Stradview

Visualisation and analysis of 3D imaging data.
http://mi.eng.cam.ac.uk/Main/StradView

Types of Volume Rendering

These examples are all based on the same data, which is much larger than typical medical imaging data sets, but fairly small for a micro-CT data set:

- Kingsnake in egg
- Open SciVis data set from Digimorph.org
- 1024 x 1024 x 795 voxels @ 8-bit
- 795 MB

They have all been run on a Dell XPS 13 9310 laptop:

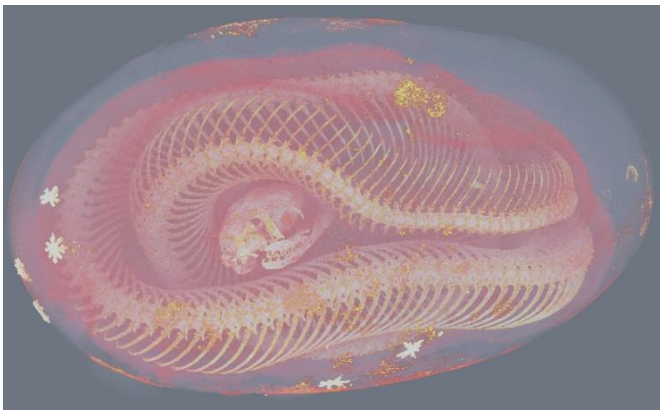
- 32 GB shared memory
- Intel Iris Xe graphics
- View size 832 x 511 pixels

This is a very low performance GPU compared to what is available on a small budget, which would typically have 100x better benchmarks.

All the rendering times are for the full rendering: there is no overhead for changing the transfer function mapping, nor for changing any of the lighting conditions. A slightly lower resolution dynamic rendering is generally possible in 75 ms (13 frames per second). Hence changes to viewpoint or rendering values can be shown dynamically.

Normally available in all software

- All volume rendering software can generate renderings with linear or nearest-neighbour interpolation of mapped colour values and optional shading.

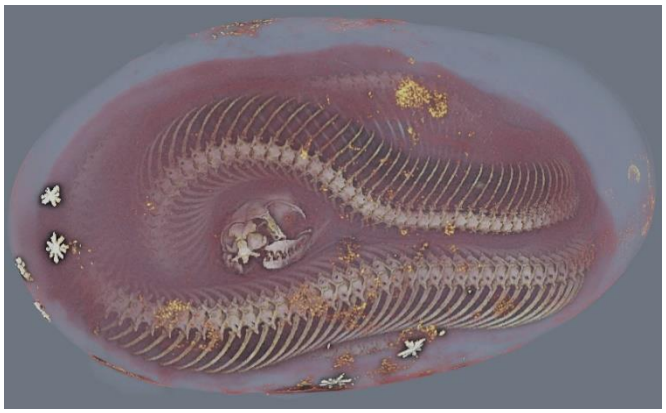


- **No shading**: just maps colour and opacity to every CT value.
- Full quality rendering in 700ms.
- Stradview can do fast cubic interpolation of data, which can increase the rendering quality particularly for smaller or poorly sampled data sets.

- **Gradient shading**: also includes local lighting interaction with surfaces in the data based on gradient values and directions.
- Full quality rendering in 720ms.
- Stradview includes a unique method to prevent intermediate data values changing the correct colour of surfaces, without having to control a 2D transfer function.

Ambient occlusion models

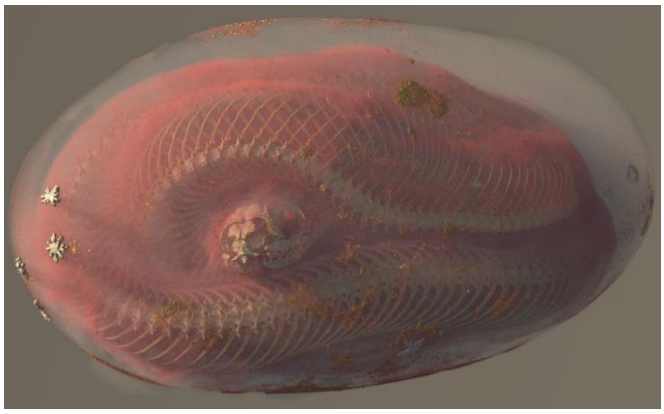
- It is possible to add an ambient occlusion model (such as would be used for surface rendering) onto the default volume rendering by making use of the depth buffer at the end of the rendering.
- Stradview does this instead by modelling secondary scattering of (forward travelling) light. This models ambient occlusion at all places in the volume, plus also some other results of secondary scattering: for instance colour bleeding and sub-surface scattering.



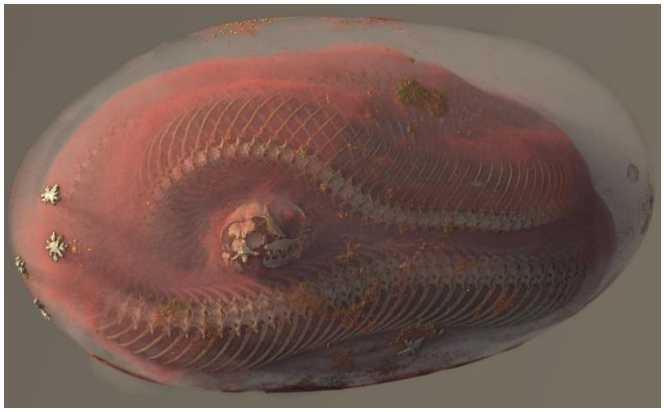
- **Ambient scatter**: partially models ambient occlusion, colour bleeding and sub-surface scattering, but only for light travelling in a similar direction to the main light.
- Shown without shading in this example.
- Full quality rendering in 960 ms.

Global lighting models (ray tracing)

- A full global lighting model can theoretically allow multiple light 'bounces' across any distance, but they are frequently restricted to a small number of bounces and a small distance in order to allow visualisations in a sensible time.
- Smaller distances allow correct local occlusion but not shadowing across the whole volume.
- Stradview models transmission of light and one light 'scatter' over an un-restricted distance.
- This is not as correct as a global scattering model, but it is considerably faster and more memory efficient.



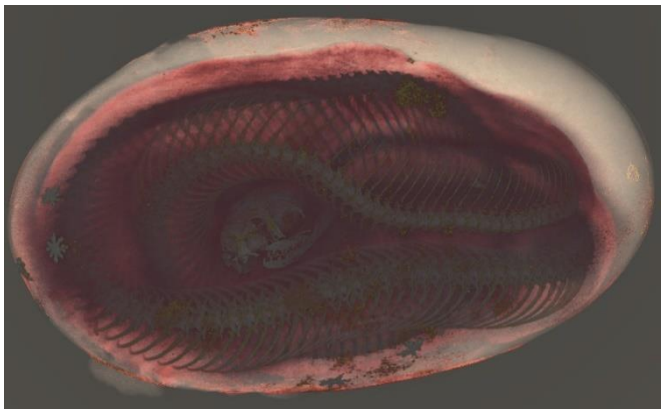
- **Shading + light transmission**: models interaction of light as it passes through the volume and can hence show direct shadowing effects as well as colour change due to translucent material.
- Shown without ambient scatter in this example.
- Main lighting from the **front**.
- Full quality rendering in 750 ms.



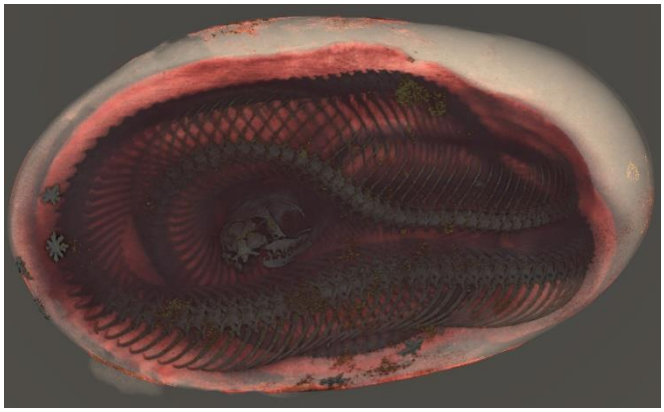
- **Shading + transmission + scattering**: with ambient scatter added in. Note the increased contrast for the vertebrae.
- Main lighting from the **front**.
- Full quality rendering in 920 ms.

Light direction and location

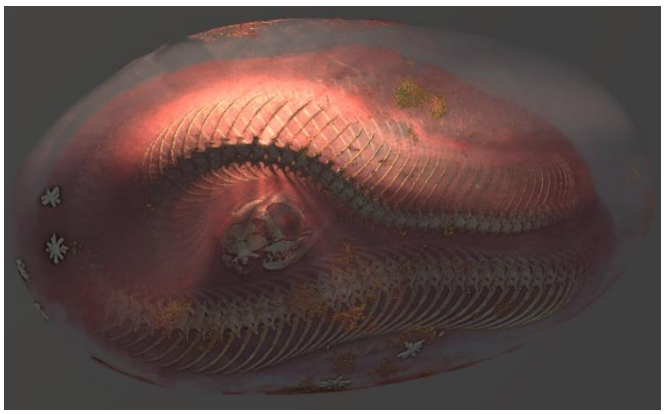
- It is often possible to have multiple lights, but these can't always face backwards and they can't necessarily be within the volume.
- Stradview has three possible lighting sources: one ambient, one directional from the front, and one mobile light which can have any direction or be a point light at any location.



- **Shading + light transmission.**
- Shown without ambient scatter in this example.
- Main lighting from the **back**.
- Full quality rendering in 1440 ms.



- **Shading + transmission + scattering**: note the increased contrast generally.
- Main lighting from the **back**.
- Full quality rendering in 1740 ms.



- **Shading + transmission + scattering.**
- Main lighting within volume at a **point**.
- Full quality rendering in 1320 ms.