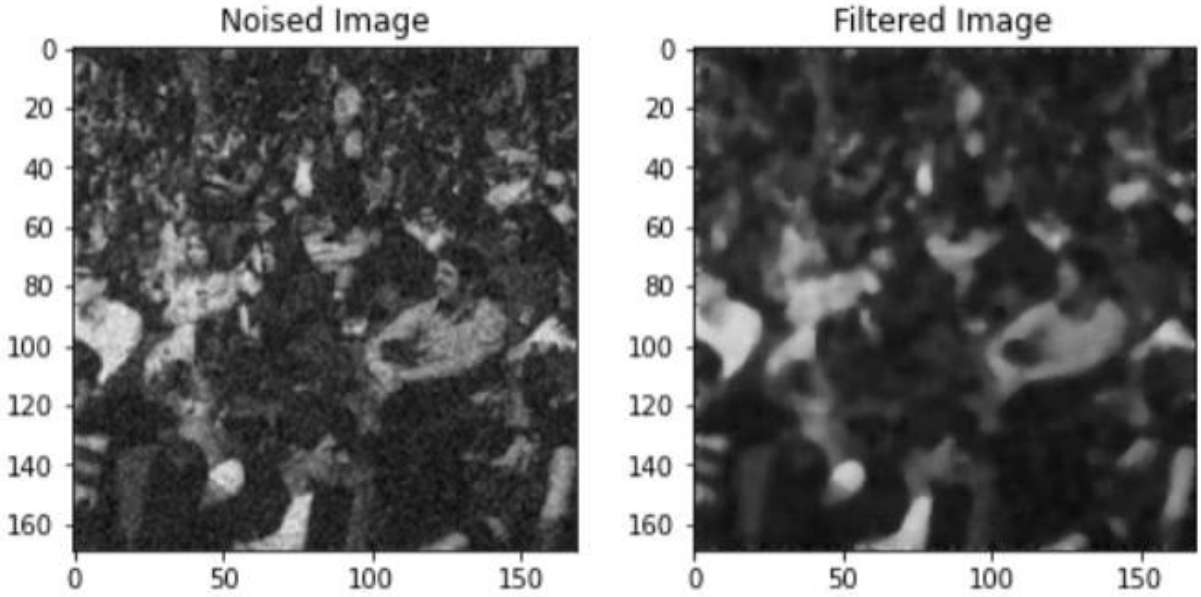
Homework #4

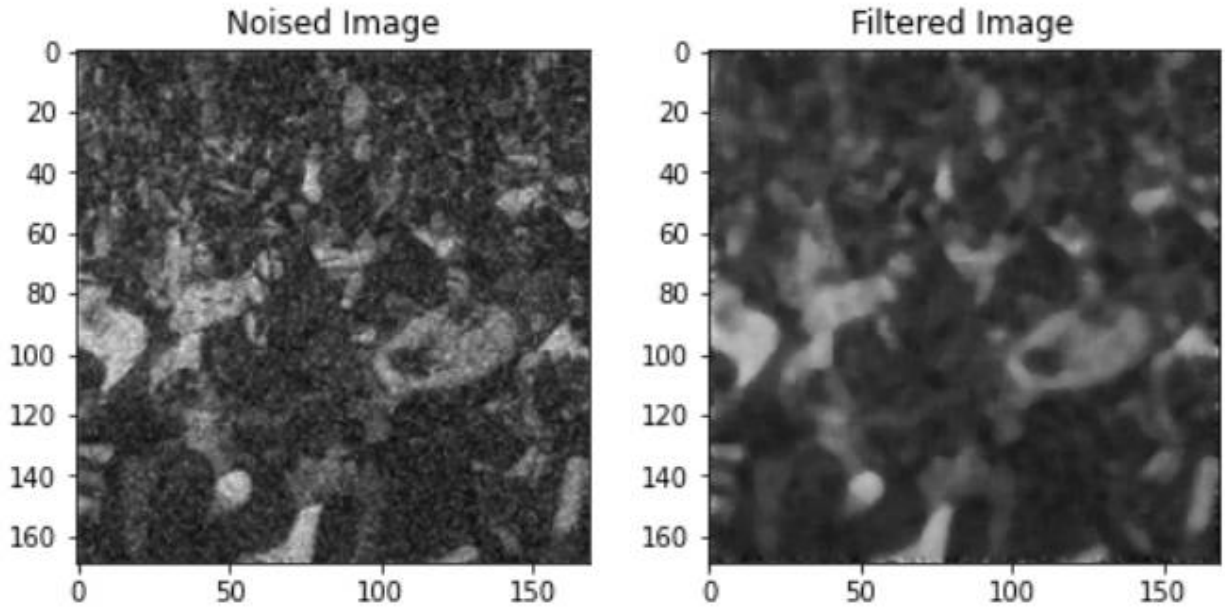
2020451142 정수영

1) To get the enhanced images, apply 5*5 median filter to reduce the noise.

- Median Filtering of Gaussian Noise image



- Median Filtering of Salt&Pepper Noise image



2) Design the 5 by 5 FIR Low Pass filter which is separable and zero-phased. (Set the desired cut-off frequency as [rad/sec]), using the Frequency Sampling method.

Ideal 1D low pass filter의 정의에 의해

$\hat{h}=\begin{cases}1 & (-\mu_0 < \mu < \mu_0) \\ 0 & (o.w)\end{cases}$ in Frequency Domain

이것을 역푸리에 변환을 통해 Spatial Domain으로 보내면

$h(k)=\dfrac{\sin(\mu_0 k)}{\pi k}$ $(\mu_0 : cutoff\ \ frequency)$ in Spatial Domain

따라서 필터를 다음과 같이 구성할 수 있다.

$[h(0), h(1), h(2)] = \left[\dfrac{1}{2},\ \dfrac{\sin(0.5\pi)}{\pi},\ \dfrac{\sin(\pi)}{2\pi}\right] = [0.5,\ \ 0.3183,\ \ 0.]$

참고로 $h(0)=\lim_{x\to 0} h(x)=\lim_{x\to 0}\dfrac{\sin(\mu_0 x)}{\pi x}=\dfrac{\mu_0}{\pi}=\dfrac{1}{2}$ 이다. ($\dfrac{\sin x}{x}$는 $x=0$에서 연속)

이것을 4-fold 하여 5×5 필터를 완성한다.

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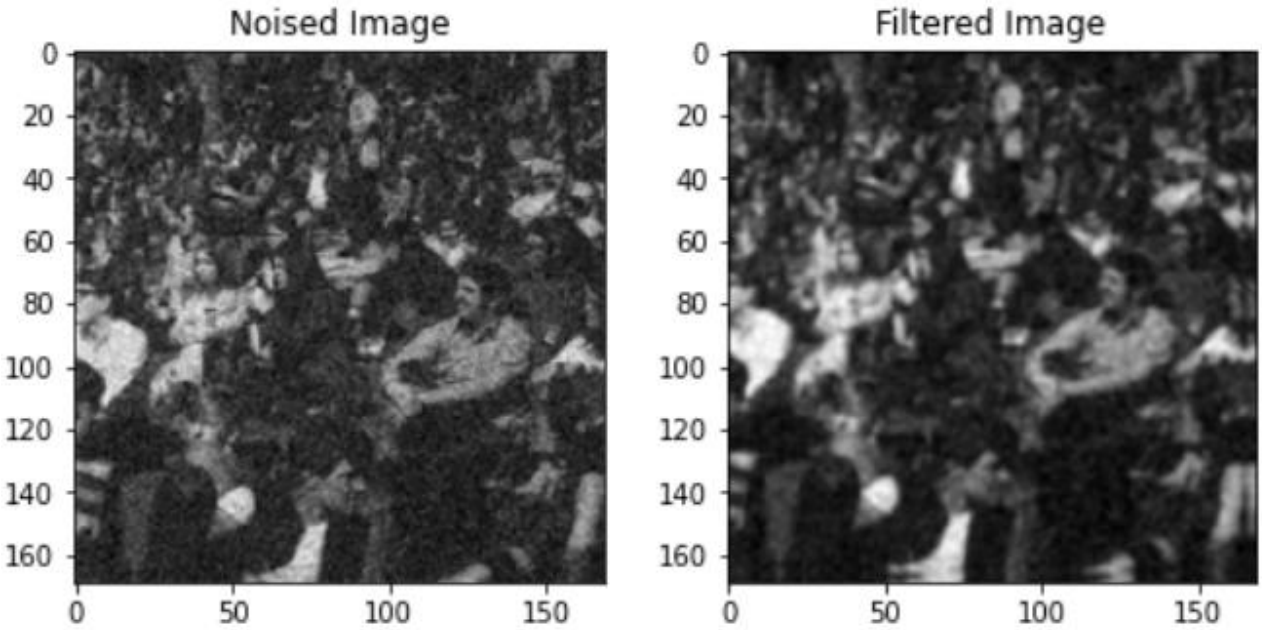
[420] # 5*5 Linear Lowpass Filter를 출력해본다.
      np.round_(LowpassFilter(np.pi/2, 5), 5)

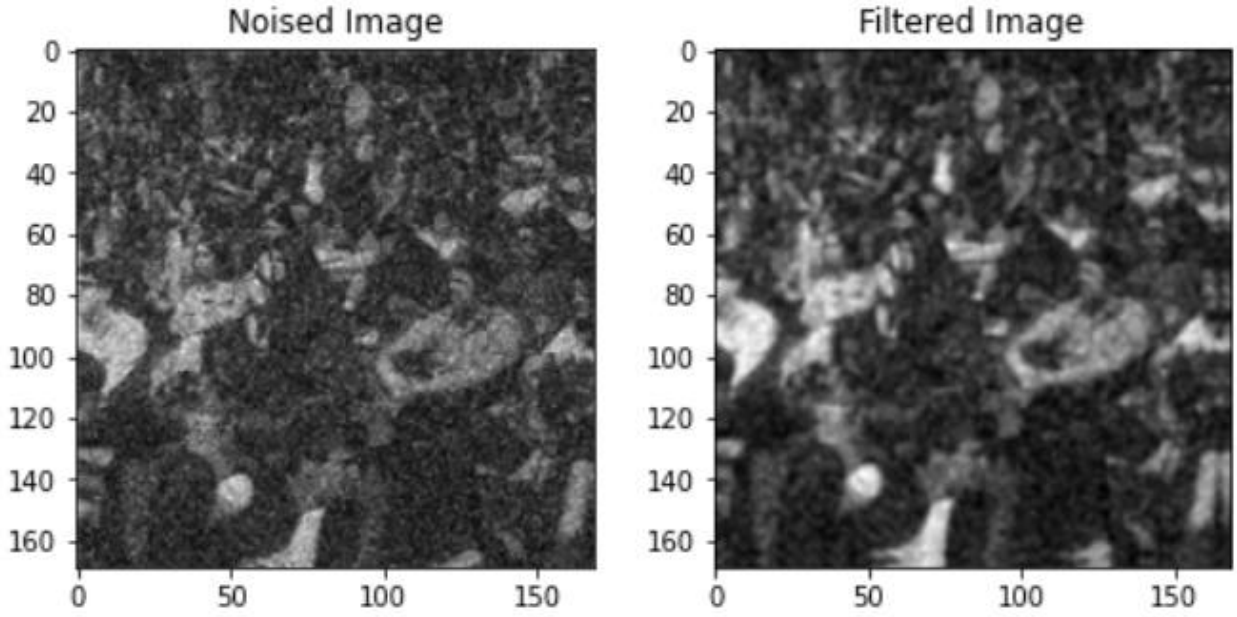
      array([[0.     , 0.     , 0.     , 0.     , 0.     ],
             [0.     , 0.10132, 0.31831, 0.10132, 0.     ],
             [0.     , 0.31831, 0.5    , 0.31831, 0.     ],
             [0.     , 0.10132, 0.31831, 0.10132, 0.     ],
             [0.     , 0.     , 0.     , 0.     , 0.     ]])
```

3) Apply the above filter to the noised images.

- Linear Lowpass Filter of Gaussian Noise Image



- Linear Lowpass Filter of Salt&Pepper Noise Image



4) Discuss the results from 1), 3).

Gaussian Noise를 Median Filtering하면 너무 Blur해진다.

반면 Salt&Pepper Noise를 Linear Lowpass Filtering하면 노이즈가 잘 제거되지 않는다.

즉, Median Filter는 Salt&Pepper Noise를 처리하는데 적합하고, Linear Lowpass Filter는 Gaussian Noise를 처리하는데 적합하다.