Parallel Computing II: Homework III

24. November 2014

This will be your third homework in the exercise parallel computing. Send your solution to Matthias.huy@daimonas.de and to t.grahs@tu-braunschweig.de until December 4th 08.00pm. Prepare a pdf file for your written text and attach the source code of your program to the mail.

Task I (25 points)

FD solver with and without texture memory

In this task, you are going to implement a finite difference solver for a twodimensional diffusion equation without source terms, such as $\Delta T = 0$. Using an explicit discretisation in time yields the following finite difference formula for the scalar T at time $n+1$ and position i, j:

$$T_{i.j}^{n+1} = T_{i,j}^{n} + \frac{\alpha \Delta t}{h^2} \cdot \left(T_{i+1,j}^{n} + T_{i-1,j}^{n} + T_{i,j+1}^{n} + T_{i,j-1}^{n} - 4 \cdot T_{i,j}^{n} \right)$$

with time step Δt, grid spacing h and diffusivity α. At the boundaries, impose Dirichlet boundary conditions, i.e. prescribe constant values of T that are not changed in the iteration step. Use two matrices for T^n and T^{n+1} in order to avoid race conditions among the threads.

a) Implement two versions of the kernel with different memory types:
   - Version I should use the global device memory
   - Version II should use the texture memory

b) Use a timer to evaluate the performance of your code

c) To visualize the simulation results, copy the results from the device to the host in certain output intervals. Use the provided function writeVTK to generate postprocess files, that can be processed with e.g. ParaView.

d) Document the task properly!