Immersive environments and applications to gaming.

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Outline

- Unique characteristics of the human visual system:
  - Depth perception.
  - Peripheral vision.
- Environments that attempt to exploit our visual capabilities:
  - Stereoscopic displays: VROOM.
  - Stereoscopic and peripheral vision: AVIE.
  - Personal immersive displays: iDome.

  Not a survey of the field but these are environments that exist now in Australia (and further afield) and for which content is being developed.
- Stereoscopy vs peripheral vision for gaming?
  Perhaps a unexpected conclusion from someone who has worked on an almost daily basis with stereographics for most of his working life.
- What is required from a software developers perspective?
  - Stereography and multiwall displays: Offaxis frustums.
  - Fisheye or cylindrical projections: Multipass rendering to textures.

Limitations of most computer displays

- Both eyes get the same image.
  (Even if the display presents a 3D model)
  This is not how we experience the real world, we get two slightly different views of our 3D environment and this is used by our visual system to give the sense of depth we experience when viewing the real world.

- Only a small part of our field of view is utilised.
  The horizontal field of view of our eyes is very close to 180 degrees (albeit not in detail or colour), our vertical field of view is around 120 degrees. Our visual system is tuned to detect motion is the peripheral region (survival capability).

- Displays are small and don't support the ability to have a 1:1 relationship between the virtual and the real. The player looks through a small portal on a miniature world.

VROOM - Virtual ROOM

- Was the VCV: Virtual Containment Vessel.
  8 stereoscopic screens,
  16 DLP projectors,
  8 computers.

- Imagined around 2001.
  Built in 2003 at the Melbourne Museum.
  Ideal for museums - ~30 people at once.

- While mostly employed as a movie playback system, multiple player interactive gaming is possible.

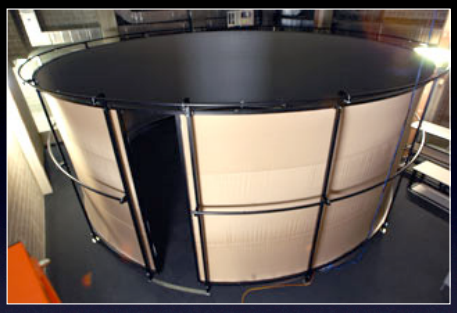
- We can induce the same sense of depth that we perceive in the real world with synthetic images. Need to present two correct perspective views independently to each eye.
  This is common to ALL stereoscopic projection systems.

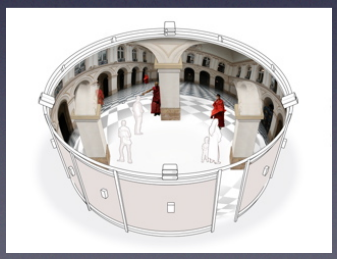
- With careful design of the stereoscopic parameters a correct sense of depth can be achieved alogn with a 1:1 relationship with the real world.

- An issue with stereoscopic projection is minimising eyestrain, particularly important for applications where users will be exposed to to stereoscopic viewing for extended periods. This can be optimised with careful choice of hardware and how the stereo pairs are created in the first place.

AVIE - Advanced Visualisation and Interaction Environment

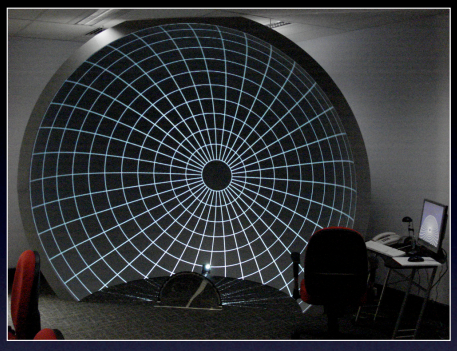
- Environment that both engages the peripheral vision and stereoscopy.
- Located at iCinema Scientia Facility, UNSW, Sydney.
- 360 degree cylindrical display,
  10m diameter, 3.5m high,
  6 pairs (12) projectors,
  In all for 8000 pixel resolution,
  Passive polaroid stereo projection.
- Can be used by multiple viewers without head tracking!
  Unusual for multiple person stereoscopic environments.





iDome - The Upright Planetarium

- All familiar with planetariums
  eg: "Horizons - The Planetarium" in Perth.
- iDome is an attempt at a more personal dome,
  with a more affordable projection system,
  where the projectors does not get in the way.
- 3m or 4m diameter, single HD projector.



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iCinema

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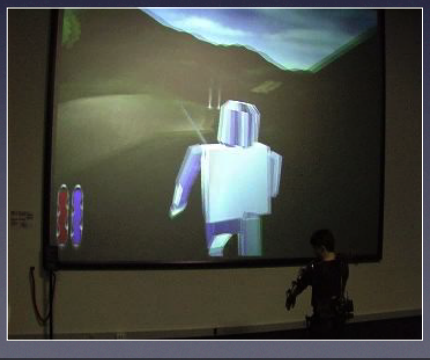
Stereoscopy for gaming

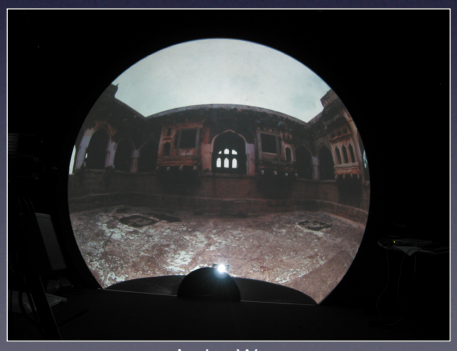
- While lots of games can be played in stereoscopic mode, very few players choose to do so for extended periods after the initial novelty has worn off (I claim).
- Even on an optimal stereoscopic projection system there will still be eye strain with prolonged use due to the conflict of the accommodation cues. Commodity stereoscopic projection systems are rarely even close to optimal.
- "Easy on the eye" stereoscopic presentation requires very careful control of stereoscopic parameters (zero parallax distance and eye separation), this is rarely accomplished with current stereoscopic enabled games or with driver enabled stereoscopic support.
- Stereoscopy without peripheral vision does not generally lead to immersion, the player is still looking at the world through a window.



Torque

Peripheral vision

- Will argue that supporting peripheral vision can give a greater gaming advantage compared to stereoscopy.
- Systems that project to our peripheral vision suffer from none of the eye strain issues associated with stereoscopic projection. The need for head tracking for a correct perspective (requirement for stereoscopic projection) is less critical.
- Our peripheral vision has evolved for exactly the kinds of survival skills required in 3D action games. eg: Early detection of the lion stalking our ancestors on the African savannah.
- Why so little support?
  Requires additional viewing hardware and image generation is harder than stereoscopy.

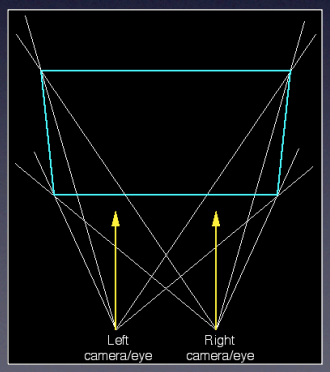


Anghor Wat

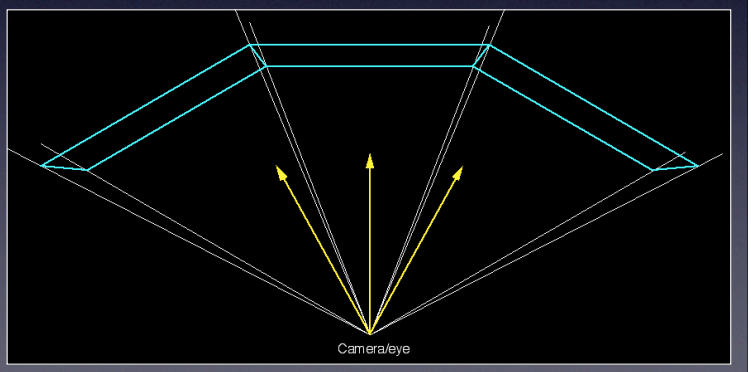
Quest3D

Considerations for game developers: Offaxis frustums

- Offaxis frustums: field of view is not symmetric about view direction.
- Required for stereoscopy and multiple wall displays.
- NOT the same as rotating a symmetric frustum!
- Additionally required for head tracking within all displays in order to maintain the correct view through the virtual window.



Stereoscopic

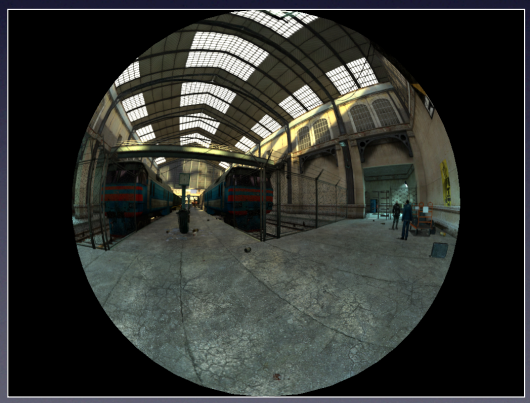


Multiple wall displays

Considerations for game developers: Multipass rendering

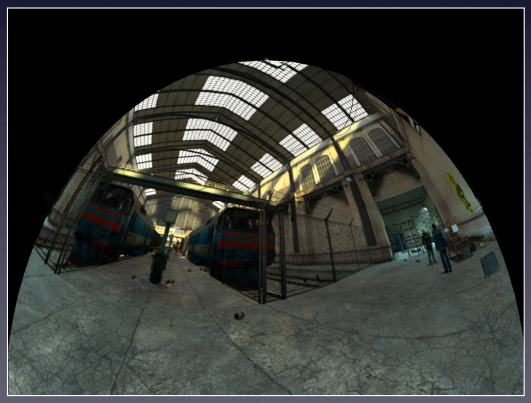
- A single perspective projection is not capable of encapsulating all the visual information required for an immersive display.
- Solution is the render the scene a number of times and stitch the results together to form the desire projection, eg: cylindrical panorama or fisheye.
- Frustums based upon cubic maps are the most common approach. Four passes are required to capture enough information for a 180 degree fisheye.
- Performance overhead is becoming less of an issue with todays graphics cards.


4 of the 6 possible cubic maps


Seamlessly stitched to form a fisheye projection

Considerations for game developers: Geometry warping

- An additional render pass is often required to correct for projection realities.
- For example
  - Warping for spherical mirror projection.
  - Geometry correction of panoramic projections for cylindrical displays.



Warped fisheye for an upright dome and spherical mirror

Upright dome environment

Final remarks

- For immersion and games that place the player in a 3D environment, more consideration should be given to supporting our peripheral vision.
- The price of the projection technology is dropping making displays that engage our peripheral vision more affordable.
- More general display algorithms need to be supported in order to create the imagery required by immersive displays. [Multipass rendering, geometry correction, image warping]

Questions?