Enabling Interactive Brain Fiber Tracking with the GPU

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Figure 1. Results interactively generated by our fiber tracking tool.

Introduction

- Fiber tracking [1] makes it possible to determine the position of the fiber bundles in a patient's brain. This is important for neurosurgeons, since it allows them to make a better planning prior to a surgery.
- Interactivity in fiber tracking applications has been limited so far by the huge amount of calculations required for the process to be executed.
- We have previously shown [2] how fiber tracking can achieve a significant performance gain when run on GPUs with Cg.
- Now we show how a CUDA implementation of fiber tracking allows a tool to find fiber tracts in real-time, thus greatly improving interactivity.

Fiber tracking with CUDA

- Fiber tracking is executed in its entirety on the GPU, while the CPU is responsible for the actual visualization of the resulting fiber tracts.
- The current bottleneck is processing time; data transfer times between CPU and GPU are negligible.
- Fibers are rendered as lines when the user is dragging the volume of interest, and as tubes as soon as the user releases the mouse button.

Results

- Figure 1 shows fiber tracking results interactively created with our tool.
- A video demonstrating a whole exploratory session is available at `http://www.lapix.ufsc.br/videos/`
- A comparison between fiber tracking on the CPU and on the GPU is given by Table 1. Measures were obtained by sweeping a 10 mm cube through the volume, from bottom to top.
- The GPU implementation outperformed the CPU by more than 10 times on average, and by over 16 times on the worst case.

Table 1. FPS measures for CPU and GPU.

	Mean FPS	*Minimum FPS*
CPU	0.99	0.43
GPU	10.56	7.03

Conclusions

- GPUs enable fiber tracking applications to take on a new level of interactivity.

References

[1] S. Mori and P. C. M. van Zijl. Fiber tracking: principles and strategies—a technical review. *NMR Biomed,* 15(7-8):468–480, 2002.

[2] A. Mittmann, E. Comunello and A. von Wangenheim. Diffusion tensor fiber tracking on graphics processing units. *Comput Med Imaging Graph*, 32(7):521–530, 2008.