Università degli studi di Genova

DIBRIS

Informatics, Bioengineering
Systems Engineering, Robotics and System Engineering

Computer Vision

Assigment 1

Report Laboratory 2

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Abstract

The main goal of this laboratory is to apply different filter on different images, implement this on Matlab and understand theirs behaviour. The first passage is to take two different photos and apply noise. After this passage we focus on build filter with goal to remove in the best way the noise we had introduced before. In the third section we focus on working with filters to obtain the detail of the images. In the last section we will pass in the frequency domain and with matlab plot different magnitude of different filter, principally to focus on the energy of different filter.

Introduction

This project was done by Andrea Chiappe and Fabio Guelfi, the matlab's code is the same.

When beginning an image acquisition process, one must always consider that this image is always subject to noise that is causing a loss of image information or several problems in the image processing. We consider two different types of noise:

- Gaussian (follows a Gaussian distribution), it's characterized by small fluctuations in image pixel values. It makes the image slightly blurry and can reduce the sharpness of details.
- Salt & Pepper: Introduces some white (salt) and black (pepper) dots scattered throughout the image.

They all cause random and not desired variations in the values of the pixel and they all can be generated by different sources such as light fluctuations, sensor noise, quantization and other.

So, we then started from two completely different images, added gaussian and salt & pepper noise, to highlight the noise on the image to represent the disturbance in the real world and thus be able to notice the actual effectiveness of the filters (moving average, low pass gaussian and median filter) and their most useful use.

A filter should be chosen carefully to have a good balance between noise removal and keeping details, in fact, too much filtering can result in a blurred or information less image and too little will not remove effectively the noise.

That's why in this lab we implemented several linear filters (shifted right, sharpening filter) and compared with each other all the images obtained after the convolution with the filter to notice all the different tasks available with these different methods.

In image processing the frequency component has a crucial role such as to notice details, edges, corners and other visual elements. The frequency component can be obtained by the Fourier transform and the magnitude and phase analysis of the image and so we used the FFT to visualize the magnitude of the different filters.

Methods

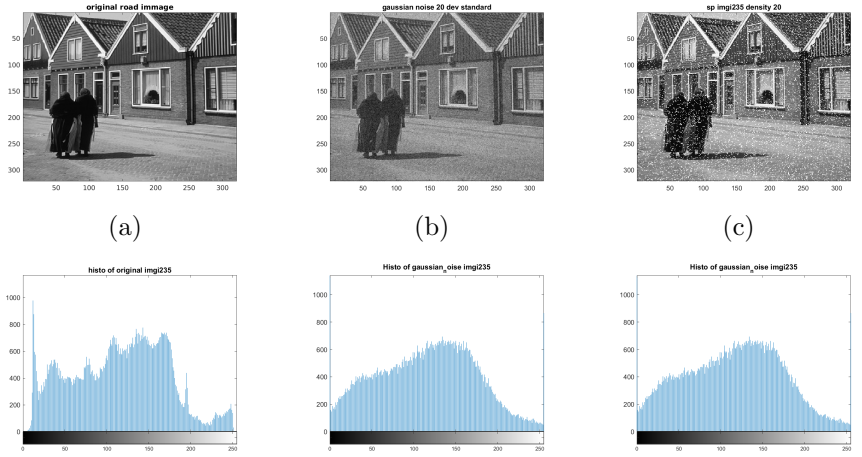
In this section we will describe all passages we did to implement all the filters and all the tasks. We show almost all the results through the i235 image because it has a bigger numbers of pixel, so a better resolution and more details than the tree image.

Apply noise to the images

In this case in Laboratory 2 we apply two different distribution noise. The noise we apply are:

- Gaussian noise with 20 standard deviation. This distribution is characterized by a bell-shaped curve, with the majority of values clustered around the mean. The mean (average) value of Gaussian noise is set to zero.
- Salt and pepper distribution noise with density 20%: This corresponds to the presence of very bright or white pixels maximum intensity "salt" and the presence of very dark or black pixels "pepper" placed randomly random in the images, with the probability of 20%.

Figure 1: Add noise to images



(a) (b) (c)

(d) (e) (f)

Filter the image for removing noise

Before starting with filtering, we need to cast the images in double format. This operation is the zero-padding and is necessary to avoid the black line around the images when we do the convolution with a filter. We decided to show only the images convoluite with the filter with spacial support 3x3 pixel. This choice

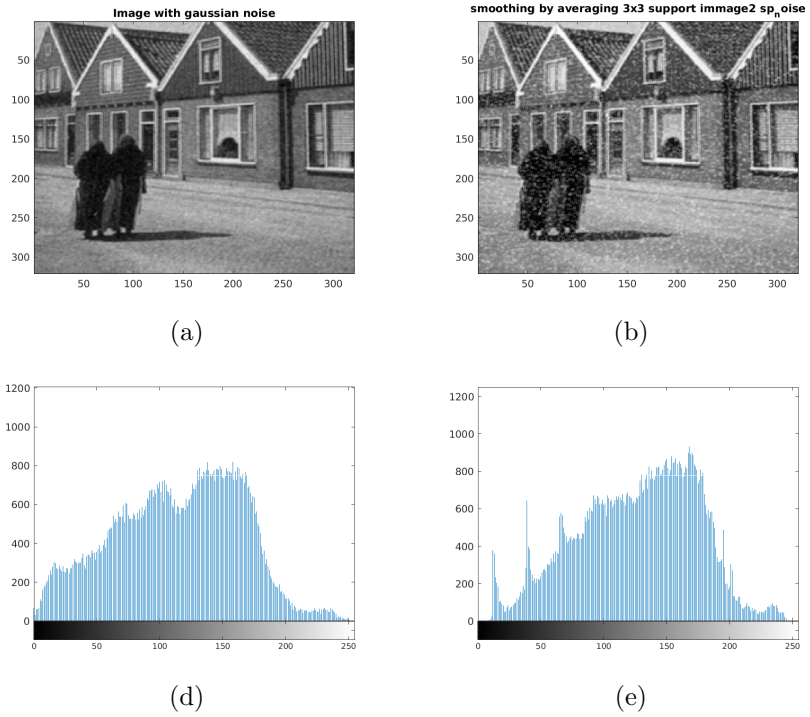
because in our images there are lots of details and so to catch them, we need a filter with smaller spacial support.

The first filter we use for removing noise is the moving average filter. The filter with spacial support 3x3 pixel is composed in this way:

$$A = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \tag{1}$$

Then we use the matlab function conv2 for the two dimensional convolution between the filter and the images. We also use the spacial support 7x7 pixel. The main difference, as wrote in the introduction is the detail the different filter can catch, according with them spacial support. In the 2 there are two images, one with gaussian noise (a) and the (b) with salt & pepper noise. We will see a good performance with the gaussian noise, with some lost of detail, and a not good performance with salt and pepper noise.

Figure 2: Filter images with moving average filter

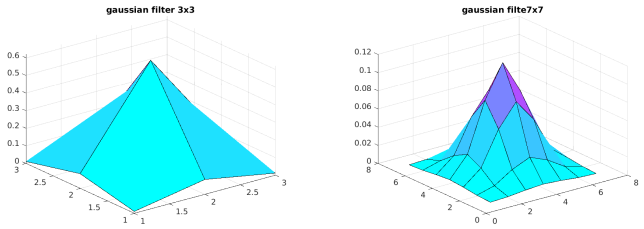


After we filter the images with a gaussian low pass filter. We built the filter with the matlab's functions fspecial. We used the the same spacial support used for moving average filter, 3x3 and 7x7 pixel. In this filter we need to set the

value of standard deviation (sigma). We used the formula :

$$\sigma = \frac{filterwidth}{6} \tag{2}$$

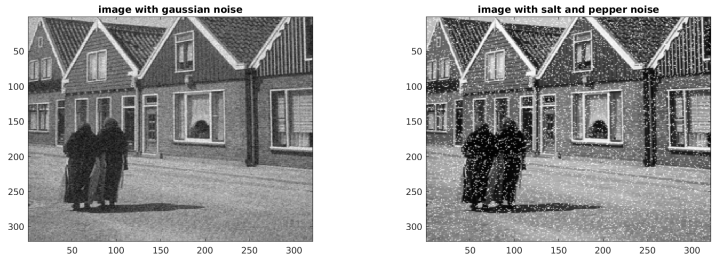
Figure 3: Gaussian Filter



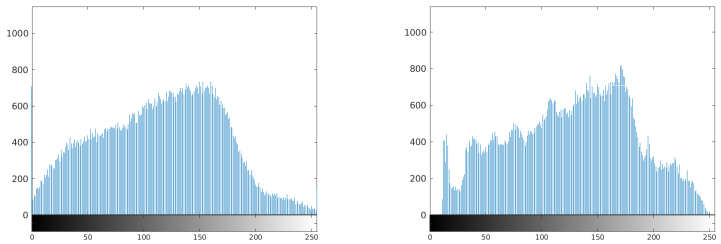
(a) (b)

In the next figure will be show the convolution between this filter (spacial support 3x pixel) and the image disturbed with the two noise distributions. We will notice a perfect performance with gaussian noise, but nearly the same result of moving average with salt and pepper noise

Figure 4: Filter with LPF gaussian



(a) (b)

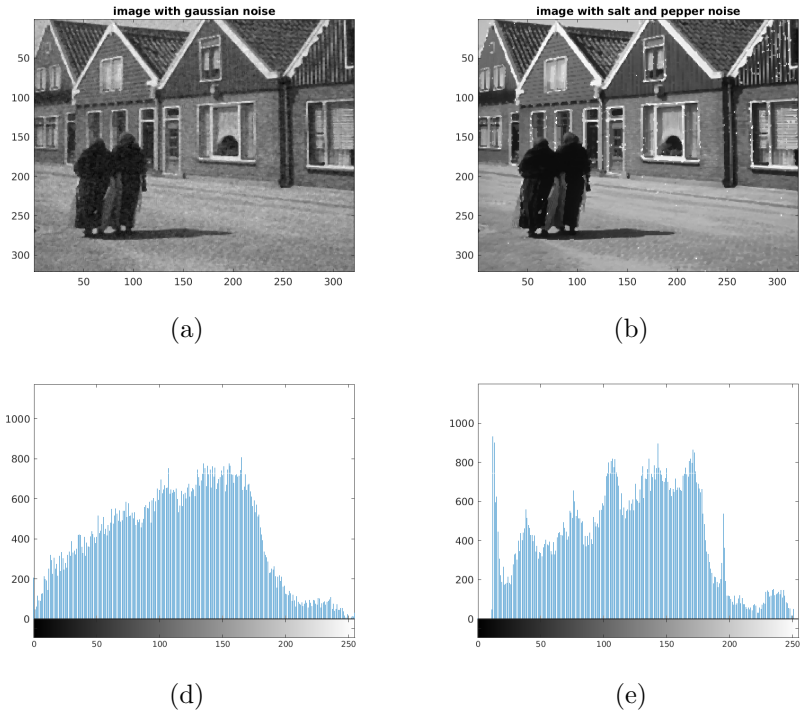


(d) (e)

The last filter we use is median filter. This is is a non linear filter. Respect at other two previous filter, this using this filter we notice a major lost of detail

in the images with gaussian noise, but it has a good performance with salt & pepper noise.So this filter has a good performance with impulse noise

Figure 5: Filter with median filter



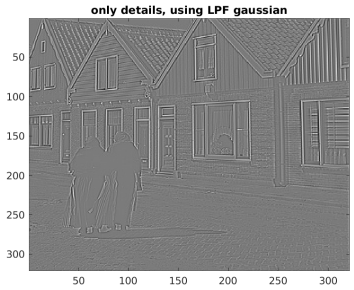
(a) (b)

(d) (e)

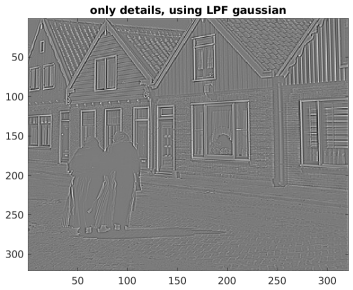
Practice with filters

In this part of the laboratory we return working withe the original image, without noise. The first practice we will do is apply filter for obtain only the detail of images. The first passage we need is to create an smoothed image. We decide to use moving average filter and Low Pass gaussian filter and do a confront from them. So we start from convoluted the original image with both filter. Now in this image the high frequency, that correspond to details were cut. Now we subtract at the original image, with all the frequency, the smoothed image we obtain only the details image. In the **??** we have on (a) the image smoothed wit moving average, and in (b) the image with LP gaussian filter. The second practice was to construct a sharpened image.
So we take the detail image, and we multiply this matrix for a scalar number, in this case is multiply for 2. After this multiply we wit sum the original image matrix. The result is an image more sharpened.

Figure 6: only detail images

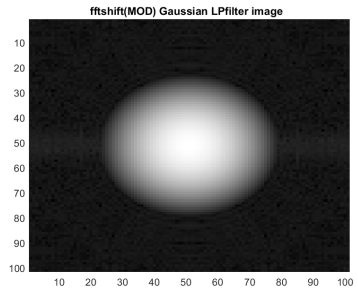


(1)

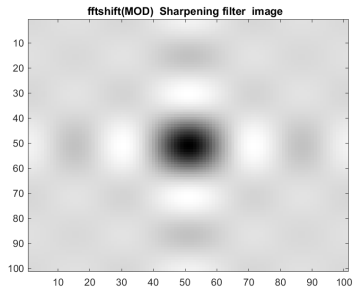


(2)

Figure 7: Fourier transform of filter



(1)



(2)

Conclusion

In conclusion we can notice that:

- Filter with smaller kernel are more sensitive to small details, we can see this property looking at the roof of the image considered.
- Moving average filter is easy to implement. It has a good performance in the image with gaussian noise, it caused a smoothing and small loosing of details. However, this filter does not perform well with salt & pepper noise.it is also easy to implement.
- Low-Pass gaussian filter has a very good performance with the image with gaussian noise. Respect moving average filter has less lost of detail. It has the same performance of the moving average filter with salt & pepper noise.
- Median filter don't have a good performance with gaussian noise and it

cause too much lost of details, but it is perfect with the images with salt & pepper noise.

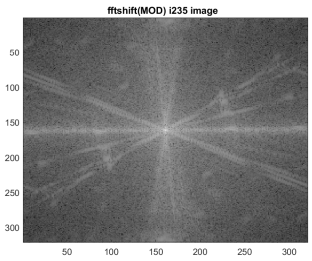
- 

Figure 8: FFT module of the i235 image

- We can see, but only through the i235 image that the Fourier Transform allows us to see the lines (probably of the roof of the picture), in fact there are some lines of high frequencies on the figure