Eurographics Workshop on Visual Computing for Biology and Medicine (2019)
J. Byška and G. Mistelbauer (Poster Chairs) *Poster*

Interactive 3D-Visualization of Brain Spatial Networks

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Abstract

*With the advancement of data acquisition techniques, a huge number of datasets describing different brain functions are generated today building the basis for data-driven and computational approaches to neuroscience. This involves an increasing need for comprehensive and intuitive tools allowing both, exploration and visualisation, of such data. 2D visualisations of graphs are generally described as superior to 3D representations in discovering complex relationships [SBS*13]. However, 3D representations of brain networks in their natural anatomical context can provide neuroscientists with complementary information on the spatial arrangement of a network and are common for the communication of results in publications. Existing software [WTS*13] for 3D graph visualization have difficulties obfuscating edges and nodes due to many connections, which creates a chaotic image and makes interrelations too complex to interpret. Moreover, an effective force-directed layout [Kob12] cannot be applied to the network with a fixed node's location.*

We have developed a view-dependent algorithm that considers the camera position and observation direction. The proposed method allows connections to be presented in a way the user could see them also during interaction with a low number of intercrossing. Edges are rendered not as straight lines but as Bezier interpolated symmetrical curves, which are aesthetically pleasing and help to avoid clutter (comparison on Figures 1). Curve's parameters depend on values projected on a device screen: the distance between the nodes and distance to the central point of the brain volume (both calculated in screen space). A user study showed that this improved the perception of the anatomical context of the network. This implementation is a part of the tool 'Brain Trawler' [GSF*18], which is currently in active use for mouse brain connectivity analysis.

Our prototype is computationally cheaper than other methods for the edge clutter reduction (e.g. Edge Bundling in 3D [ZWHK16]). Therefore, it is possible to perform a real-time interaction with an anatomical 3D model with smooth unnoticeable changes in bows' shapes keeping a clean structure of a network. The web-based nature of the initial application requires fast rendering in order to be.

Through this method for a visualization we aim to improve effectiveness of the biomedical research related to big networks and to simplify a way of sharing results.

References

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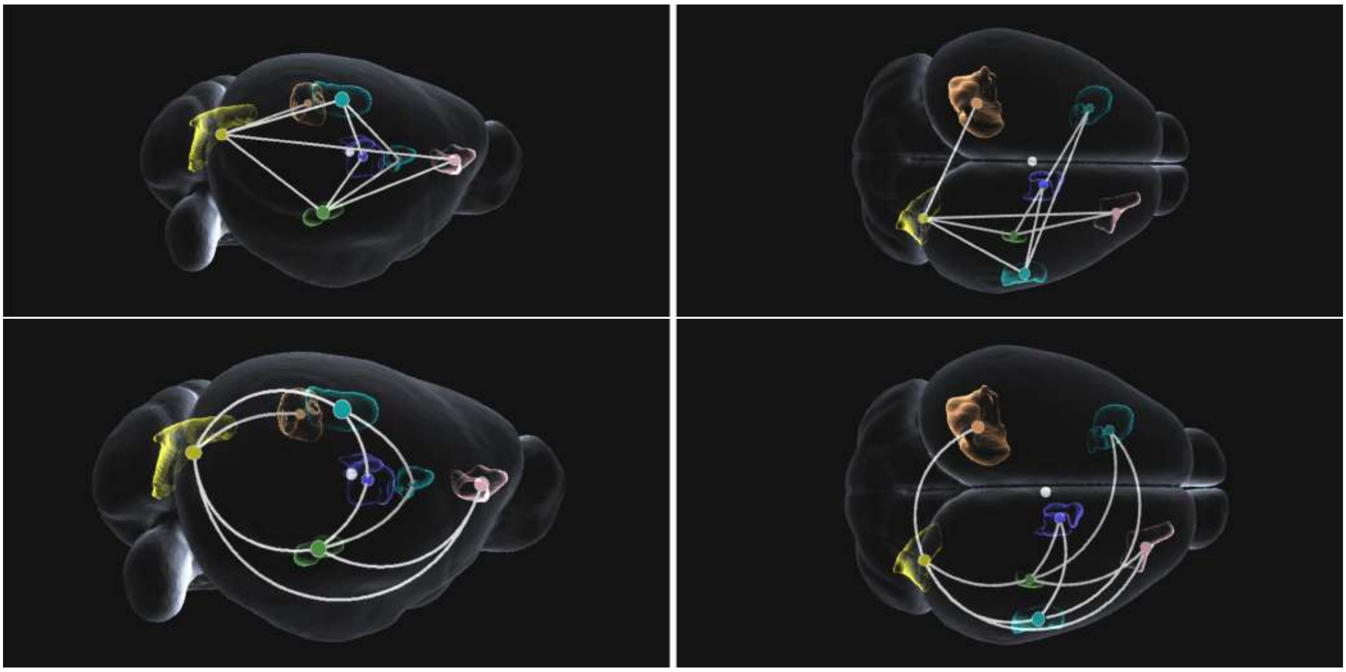

Figure 1: ***Screenshots of the visualization.*** *The first row shows visualization with straight lines connections as an example of harder understanding due to obfuscating edges. Proposed method is on the second row. Different regions of the mouse brain are rendered in the same colours as nodes at their centre of mass, connections are shown as white lines. Two views (front and from above) are presented.*