EQ2330 – Image and Video Processing

Assignment #2

The following preparation assignment is to be solved before the next exercise session indicated by the due date of the assignment. You bring your solution to the exercise session and on one of your peers will correct it during that session. After that you will discuss the correction with your peers and resolve any open questions. If necessary, the teaching assistant can help you. It is required to solve all the assignments and correct at least one peer solution of each assignment in order to pass the course.

Problem

This problem is about basic spatial filters.

1. Describe how an averaging filter, a weighted averaging filter, and a down-sampling filter can be implemented. For each filter, state whether it is linear or not.

2. Consider the example gray scale image in Fig. 1. To the right is a "zoomed" portion of the image, where the actual (8-bit) gray scale levels are indicated. Determine the output from the (unweighed) averaging filter for the case when a 3×3 filter mask is centered on the pixel with gray level 166. Compute also the result of performing (2:1) down-sampling on the portion of the image.

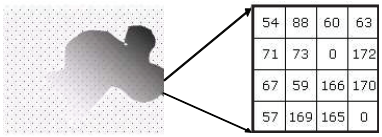

Figure 1: Gray scale image example. To the right is a "zoomed" portion of the image, expressed in terms of the actual gray level values.

3. We continue with filtering of images. Consider the averaging filter mask:

$$\mathbf{H} = \frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}. \tag{1}$$

Show that this mask can be decomposed into two smaller masks, such that the result from applying these masks consecutively over an image yields the same result as the bigger mask.

4. What is the benefit of such a two-step processing? *Hint:* Consider how many multiplications and additions are required to accomplish filtering operations.

5. What general condition is necessary for such a two-step processing of images?

6. Discuss the limiting effect of repeatedly applying the averaging filter to a digital image. You may ignore border effects.

7. Consider the following filter mask

$$\mathbf{G} = \begin{bmatrix} -\frac{1}{2} & -1 & -\frac{1}{2} \\ 1 & 2 & 1 \\ -\frac{1}{2} & -1 & -\frac{1}{2} \end{bmatrix}. \tag{2}$$

Assume that this filter has been applied to an arbitrary image. What is an average pixel value of the filtered image? Motivate!