1 Instructions

For this assignment you must solve 3 individual exercises.

1. You can choose any two of the three proposed exercises below.

2. You also must implement a segmentation algorithm as seen in class, mean-shift or belief propagation.

You can choose to do mean shift and belief propagation; then you only have to do one more from the three proposed exercises below.

For each of your three exercises, you need to submit a report of no more than 3 pages (IEEE style) with a general description of your solution (without including the source code).

You can use any function provided by OpenCV or any other vision library, anything what you find available on the net, but you need to cite accurately which sources you have used in your report.

In particular for the segmentation algorithms, *remember that the idea is to detail the strengths and weaknesses of each algorithm.*

1.1 General algorithms

1. *Variations of Histogram Equalization.* The book [R. Klette and P. Zamperoni: Handbook of Image Processing Operators. Wiley, Chichester, 1996] discusses variations of histogram transforms, in particular variations of histogram equalization

$$g_{equal}^{(r)}(u) = \frac{G_{max}}{Q} \sum_{w=0}^{u} h_I(w)^r \tag{1}$$

$$Q = \sum_{w=0}^{G_{max}} h_I(w)^r \tag{2}$$

   Use noisy (scalar) input pictures (of your choice) and apply the sigma-filter prior to histogram equalization. Verify by your own experiments the following statements: A stronger or weaker equalization can be obtained by adjusting the exponent $r \geq 0$. The resultant histogram is uniformly (as good as possible) distributed for $r = 1$. For $r > 1$, sparse gray values of the original picture will occur more often than in the equalized picture. For $r = 0$, we have about (not exactly!) the identical transform. A weaker equalization in comparison to $r = 1$ is obtained for $r < 1$.

2. *Different Impacts of Magnitudes and Phase in Frequency Space on Resulting Filtered Images* The task is to study the problem of evaluating information contained in magnitude and phase of the Fourier transforms:

(a) Select scalar images showing some type of homogeneous textures; transform these into the frequency domain and modify either (i) the magnitude or (ii) the phase of the Fourier transform in a uniform way (for all frequencies), before transforming back into the spatial domain.

(b) Do the same for a set of images showing faces of human beings.

You can also combine the magnitude of one scalar image and the phase of another image (both of the same size), and do the inverse Fourier transform on this created combination. Which image is "winning"? The one contributing magnitude, or the one contributing phase?

Discuss your findings. How do uniform changes (of different degrees), either in magnitude or in phase, alter the information in the given image?

3. *Directional Normalization of Images.* Capture freehand (i.e. no tripod or other means for leveling) still images in an environment showing many vertical and horizontal edges. Identify such "near-vertical" and "near-horizontal" edges by lines using the Hough transform and a criterion for rejecting slopes neither "nearly vertical" nor "nearly horizontal". Calculate from all the identified vertical and horizontal lines a rotation angle for the given image such that the mean directions of horizontal and vertical lines become isothetic (i.e. parallel to the image's coordinate axes). This is one (certainly not the simplest) way for normalizing images with respect to recorded environments.