Fast Stitching of Huge 3D Biological Datasets

Abstract:

In order to study the development of organisms there is an increasing demand to image large specimen as Drosophila Melanogaster in their totality using high resolution 3D imaging. Confocal microscopy is able to produce such images but is on the other hand limited by its relatively small field of view compared to the size of such specimen. To overcome this drawback motorized stages moving the sample are used to create a tiled scan of the whole specimen. For the reconstruction (“Stitching”) of the whole image from the single image stacks it turned out that the physical coordinates provided by the stage are quite often far away from the correct alignment parameters.

We developed an algorithm as well as an ImageJ Plug-in based on the Fourier Shift Theorem that computes all possible translations (x, y, z) between two 3D images at once yielding the best overlap in terms of the cross correlation measure. Apart from the obvious gain in computation time it has the advantage that it cannot be trapped in local minima as it simply computes all possible solutions. Computing the overlap between two adjacent image stacks is extremely fast (12 seconds for two 512x512x89 images on a Mobile Core2Duo@2.2Ghz given an estimation the overlap, otherwise 35 seconds) making it suitable for real time use, i.e. computing the output image during acquisition of the images. To cope for possible shading- and brightness differences we apply a smooth linear intensity transition between the image stacks in the overlapping cube of the image stacks.

Although developed for a fast stitching of images the Plug-in showed useful in various applications for 3D registration. We used it to register time lapses of 3D stacks of very noisy images and extended it to generic 3D registration using gradient based rotation detection on top of the phase correlation Plug-in. We demonstrate the performance of our 3D stitching Plug-In on several multi color tiled confocal images and show examples of the recent extensions.

Keywords:
3D Stitching, 3D Registration, Fourier Analysis

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Short Biography

2006: Received Diploma Thesis in Computer Science from the Technical University Dresden

Since 2002: Continious scientfic work at the IZBI Leipzig on the analysis of microarray data, which is still ongoing

Since 2006: PhD student at the Max Planck Institute of Molecular Cell Biology and Genetics in Dresden with focus on image processing

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