MSc MAIA/Computer Vision/VIBOT

Image Processing

Practicals

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Lab 3: Filtering and Edges

1 Image filters

Given an image I and a filter M of size $2N+1$, the result of the filtering operation is given by

$$I_f(i,j) = \sum_{k=-N}^{N} \sum_{l=-N}^{N} I(i+k, j+l) M(k,l).$$

1. Apply the following filter to the image `building.jpg`.

$$M = \frac{1}{36} \begin{pmatrix} 1 & 4 & 1 \\ 4 & 16 & 4 \\ 1 & 4 & 1 \end{pmatrix}$$

   Use the Matlab function *imfilter*.

2. When using a filter we need to deal with image borders. Matlab offers different options. Try the border conditions *symmetric, replicate* and *circular*, and comment on the obtained results.

1.1 Linear filtering

We consider the following two filters, an average filter and a Gaussian filter:

$$M_{avg} = \frac{1}{9} \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix} \qquad M_{gaussian} = \frac{1}{36} \begin{pmatrix} 1 & 4 & 1 \\ 4 & 16 & 4 \\ 1 & 4 & 1 \end{pmatrix}$$

1. Apply the two filters to the image `saturn.png`. Comment on the results.

2. Plot the intensity profile of one image row before and after filtering. Which type of filters do we have? (high pass or low pass filters?).
   You can use the command `plot(I(row,:))`.

3. Apply the two filters to the image `saturn_noise.png`. Comment on the results, show an intensity profile.

1.2 Nonlinear filtering

1. Apply a median filter to the image `saturn_noise2.png`, and compare with the results obtained with the average and Gaussian filters defined above.

2 Edges detection

In this section, you will implement some of the edge detection methods learned in class.

2.1 Sobel filters

Gradient filters allow the computation of image derivatives. There are many type of such filters, here we will use the Sobel filter defined by:

$$M_x = \begin{pmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{pmatrix} \qquad M_y = \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix}$$

1. Apply these two filters to the image `saturn.png` to obtain the derivative w.r.t. x, I_x, and the derivative w.r.t. y, I_y.
2. Compute the norm of the gradient vector $\begin{pmatrix} I_x \\ I_y \end{pmatrix}$. Comment on the result.
3. Finally, we can threshold the image of the gradient's norm to get an image of contours. Find the threshold that provides the best contours.

2.2 Comparison

1. Using Matlab function `edge`, compare the edge detection results obtained with different filters: Prewitt, Sobel and Canny, for images `house.jpg`, `satellite.jpg`, and `railway.jpg`.

3 Hough transform

The Hough transform is a method that allows the detection of regular shapes (lines, circles, ellipses etc) in a binary image.

1. Read the help of Matlab functions `hough`, `houghpeaks`, `houghlines`.
2. Write a function `my_hough_transform(I, N)`, that takes as input an image I and a number N, and draw the N longest lines in image I.

   Test your function with images `biblio.jpg` and `railway.jpg`.

4 What to submit

- For this Lab, you have to submit a report including your codes and examples for all Sections 1, 2 and 3.
- A well written report would be evaluated more favorably !
- A late submission will lead to a penalty in the mark.
- This is an individual work. Any form of plagiarism or submitting the work of another student, will not be tolerated.