Week 3 - Computer Vision

Tushar Nimbhorkar 11394110
Diede Rusticus 10909486

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Abstract

This report covers assignment 3 of the Computer Vision course. The firs part "Gaussian Filters" is implemented but not documented in this report. We implemented a 1D Gaussian Filter, 2D Gaussian Filter and a Gaussian Derivative filter. The second part "More on Filters" is implemented and documented. The results are also included in this report by figures.

2 More on Filters

2.1 Gaussian Versus Box

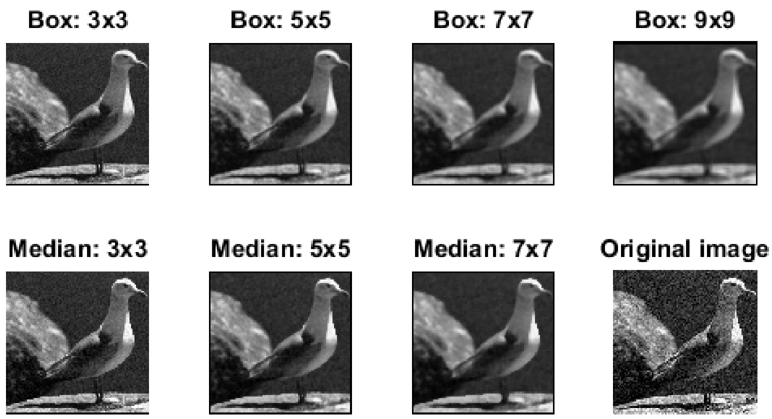
Figure 1 shows the results of the denoise function that removes the noise from a given input image. It either applies median filtering or box filtering with a different kernel size.

a) Figure 1 shows the results of the box and median filters for different kernel sizes

b) Increasing the filter size of the sliding window, will result in a more blurred or smoothed picture. Because the mean or median now covers more pixels, because the window covers more pixels.

c) The difference of the box and the median filter is that the median filter will not be much influenced by outliers. The box filter uses the mean value and therefore takes into account all values, including outliers. The median filter will therefore be more stable.

Figure 1: Denoise with Box or Median filters and different kernel sizes

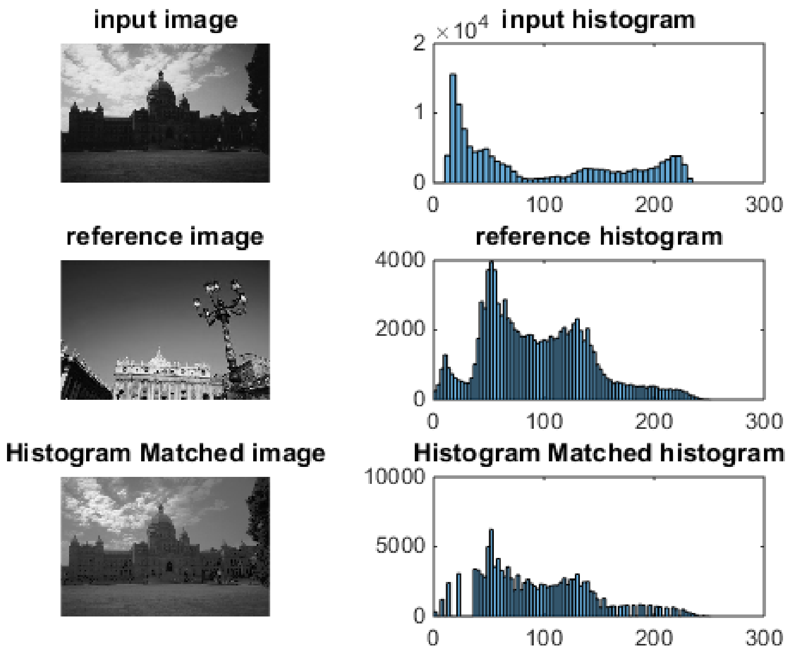


2.2 Histogram Matching

Figure 2 shows the results of matching the histogram of an input image to a reference image. The histograms are not equal, however the input's cumulative distribution (CD) function is approximated towards the CD function of the reference image. Histogram matching results in some holes in the resulting histogram. This is to be expected because the histogram is being distorted. This is what we did:

- The histograms are computed of both images.
- Then, the accompanying cumulative histograms are computed.
- These CDs are normalised.
- A mapping function from the input's CD to the reference's CD is defined.
- The input image is mapped based on the mapping function to the reference image and this results in the output image

Figure 2: Histogram Matching

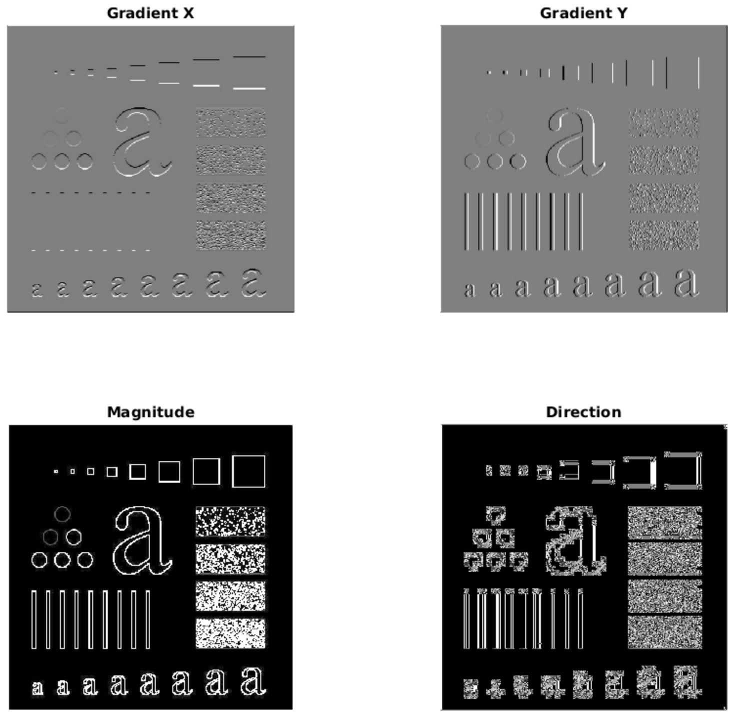


2.3 Gradient Magnitude and Direction

Figure 3 shows the results of computing the magnitude and the direction of the gradient vector corresponding to a given image. The function uses the Sobel kernel.

We can see from the image of Gradient X only horizontal lines are visible. Same for gradient in Y direction The vertical lines should be visible. As for the Magnitude of the image only the outlines are detected.

Figure 3:



2.4 Unsharp Masking

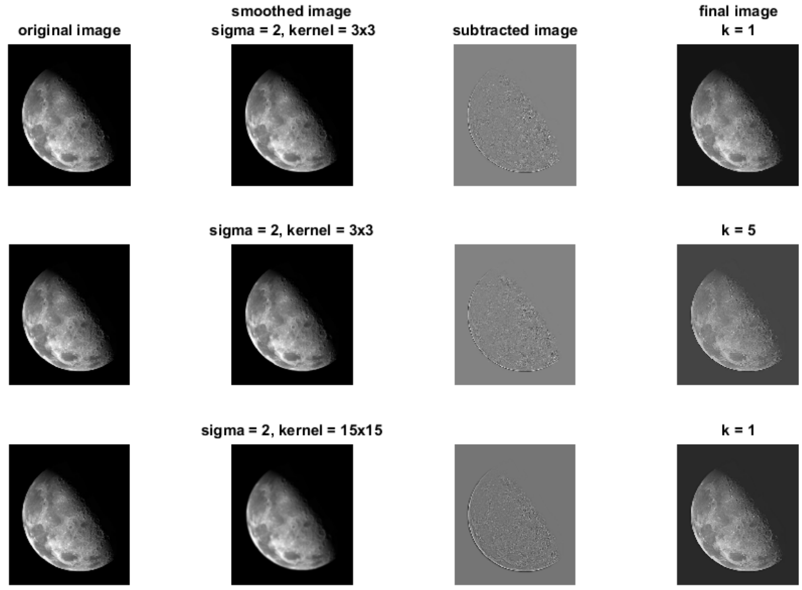
a) The results are shown in Figure 4.

b) The difference between k = 1 and k ¿ 1 is the sharpness. A higher k means that the highlights of the image are strengthened more, so the image will look sharper.

c) Increasing the kernel size would make the Gaussian image more blurred. This results in a loss of information of the details. The subtracted image will show less highlights, so the final image will look more like the original image.

d) Unsharp masking is used to enhance images, for digital image processing software and for scanners.

Figure 4: Unsharp Masking. Sigma is always set to 2. The second and third row are the results of experimenting with k and kernelsize respectively.



2.5 Laplacian of Gaussian

Three methods are implemented for the Laplacion of Gaussian:

a) The results of the 3 methods of Laplacian of Gaussian filter are shown in Figure 5.

b)
- Method 1: Laplacian is applied to an image that has first been smoothed with Gaussian filter in order to reduce its sensitivity to noise.
- Method 2: LOG operators are second-order derivatives operator.
- Method 3: This method involves Subtracting a blurred version of original image with less blurred version of the same original image. Subtracting one image from the other preserves spatial information that lies between the range of frequencies that are preserved in the two blurred images.

c) It is important to convolve an image first with a Gaussian operator, because it smooths the picture. If not applied before the Laplacian operator, the Laplacian would enhance noise instead of just showing the real edges.

d) According to Marr and Hildreth (1980), the best ratio between σ_1 and σ_2 to achieve the best approximation of the LoG is 1.6.

e) LoG filters are often used for blob detection, edge detection or other detail visualization.

References

Marr, D. and Hildreth, E. (1980). Theory of edge detection. *Proceedings of the Royal Society of London B: Biological Sciences*, 207(1167):187–217.

Figure 5: 3 Methods of Laplacian of Gaussian