Assignment Guidelines

- Write a short report to illustrate your work. Explore and include interesting results (necessary to achieve $> 90\%$) and use full sentences to explain your reasoning.
- Reports may be handed in during the lecture on the due date.
- Feel free to discuss the work amongst one another, but write your own report and code.
- Working code has to be provided via e-mail, as an archive on the web or in an online code repository such as GitHub or BitBucket. You may use any open source language, such as Python, Octave, C#, etc.

Sample images are provided on the web-site, but feel free to use your own.

Problem 1: Intensity Transformations

Illustrate each of the following intensity transformations, and describe a typical application. Plot both the transformation (input intensity r versus output intensity s) and the effect it has on an image.

- Brightness adjustment
- Inverse
- Log
- Power-law or "gamma"

Problem 2: Histogram Equalisation

Histogram equalisation is often used to improve image contrast. Use it to enhance an image in which the intensity values vary little. Show the image histogram before and after the operation, as well as the transformation function. Is the histogram of the resulting image perfectly flat? If not, explain.

Problem 3: Smoothing filters

Consider the smoothing kernel of size $N = 3$,

$$w = \frac{1}{9} \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix},$$

or, more generally, $w_{ij} = 1/N^2$, $i = 0 \ldots N-1$, $j = 0 \ldots N-1$.

(a) Implement a correlation routine that applies any $N \times N$ kernel to an image (N uneven). Assume out of bound values are zero.

(b) Use your routine to apply the mask, w, to a test image. How does the output vary for different values of N?

(c) For masks of the form w, improve performance of your implementation by using an integral image (also known as a "summed area table"). Compare execution times with those in (a).

Complete *either* of the following research problems.

Research Problem A: Difference of Gaussians

An important problem in image processing is *feature detection*. Implement the technique known as "Difference of Gaussians" (DoG) to highlight features in a test image.

Research Problem B: Bilateral filter

Implement and illustrate the working of a bilateral filter.