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Computer Graphics I
Assignment 6

Submission deadline for the exercises: Monday, 10th December 2007
Rule: Solutions have to be submitted in the lecture room before the lecture.

6.1 Sampling Theory (15 + 15 Points)

Let $f(x)$ be an infinite signal that fulfills the Nyquist property, thus the highest frequency of the signal is smaller than $\frac{1}{2T}$ if T is the sampling distance. Consider a regular sampling $f_S(x)$ of $f(x)$ with sample distance T.

a) Is an exact signal reconstruction of $f(x)$ possible? If so, why?

b) How has the reconstruction to be performed in image and Fourier space?

6.2 Antialiasing (15 + 15 Points)

a) Explain what sampling of a continuous signal means in signal and Fourier space. Further explain what aliasing of a sampled signal means in signal and Fourier space.

b) Consider an infinite signal $f(x)$ and a regular sampling $f_S(x)$ with sampling distance d that shows no aliasing artefacts. The sampling distance d is now increased step by step until the first aliasing artefacts occur.

How can we best get *an aliasing-free* sampling from these samples f_S again? The sampling distance should stay d and as much useful information as possible should be recovered.

Describe the filter procedure in Fourier and signal space. You do not have to derive the exact filter kernels (but you can of course).

6.3 Triangle Filter (40 Points)

Show that reconstructing a signal that is sampled at sampling distance 1 with the triangle filter $T(x)$ is equivalent of performing linear interpolation.

$$T(x) = \begin{cases} 0 & \texttt{for } x \leq -1 \\ x+1 & \texttt{for } -1 < x < 0 \\ -x+1 & \texttt{for } 0 \leq x < 1 \\ 0 & \texttt{for } 1 \leq x \end{cases}$$