UNIVERSITÄT STUTTGART
Institut für Visualisierung und Interaktive Systeme (VIS)

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Scientific Visualization (Assignment 6)

Exercise 6. 1 [2 Points] Color Interpolation on Triangle Grids

Regarding interpolation of colors, what problems would you expect when having two adjacent triangles instead of a square? Discuss the implication on triangle grids and the advantages of having a triangulation that satisfies the Delaunay properties.

Exercise 6. 2 [4 Points] Signal Processing

In the lecture, the Fourier Transform, as well as the basics of convolution, sampling theory, and filter design, was discussed. A signal's spectrum is given by

$$X(\nu) = \begin{cases} 1 - |\frac{\nu}{\nu_X}| & \text{if } |\nu| < \nu_X \\ 0 & \text{otherwise} \end{cases}$$

while the sampling is given as

$$S(\nu) = \sum_{n=-\infty}^{\infty} \delta(\nu - n\nu_S)$$

The input signal and the sampling are sketched in Figure 1 and Figure Figure 2, respectively. Note that both signals are given in the *frequency* domain.

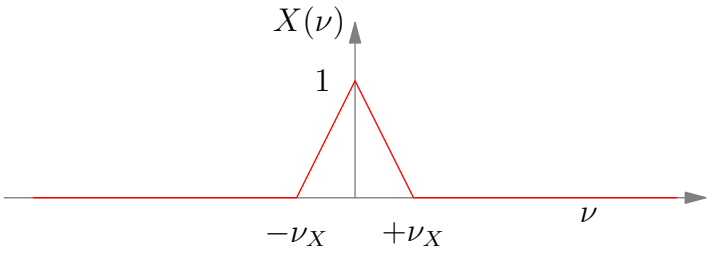


Figure 1: Input signal in frequency space

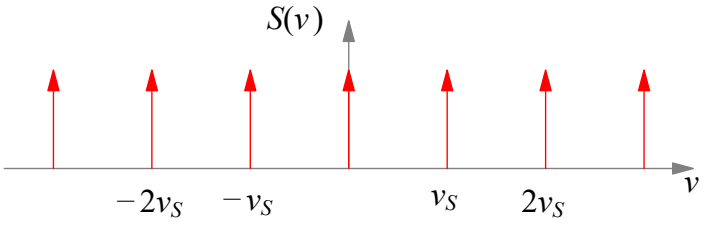


Figure 2: Sampling signal in frequency space

1. (1 Point) Give the condition for the sampling frequency ν_S that is needed to correctly reconstruct $X(\nu)$ with respect to ν_X. Submit the condition.

2. (2 Points) $S(\nu)$ is used for the sampling of $X(\nu)$. Construct the sampled signal (in the frequency domain) for a case where the condition in item 1. Is fulfilled and one where it fails. Submit sketches of examples for both cases.

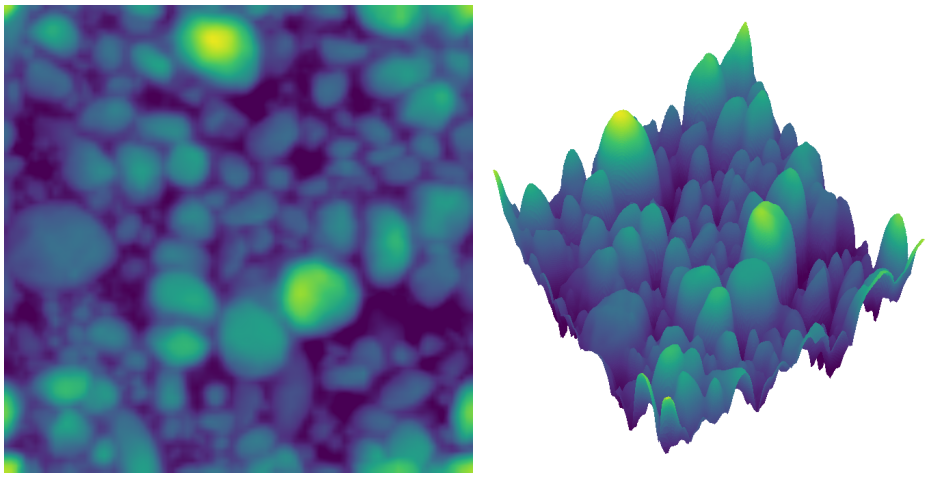
3. (1 Point) Specify a filter which needs to be applied to the sampled signal so the original signal can be reconstructed. Submit a sketch of the filter and how it is applied.

Sketches can be submitted in any human readable format. Code/tools may be used to generate the sketches, but are not considered valid formats.

Exercise 6. 3 [5 Points] Mapping to Color and Position with Shaders

Prerequisites: Obtain the shader skeleton (`mapping.glsl`) from ILIAS and familiarize yourself with *ShaderToy* (`https://www.shadertoy.com/new/`). *ShaderToy* is a website that essentially provides you a pre-configured fragment shader in a WebGL context for prototyping shader code. Opposed to standard fragment shaders, some additional input parameters like the current time, mouse coordinates, or sound processing capabilities are also available. For this, it requires a WebGL-compatible browser, such as Google Chrome, Mozilla Firefox, or Microsoft Edge. To get started, watch the *ShaderToy Introduction* video on ILIAS.

Your task is to implement functions that map a 2D scalar field to color and position of a surface (cf. Figure 3):



(a) (b)

Figure 3: Scalar values of *Pebbles* texture mapped to (a) color and (b) color plus position

1. (2 Points) Implement the function `mapToColor`: For this, map the scalar value to a color using the provided *Viridis* color map (`http://www.kennethmoreland.com/color-advice/`). Limit the input value range to the interval $[0, 1]$. Use linear interpolation to calculate the color between the given points of the color map.

2. (2 Points) For this task we transfer the data to be visualized as texture to the graphics hardware and access it using pixel coordinates. Usually the resolution of the data and the resolution of the visualization grid differ. Discuss (in max. 5 sentences) the effects of sampling the data onto a new grid and how different settings for texture minification and magnification affect the visualization (see `https://www.learnopengl.com/Getting-started/Textures` and `https://www.khronos.org/registry/OpenGL-Refpages/es3.0/html/glTexParameter.xhtml`).

3. (1 Points) Implement the function `mapToHeight`: For this, map the scalar value to the elevation of a surface with $f(x) = \frac{1}{3}\log_2(7x + 1) - 0.5$. Limit the input value range to the interval $[0, 1]$.

Write your answer for item 2 as comment after the respective `TODO`. Submit the complete, modified shader as code/text file.

Submission Deadline: 2020-06-12, 23:55

please hand in your submission through the ILIAS system.

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