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High Performance Computing with GPUs

Exercise Sheet 1

Hint: In my OpenGL examples I use either RGB or RGBA coding for the pixels. RGB coding uses an `uchar3` array, that is a `uchar` structure with components x, y and z, that contains values between 0 and 255 for red (=x), green (=y) and blue (=z). In case of RGBA a `uchar4` array is used there the 4th elements (=w) should be set to 1.
This array is allocated linearly and begins in the lower left corner.

Task 1: Simple Textures
In this task you are going to write a kernel that colours 1000 × 1000 pixels based on the given files `Framework_GL.cpp` and `kernel_frame.cu` (they use smaller windows - don't forget to adjust them). Properly compiled (see sheet 1) and called with `rhrk-launch` a window is opened. The array is not initialized and your first picture is random noise of the card.
Think of a 1000 × 1000 matrix that should be divided into 9 almost equal sized blocks. Start with an identical color per block (result 1) but all blocks with different colors. Change this into a picture with a color gradient for a block like

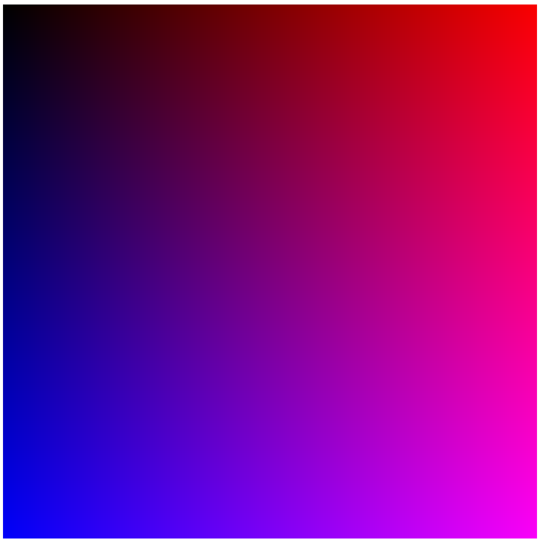

Abbildung 0.1: Gradient Texture

Each block should have a different gradient and the colours should be choosen so that neighbouring edges have different colours.

Task 2: Julia Sets Julia sets are subsets of the complex numbers. They were invented by Gaston Julia and Pierre Fatou. Julia sets often form fractals one of which we are going to visualize in this exercise. The sets are mathematically defined by the iteration rule:

$$Z_{n+1} = Z_n^2 + C \tag{0.1}$$

Hereby $Z, C \in \mathbb{C}$ are complex numbers with C constant. The Julia set is defined as the numbers that are less than a certain threshhold when executing the iteration rule n times.
Implement the calculation of a Julia set as a CUDA kernel starting again from the 2 given files. Execute the iteration rule for the numbers in the set $Z \in \{z|Re([-1,1]) + Im([-1,1])i\}$ with iteration depth 300 taking 1000 equidistant numbers in each direction (real and imaginary) in this set. Use the constant $C = -0.8 + 0.156i$. Fulfills a number the condition $\|Z_n\|^2 < 2$ then the number is a member of the

corresponding Julia set. Colour the members different from the rest (= background colour). Use a proper division of the problem size 1000 × 1000 to execute the iteration rule in parallel in a CUDA kernel.
Now the parameter `t` in the simulate call is used. It is a simple counter starting from 0. Use the *Euler formula* and

$$C = 0.7885 \times exp^{iA}$$

with A=0.08+(t%100)/1220 in the interval $[0, 2\pi]$.