# Presentation of visualisation data

## Adventures on the fringe

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# Motivation

- Researchers are used to the limitations when presenting results in journals, generally only images, sometimes supplementary video material.
- Researchers often present visualisation results at conferences to their peers in the form of posters or in one on one discussions.
- There is also the presentation of results in public spaces for outreach and educational purposes.
- The visualisation resources the researcher may be familiar within their institution are often unsuited to these activities, they may be:
  - too delicate for unsupervised operation.
  - too large or inconvenient for casual transportation (eg: hand luggage).
  - requires installation time/expense.
- Goal is was to explore some engaging and novel forms of presentation compared to traditional approach of presenting large posters.
- A number of ways of addressing this but three options will be introduced here: rapid prototying, 3D engraving into crystal, and holograms.
- Their strengths, or otherwise, will be discussed along with examples of their use to date.

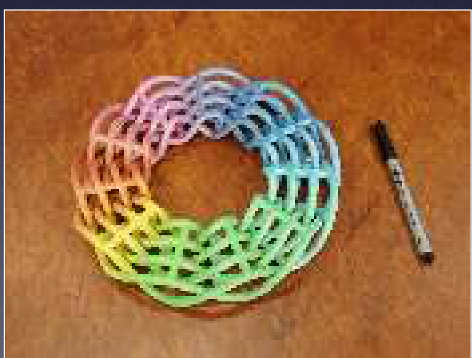
# Rapid Prototyping: Tactile visualisation

- The approach considered here is "3D printing", that is, take a dataset and produce a physical model.
- Besides being applied to data presentation it also allows for tactile visualisation of data, a sense not often catered for and a different more real sensation compared to haptic interface devices.
- There are a number of rapid prototyping technologies, one option that is available within computer science UWA is a product by ZCorp. Essentially a modified ink jet printer that deposits glue onto layers of fine powder, building up the 3D model as solid contour sections.
- Capable of reasonably large objects (~25cm) and supports colour (4 colour glues, CMY and clear).
- Obviously best suited to largely single connected objects.
- Limitations in the rapid prototyping technology dictate what geometries can reasonably be created.
  - Polymer based systems have issues with non-supporting structures.
  - Power based machines (used here) have problems with breakage of small parts.
  - Extruders have limits on the types of geometry.
  - Milling machine are only 2.5D.

# Examples

Miscellaneous examples from geology

Reconstructed rock face: Sirovision



Vision research mathematics

Placoderm fish vertebra

# 3D crystal engraving

- Sub Surface Laser Engraving (SSLE), been around since the 80's.
- Laser focussed at a point in a block of crystal causes a "bubble" that then scatters impinging light.
- Extremely small bubbles can be formed, in the order of 1/20mm.
- You have probably seen tourist products based upon this and there is a franchise system for engraving faces captured using a stereo-photograph pair.
- Uses the point cloud primitive in a DXF formatted file.
- Limitations
  - No colour.
  - Bubbles are a fixed size.
  - Largest block is on the order of 10cm x 10cm x 10cm.
  - Range of successful data point densities.
  - Only points accepted, up to the user to represent other geometry as points.
- Particularly suited to some astronomy datasets, for example, stars within galaxies and galaxy survey data. Used successfully for volumetric based porosity data.

# Examples

ASKAP telescope dish, point cloud from CAD model

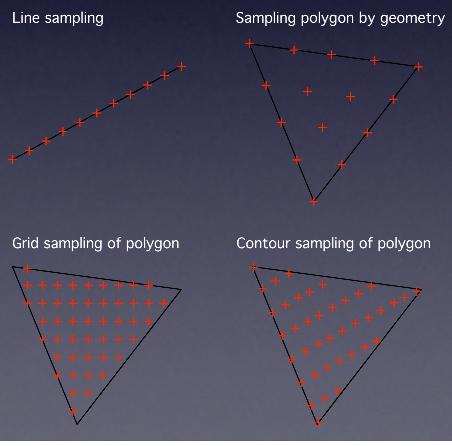
Egyptian mummy, bone isosurface of CAT scan data

Lorenz attractor, derived from attractor equations

Human heart, segmentation of MRI data

# The trick: Controlling the point cloud density

- All data needs to be converted to points at an appropriate density.
  - Too low density results in faint models.
  - Too high density results in splintering.
- Lines and planes can be tessellated by a variety of methods.
- Conversion of volumetric data by direct iso-surface sampling or by sampling (eg: contouring) the triangular mesh.



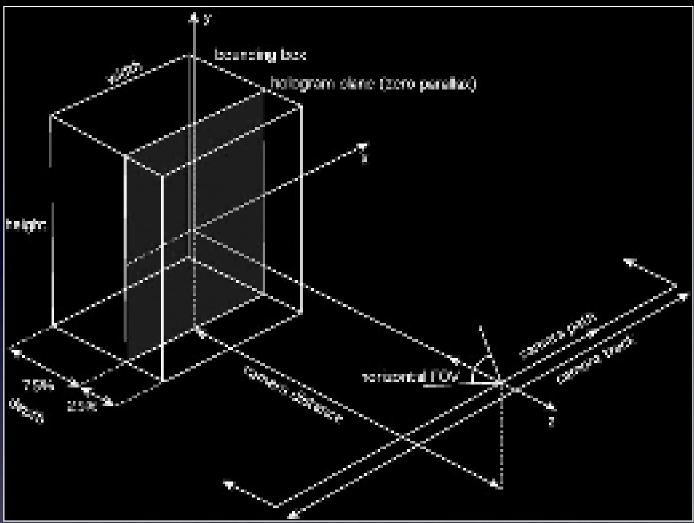

Density too low: 6df galaxy survey data

Splintering in high density regions

# Holography (i-Lumograms)

- Like many other glasses free 3D viewing systems this is also a "slight" abuse the use of the word "Hologram", but closer that most others. Has familiar characteristics: break off a piece and the whole can still be seen in both bits, damage to a localised part causes global damage.
- Variously known as
  - "holographic panoramagrams" (Jacques Desbien, early adopter circa 2005).
  - "synthetic dynamic holograms" (initially used by myself, 2006).
  - Initially known as "Sythograms" by the developers (2007).
  - Currently referred to as i-Lumograms by the developers based in Lithuania!
- Constructed from hundreds of renderings from a camera moving horizontally in front of the object being recorded. As such only horizontal parallax is recorded.
- True holograms of real objects are created by recording the interference pattern between light reflected off the object and a reference beam. The light field is reconstructed by diffraction when the hologram is illuminated by a light source identical to the reference beam.
- The light reflected off the object can be considered to be a large number of point sources, we can approximate this by rendering a large number of images of the object from different positions.
- Unlike conventional holograms the i-Lumograms have significantly better colour reproduction and are able to encode (limited) animation. Can be viewed simply with "reasonable' monochromatic light.

# Rendering




Very precise camera track is required for recording an approximation of the point sources. The camera track mimics the eventual viewers positions.

Animation during the camera path is limited to very slow transitions if a valid stereo pair is desirable across the viewing range.

Negative parallax is limited to about 25% of model bounding box, distant objects to about 75% of model bounding box.

Following example of a prehistoric fish tooth fossil, courtesy Kate Trijinastic, geology, UWA. Animation rendered with Drishti.

# Examples

Placoderm fish "teeth", no animation but the parallax from different viewing positions is clear from the above

Geological sample, slight modification of the voxel transfer function between left and rightmost views.

# Concluding remarks

- Generally enthusiastic response although in practice the rapid prototyping and crystal engraving are only suited to a small subset of possible science visualisation applications.
- Uses so far include:
  - crystals being used at conferences by geologists to convey porosity within rock samples.
  - rapid prototyping of fossils for museum displays and in teaching.
  - crystals of ASKAP dish used for gifts for visiting dignitaries.
  - rapid prototyping of polyhedra for high school mathematics.
  - rapid prototyping of crystals and Herschfield surfaces for undergraduate teaching.
- i-Lumograms currently priced at a slightly problematic level and there is not yet any full colour copying process available.
  (0.4 euro per square cm)
  They can be manufactured at up to 1m by 1.5m.
- Interesting future work based upon small laser projectors. Currently in OEM stage but easily fit inside a mobile phone sized package, currently 800x600 pixels full colour, focus at any distance, and battery powered.