Immersive displays:
A demonstration of current technology and future possibilities

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Introduction

- Immersion, "being there" ... around the extent to which one feels like one is really within an imperfectly mediated world (Mimetic Immersion).

- Werner Wolf describes immersion as : "... a feeling, with variable intensity, of being imaginatively and emotionally immersed in a represented world and of experiencing this world in a way similar (but not identical) to real life".

- My visualisation interest is around the extent to the digital capture and delivery engages/ leverages the human visual system, and other senses.
  In the case of vision this is:
  - stereopsis (depth perception arising from images from two positions, our eyes)
  - peripheral vision (for humans about 170 degrees by 120 degrees)
  - fidelity (spatial and temporal resolution)

- Recommended reading, PhD by Matthew McGinity
      http://www.ladispersiondufils.net/text.html
  Proposes that it is the degree to which one can represent and deliver the plenoptic function.

Light field

- The "light field" is the infinity of 3D points through which innumerable light rays diverge and converge.

- Converging rays arriving at any single point of the light field can be described by a spherical image of the world seen from that single position.

- The part of the light field we observe are the two spherical images located at the position of our eyes.

- The plenoptic function is a 7 dimensional function of position (3 variables), polar angle (2 variables), wavelength and time. $L(x, y, z, \theta, \phi, \lambda, t) = i$


Requirements

- An ideal immersive display needs to represent the light field at a level that reaches the capabilities of the human visual system. $L(x, y, z, \theta, \phi, \lambda, t) = i$

- Any (current) display is only an approximation of the light field, display artefacts are:

| Display artefact	Display Feature	Limitation of L()
Frame	Limited field of view	θ, ϕ
Pixels	Resolution	θ, ϕ
False colour	Colour gamut	λ
Colour banding	Colour depth	λ, i
Low contrast / brightness	Dynamic range	i
Noise	Signal to noise	i
Lag	Latency	t
Refresh rate / flicker / jitter	Frame rate	t

iDome

- First developed in 2003 jointly with UNSW.

- Main applications to date
    - truck driving simulator for the mining industry (UNSW Centre for Mining)
    - cultural heritage (CityU, Museum Victoria)
    - education / teacher training (ECU)
    - science visualisation
    - exhibits in museums and art galleries
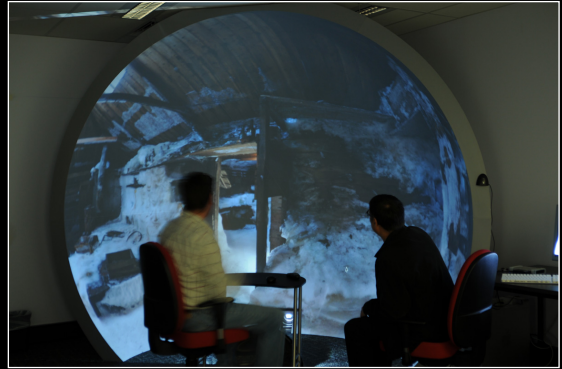
Mawsons huts simulator
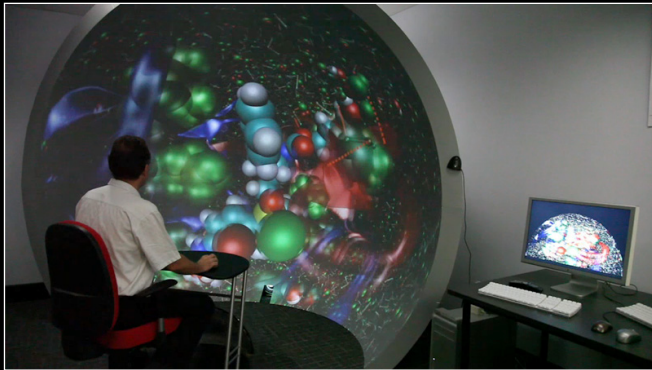
Molecular simulation
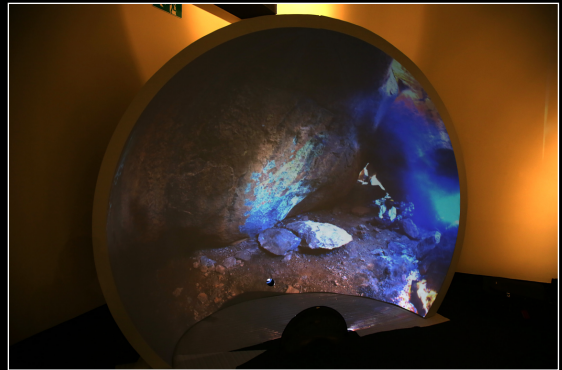
Ngintaka exhibition, Museum of South Australia

Oculus Rift

- Crowd sourced (Kickstarter) project in 2011.

- First development version released late in 2012, second release in 2014.

- Company acquired by Facebook in 2014.

- Presents (optionally)
    - a stereo image pair
    - approximately 100 degrees FOV
    - 960x1080 max pixels per eye
    - inertia and camera for 3 axis rotation and position tracking

Another path: Tiled or projected displays

- Another path might be a tiled display, possibly surrounding the viewer.
  Even a flat display of high enough resolution can occupy a wide field of view.

- Head tracking provides consistent views.

- Can optionally support stereo3D.

- Tiled vs projected is largely a trade-off between resolution and bezels.

  ... presentation of this type of display will be left for another day.

(Rough) Comparison

	iDome	Oculus	Tiled display
Price	Medium	Low	Medium to high
Stereo3D	Possible but difficult	Yes	Possible
Horizontal field of view	180	100	Variable (low to high)
Resolution	1600 pixels	960 pixels	Generally very high
Head tracked	No	Yes	Yes
Audience	2-3 (Ideally 1)	1	Varies (1 to 10)

- Note: the tiled display column is more vague since it isn't a single entity, there are lots of possible configurations.

Live demonstration

- Content types
  - 360 spherical panorama image (2D)
  - 360 stereo3D cylindrical panorama image (limited vertical FOV)
  - 360 spherical panorama movie (2D)
  - 3D virtual environments based upon Unity3D

- Introduce the team: Yathu Sivarajah, Paul Bourke, Nick Oliver, Dominic Manley