NeuroBlender: a Blender add-on for creating neuroscience artwork

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Introduction:

Many neuroscientists love creating art, particularly when it involves the brain. This love for brainart has become clear from the numerous art competitions that are organised by neuroscience organizations (OHBM, SfN, FENS, etc.). Also, digital scientific visualization formats become increasingly varied in their form and content, requiring neuroscientists to keep up to date with brain visualisation tools. However, many of the current visualization tools lack flexibility.
Blender is a versatile, extendible, free and open source platform for realistic modelling, animation and game development that also has potential for scientific visualization and artwork. However, getting started with neuroscientific visualization in this environment can be somewhat daunting. NeuroBlender was developed as a Blender add-on to leverage its capabilities in creating artistic and scientific visualizations of the brain from real data. While NeuroBlender's default functionality allows for creating stunning digital artwork, the add-on is most useful as a springboard for creative use of the Blender platform.

Methods:

NeuroBlender is developed as a Blender add-on written in Python. In its current beta version (v0.9) it features 4 GUI panels for interacting with base geometry, overlays, scene presets and settings. All NeuroBlender classes and methods are exposed through the Blender Python API, making scripting of scientific visualisations and reuse of artwork straightforward. NeuroBlender uses node-based materials for use with the Cycles Render raytracing engine, allowing GPU rendering and fast prototyping of artwork and compositing of animation scenes. The add-on can read a large number of neuroimaging tract/surface/volume formats including MRtrix, Camino, Diffusion Toolkit/TrackVis, Dipy, vtk, obj, stl, gifti (through nibabel), nifti, png series. NeuroBlender will be released under a GNU GPL license at http://github.com/michielkleinnijenhuis/NeuroBlender.

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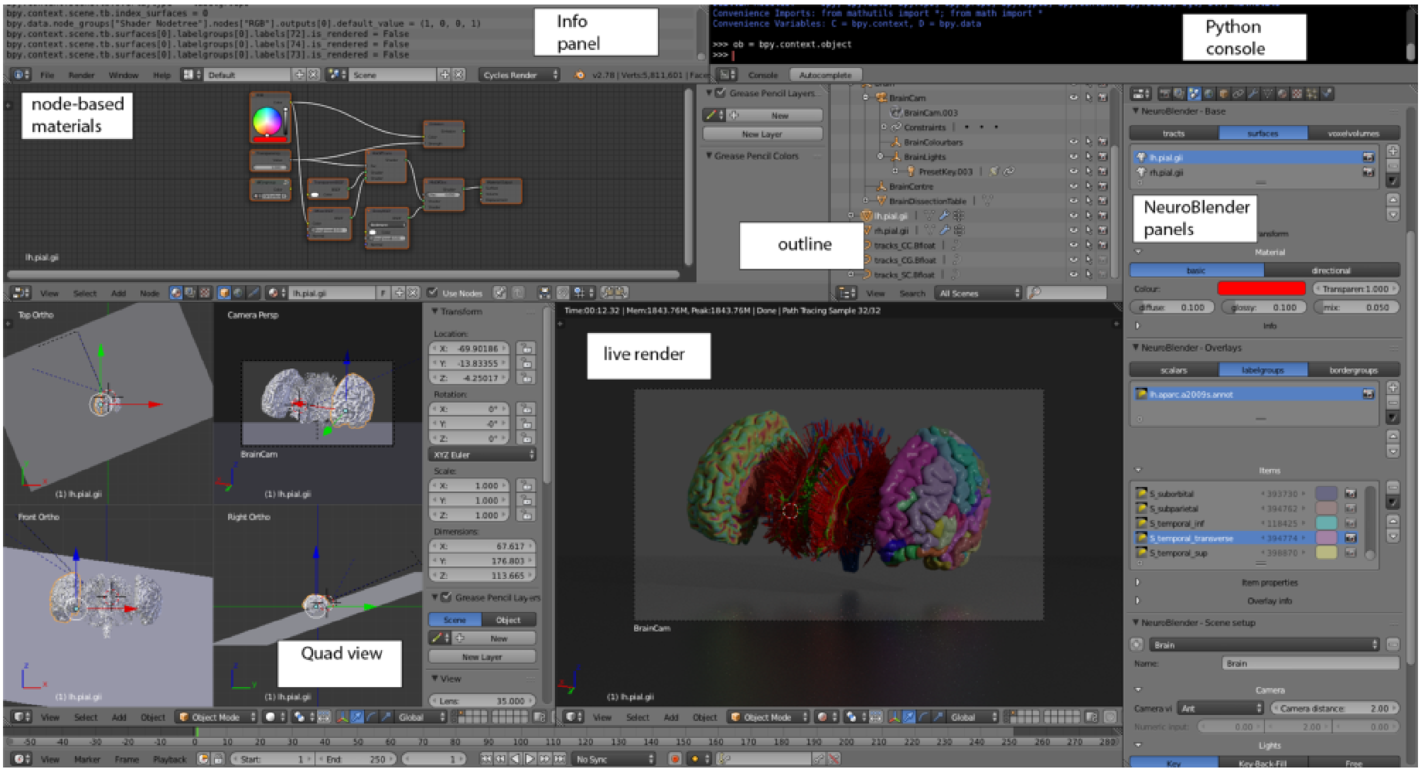

·Figure 1. NeuroBlender panels and environment with work-in-progress.

Results:

The functionality of NeuroBlender includes data import, material assigment/overlays, scene composition and simple animation. NeuroBlender imports three kinds of base geometry: tracts, surfaces and voxelvolumes. This base can be augmented by an endless scala of transforms, modifiers and textures. This includes the common overlays such as scalars, time series, labels and borders. Scenes can be set up using convenient presets, adapted and saved to easily switch between camera views and lighting conditions. The most basic animation capabilities are also available as presets (e.g. camera rotations, slice views and time series).
While scientific presentation requires colour constancy throughout the brain to represent results, digital artwork relies on lighting techniques for desired effects. Therefore, NeuroBlender has two modes of operation, 'artistic' and 'scientific', switching between elaborate lighting rigs and simple flat 'emission' behaviour, as well as turning on/off features such as colour bars and annotations.
Figure 2 shows an example of artwork created using NeuroBlender, where the glass brain is generated with NeuroBlender functions and the paper brain is added to the scene independently. Combination of such elements, as well as the ray-traced lighting and textures are not easily achieved in existing neuroscience visualization packages.

Conclusions:

NeuroBlender provides a convenient starting point to explore your digital creativity using neuroscience data in Blender. While NeuroBlender has been tested with MRI data only, the functionality is easily extended to other domains. In single cell visualisation, for instance, dendritic arbours can be loaded as 'tracts', the neuronal body as a 'surface' and confocal microscopy data from immunohistochemistry as a volume-rendered 'voxelvolume'. Further anticipated additions to the functionality include tractography animations, game development and VR applications.

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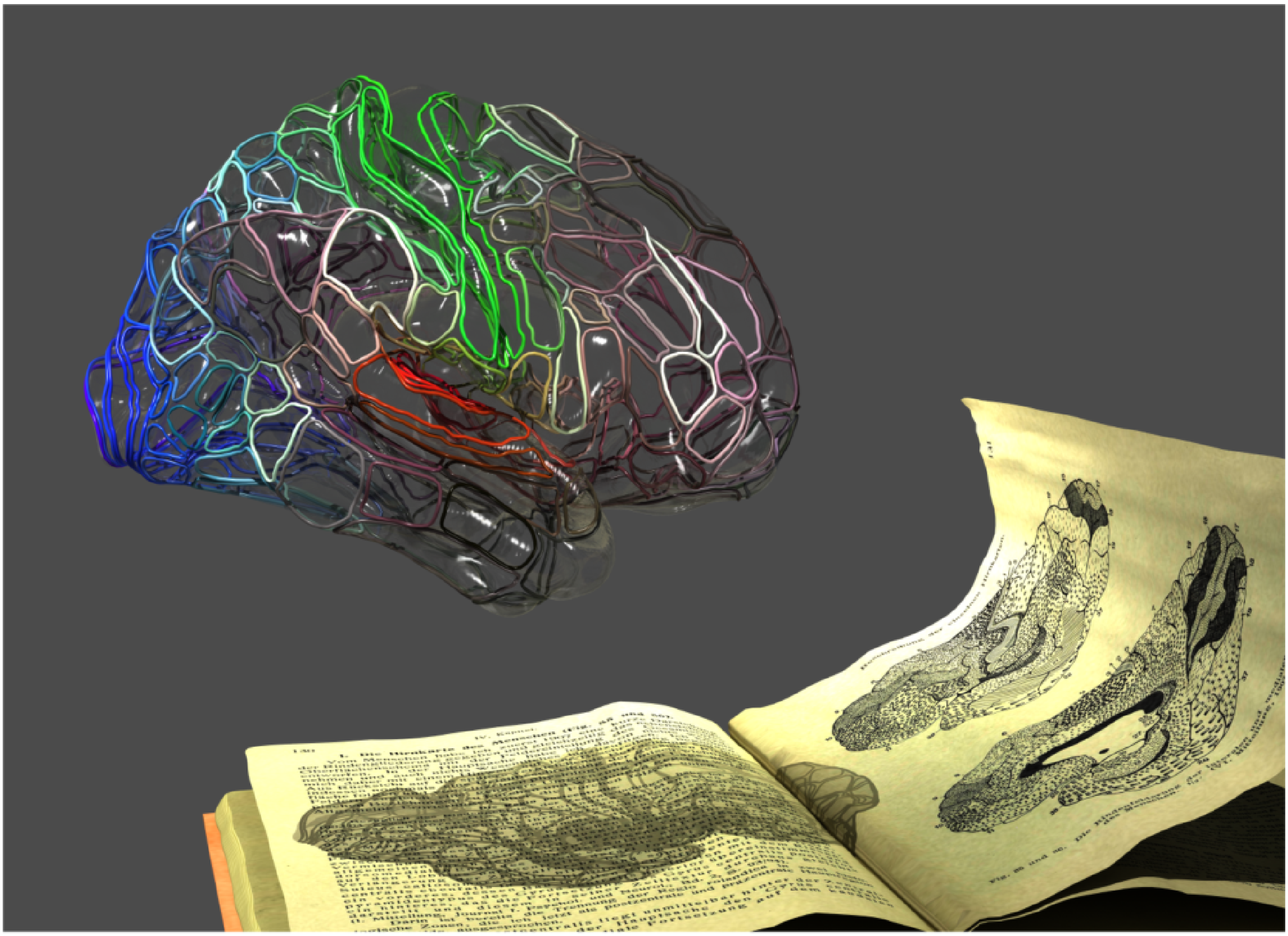

A century of brain mapping. The image depicts one of the most iconic images in the history of human brain mapping together with a recent modern subdivision of the human cerebral cortex. In the display, the new model of the brain casts a shadow on the old description, while the old scheme is still found reflected in the new model. The old map on the right page of the book was created at the start of the 20th century by Korbinian Brodmann (1909) by staining brain specimens and identifying 52 distinct regions on the basis of the layered structure of the cortex. The wireframe over the glass-brain model hovering above visualizes the 180 regions of the right hemisphere derived by Glasser and colleagues (2016) from a combination of MRI techniques using the many subjects of the Human Connectome Project. The colour scheme indicates what functions the regions are involved in where red corresponds to auditory, green to sensory-motor, blue to visual, while moving towards white and black indicates involvement in "task-positive" and "task-negative" brain states, respectively.

·Figure 2. A century of brain mapping.

Imaging Methods:

Anatomical MRI
Diffusion MRI
Multi-Modal Imaging
Imaging Methods Other [2]

Informatics:

Workflows [1]

Keywords:

MRI
STRUCTURAL MRI
Structures
Tractography
Workflows
Other - art, visualisation

[1|2]Indicates the priority used for review

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Not applicable

Please indicate which methods were used in your research:

Functional MRI
Structural MRI
Diffusion MRI
Postmortem anatomy

Which processing packages did you use for your study?

Other, Please list - Blender

Provide references in author date format

Figure 2:

The data used to create the depiction of the multi-modal MRI atlas was downloaded from the BALSA database (https://balsa.wustl.edu/study/show/RVVG).
Data were provided [in part] by the Human Connectome Project, WU-Minn Consortium (Principal Investigators: David Van Essen and Kamil Ugurbil; 1U54MH091657) funded by the 16 NIH Institutes and Centers that support the NIH Blueprint for Neuroscience Research; and by the McDonnell Center for Systems Neuroscience at Washington University.
Glasser, M. F., Coalson, T. S., Robinson, E. C., Hacker, C. D., Harwell, J., Yacoub, E., … Van Essen, D. C. (2016). A multi-modal parcellation of human cerebral cortex. Nature, 536(7615), 171–178. http://doi.org/10.1038/nature18933

The book model was adapted from https://www.blender-models.com/model-downloads/objects/id/old-book

The Brodmann atlas book pages were downloaded from the Wellcome Image collection.
Brodmann, K. (1905). Beiträge zur histologischen Lokalisation der Grosshirnrinde: Dritte Mitteilung: Die Rindenfelder der niederen Affen. Journal Für Psychologie Und Neurologie, 4, 177–226.