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ECE

ELEC 546 COMPUTER VISION

Assignment 1

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Part I

Exercise 1

1. Crop the head of the superhero from the image.

Figure 1: Iron man

Figure 2: the head of the superhero

In this problem, I first check the size of original image. Then trying to locate the region of the head in the image. And finally crop the head region using the coordinates that we got.

2. Save the cropped sub-image as a PNG file
   I use the **imwrite** function to save the image. imwrite(img_head,'iron_man_head.png')
3. Display the green component of the cropped image.

Figure 3: green component of the cropped image

Create a new image where the green component is the same as the green component of the original image. The red and blue component is set to be zero.
One thing I notice is that, if we don't set red and blue channels, we will have a gray image instead of RGB image. In that gray image, the value of each pixel represents only the intensity of green component. So it explains why we can get a gray image by doing that.

4. Change the order of the color components to [Green, Red, Blue] for the original image and display the image.

Figure 4: the original image and disordered image

The method of this problem is basically the same as problem 3. We exchange the order of the red and green components. As we can see, the red iron man's armor now has turned green. Since we don't change the blue component, the blue arc reactor and the background stay almost the same.

Exercise 2

Write a Matlab script to perform the following operations on "Barbara.jpg":

1. Convert the image to gray scale.

Figure 5: the gray scale image of Barbara

In this problem, I use the **rgb2gray** function to get the gray scale image.

2. Plot a histogram of the gray scale image with bin-size of 5 in intensity.

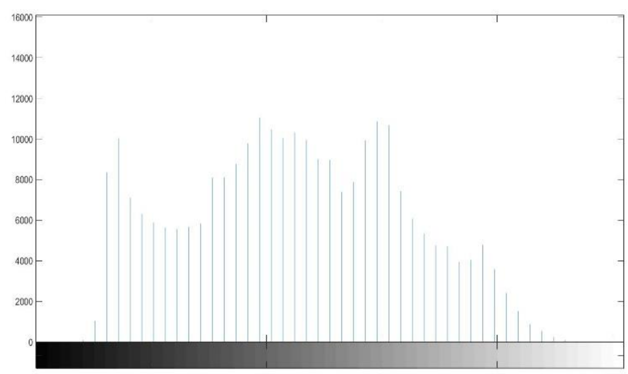


Figure 6: histogram with bin-size of 5

Use the **imhist** function. Since it's a gray image, the image should have 256 different bins originally. Therefore if we want our bin-size to be 5, we should set the number of bins parameter **n** in **imhist** function to be 51.

3. Blur the gray scale image y using Gaussian filters of size 15 x 15 with standard deviations 2 and 8.

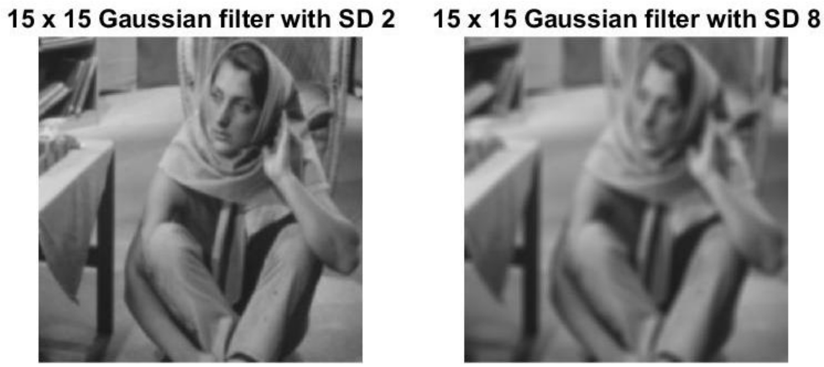


Figure 7: blurred images

Use the **fspecial** function to get Gaussian filters and the use **imfilter** function to convolve image with the filters. Compared with SD = 2, by using the filter with SD =8, the image become smoother and fuzzier.

4. Plot histograms for the blurred images. How do they differ for each other and the original histogram?

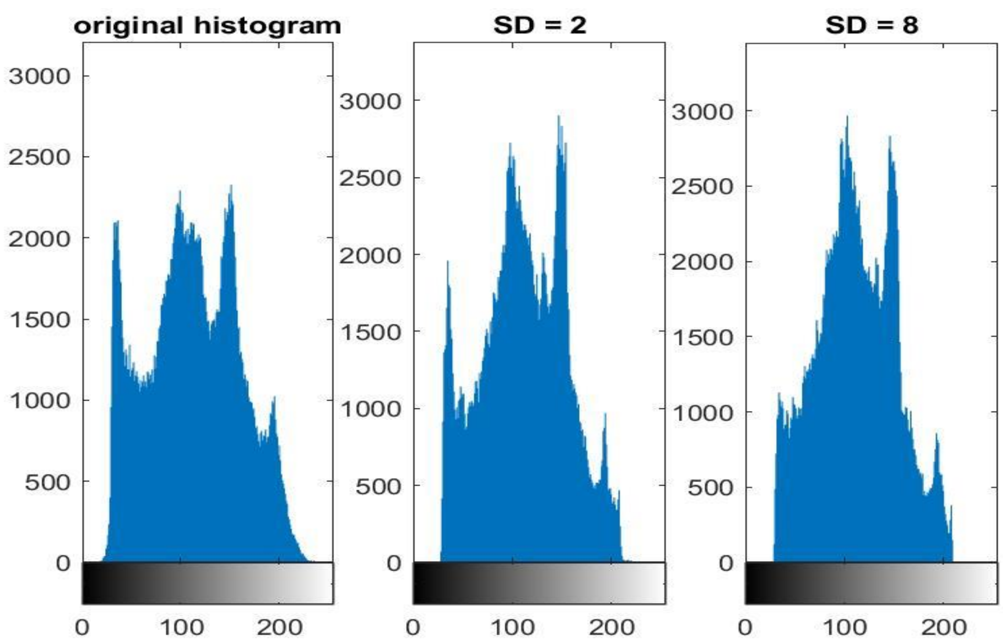


Figure 8: histograms for the original and blurred images

With the increase of standard deviation, the number of pixels at low and high end of the histogram become less than original. The variance of the pixel intensity also declines, which means the difference of intensity among different pixels is less. We can imagine, if we set standard deviation to be very large, in the histogram there will be less pixels at the low and high end and most pixels will lie in the center.

5. Subtract the blurred image obtained using the filter with standard deviation of 2 from the original gray scale image.

Figure 9: the resultant image

6. Threshold the resultant image at 5% of its maximum pixel value.

Figure 10: image with a threshold

Part II

Filtering

1.

```
I1_filter1 =

     0   107   105    82     0
     0   138   112    78     0
     0    98    68    38     0
     0    57    37    27     0
     0    33    23    15     0
```

```
I1_filter2 =

     0     0     0     0     0
   130   120    93    72    33
   117    98    78    40    25
    82    65    42    22    17
     0     0     0     0     0
```

```
I1_filter3 =

     0     0     0     0     0
     0   114    95    66     0
     0    98    72    48     0
     0    63    43    27     0
     0     0     0     0     0
```

```
I2_filter1 =

     0   130   125   123     0
     0   138   142   138     0
     0    60    53    47     0
     0    38    33    27     0
     0    17    17    15     0
```

```
I2_filter2 =

     0     0     0     0     0
   112   108   108   103    97
    83    77    77    75    60
    40    37    38    28    22
     0     0     0     0     0
```

```
I2_filter3 =

     0     0     0     0     0
     0   109   107   103     0
     0    79    76    71     0
     0    38    34    29     0
     0     0     0     0     0
```

2. Apply the Central different Gradient filter, Sobel filter, mean filter and median filter on the gray scale image of Barbara.

Figure 1: Central different Gradient filter [-1,0,1]

Figure 2: using Sobel filter

Figure 3: using mean filter

Figure 4: using median filter

In this problem, I used the **fspecial** and **imfilter** functions to accomplish the task of Sobel and mean filter. I used the **medfilt2** function to apply the median filter.

Smoothing

Read the image 'camera_man_noisy.png' and filter using following filters:

1. Average filters with sizes of 2 x 2, 4 x 4, 8 x 8, 16 x 16.
2. Gaussian filter of standard deviations 2, 4, 8, 16.

Figure 5: the original image

In this problem, I use the **fspecial** function to create different average filters and the use **imfilter** function to convolve image with the filters.

(a) 2 x 2

(b) 4 x 4

(c) 8 x 8

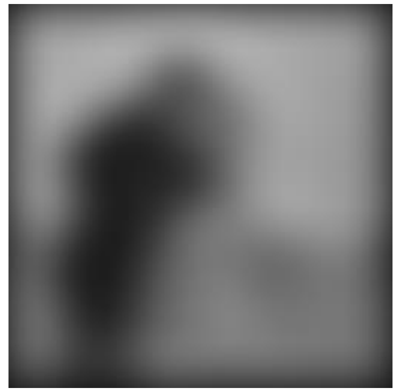
(d) 16 x 16

Figure 6: using different average filters

(a) SD = 2

(b) SD = 4

(c) SD = 8



(d) SD = 16

Figure 7: denoised images using Gaussian filters

1. Which filter works best?
   Solution. I think the Gaussian filter with standard deviation = 2 works best. Since it makes the image smoother. The edges and details are not losing too much.
2. Which happened when you vary the box filter size?
   Solution. As the box filter size going up, the images become smoother. The noise of the images also decline as the size goes up. The images become more blurry. But we also lose some edge and detail information in the original image.
3. Which happens when you vary the standard deviation of gaussian filter?
   Solution. When we increase the standard deviation of the Gaussian filter, the images become smoother and the noise is also reduced. But on the other hand, the details, such as the edges, in the image vanish too. Gaussian filter is also a kind of low-pass filter, it can eliminate the higher frequency of the image, like the details and noise, and leave the lower frequency.

Grad credits: Edge preserving smoothing

1. Find the best parameters

   intensity standard deviation

Figure 8: the denoised images using bilateral filter vary the intensity standard deviation. Range from 0.2 to 0.45

I set the size = 5 and the spatial standard deviation = 5. For intensity standard deviation, 0.4 works the best. Since it reduces most of the noise without losing too many details.

Spatial standard deviation

Figure 9: varying the spatial standard deviation of bilateral filter, from 3 to 6

I set the other two parameters the intensity standard deviation and size to be 0.5 and 5. As we can see from the images above, when we vary the spatial standard deviation of bilateral filter, the denoised images are pretty much the same. Therefore, we choose 5 for spatial standard deviation.

Size

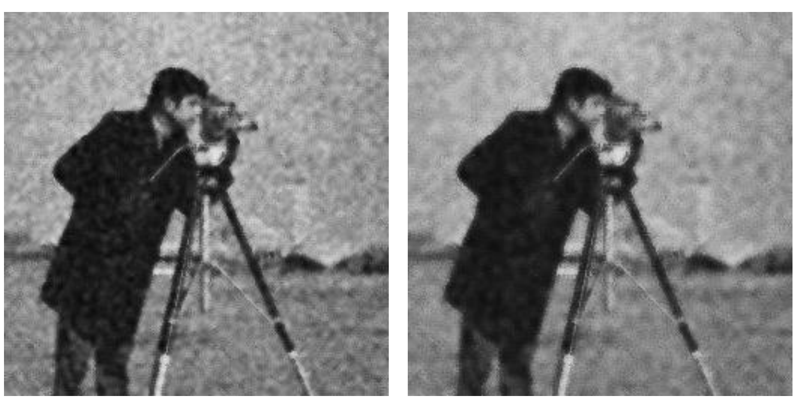


Figure 10: varying the size of bilateral filter

For the size of bilateral filter, we choose 4. Finally, I choose the spatial standard deviation = 5, intensity standard deviation = 0.4 and size = 4 as our best parameters.

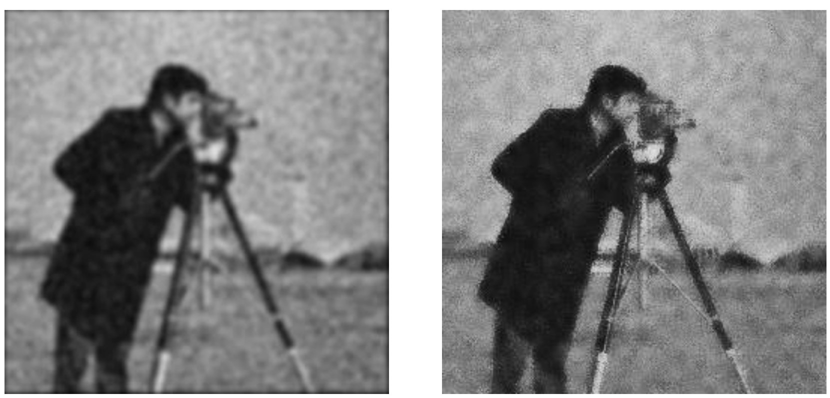


Figure 11: left: denoised image from the best Gaussian filter. right: image from best bilateral filter

The results show that the bilateral filter can preserve more edge information than Gaussian filter. Both two filters can reduce the noise in the image and smooth the image. The one using Gaussian filter is more blurry and lose more edge information. On the country, the one using bilateral filter an edge-preserving smoothing filter.

1. What will happen if we choose the intensity standard deviation to be very large?

Solution. If we choose the intensity standard deviation to be very large, the denoised image tend to be smoother and blurrier. And the edge-preserving ability has declined as the intensity standard deviation goes up. Also I find that If the intensity standard deviation to be very large, the denoised image is like the one using gaussian filter.

2. What will happen if we choose the intensity standard deviation to be very small?
   The image doesn't change to much. The edges are distinct, but the noise has not been reduced.
3. For a particular noise standard deviation, what value of signal would you prescribe?
   Solution. In this problem, we can manual set a Gaussian noise, whose standard deviation we already know, to the image that we want to test. Then we use bilateral filter of different intensity standard deviations to smooth the image. By analyzing the detail of the denoised image, we can pick the best parameter. Then we can find the relationship between noise standard deviation and intensity standard deviation. From our result, we can find that when the intensity standard deviation is approximately 2 times of noise standard deviation, the denoised image is the best. If we add SD=0.1 gaussian noise, the range of value of sigmaI would be 0.15-0.25. if the gaussian noise is SD=0.2, then we find the range is 0.3-0.5. if the noise SD=0.05, the best result is the bilateral filter with intensity standard deviation around 0.1. Here are some image I got.

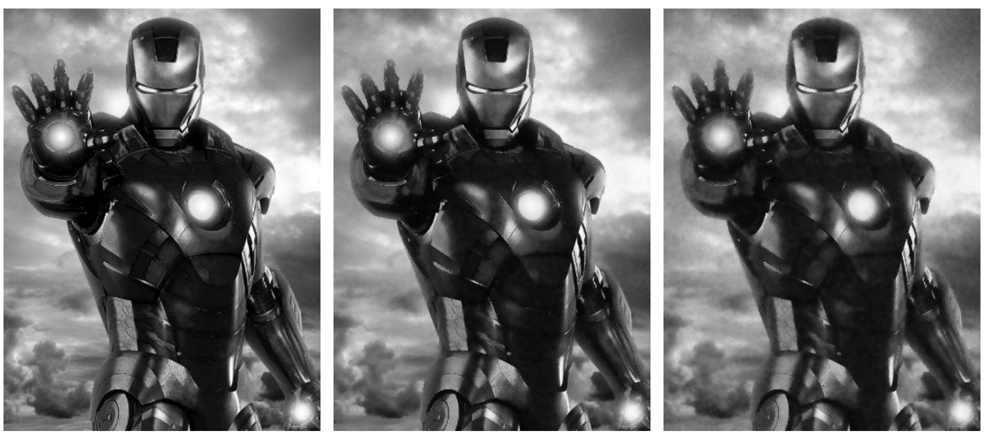


Figure 12: Left: the original gray image. Middle: introduce 0.05 SD noise, the sigmai = 0.1. Right: 0.1 SD noise, sigmaI = 0.2