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GENEHMIGT

1.1

$$\begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 5 & 4 & 3 & 4 & 5 \\ 5 & 4 & 3 & 4 & 5 \\ 5 & 4 & 3 & 2 & 1 \end{bmatrix} \qquad \begin{bmatrix} 1 & 1 & 1 \\ 2 & 2 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

kernel has to be reflected in both directions before multiplying

$\Rightarrow$ $X_{22} = 1\times1+2\times1+3\times1+5\times2+4\times2+3\times2+5\times1+4\times2+3\times1 = 46.$

similarly, $X_{23} = 45$, $X_{24} = 52$

$X_{32} = 52$, $X_{33} = 45$, $X_{34} = 44$.

$\Rightarrow$ result $X = \begin{bmatrix} 2 & 3 & 4 & 5 \\ 5 & 46 & 45 & 52 & 5 \\ 5 & 52 & 45 & 44 & 5 \\ 5 & 4 & 3 & 2 & 1 \end{bmatrix}$ (✓)

1.2

① x-direction: $\frac{1}{8}\begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}$

$\Rightarrow$ $X_{22} = \frac{1}{8}(1\cdot1+1\cdot0+(-1)\cdot1+2\cdot1+0\cdot1+(-2)\cdot1+1\cdot1+0\cdot1+(-1)\cdot1) = 0.$

similarly, we get

result $X_1 = \begin{bmatrix} 1 & 1 & 1 & 9 & 9 & 9 & 1 & 1 & 1 & 9 & 9 & 9 & 1 & 1 & 1 \\ 1 & 0 & -4 & -4 & 0 & 4 & 4 & 0 & -4 & -4 & 0 & 4 & 4 & 0 & 1 \\ 1 & 0 & -3 & -3 & 0 & 3 & 3 & 0 & -3 & -3 & 0 & 3 & 3 & 0 & 1 \\ 9 & 0 & -1 & -1 & 0 & 1 & 1 & 0 & -1 & -1 & 0 & 1 & 1 & 0 & 9 \\ 9 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 9 \\ 9 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 9 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$ (✓)

② y-direction: $\frac{1}{8}\begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$ $X_{22} = \frac{1}{8}(1\cdot1+2\cdot1+1\cdot1+0\cdot1+0\cdot1+0\cdot1+(-1)\cdot1+(-2)\cdot1+(-1)\cdot1) = 0$

similarly, we get

result $X_2 = \begin{bmatrix} 1 & 1 & 1 & 9 & 9 & 9 & 1 & 1 & 1 & 9 & 9 & 9 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & -4 & -3 & -1 & 0 & -1 & -3 & -4 & -3 & -1 & 0 & -1 & -3 & -4 & 1 \\ 9 & -4 & -3 & -1 & 0 & -1 & -3 & -4 & -3 & -1 & 0 & -1 & -3 & -4 & 9 \\ 9 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 9 \\ 9 & 45 & 45 & 45 & 45 & 45 & 45 & 45 & 45 & 45 & 45 & 45 & 45 & 45 & 9 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$ (✓)

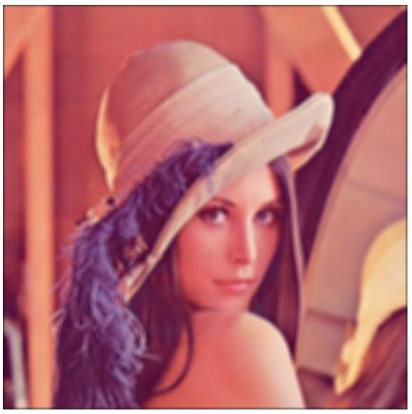
In problem 2 we choose lenna.jpg to practice in digital Image processing.

2.1

♣ Box filter (in the tool named Average Filter)

$$\frac{1}{9}\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 1\\ 1 & 1 & 1\end{bmatrix}$$

Box filter with size 3



Box filter with size 7

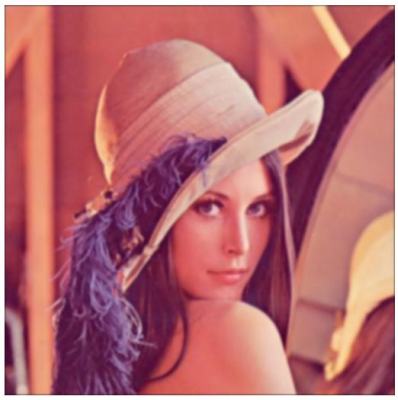
It can be found that comparing two pictures, Image fixed with box filter with size 3 is sharper then image fixed by size 7. The size of filter grow bigger, the blurrier the image is. Also the edge and place which light change very sharp are smoother.

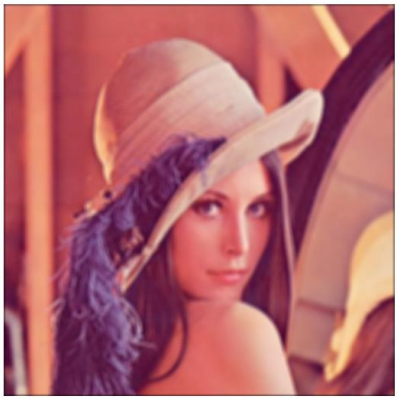
♣ Gauss filter

$$g(x,y) = \frac{1}{2\pi\sigma^2}\cdot e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Size 3 with variance 1.5

Size 3 with variance 5



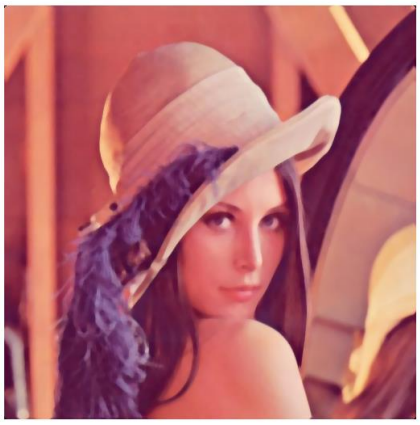


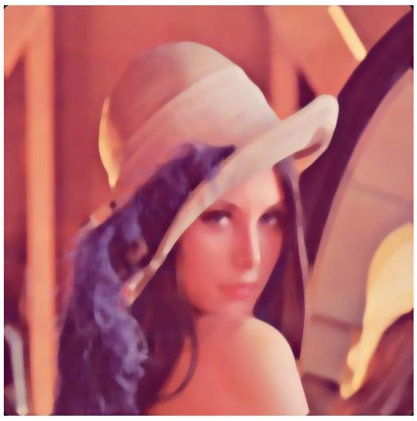
Size 7 with variance 1.5 Size 7 with variance 5

It can be found that when filter with same size and different variance, the image are different. It is because when σ grows, the width of the filter also grows, and the image will become smooth. And by comparing image with same variance and different size, it is very obvious that when size grow bigger, the image will also become smooth in all the place.

case not shown

♣ Median filter





Size 7 size 11

After dealing the image with median filter, it can be found that some parts of the image for example hair changed very obvious while some parts of the image for example the skin didn't have too many changes. It is because Median Filter is a nonlinear digital filtering technique it can remove the noise from the picture and also protect most parts of the picture.

which noise

2.2

Image with edge detection

Image with sharpen

After using sharpen to the image, the information are more obvious and where the value of the image changes are more obvious and become very sharp. And also other information are remained like skins which didn’ t have any change. However, the

noise in this image will influence the result and make the noise more obvious. When using edge detection to the image by Photoshop, the edge information are very obvious. The change of vectors value are detected and other information are ignores. Sharpen and edge detect are similar but sharpen will remain the information of the rest and edge detect will not remain other information.

3.1 Both, rank filters and convolutional filters make use of a sliding window approach. Nevertheless, a rank filter cannot be realized by convolution. Why?
It is because that rank filters for example median filter are non-linear filter, not all the values of the images are involved in the result. A convolution operation is an element wise matrix multiplication operation, and convolutional filters are linear filter it will compute all the value and make use of them. So a rank filter cannot be realized by convolution.

3.2 What is the advantage of a Binomial Filter compared to a Gaussian Filter?
A binomial filter is a statistical smoothing technique that is used to reveal underlying trends in data. For example for a 3*3 filter, the nine points refer to the number of weighted terms used to approximate the Gaussian distribution. So the calculation are faster and more effective.

why do you want to approximate?

3.3. Why is a Binomial Filter or Gaussian Filter a better smoothing filter than a Box Filter?
Box filter is very simple and each pixels have same power and are equal important. And it calculate the average value of the image. So the distance information are not involved. It will make the image blurry. And Binomial Filter or Gaussian Filter consider the power of the each pixels and the main pixels are more important that other pixels, in that way the information of the image can be saved. So binomial filter or Gaussian filter are better smoothing filter than a box filter.

Gibb's Phenomenon?

3.4. Why should you use a Median Filter for eliminating Binary Noise (instead of a Gaussian Filter)?
The first reason is when use a median filter for eliminating binary noise, because it's a non-linear filter, it can work very effective and also protect the edge information in the image. When using a Gaussian filter, it tend to blur the sharp edges and destroy the lines and other fine details of the image. The second reason is that Gaussian filter is not very effective, because the pixels value of noise are very different. They are calculated in the results and make it have a sharp change. When using a median filter, the value of the noise are not calculated and replace by the value from other pixels.