Vision-mini-project 1

Image restoration

CS 11007 Introduktion til Robotics og Computervision
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Purpose

The purpose of this mini-project is to analyze pictures with artificial introduced noise, to determine which kind of noise is present. Furthermore this mini-project seeks to restore the images, so they will be approximately the same as the original image.

Procedure

The class VisionMethods has been created, which contains the required methods for image restoration and analysis. The class' constructor takes the file path to the image, and keeps the images produced by the different methods in a vector.

The general procedure is to first analyze the picture, by making a histogram of an assumed uniform region in the picture with *histogramOfRegion*, and also making a frequency domain analysis based on the DFT with *dftFunc*.

When a model of the noise has been established, appropriate filters will be applied to increase image quality.

Analysis

1 Image1

A histogram of an assumed uniform region and a magnitude plot of the DFT is shown in figure 1.

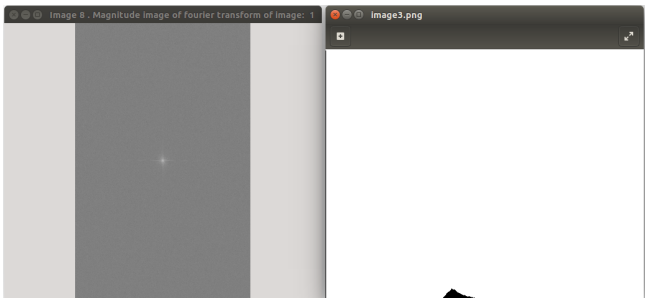

Figure 1: The left image shows the magnitude plot of the discrete Fourier transform of image1. The right image shows a histogram of an assumed uniform region of image1. A bar at the left of the image shows that there is a lot of black pixels in the region.

The magnitude plot does not reveal much information, how ever the histogram shows that there is a lot of black pixels in the region of interest. This suggest that there is pepper noise in the image. To filter out the pepper noise a max filter is applied. The original image and the reconstructed is shown in figure 2.

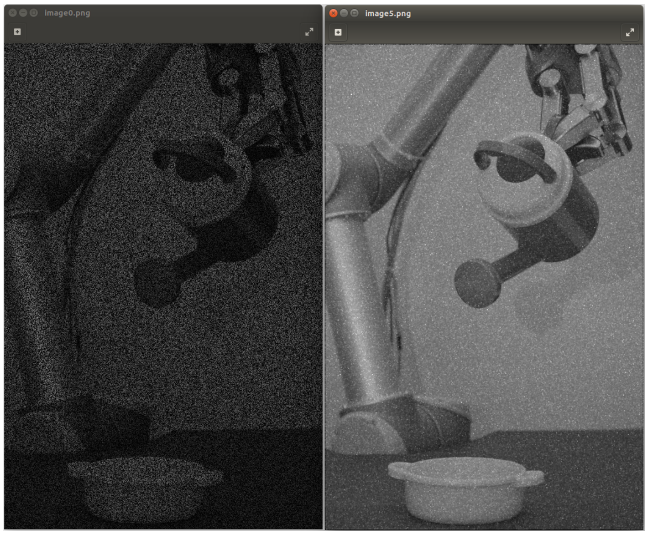

Figure 2: The left image shows the original image and the right image shows the reconstructed image by max filtering.

2 image2

Our procedure was used to determine which kind of noise the image was inflected with. The histogram and magnitude plots is shown in figure 3.

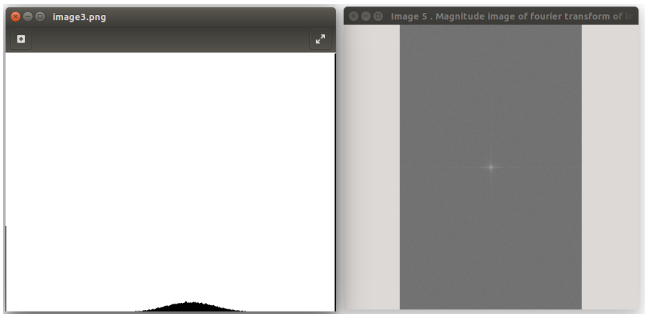

Figure 3: The left image shows the histogram of a assumed uniform region of interest in image2, where both salt and pepper noise is present. The right image shows the magnitude plot of a discrete Fourier transform of image2.

The histogram of the uniform region shows that both salt and pepper noise is present. To remove this an adaptive median filter was used with a max mask width size of eleven. The before and after images is shown in figure 4.

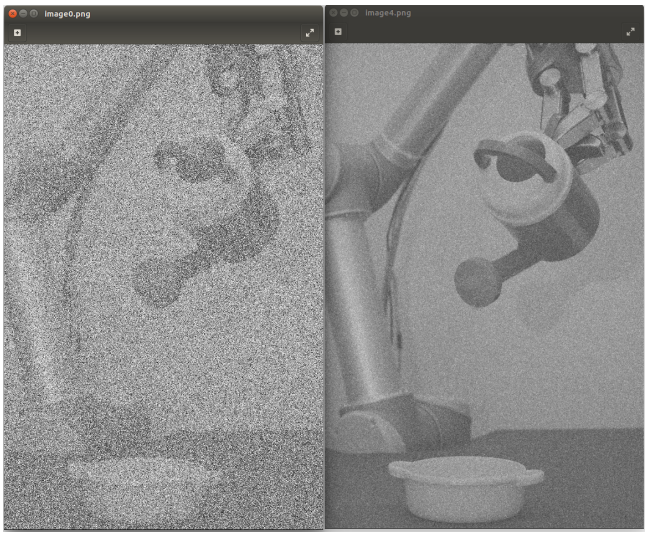

Figure 4: The left image is the original image, where a lot of salt and pepper noise is present. The right image is the reconstructed, which looks significant better after being adaptive median filtered.

3 image3

The original image was filled with noise as seen in figure 5. To determine what

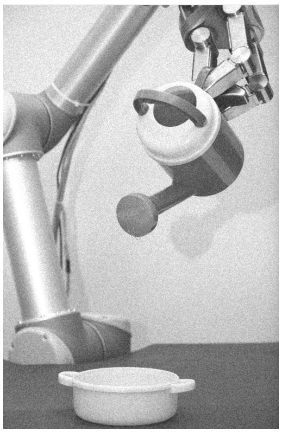

Figure 5: This is the original image given in the mandatory assignment.

kind of noise the original image contained, a region of interest was chosen (a square just below the watering can) were we should have an uniform intensity. The region of interest and a histogram plot of the region can be seen in figure 6.

The noise from the histogram led us to think that the noise model on the image was uniform, so to account for that a low pass Butterworth filter was implemented in the magnitude plot in the frequency spectrum. The magnitude plot can be seen in figure 7.

The resulting image after the filtering can be seen in figure 8. The image is more blurred than the original but the noise is almost gone.

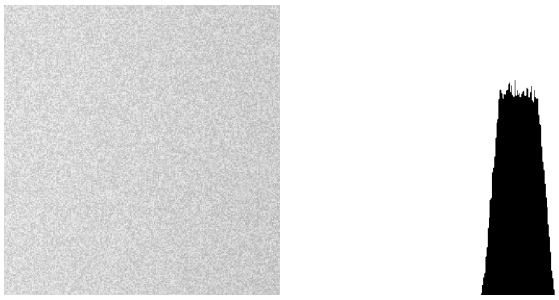

Figure 6: The leftmost image is the region of interest from where the noise model was created. The right image is the noise model which looked uniform, hence the low pass Butterworth as filter choice.

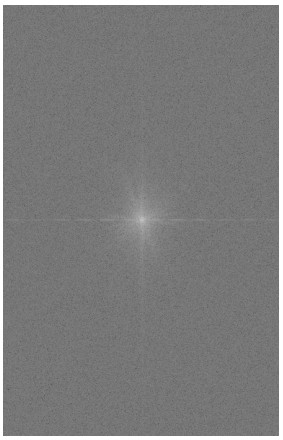

Figure 7: The magnitude plot of the unedited image. Unfortunately this does not give a lot of new information therefore the decision must be based on the results from the histogram.

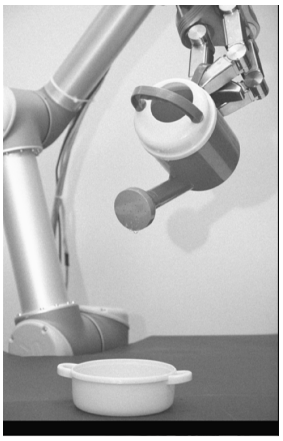

Figure 8: The edited image. The uniform noise is gone but with a small cost as the image looks a bit more blurred than before.

4 image4_1

A visual inspection of the original image hints that there may be some periodic noise present. The Fourier magnitude plots shows these frequencies as two crosses in the diagonal of the plot. The histogram does not reveal much information of the noise. Both plots is shown in figure 9.

To remove the periodic noise a low pass Butterworth filter of order 2 was applied to the original image, it results in the image restoration getting slightly blurred, but the periodic noise has been filtered out. In figure 10 both the original and the filtered image is shown.

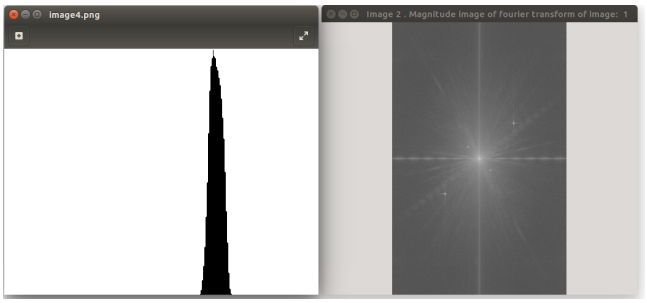

Figure 9: The histogram looks normal and does not reveal which kind of noise is present. However the magnitude Fourier transform plot shows the periodic noise as two crosses in the diagonal of the picture.

Figure 10: The left image is the original image. The right image shows the reconstructed image after passing through a low pass Butterworth filter.

Conclusion

For all the required images it was possible to increase the image quality by first identifying the noise in the pictures and then applying suiting filters. Even though the image quality was increased the filters did in most cases also degenerate the images in some way. Especially the low pass Butterworth filter made the reconstructed images blurred.
In general there is room for improvements. One way of improving the images could be to do another analysis on the filtered image, to see if additional filters should be applied. A notch filter could also have been used, which only would target the wanted regions in the magnitude plot. It would probably do a better job at reconstructing the image without that much blurring. In general the images were restored using various methods, to a satisfying degree.