GPU-BASED IMAGE PROCESSING FOR MULTI-VIEW MICROSCOPY DATA

Bálint Balázs[1], Marvin Albert[2], Lars Hufnagel[1]
[1]Cell Biology and Biophysics Unit
[2]Developmental Biology Unit
European Molecular Biology Laboratory
Meyerhofstr 1, 69117 Heidelberg, Germany
E-mail: balint.balazs@embl.de

KEY WORDS: image processing, GPU computing, light-sheet microscopy

Multi-view light-sheet microscopy is one of the best tools to investigate early embryonic development due to its inherent optical sectioning, fast imaging speed, and low phototoxicity. Evaluating, or simply just storing the data, however, is an extremely challenging step, since each experiment can generate terabytes of data. Furthermore, this data has to be pre-processed before any evaluation step can be performed, i.e. multiple views have to be fused to create a single, high quality image.

As part of this preprocessing pipeline, the different views are registered in 3D and transformed to a common reference frame. This is followed by a fusion step, which depends on the sample properties and analysis requirements. However, in the case of microscopes with double-sided detection [1], this ill-defined step becomes trivial as the use of confocal slit [2] reduces the fusion step to the direct sum of the transformed opposing views.

To further exploit the simplification provided by this use case, we reduce 3D image registration to a 2D problem. Building upon this, we implemented a fast, GPU-based image pre-processing pipeline, which is capable of fusing opposing views instantly during acquisition, thus completely eliminating the need for a separate fusion step. This not only speeds up further data analysis considerably, but also reduces the necessary storage space by a factor of three, since only the final, fused images have to be stored.

To further reduce data size, we expanded our GPU pipeline by including a fast compression step. Both lossless and within noise level compressions are available, achieving up to 7 and 30-fold compression ratios, respectively, while reaching compression speeds up to 80 times faster than conventional methods (JPEG2000) and up to 7.2 times faster than current state of the art (KLB [3]). The compression filter is also implemented as an HDF5 plugin, offering compatibility for many existing applications.

REFERENCES

[1] U. Krzic, S. Gunther, T. E. Saunders, S. J. Streichan, and L. Hufnagel, "Multiview light-sheet microscope for rapid in toto imaging," *Nat. Methods*, vol. 9, no. 7, pp. 730–733, Jul. 2012.
[2] G. de Medeiros *et al.*, "Confocal multiview light-sheet microscopy," *Nat. Commun.*, vol. 6, p. 8881, Nov. 2015.
[3] F. Amat, B. Höckendorf, Y. Wan, W. C. Lemon, K. McDole, and P. J. Keller, "Efficient processing and analysis of large-scale light-sheet microscopy data," *Nat. Protoc.*, vol. 10, no. 11, pp. 1679–1696, Nov. 2015.