AbstractID: 10187 Title: Convolution-superposition dose calculations with GPUs

Purpose: To study the impact in terms of execution time and accuracy of using graphics hardware for calculating the dose in a treatment planning system. The architecture of Graphics Processing Units (GPU) is well suited for numerical tasks that are intrinsically parallel, such as dose calculations.

Method and Materials: This work was made within the framework of PlanUNC, or PLUNC, a treatment planning system developed and maintained by the Department of Radiation Oncology of the University of North Carolina at Chapel Hill for research and development purposes. The objective was to transparently integrate a GPU dose calculation engine to PLUNC. The CUDA platform from NVIDIA was used for the GPU implementation. A convolution/superposition (CS) dose calculation algorithm was ported by developing programs (called *kernels*) that are executed on the GPU. Firstly, the CS engine of PLUNC was directly ported to the GPU, with the original code preserved as much as possible. Secondly, parts of the original algorithm were redesigned to better exploit the massively parallel architecture of GPUs. The numerical experiments were conducted with a NVIDIA GeForce GTX280 and an Intel Q6600 CPU.

Results: Acceleration factors of 10x to 20x were achieved with the GPU implementation relative to the CPU version with the direct port of the CS algorithm. The numerical accuracy of the results was preserved with the GPU implementation. A 40x acceleration factor was obtained for the TERMA calculation subroutine, which was rewritten with the GPU architecture in mind. These acceleration factors were sufficient to significantly improve the responsiveness of the PLUNC graphical interface.

Conclusion: This work demonstrates the potential of graphics hardware for dose calculation in treatment planning systems. This could in turn have a significant impact on optimization strategies for complex delivery techniques such as IMRT.

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