Navigable movies: A Real QuickTime VR

Paul Bourke
Ian Hooper

WASP
University of Western Australia

AUC

Contents

- What is it? A brief history.
- Projects over the last few years that add functionality and remove restrictions inherent in the QTVR player.
- A real navigable movie player!
- Applications and some technical details.
- Examples.

QuickTime VR

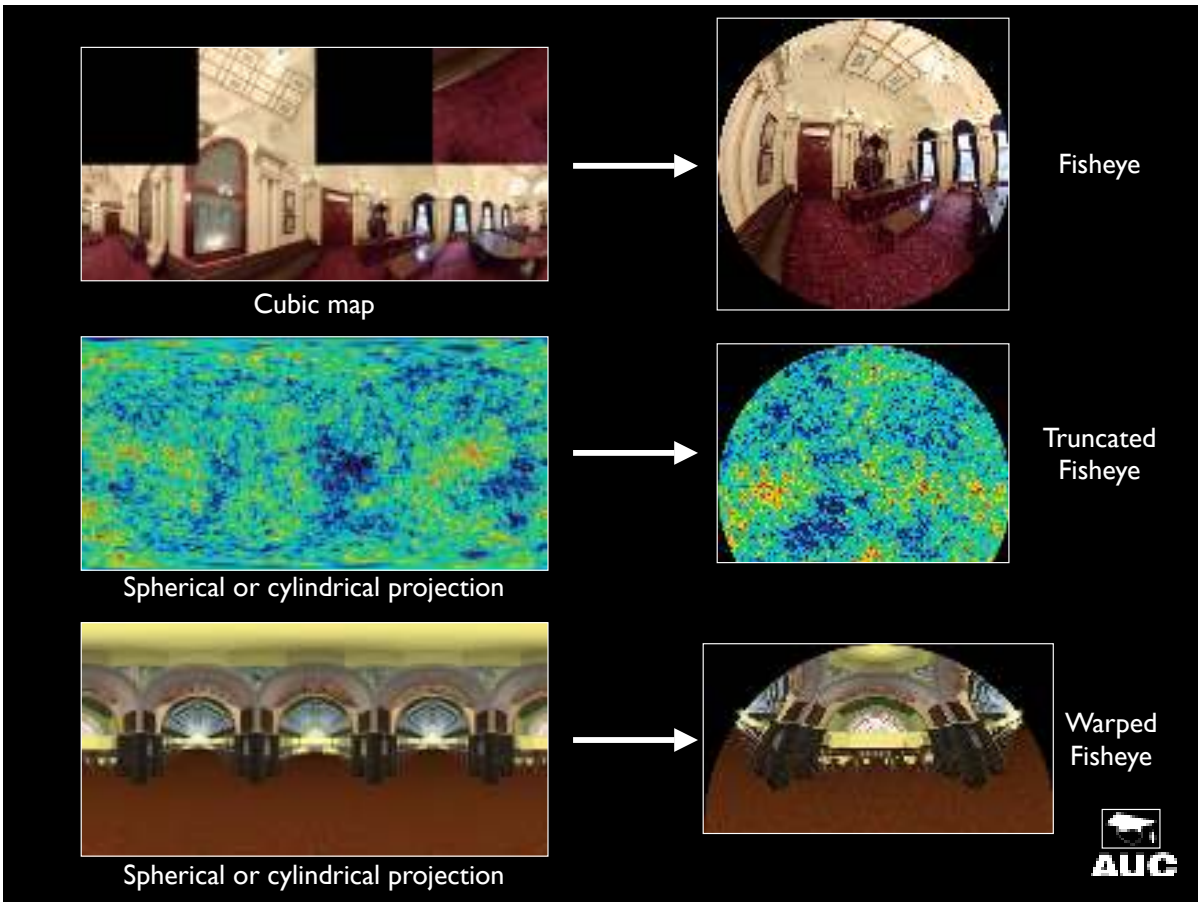
- Beta version circa 1994.
- QTVR was integrated into QuickTime at version 2.5 in 1996.
- Initially only supported cylindrical and spherical projections.
- Cubic maps were added to QuickTime in version 5 in 2001. This solved the problem of distortion at the poles that occurs with spherical projections and it is more convenient for computer generated content.
- Cubic maps is now perhaps one of the more common input projection, there are tools that convert older panoramic projections and photographically generated panoramas into cubic maps.
- Often called navigable movies because one can navigate and they are encapsulated in a QuickTime movie format.

First Project: "Panoramic"

- Supported stereoscopic panoramic projection.
- Developed an independent QuickTime VR "look-a-like" from 2000 onwards.
- Mac OS-X and Linux: An OpenGL application with lots of locally required adaptions, eg: support for 3D input devices. Acts as a direct QTVR replacement for monoscopic panoramic images for Linux.
- Input projections include cubic maps, cylindrical and spherical projections, planar maps.
- Used for photographic applications but also visualisation where it offers limited navigation but high quality pre-rendered visuals.
- Removed the inability to "roll" the camera, useful for datasets where there is no "up" (eg: astronomy applications).

Second Project: "Panodome"

- Player that supports other than just a perspective output projection, in particular, fisheye and warped fisheye (examples later).
- Mac OS-X and Linux. An OpenGL based application.
- Optimised for large frame sizes, for example, 8K x 4K spherical maps.
- Primarily designed for planetarium and other immersive environments that require fisheye projections.
- First implementation of a warping map file that describes the mapping between the input and output projection (see later).



Current Project: Innovation #1

- Replace the image in QTVR with a movie!
  Instead of navigating within a single image, one is navigating within a movie!
- Each frame of the movie may consist of any projection type, commonly still panoramic (spherical or cylindrical) projections. Any (reasonable) input projection that captures a large proportion (or al) of the vidual field can be supported.
- Result: a true navigable movie.
  The viewer potentially has different experience each time the movie is viewed.
  "Interactive cinema".

AUC

Current Project: Innovation #2

- Output projections other than just perspective. QuickTime VR only supports perspective projections, suitable for flat displays.
- The output projection of each frame of the movie is actually irrelevant, that detail is part of the warping mesh. Any (reasonable) output projection can be supported.
- In particular: support is provided for fisheye projections and warped fisheye projections as required for projecting into immersive environments using a spherical mirror.
- Of course the warp needs to be precisely defined for a particular input and output projection for the result to make sense.

Hemispherical domes

- One of many immersive environments, projection systems that engage the human peripheral vision.
- Natural projection is a fisheye image, only that output projection contains the visual information necessary to cover the field of view supported by the dome surface.
- Vertical and horizontal orientation (eg; planetariums).

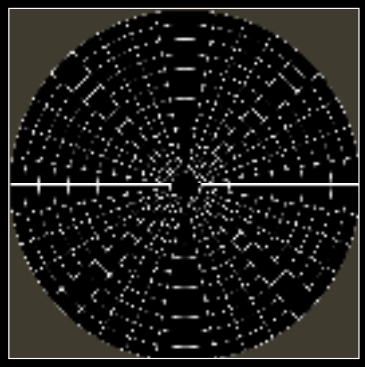
Spherical mirror projection

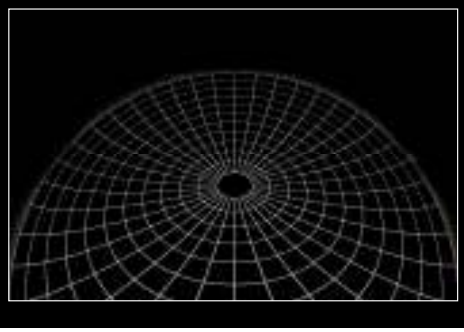
- Instead of a relatively expensive fisheye lens, employ a spherical mirror to scatter light from a data projector across the wide angles required.
- In order for the result to appear undistorted on the hemispherical surface, the input fisheye image is warped in just the right way to correct for the distortion.
- Example of a warped fisheye, "Dawn of the Space Age" courtesy Mirage3D.

AUC

Warping mesh

- Each frame of the movie is applied as a texture to a mesh.
- The mesh is designed in such a way that it warps the input image projection to form the intended output projection.
- Navigation is performed by modifying the (u,v) texture coordinates.

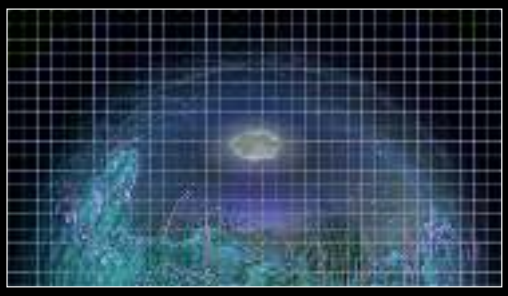


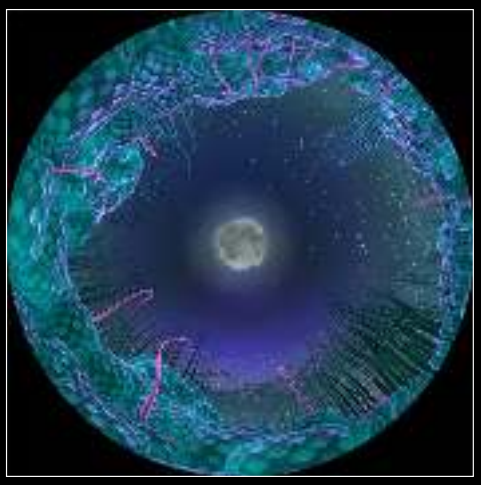


AUC

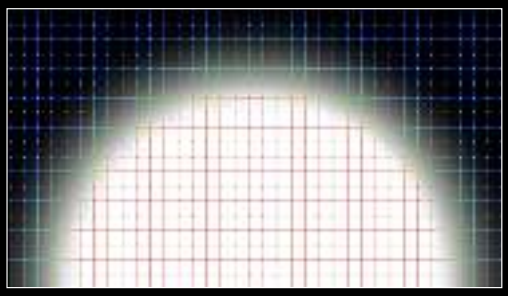
Mesh arrangement

Texture mesh formed by a regular grid (x,y).
Warping is achieved with texture coordinates (u,v).





Single frame applied as a texture,
(u,v) coordinates each range from 0 to 1



Intensity mapping to possibly
adjust for variable brightness on the final surface.

AUC

One movie, multiple views

AUC

Other comments/challenges

- For immersive environments one often needs high resolution source images. Movies made up of spherical projections are often 4K pixels wide, fisheye frames for a HD projection system are typically 2K square and are designed to be played at 30fps.
- Cylindrical and spherical projections that need to wrap horizontally must be a power of 2 pixels ... a (current) limitation.
- For most projection environments the images need to be presented full screen, that is, no menu bar or window frame/decoration.
- Typical mesh resolutions are around the 80 to 120 quads on each dimension, this seems to pose a minimal performance overhead on current graphics hardware. Typically under 1/2fps penalty.

AUC

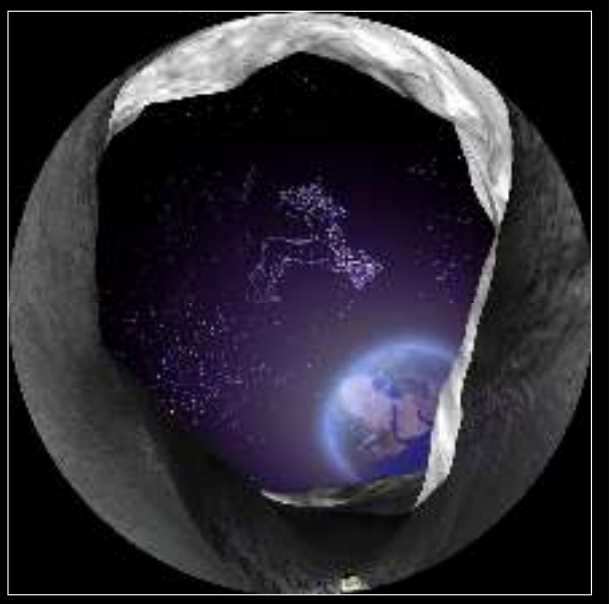
Example 2: Planar (CG)

- Panning around within a high resolution movie.
- Example from 6dF galaxy survey.

AUC

Example 3: Fisheye (CG)

- Example courtesy "Moonlight" by Andrew Quinn.
- The only appropriate navigation is rotating about the center of the fisheye, no extra visual information is supplied in a fisheye image ... zooming and panning don't result in correct projections.
- Illustrate direct fisheye and warped fisheye, the only difference is the warp mesh.



AUC

Example 4: Spherical (Digital video)

- Captured using LadyBug camera, courtesy iCinema UNSW.
- Each frame 3600 pixels by 1200.
- Spherical projection, 360 degrees in longitude, 120 degrees latitude.
- Illustrate fisheye, warped fisheye, and perspective projections.

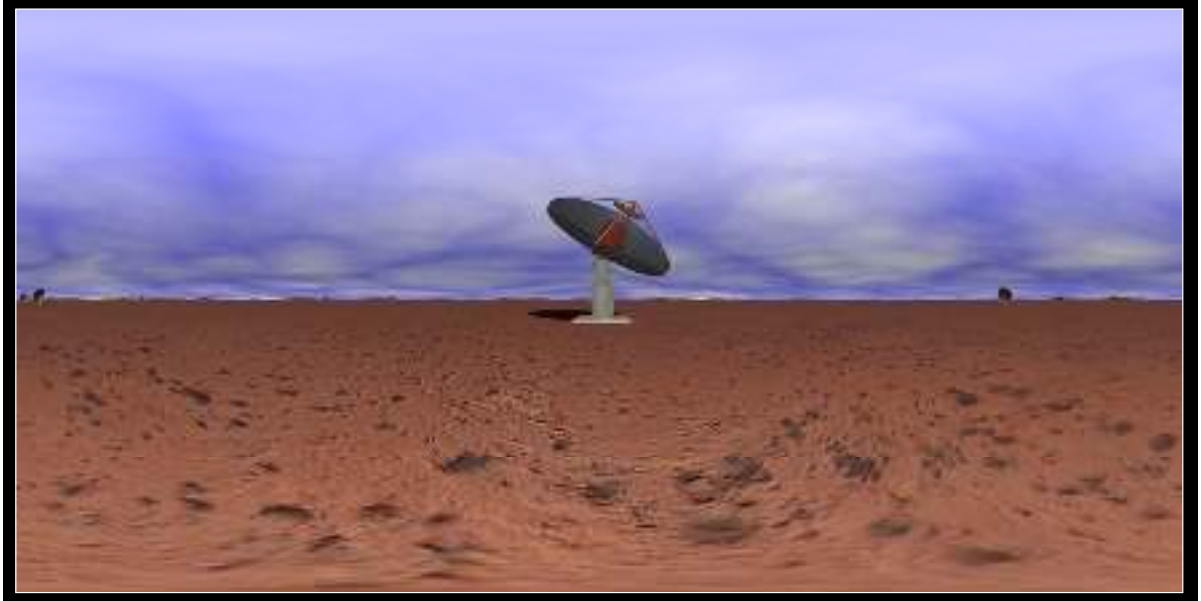
AUC

Example 5: Panorama (Image + CG)

- Combination of panoramic stills and composited computer generated animation.
- Cylindrical projection, 360 degrees longitude and 40 degrees latitude.
- Example courtesy Place Hampi.
- Illustrate perspective projection.

AUC

Example 6: Full Spherical (CG)



- ASKAP telescope dish proposal.

AUC

Questions?

- PDF of this paper can be found here
  http://local.wasp.uwa.edu.au/~pbourke/papers/auc2007/
- Stereoscopic panoramic player
  http://local.wasp.uwa.edu.au/~pbourke/papers/vsmm2006/
- Panodome
  http://local.wasp.uwa.edu.au/~pbourke/projection/panodome/
- Spherical mirror projection into hemispherical domes
  http://local.wasp.uwa.edu.au/~pbourke/papers/graphite2005/