Immersive Visualisation of 3-Dimensional Neural Network Structures

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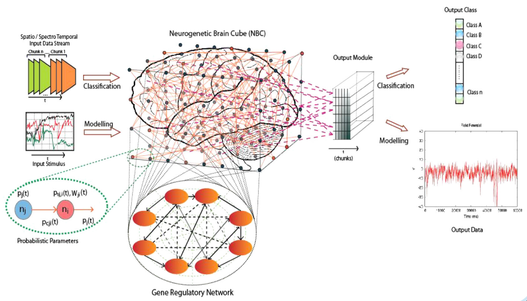
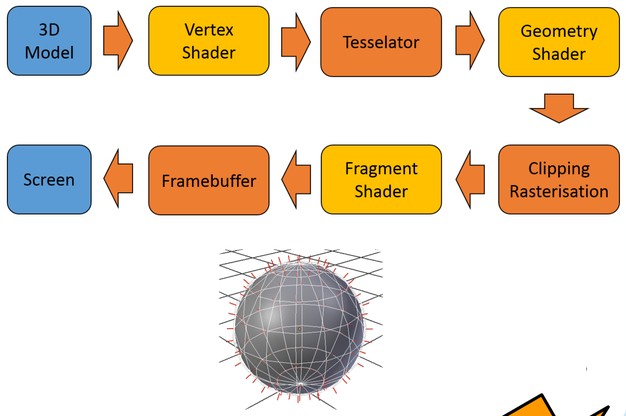
Task

To enable intuitive visualisation and interaction with the 3-dimensional spatial structure and temporal activity of NeuCube or any other artificial spiking neural network.
Performance and scale considerations:

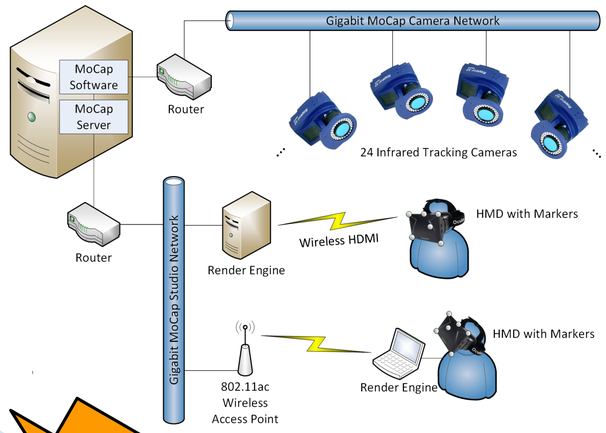
- Framerates need to be around 60Hz to be suitable for Head Mounted Displays (HMDs)
- The amount of neurons and connections should be considered in the range of millions



Shader-Based Rendering



Motion Capture Framework



Problems and Solutions

<u>Polygon Count:</u>

Rendered in the traditional way using polygons, the amount of data necessary would quickly exceed even the performance of modern graphics cards.
As an example, rendering 1.5 Million neurons using spheres consisting of 256 polygons would result in 384 Million Polygons. That multiplied by 60 frames per second would result in ~23 Billion polygons per second. Modern graphics cards have a “fill rate” of ~11 Billion Pixels per second, so even when assuming that each polygon will only show as one pixel on the screen, this method would not be feasible for rendering.

The solution to this problem is the use of “Shader programs” to reduce the amount of data that needs to be passed from the simulation to the graphics card. The highly programmable Graphics Programming Unit (GPU) of modern graphics cards allows for a range of fast 3D processing and manipulation on the graphics card itself, making use of the highly optimised processing architecture.
In addition, rendering the neurons as “billboards” instead of fully defined spheres further reduces the amount of processing and, in result, these two methods lead to framerates well within the desired range.

<u>Interactivity:</u>

Navigation within a 3-dimensional space on a 2-dimensional screen is problematic due to the loss of one dimension on the output medium and the necessity to use keyboard and mouse for navigation and interaction.

We are investigating the influence of a motion capture (MoCap) framework on the ease of navigation and interaction. Using a 24 camera Motion Capture setup, we are able to track the user's head and any tool positions down to less than a millimetre within a 5x5x2m volume. This enables the user to simply walk through the space and look at the neural network structure from all angles in an intuitive way.
In conjunction with a stereo-vision Head Mounted Display (HMD), the user can also see the structure in 3D, potentially increasing the ease of spatial awareness and the ability to navigate and interact.