EXERCISE 2

IMAGE CONTRAST

Tasks and questions

1. Prepare a set of images (at least 3) of achromatic 8-bit depth (256 possible grey levels) images with a resolution of at least 512×512 pixels, with varied content and different contrast. (0 point)
2. Analyse and compare histograms (MATLAB `imhist`) of the prepared images. Is the histogram a good method for evaluation of image contrast? (1 point)
3. For selected (at least 2) images perform a point operation

$$y = ax^{\gamma} + b \tag{1}$$

with different values of parameters a, γ and b, where x and y are, respectively, grey level values of the input image and output images.

How different parameters of the equation affect the images? How the applied transformations affected the histograms of images? Specify the conditions under which certain parameter values should be used. (1 point)

4. Propose and test other point processing functions. Check how the used functions affected the image histograms. Analyse the obtained results. (additional 1 point)
5. Implement the histogram stretching method. What conditions must be met for this method to give the best results? (1 point)
6. Propose and implement histogram stretching with clipping less important pixels with extreme values. (additional 1 point)
7. Test histogram equalisation method (MATLAB `histeq`). Compare results with other tested histogram-based methods. (1 point)
8. Are these global contrast enhancement methods useful in every case? Try to determine the cases in which these methods give best results. (1 point)
9. Implement and compare local contrast enhancement methods. (1 point)

10. Compare the following methods for evaluation of image contrast

$$k_1 = \frac{1}{255}(l_{max} - l_{min}) \tag{2}$$

$$k_2 = (l_{max} - l_{min}) \cdot \bar{l}^{-1} \tag{3}$$

$$k_3 = \frac{l_{max} - l_{min}}{l_{max} + l_{min}} \tag{4}$$

$$k_4 = \frac{4}{255^2 MN} \sum_{m=1}^{M} \sum_{n=1}^{N} \left(l(m,n) - \bar{l}\right)^2 \tag{5}$$

where $M \times N$ is the image resolution, $l(m,n)$ is the grey level of the pixel (m,n) and

$$\bar{l} = \frac{1}{MN} \sum_{m=1}^{M} \sum_{n=1}^{N} l(m,n) \tag{6}$$

$$l_{min} = min_{\forall m,n}\left(l(m,n)\right) \tag{7}$$

$$l_{max} = max_{\forall m,n}\left(l(m,n)\right) \tag{8}$$

Determine if the numerical results agree with the visual judgment. (1 point)

Answers to the above-mentioned questions place in your report. The report should contain also: program codes, exemplary results, discussion of the results and conclusions.

Additional information

- In case of short report ("in class" report) it is enough to do the obligatory exercises (these with red points).
- In case of full report, it is necessary to realise all tasks.
- The minimum number of points that should be obtained during classes is 3 points. These points can be obtained by completing:
  - tasks 1–3 and 5 in the case of performing obligatory tasks only,

  or
  - task 1–4 in the case of performing obligatory and additional tasks.