

TEL411 – Digital Image Processing

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Assignment 1

Due date: Tuesday, October 8, 2020

Exercise 1

Let $I(i, j)$, where $i = 1, \dots, N$ and $j = 1, \dots, M$, be a digital 2D grayscale image. The goal of this exercise is to downsample the initial image using the following scaling parameters $\left(\frac{1}{2}, \frac{1}{4}, \frac{1}{8}\right)$ and upsample again in order to create a new image $\tilde{I}(i, j)$ of the same original size $N \times M$. You should verify the impact of using or not an anti-aliasing filter as well as what is the best kernel function among the nearest-neighbor interpolation, the bilinear interpolation and the cubic interpolation.

To compare the original and the reconstructed image is should be utilized the Mean Square Error (MSE) function

$$MSE(I, \tilde{I}) = \frac{1}{MN} \sum_i^N \sum_j^M (I(i, j) - \tilde{I}(i, j))^2$$

Theoretical Background

Aliasing is an effect that causes different signals to become indistinguishable when sampled. It also often refers to the distortion or artifact that results when a signal reconstructed from samples is different from the original continuous signal. When an anti-aliasing filter is applied before sampling it satisfies that the a signal sampler to restrict the bandwidth of a signal to satisfy the Nyquist–Shannon sampling theorem over the band of interest.

When an image is scaled down to a lower size, there is a question of what will be the color of the remaining pixels. When an image is scaled up to a larger size, the inverse question is what will be the color of the new pixels in between the original pixels. Constructing new data points within the range of a discrete set of known data points is called **interpolation**. There exist several answers to these questions and different kernel function that address the aforementioned issues.

Hints

You can find some original grayscale images on eclass Labs/Input_Data. Maybe it would be useful to use the “imresize” function.

What to turn in

You should turn in both your code and a report. For every different case (18 in total) you should provide the downsampled and the upsampled images, the MSE value and discuss the results in your report.