

Introduction

A quick, flexible, accurate and automatic volumetric image processing software package will enable biomedical researchers to analyse orders of magnitude more data. In particular this could have a huge impact on the advancement of the field of neuroscience and our understanding of the brain.

For certain operations Graphics Processing Unit (GPU) processing is many times faster than performing the same operations on a standard computer Central Processing Unit (CPU). Up to 100x performance improvement can be achieved in some cases.

3D Annotation

Large 3D volumetric data is very difficult to analyse because processing time required for each operation quickly becomes prohibitive. In many cases data must be annotated manually to extract useful information (Figures 1-3). Manual annotation is very time consuming but very few automatic annotation tools exist.

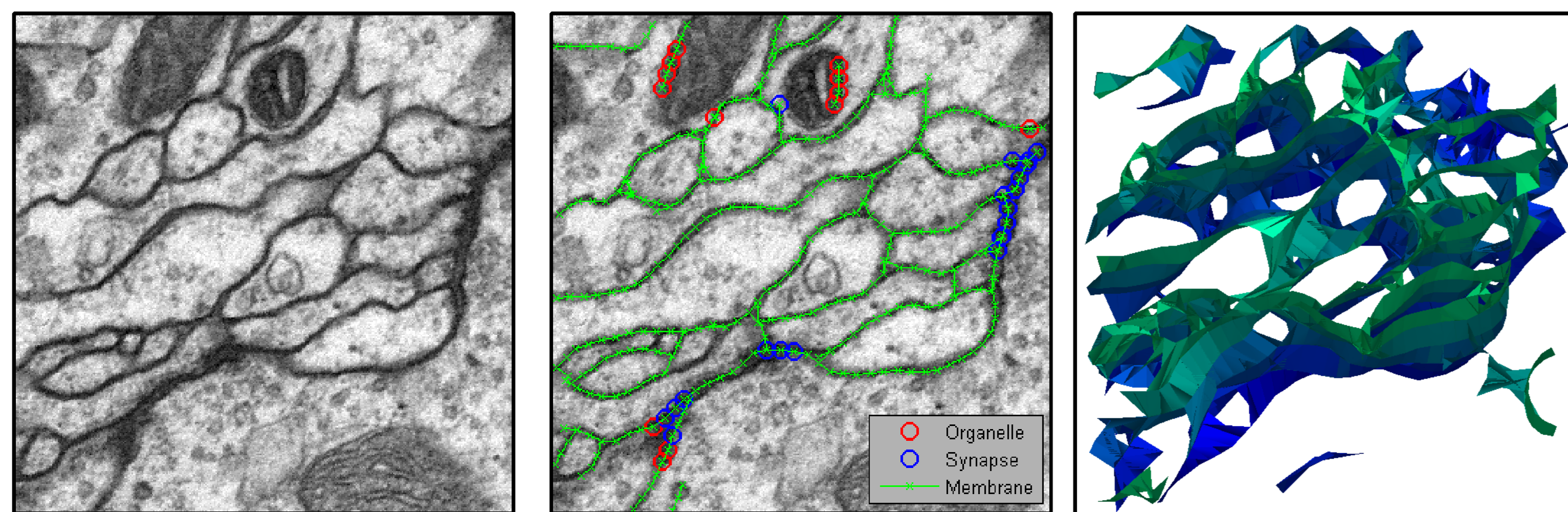


Figure 1: Left: Single slice from a volume of serial section electron microscope (EM) images [1]. Middle: Automatic tracing. Right: Reconstruction.

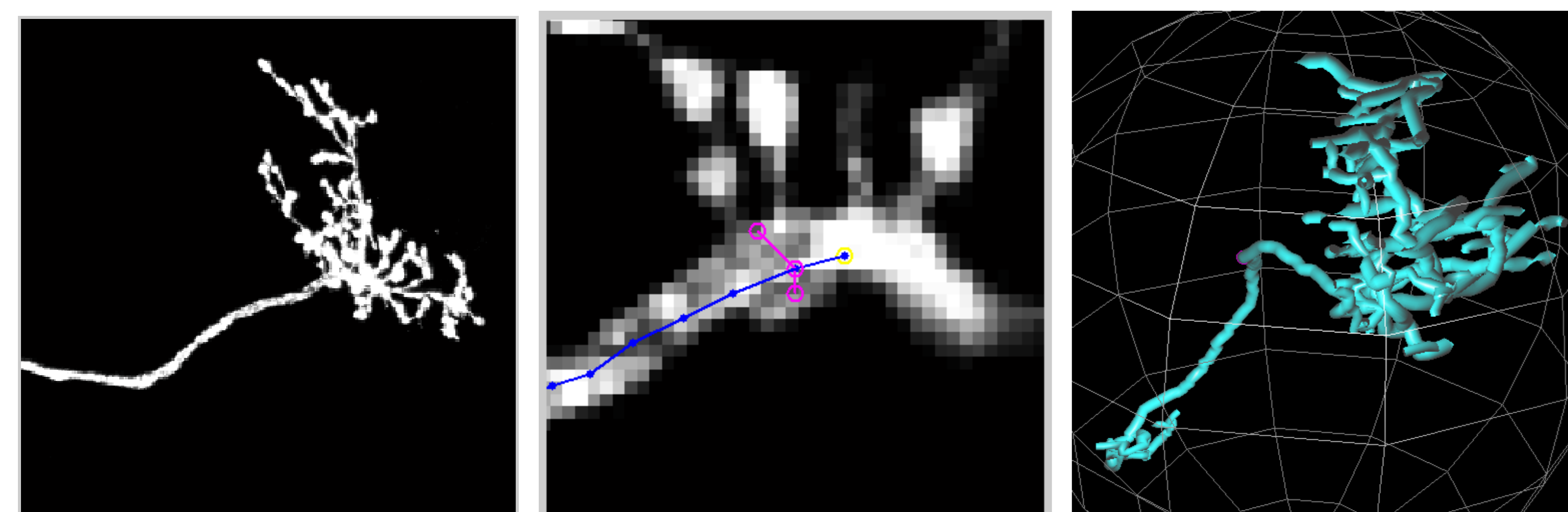


Figure 2: Left: Volumetric data from a confocal microscope [2]. Middle: automatic tracing in progress. Right: Reconstruction.

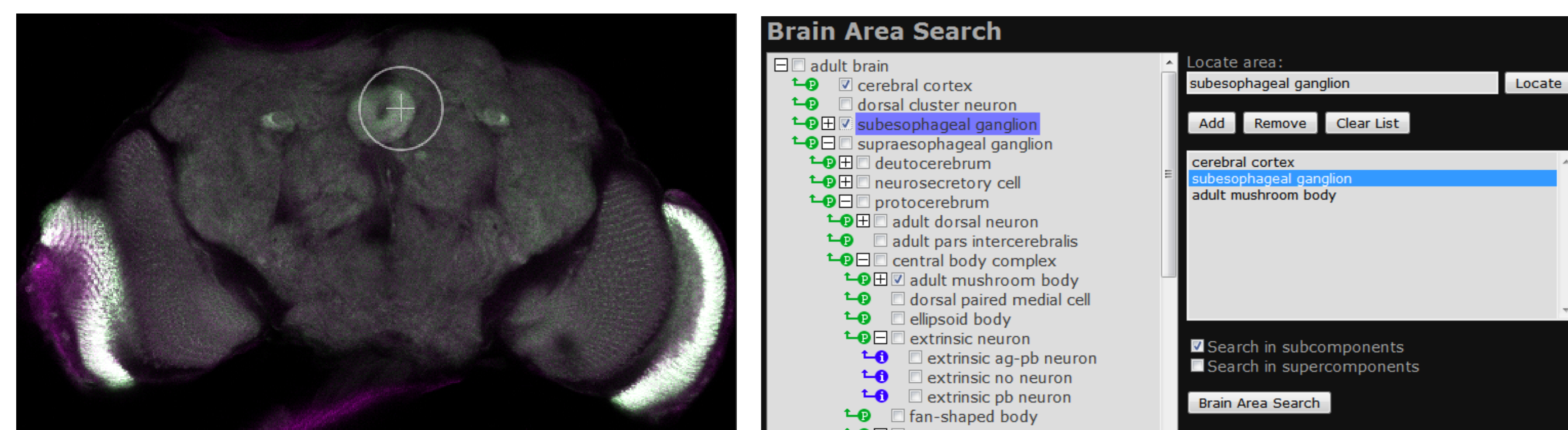


Figure 3: Left: Volumetric data from a confocal microscope showing manual annotation. Right: Annotation Search [3].

GPU Computing

Advances in GPU technology allows greater computing power by utilising as many as 240 computing cores on a single graphics card (Feb 2010). Parallel processing is also scalable to multiple graphics cards in one computer, or even clusters of GPU based systems, to achieve high performance computing levels .

Volumetric analysis operations, such as filtering or convolution, require the same operation to be repeated many times over the volume and are ideal candidates to benefit from GPU acceleration.

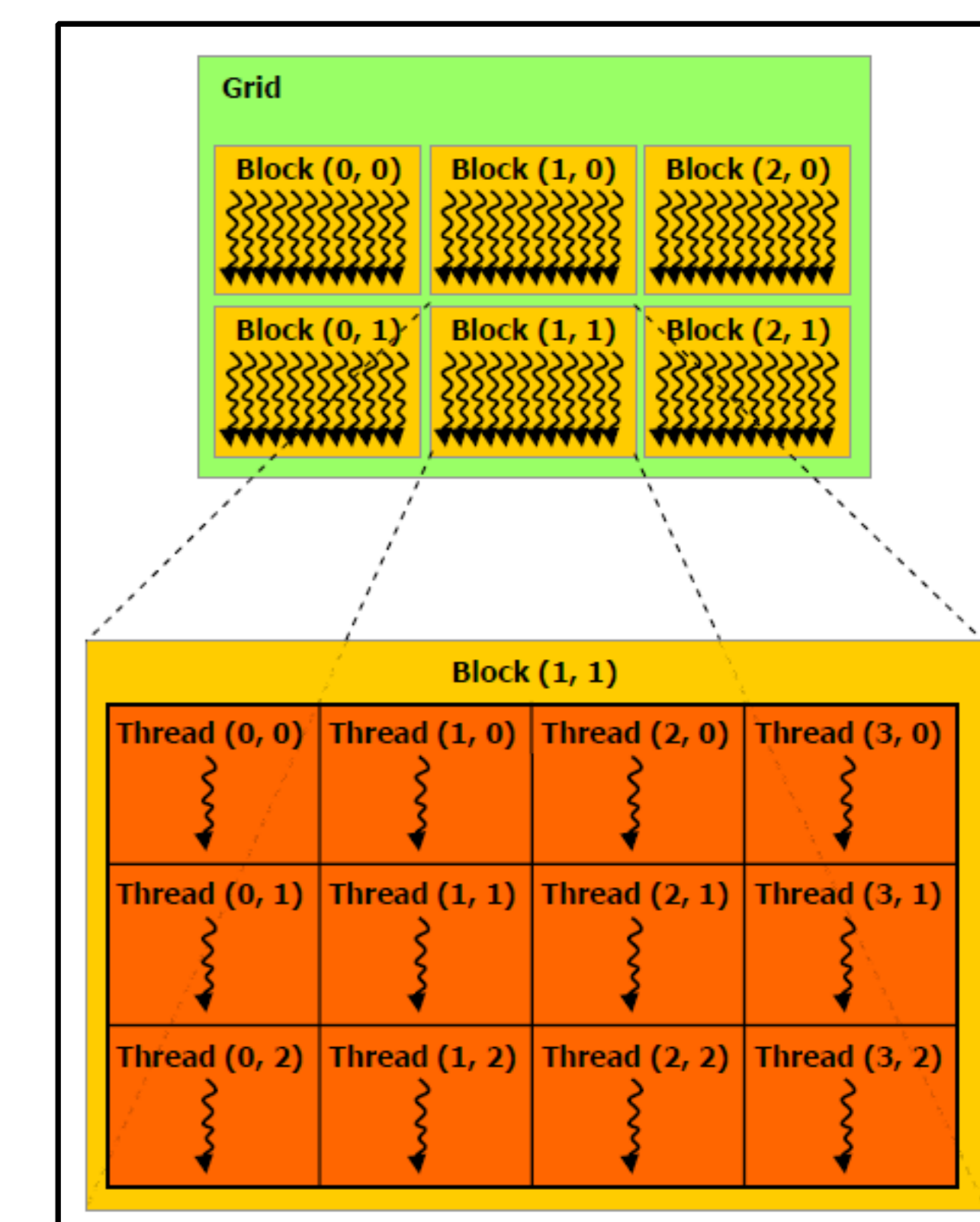
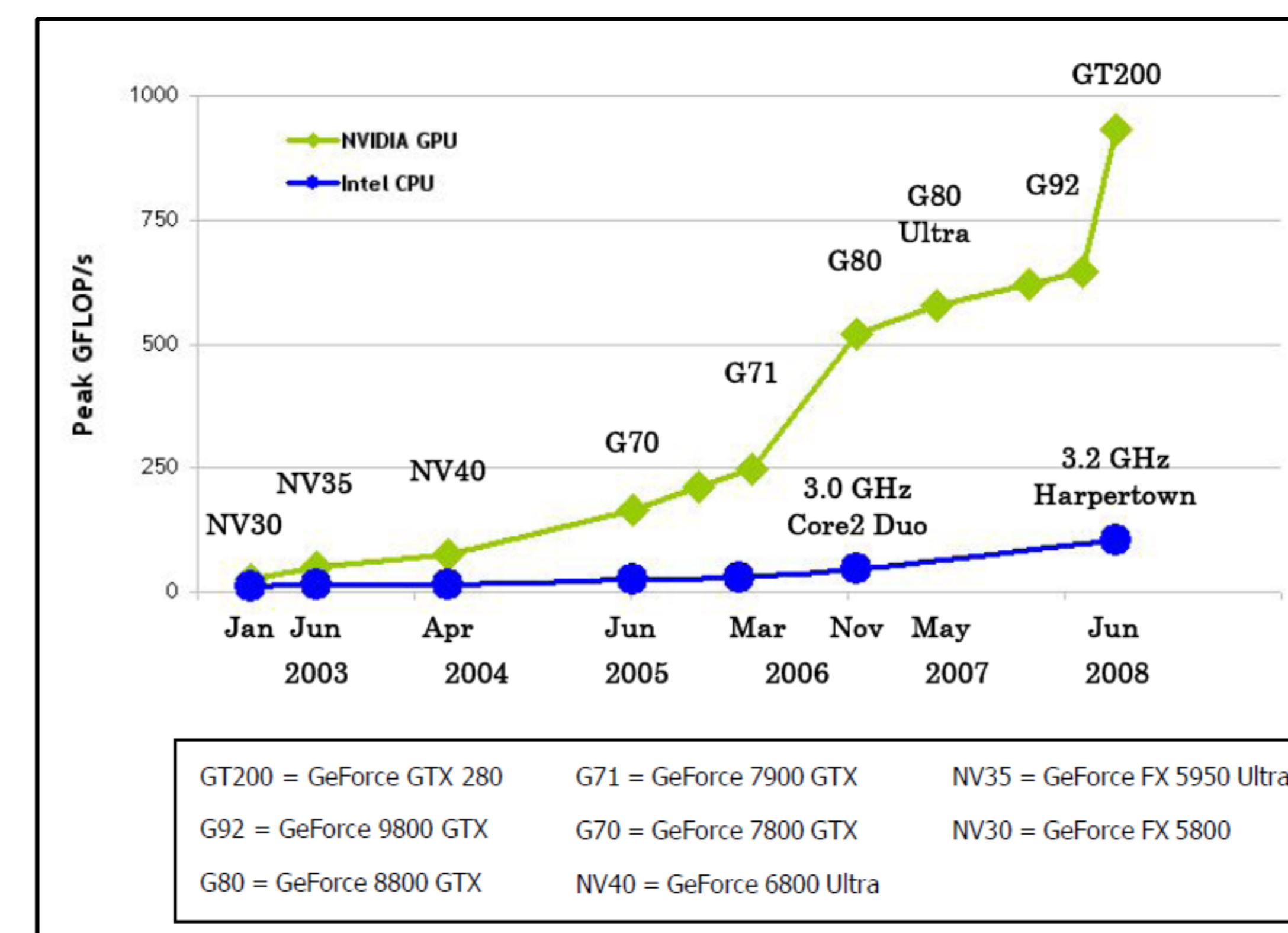


Figure 4: (Left) GPUs offer higher peak computing power than CPUs. (Right) Parallel computing on a GPU. Many threads perform the same operations. Source: NVIDIA CUDA Programming Guide, http://www.nvidia.com/object/cuda_develop.html

References

- [1] Leiss, F., Groh, C., Butcher, N. J., Meinertzhagen, I. A., and Tavoanis, G. Synaptic organization in the adult *Drosophila* mushroom body calyx. *The Journal of Comparative Neurology*. [Online] August (2009). <http://dx.doi.org/10.1002/cne.22184>
- [2] Jefferis G.S. et al. Comprehensive maps of *Drosophila* higher olfactory centers: spatially segregated fruit and pheromone representation. *Cell*. 128(6):1187-203 (2007). <http://dx.doi.org/10.1016/j.cell.2007.01.040>
- [3] <http://fruitfly.inf.ed.ac.uk/braintrap>

Acknowledgements

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