

ENGN 1610/2605 Image Understanding

Lab #2 Filtering and Convolution, Neighborhood Operations,

Deblurring

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Problem 1. Implement a 2D convolution

The code for this result is in "P1.m" file.

```
P1.m x +
32 for x = 1:cols
命令行窗口
不熟悉 MATLAB? 请参阅有关快速入门的资源。

o =

    369    377    209     61    193    300    377    359    311    203
    454    550    398    191    289    432    550    548    491    320
    435    549    417    210    283    401    549    567    510    321
    436    568    436    209    252    395    568    586    509    302
    392    512    430    328    371    444    512    505    453    283
    248    431    479    547    515    488    431    404    422    289
    154    325    473    716    664    507    325    323    416    320
    135    324    492    735    658    476    324    342    435    321
    136    343    511    734    627    470    343    361    434    302
     51    245    397    529    406    313    245    247    279    185

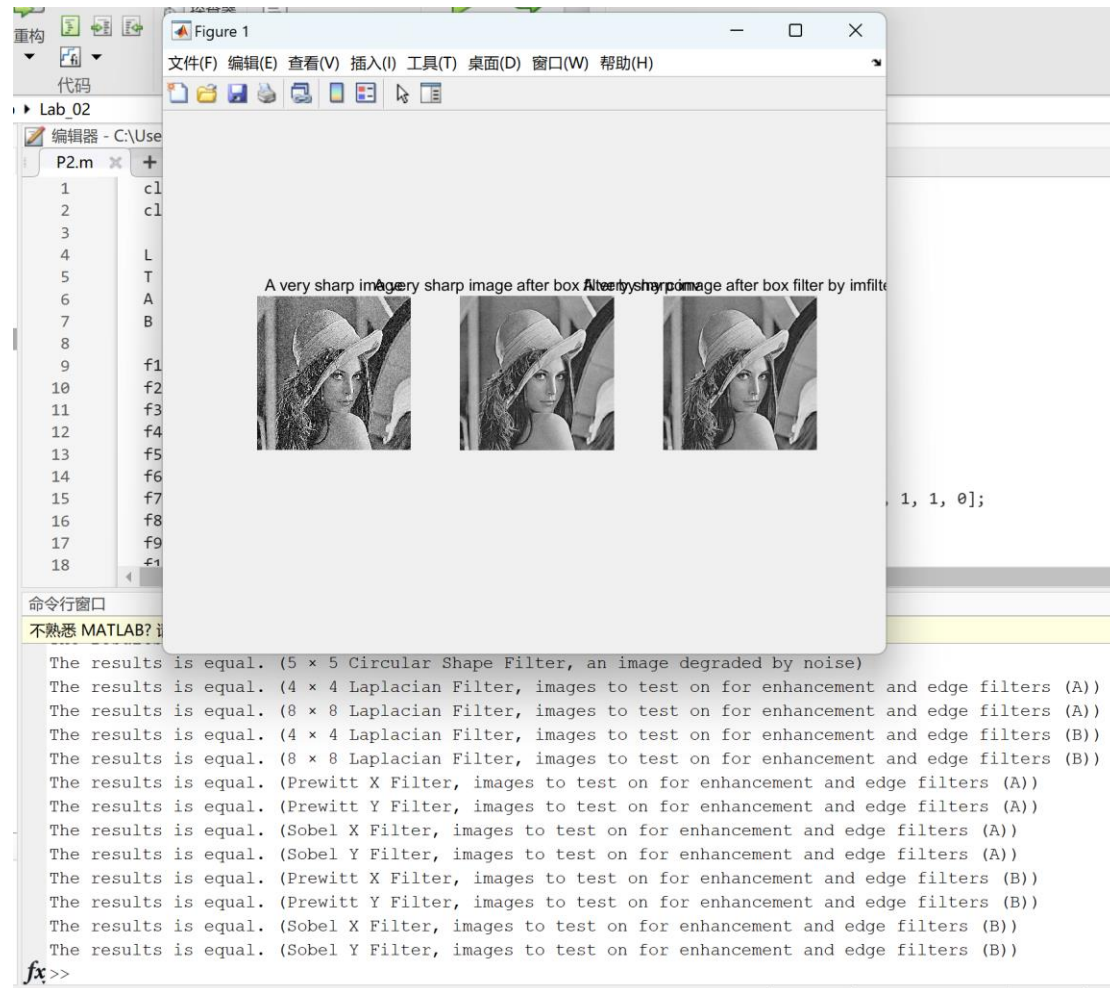
o1 =

    369    377    209     61    193    300    377    359    311    203
    454    550    398    191    289    432    550    548    491    320
    435    549    417    210    283    401    549    567    510    321
    436    568    436    209    252    395    568    586    509    302
    392    512    430    328    371    444    512    505    453    283
    248    431    479    547    515    488    431    404    422    289
    154    325    473    716    664    507    325    323    416    320
    135    324    492    735    658    476    324    342    435    321
    136    343    511    734    627    470    343    361    434    302
     51    245    397    529    406    313    245    247    279    185

The results is equal.
fx>>
```

Problem 2. Play with the filters

The code for this result is in "P2.m" file.



Please answer the following questions:

Smoothing Filters: Give some general comments on each filter. What do you observe?

What is the difference between the box filter, and the weighted box filter?

Box filter: has the effect of smoothing out noise, but if the window is too large, the image will be blurred.

Horizontal filter: The horizontal edge feature of the filter result is obvious.

Vertical filter: The vertical edge feature of the filtering result is obvious.

Circular-Shape filter: The effect of removing image sharpening is significant.

5×5 Box filter: The range of convolution kernel filtering is larger, and the effect of image mean is more significant.

5×5 Circular shape filter: The range of convolution kernel filtering is larger, and the effect of image mean is more significant.

Which filter performs the best on each image?

5×5 Circular shape filter.

What is the difference between the box filter, and the weighted box filter?

Under the influence of weight, the image features are kept intact while the denoising effect is guaranteed. Because it is not mean filtering, it will increase the influence of the central feature of the convolution kernel.

Give some general comments on what this filter does to the image. Which filter does the best on each image?

4×4 Laplacian: Strong edge enhance ability.

8×8 Laplacian: Has a strong edge enhance ability, compared to 4×4 Laplacian edges.

8×8 Laplacian is the best on each image.

Which filter performs the best on each image?

Sobel X/Y.

What effect does weighting the center pixel have on the performance?

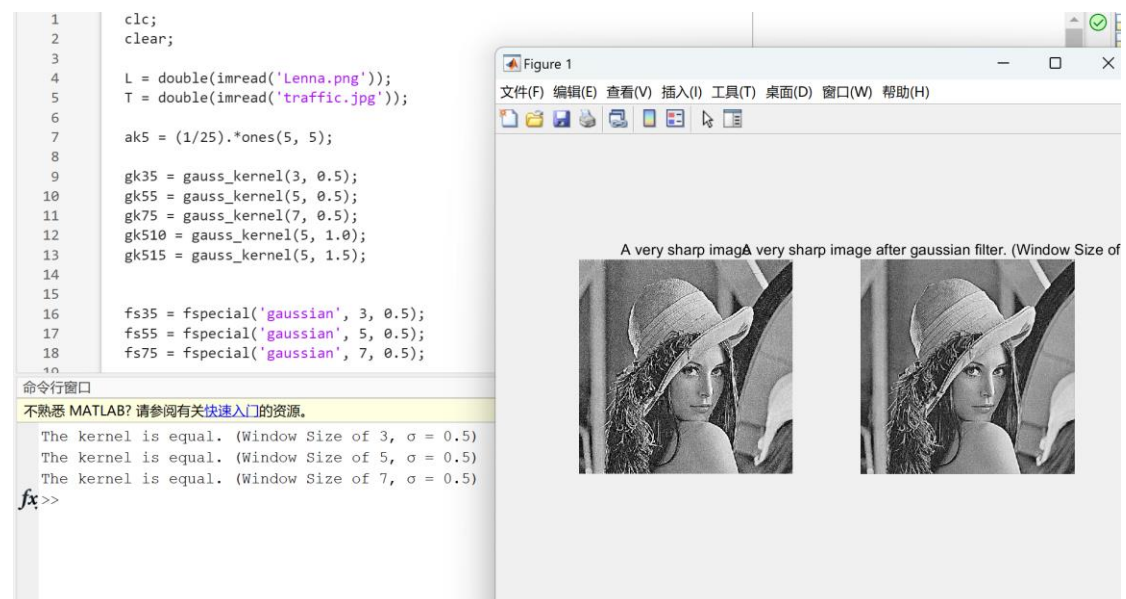
The detected edge features are more significant and reduce the feature weakening caused by the mean.

What difference do you notice between the enhancement filters and edge filters?

Edge filtering extracts features in the direction we want, while enhanced filtering enhances edges in all directions.

Problem 3. Gaussian Smoothing

The code for this result is in "P3.m" file.



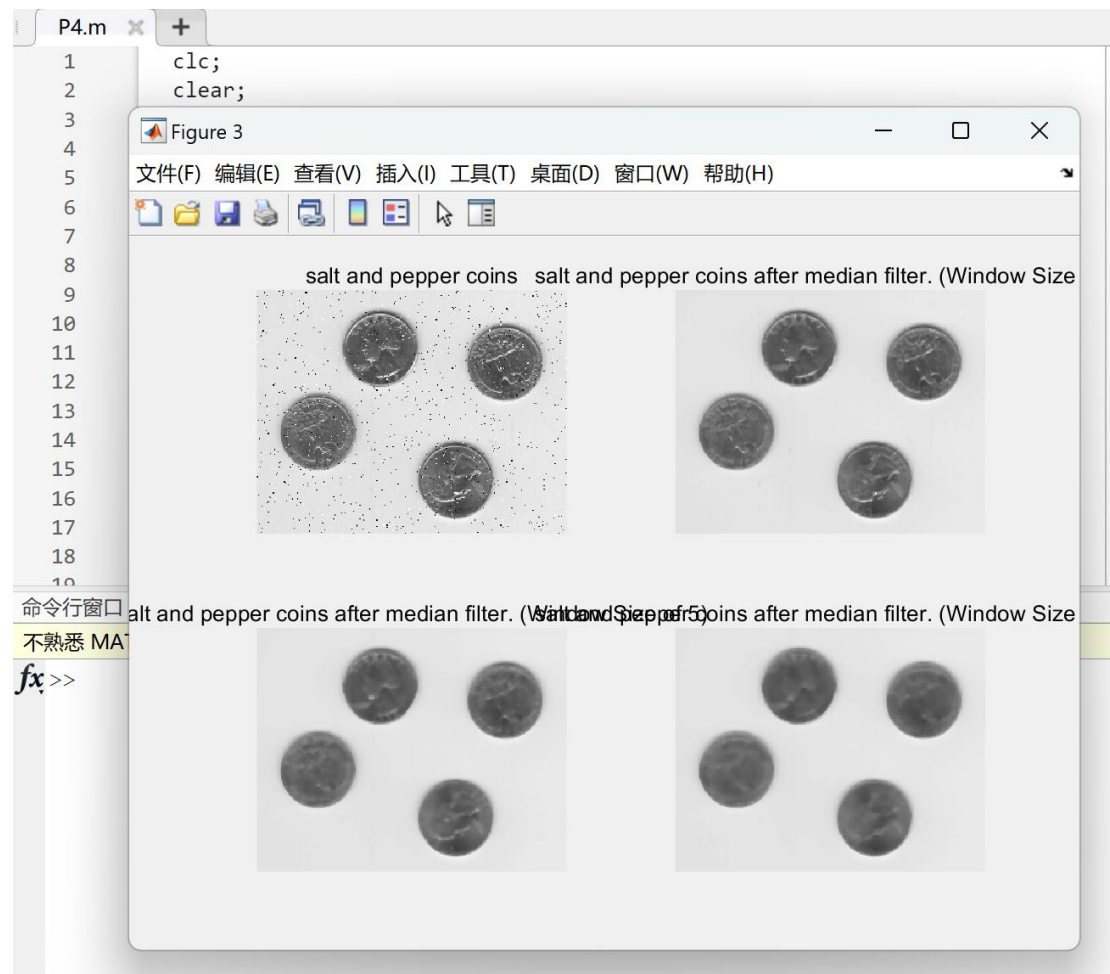
Discuss what the effect of increasing window size is, what the effect of increasing sigma

is, and compare the Gaussian kernel with other smoothing filters you tried.

Increasing the window will make the image smoother but increasing the Sigma will retain more features. Compared with box filters, Gaussian filters retain more features.

Problem 4. Non-Linear Filters

The code for this result is in "P4.m" file.



Report the best setting for each type of filter. Out of the three types of the filters, which filter performs the best.

Min filter. (Window Size of 3 best)

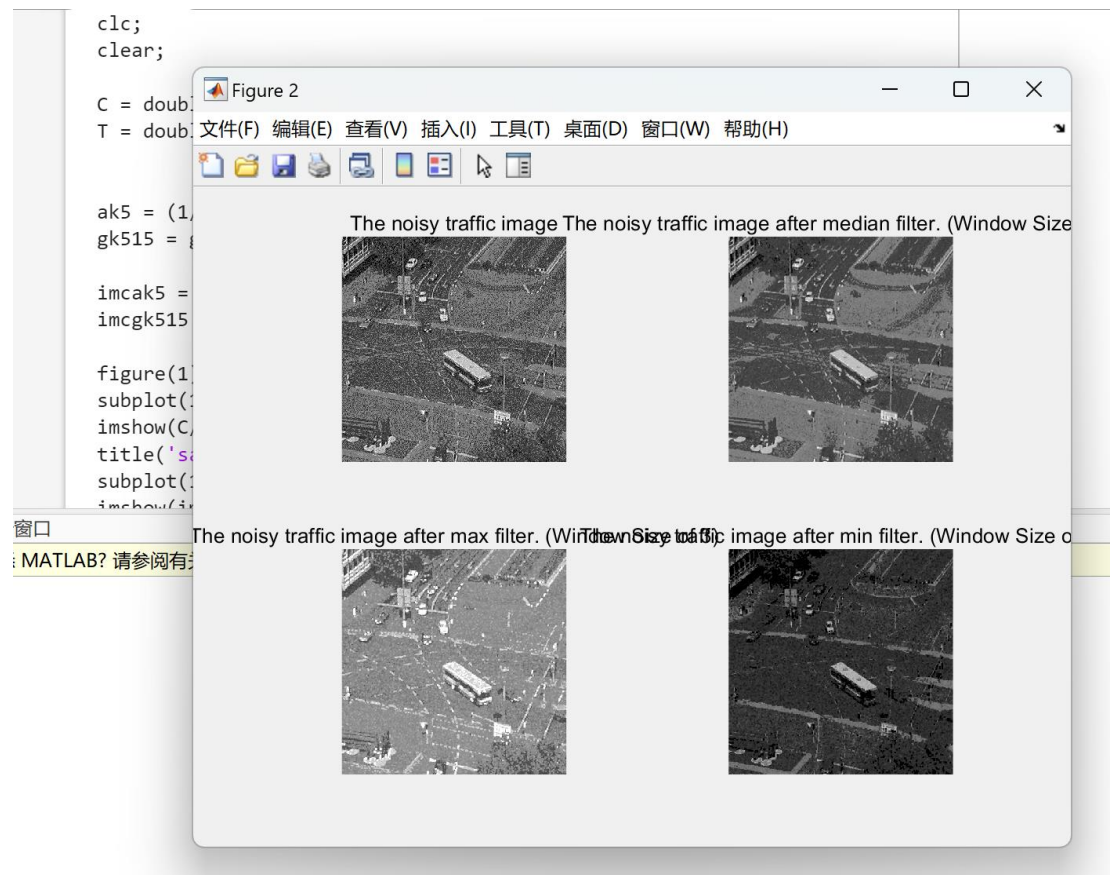
Max filter. (Window Size of 3 best)

Med filter. (Window Size of 3 best)

Med filter (Window Size of 3) performs the best.

Problem 5. Salt and Pepper vs White Noise

The code for this result is in "P5.m" file.



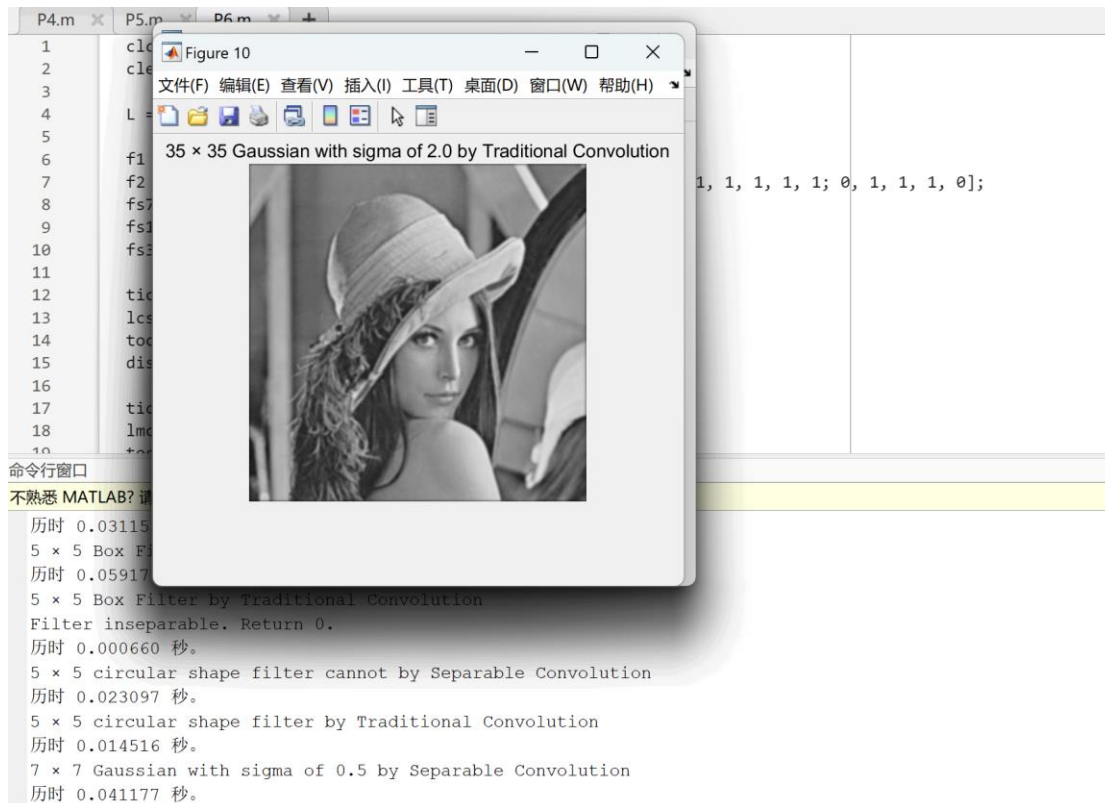
Which type of filter is best for white noise, and why? Which type of filter is best for salt and pepper noise, and why?

Med filter, because the median filter is not affected by the extreme maximum and minimum values in the filter range, so it performs best in removing white noise.

The box filter is better because it weakens the characteristics of the salt and pepper noise by means of an average.

Problem 6. Separable Convolution 2D

The code for this result is in "P6.m" file.



Which filters in problem 2 are separable? Describe a way to test whether a filter is separable.

5×5 Box Filter, 7×7 Gaussian with sigma of 0.5, 17×17 Gaussian with sigma of 0.5 and 35×35 Gaussian with sigma of 2. Determine whether the matrix can be decomposed into the product of a horizontal vector and a vertical vector.

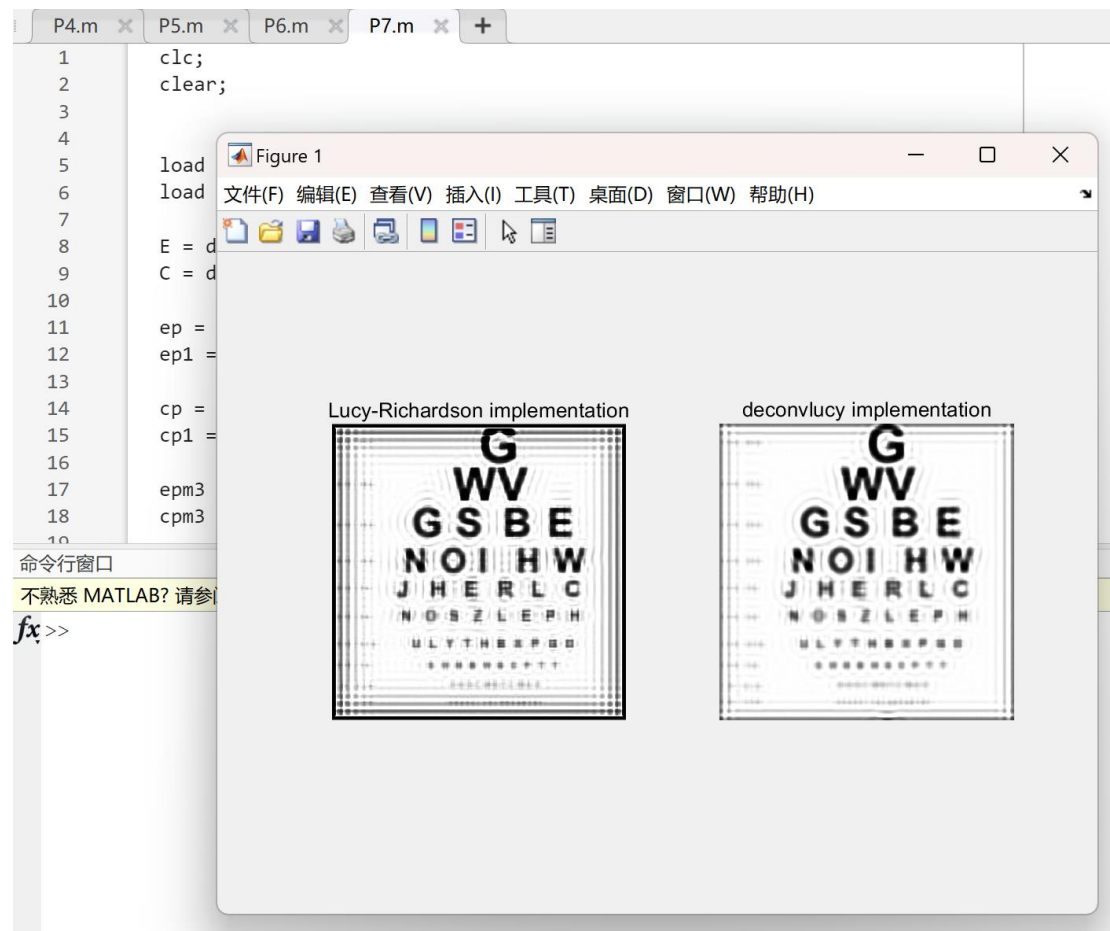
Compare the computational time of convolving the image with the following filters using the separable and the brute force approach.

Separable convolution takes less time than the brute force algorithm.

```
历时 0.031153 秒。
5 x 5 Box Filter by Separable Convolution
历时 0.059176 秒。
5 x 5 Box Filter by Traditional Convolution
```

Problem 7. Deblurring - Lucy Richardson

The code for this result is in "P7.m" file.



You might have noticed that the restored images contains some ringing. What causes this? What can be done to deal with this? Submit your results with your solution. Because the Lucy-Richardson algorithm is an iterative algorithm, it attempts to recover the original image by repeatedly updating the image estimate. In each iteration, it updates the image according to the difference graph (the difference between the observed image and the currently estimated image). This iterative process itself amplifies the noise, since noise usually appears as a high-frequency component in the image, and the iterative process increases the high-frequency component.

The color of the surrounding normal background is taken by the maximum filter to eliminate artifacts.

