SGN-12006 Basic Course in Image and Video Processing

EXERCISE 2

07.09.2015 - 09.09.2015

This exercise consists of both lab exercises and homework. Complete the lab exercises and present your results for the TA. Prerequisite for submitting the homework is attendance in an exercise session. Homework should be submitted only online using Moodle2.

Follow the naming format 'ExN_surname_ID.pdf' (N is the number of exercise). Also please clearly write down your full name and student number in the document. The homework report should be no more than 1 page long and it should be done individually (no pairs allowed). Questions on this exercise should be addressed to TA's email address: (firstname.surname@tut.fi).

Lab exercises:

1) Familiarization with MATLAB's Quantization Functions (1 point)

a) Check help quant and help quantiz

b) Create vector A with numbers 0 … 255

c) Run the following MATLAB codes:

```
step = 256/4;
QA1 = quant(A, step);
partition = step:step:256-step;
codebook = step/2:step:256-step/2;
[indx,QA2] = quantiz(A, partition, codebook);
```

d) Find out the values in quantized vectors QA1 and QA2 (Hint: help unique)

2) Quantization (4 points)

a) Using quantiz function, design 128, 64, 32, 16, 8 and 4-level uniform quantizers and quantize the gray-level image *lena_face.png* (Hint: help reshape).

b) Try to use noise (add noise to the image before the quantization, help randn) to reduce the contouring effects. Quantize again *lena_face.png* to 16 levels, and compare the result with the noiseless image quantized to 16 levels.

3) Simultaneous Contrast (2 points)

Using MATLAB, generate two 8-bit images as in the figure 1, where the small squares have gray level values of 127 and the backgrounds have the values 63 and 223. Verify the simultaneous contrast: the small squares in the middle have equal luminance but do not appear equally bright. Next, change the gray level in one of the small squares until the small squares will appear equally bright. What is the value of the obtained gray level? (Hint: help ones, imshow. Avoid using for loops).

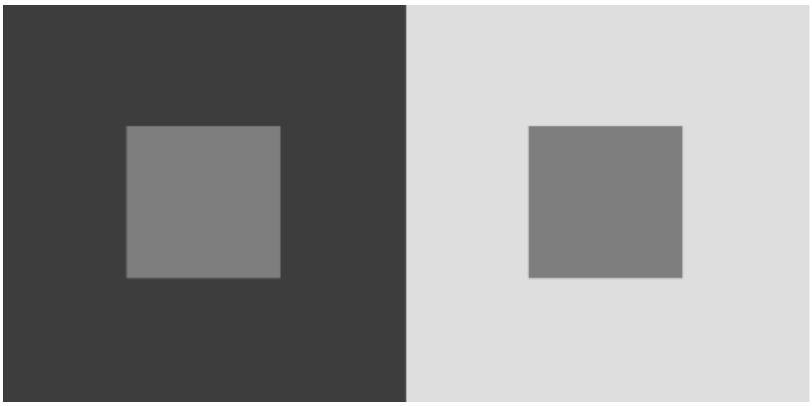

Figure 1: Simultaneous contrast example

Homework:

4) Image Formation in the Eye (3 points)

Consider the cross section of the eye (from Gonzalez and Woods' book or from http://hyperphysics.phy-astr.gsu.edu/hbase/vision/rfreye.html). The fovea is a circular indentation in the retina of about 1.5mm in diameter. By taking some liberty of interpretation, we can view the fovea as a square sensor array of size 1.5mm×1.5mm. The density of cones in that area of the retina is approximately 150 000 elements per mm2. The principal difference between the lens of the eye and an ordinary optical lens is that the former is flexible. The shape of the lens is controlled by tension in the fibers of the ciliary body. To focus on distant objects, the controlling muscles cause the lens to be relatively flattened. Similarly, these muscles allow the lens to become thicker in order to focus on objects near the eye.

The distance between the center of the lens and the retina (called the focal length) varies from approximately 17 mm to 14mm, as the refractive power of the lens increases from its minimum to its maximum.

Using this simplified information about the cross section of the eye and thinking purely in geometric terms, estimate the diameter of the smallest printed dot that the eye can discern if the page on which the dot is printed is 0.2 m away from the eyes. Assume for simplicity that the visual system ceases to detect the dot when the image of the dot on the fovea becomes smaller than the diameter of one receptor (cone) in that area of the retina. Assume further that the cones and the spaces between the cones are distributed uniformly throughout this array.