FluoRender: An Interactive Visualization System for 3D and 4D Confocal Microscopy Data in Neurobiology Research

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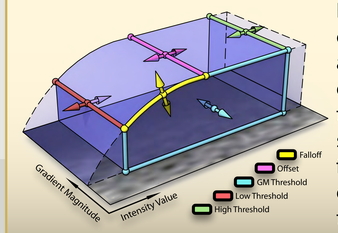
Multi-channel Inputs

The confocal microscopy data are 3D image stacks. There can be multiple channels in one dataset, containing differently stained tissues or cells, such as neurons, muscles, etc. In addition to TIFF as a common exchange format, FluoRender also supports several confocal raw formats, such as Olympus and Zeiss formats.

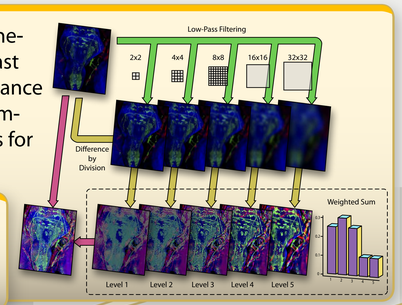
Transfer Function



For each confocal channel, there are five parameters to adjust its transfer function shape. The transfer function is evaluated on-the-fly.

Tone Mapping

The volume-rendered results are tone-mapped to adjust brightness/contrast and enhance details. Gamma, luminance and scale-space equalization are combined into one post-processing pass for real-time performance.

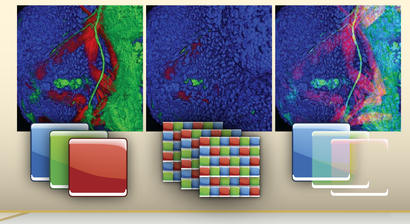


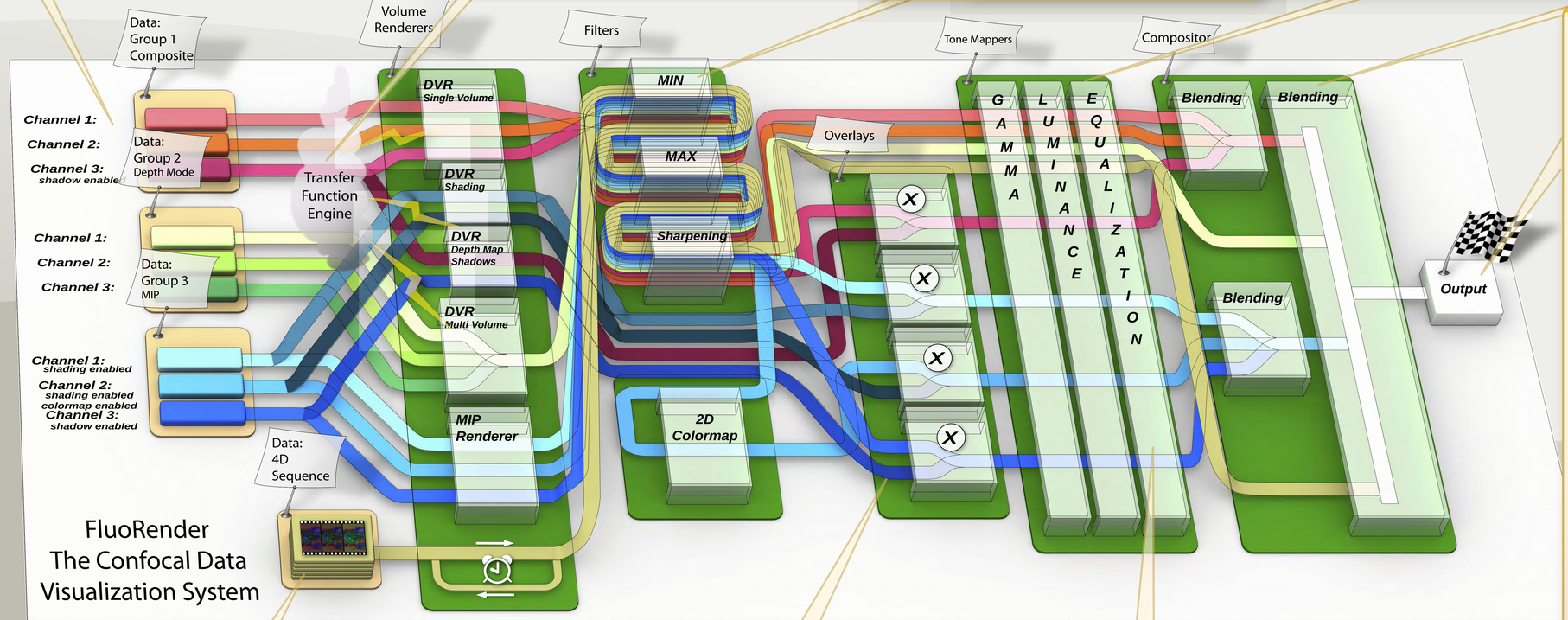
Filtering

The volume-rendered results are filtered for a smoother look. Since the filtering is calculated in 2D, real-time interactions are retained.

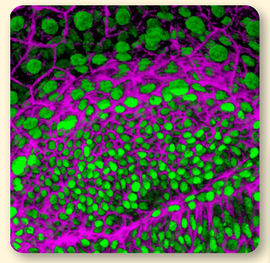
Render Modes

Different render modes are designed to combine multi-channel data in 3D or blend the results in 2D.

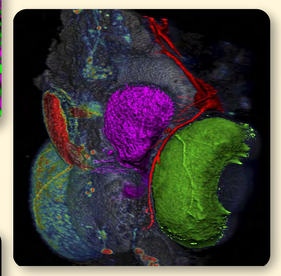




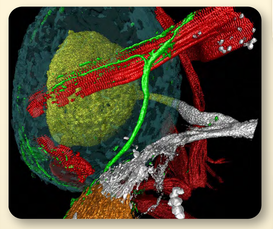
Results



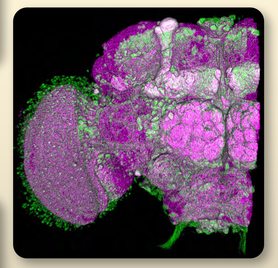
Time sequence. Cells of eye region , zebrafish embryo.



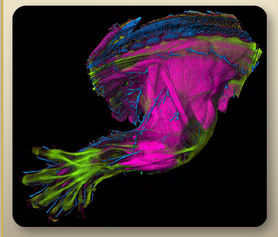
Segmented data. Zebrafish head.



Neurons and muscles around a zebrafish eye.



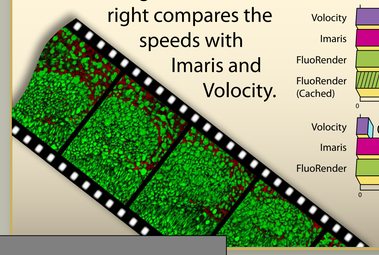
Drosophila head.

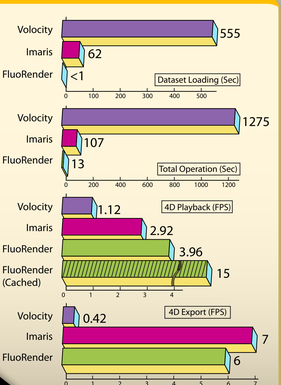


Muscles, tendons and neurons of a mouse hind limb,

4D Data Inputs

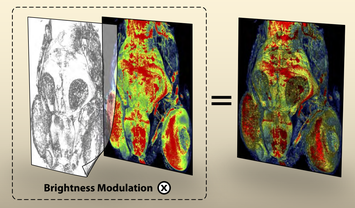
FluoRender supports reading time sequences (4D data). By implementing customized readers for confocal raw formats, it loads and processes faster than similar tools. The diagram on the right compares the speeds with Imaris and Volocity.





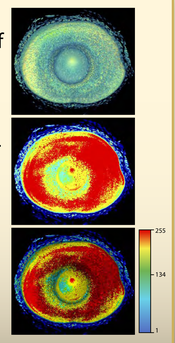
Overlays

To enhance shape and depth perception, a shading pass and/or a shadow pass can be layered on top of maximum intensity projection rendering results. For standard volume-rendered results, a shadow effect layer can be added similarly. Since the calculations are in 2D, real-time performance is retained.



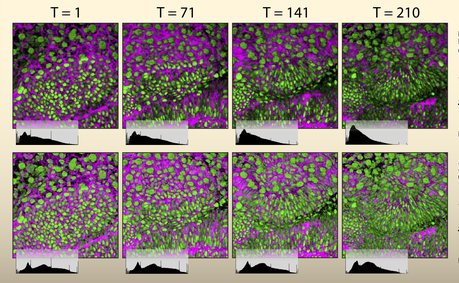
Result

A comparison of standard volume rendering, maximum intensity projection, and MIP with shading overlay.



4D Equalization

4D confocal data have decreasing brightness due to bleaching of the dyes. Using scale-space equalization as 2D post-processing of the volume-rendered results, brightness and contrast can be equalized through time.



FluoRender

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