

From the desktop to virtual reality: Genuage for visualizing and quantifying multidimensional single-molecule super-resolution microscopy data

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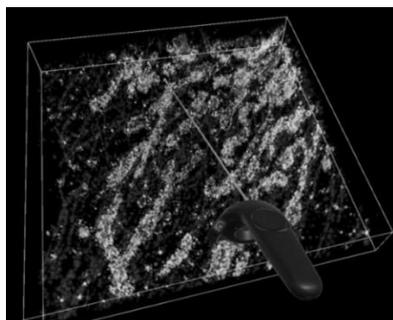
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Single-molecule localization microscopy (SMLM) offers new insights about cellular functions at the nanometer scale. New optical methods are generating more complex data sets with growing dimensionality exceeding the typical two- or three-dimensional point clouds acquired from SMLM. These additional dimensions come not only from our ability to localize single-molecules in space, but also to track their movement in time (4D) at high temporal resolutions, to image in several color channels and to retrieve molecular orientations [1, 2, 3]. This growing dimensionality raises many concerns regarding the visualization and efficient handling of the data. There is clearly a lack of dedicated tools for visualizing complex SMLM data sets.



Here we present Genuage [4] a free and open-source tool for visualizing and analyzing multidimensional SMLM data. Genuage features two visualization modes: (i) a desktop mode for a simple visualization of the data sets on a 2D screen and (ii) a virtual reality (VR) mode for an immersive experience inside the point cloud. [Figure 1]

Figure 1 : Dual-color SMLM data in Genuage VR mode.

The desktop mode allows the user to adjust the visual parameters, to easily program the presented variables and to perform basic manipulations. In addition to the before mentioned controls, the VR mode offers a completely immersive experience inside the point cloud. First, the stereoscopic vision in VR allows an intuitive understanding of the reconstructed multidimensional structure. Second, active tracking of the headset and VR controllers facilitates the interaction with the data set and simplifies user-inputs for measurements and selections actions. Genuage can represent n-dimensional point clouds in both static (3D) and dynamic forms (3D trajectories) and offers tools to quantify and analyze the data in the VR environment. Moreover, Genuage offers simple ways to interface with other platforms such as MATLAB and Python, to import user defined libraries, and to create relevant scientific videos. To date Genuage has been interfaced with a Python-based Graph neural network to perform real time inferences of properties on selected areas of SM trajectory datasets performed in VR.

[1] Hajj et al. PNAS 2014

[2] Aristov et al. Nature Communications 2018

[3] Augusto Valades Cruz et al. PNAS 2016

[4] Blanc et al , Nature methods 2020