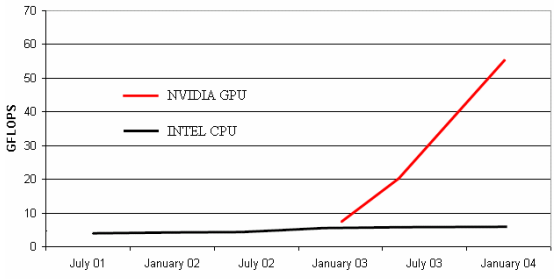
Graphics Cards → Computational Engine of the Future?

In 2003 *32bit floating point* arithmetic was introduced in graphics cards from NVIDIA.

The NVIDIA 6800 chip has *16 pipelines* that can execute up to *two instructions simultaneously*. Each instruction processing *four 32bit floating point numbers*.



While the CPU performance follows Moore's law (doubling every 18th month), **the *GPU has been observed to follow Moore's law squared*** (quadrupling every 18th month). The performance increase of the CPU is expected to slow down in the coming years.

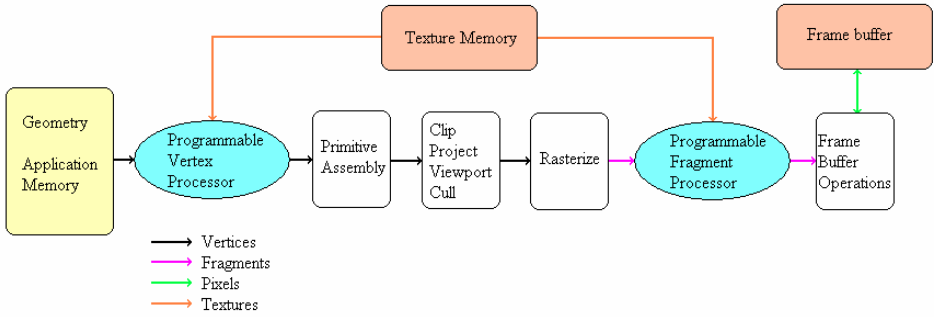
From the architectural point of view it is easier to increase the number of parallel processors on the GPU than to increase the number of CPUs. On the CPU the Cache increases instead of number of processors. The performance gap between the CPU and the GPU is thus expected to rapidly increase.

The development of the GPU has been driven by the game market. The cost of advanced game oriented graphics cards is low with high end cards priced around 600$ / 4000NOK.

- Current cards have floating point performance up 40Giga Flops.
- The cards are programmable with a stream processor like architecture
- C like high level programming interfaces exist for
  - Vertex shaders – Necessary for initiating scientific calculations
  - Fragment shaders – Best suited for scientific calculations
- Integration of CPU and GPU programs through DirectX or OpenGL

Rapidly growing interest in using the GPU as a computational resource for:

- Solving partial differential equations
- Image processing
- Geometric computation



Graphics processing pipeline

mai 2005

Information on GPU-programming: www.gpgpu.org, www.math.sintef.no/gpu/

Graphics hardware as a high-end computational resource

http://www.math.sintef.no/gpu/

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Project Primary Objective

The main objective of this project is to demonstrate to Norwegian (and international) industry the potential that lies in graphics hardware used as a high-performance computational engine. This will be achieved through building demo applications and prototype numerical libraries for graphic cards.

Secondary Objectives

The secondary objective is to build a strong research group in the use of graphics cards as computational engines and to offer leading expertise on its industrial use. We will focus in particular on problems within computational geometry and image processing.

Project summary

In the last few years, modern graphics cards have developed extremely rapidly in terms of processing speed, memory size, and most significantly, programmability. So far, this development has largely been driven by the mass-market demand for faster and more realistic computer games and multi-media entertainment. But several research groups are now realizing that this graphics hardware can also be used to dramatically speed up many conventional numerical methods of importance in scientific computing. A new interdisciplinary research field is emerging, which requires a special combination of expertise in computational mathematics and advanced use of graphics hardware.

In this strategic project we aim to get to the forefront of this emerging technology and apply it to problems of industrial interest. The expertise gained will be used to give Norwegian IT companies a head start in building software applications which harness this new computational power.

To achieve this ambitious goal we will establish a strong (virtual) research group based on current collaborations between key people at

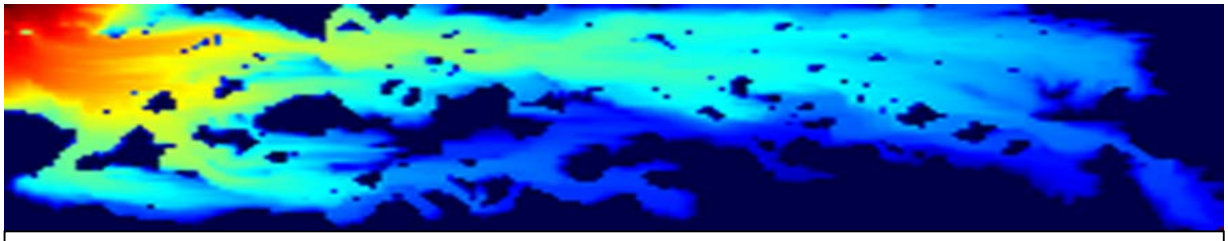
- SINTEF
- Centre of Mathematics for Applications - a national centre of excellence within applied mathematics
- simula.research laboratory
- Image Processing Group, Department of Mathematics, University of Bergen
- Narvik University College

Research keywords

- GPU
- Computer Graphics
- Geometric modelling
- Image processing
- Industrial applications
- Linear algebra algorithms
- Numeric simulation

Reflection / Refraction

Nonlinear wave equation



Water injection in a fluvial reservoir

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