Exercise 2

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Edges and Structure tensor

1 Amount of Image Data

1. How much memory is required for storing Magnet Resonance (MR) images of one day?

   Given:

   - MR scanner is used for 10 hours per day,
   - MR scanner resolution is 512×512 pixels,
   - Average slice number in a study is 20,
   - Voxels are encoded with 12 bits dynamics,
   - One study requires 10 minutes of time.

2. What is the maximum of gray levels of a MRI scan ($512 \times 512 \times 30$ voxels) if it consumes 11520 KB of memory?

2 Edge images

There are different techniques to compute edge images. Use first the Horizontal Sobel mask
$f_y = \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix}$ apply then the vertical Sobel filter mask and generate the gradient
magnitude image. MATLAB provides some commands to compute easily Sobel images. Try
them. Use therefore the MR image *mr14.dcm*.

Think of another way to compute an edge image and implement it (see lecture slides: Scatter
Correction & Edge Detection).

3 Differentiation as an ill-posed problem

In practice, there is the need to compute derivatives. Unfortunately differentiation is quite sensitive to noise. Consider a noise-free signal. Compute the first and second derivative. Now, add some gaussian noise to the signal and plot again the first and second derivative (see Fig. 1). Complete the source code in *differentiation_exercise.m*.
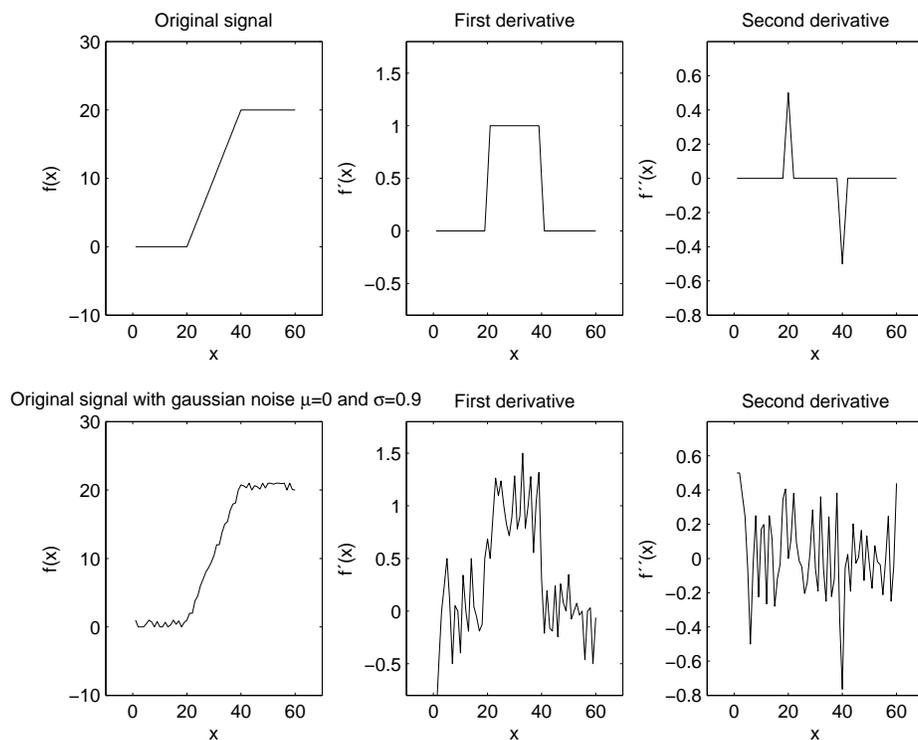

Figure 1: First row: original signal with clear distinguishable first and second derivative. Second row: signal with additive gaussian noise ($\mu = 0, \sigma = 0.9$), first and second derivative respectively.

4 Structure tensor

Use the lecture slides: Scatter Correction & Edge Detection. Implement the structure tensor by completing the source code in *structure_tensor.m*. Keep in mind the following steps:

1. Think about the gaussian filtering (σ). You have to combine the filtering and the derivative computation.

2. Apply the gaussian filtering as spatial averaging (ρ).

3. Adjustable parameters: masksize of the filter, regularization terms σ and ρ, and threshold for distinguishing the 3 cases: homogeneous region, edge or corner.

4. Compute the angle between the eigenvector of the smallest eigenvalue and the x-axis.

5 Useful MATLAB commands

dicomread, dicominfo, edge, conv2, fspecial, imfilter, gradient, quiver

We will work interactively on the implementation of the above mentioned tasks!