

CSE 190: Virtual Reality Technologies

LECTURE #19: PANORAMA IMAGING

Announcements

Project 3

- Late submissions accepted until June 7th at 11:59pm

Final Exam:

- Released Monday at 6pm PT on Canvas
- Submission deadline: Tuesday at 6pm PT

Today: Guest lecture by Sam Hessenauer from Nanome, Inc.

Today's VR app presentations:

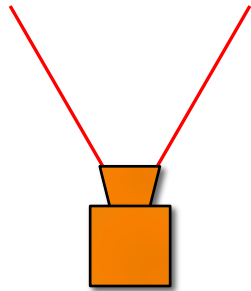
- Kenny Nguyen: VRChat
- Kyle Stadelmann: Rec Room
- Trevor Hedstrom: No Man's Sky

Panorama Capturing

Panorama v Stereo Movie v Stereo Panorama

Panorama

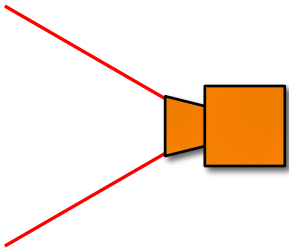
mono & head rotation



Panorama v Stereo Movie v Stereo Panorama

Panorama

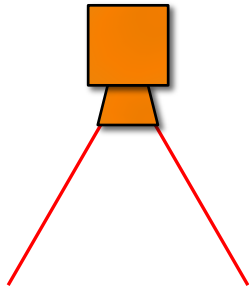
mono & head rotation



Panorama v Stereo Movie v Stereo Panorama

Panorama

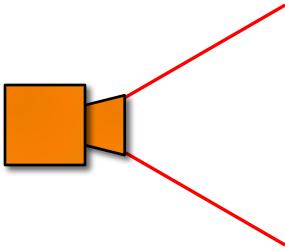
mono & head rotation



Panorama v Stereo Movie v Stereo Panorama

Panorama

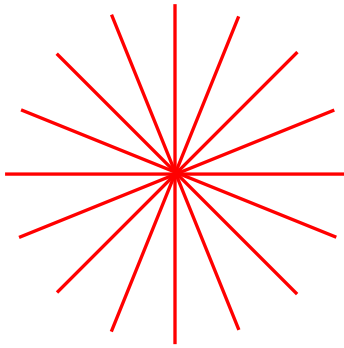
mono & head rotation



Panorama v Stereo Movie v Stereo Panorama

Panorama

mono & head rotation

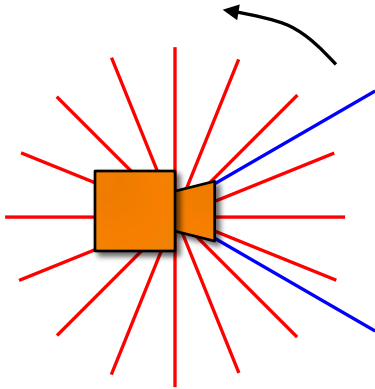


1 center of
projection!

Panorama v Stereo Movie v Stereo Panorama

Panorama

mono & head rotation

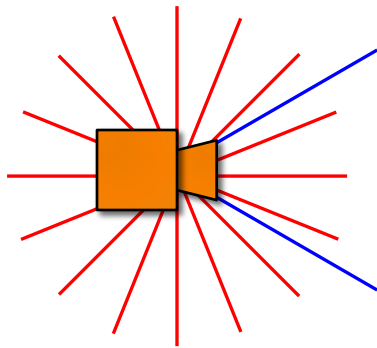


1 center of
projection!

Panorama v Stereo Movie v Stereo Panorama

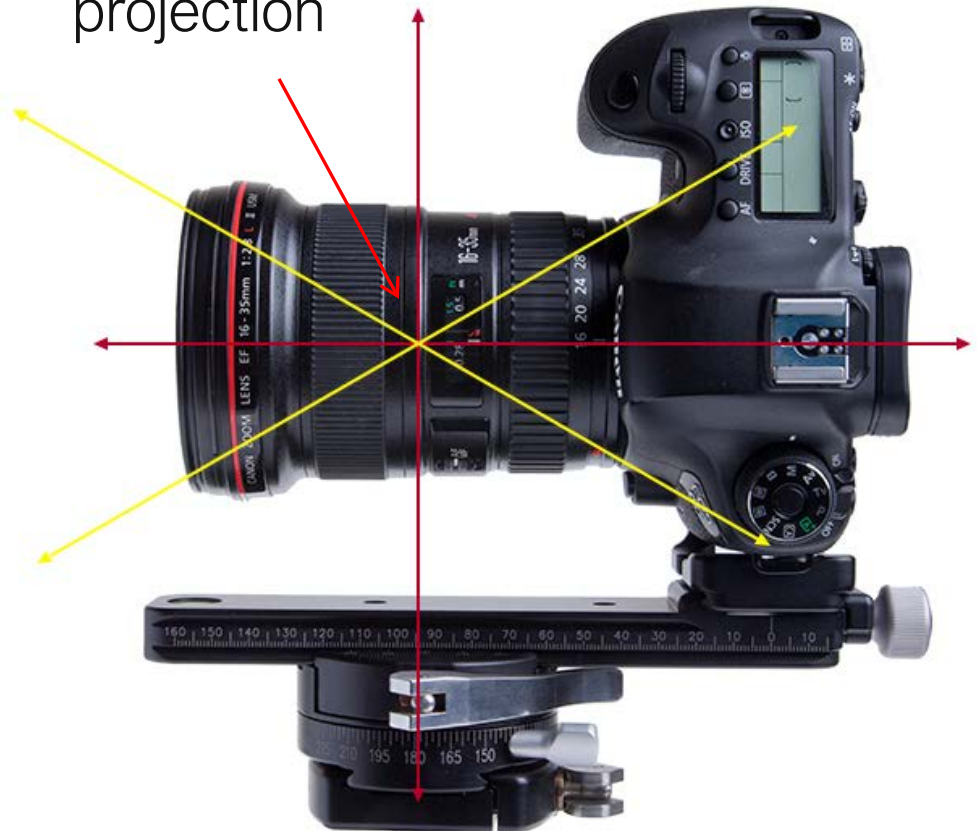
Panorama

mono & head rotation



1 center of projection!

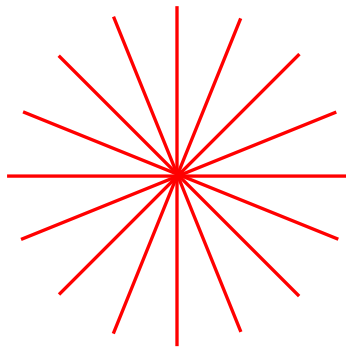
center of projection



Panorama v Stereo Movie v Stereo Panorama

Panorama

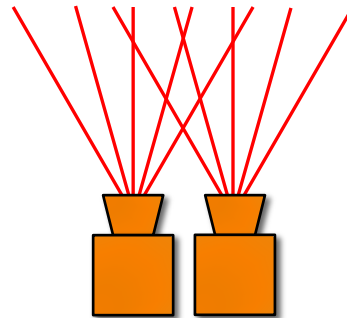
mono & head rotation



1 center of
projection!

Stereo

stereo & no head rotation



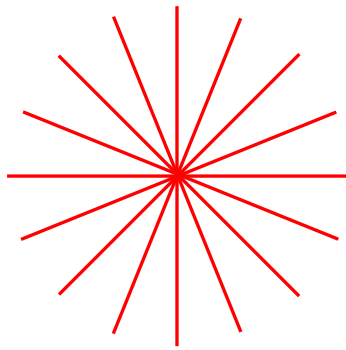
Stereo Panorama

stereo & head rotation

Panorama v Stereo Movie v Stereo Panorama

Panorama

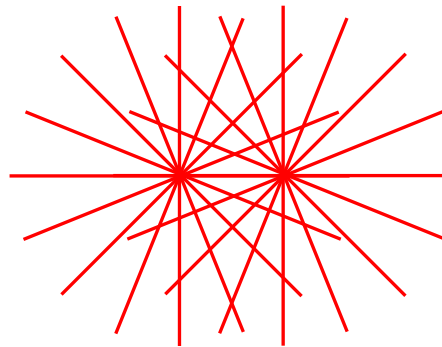
mono & head rotation



1 center of
projection!

Stereo

stereo & no head rotation



2 centers of
projection!

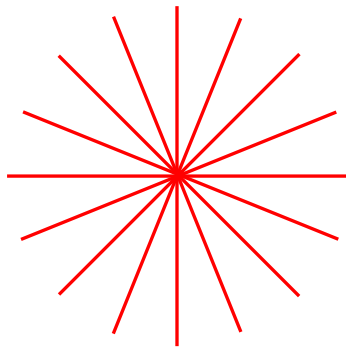
Stereo Panorama

stereo & head rotation

Panorama v Stereo Movie v Stereo Panorama

Panorama

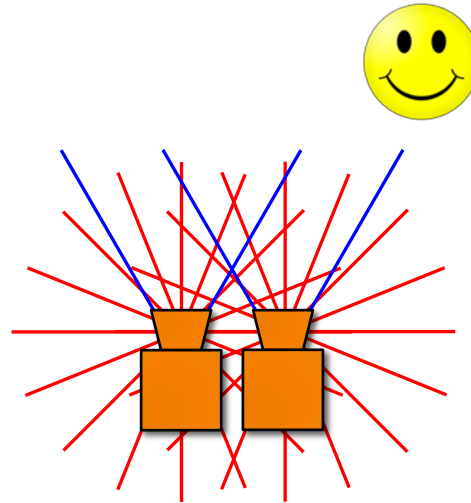
mono & head rotation



1 center of projection!

Stereo

stereo & no head rotation



2 centers of projection!

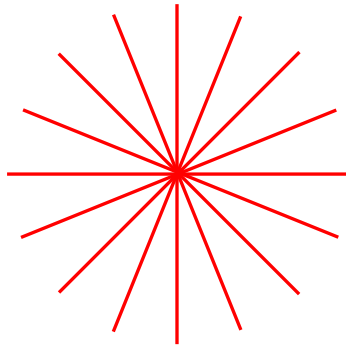
Stereo Panorama

stereo & head rotation

Panorama v Stereo Movie v Stereo Panorama

Panorama

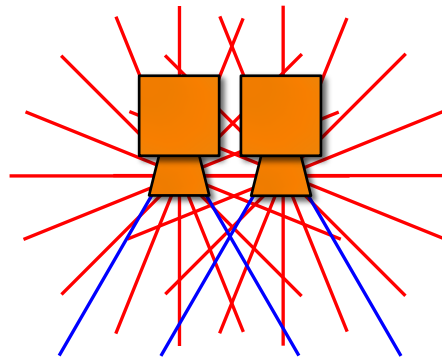
mono & head rotation



1 center of projection!

Stereo

stereo & no head rotation



2 centers of projection!

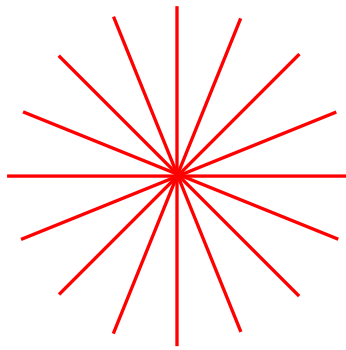
Stereo Panorama

stereo & head rotation

Panorama v Stereo Movie v Stereo Panorama

Panorama

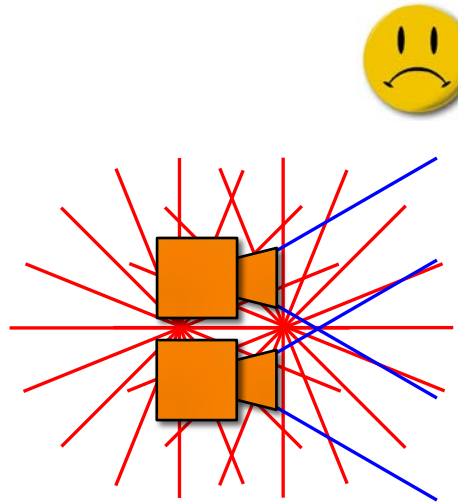
mono & head rotation



1 center of projection!

Stereo

stereo & no head rotation



2 centers of projection!

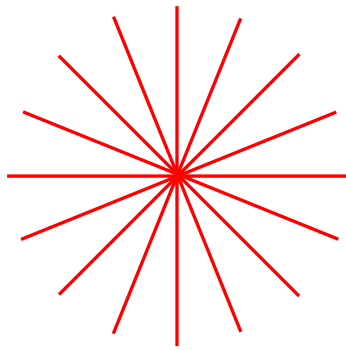
Stereo Panorama

stereo & head rotation

Panorama v Stereo Movie v Stereo Panorama

Panorama

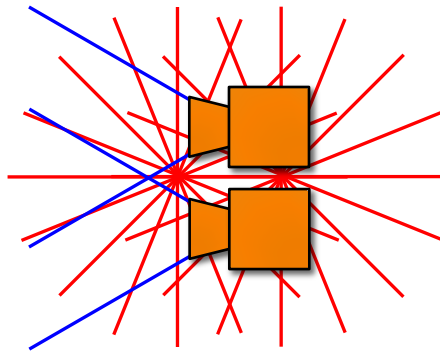
mono & head rotation



1 center of projection!

Stereo

stereo & no head rotation



2 centers of projection!

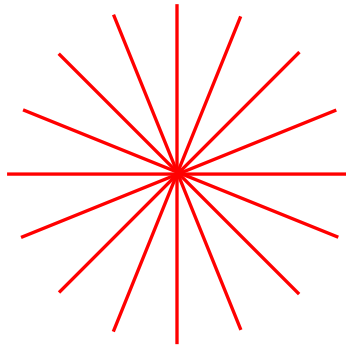
Stereo Panorama

stereo & head rotation

Panorama v Stereo Movie v Stereo Panorama

Panorama

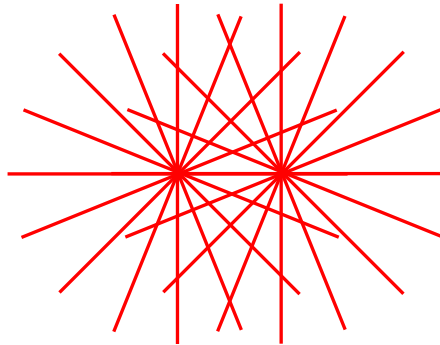
mono & head rotation



1 center of projection!

Stereo

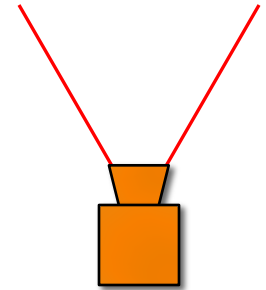
stereo & no head rotation



2 centers of projection!

Stereo Panorama

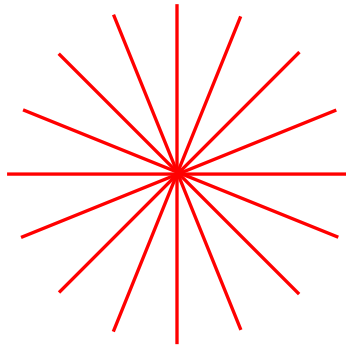
stereo & head rotation



Panorama v Stereo Movie v Stereo Panorama

Panorama

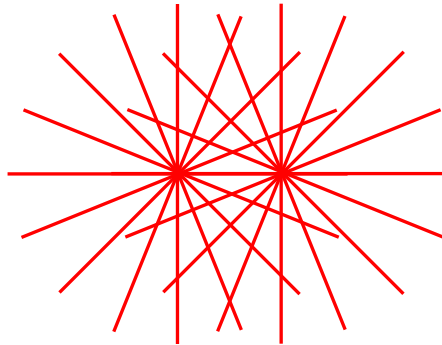
mono & head rotation



1 center of projection!

Stereo

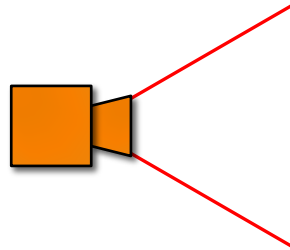
stereo & no head rotation



2 centers of projection!

Stereo Panorama

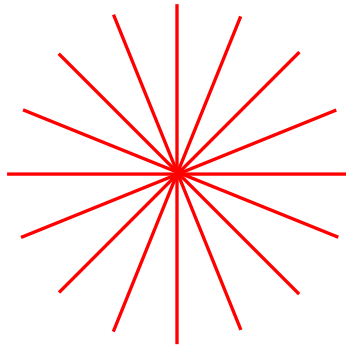
stereo & head rotation



Panorama v Stereo Movie v Stereo Panorama

Panorama

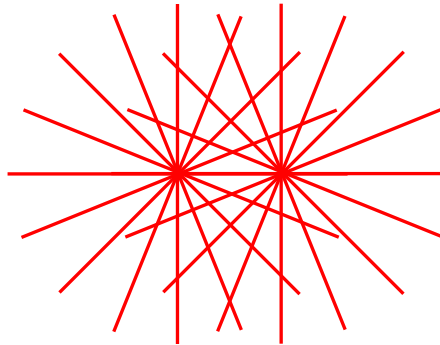
mono & head rotation



1 center of projection!

Stereo

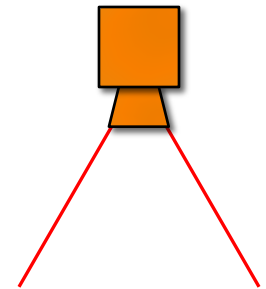
stereo & no head rotation



2 centers of projection!

Stereo Panorama

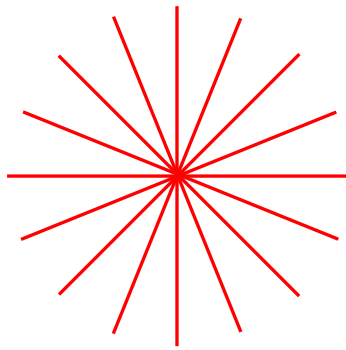
stereo & head rotation



Panorama v Stereo Movie v Stereo Panorama

Panorama

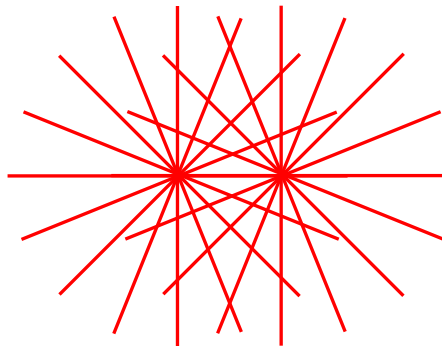
mono & head rotation



1 center of projection!

Stereo

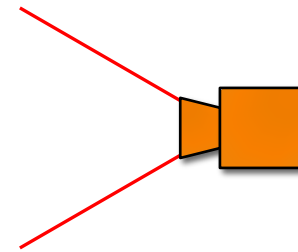
stereo & no head rotation



2 centers of projection!

Stereo Panorama

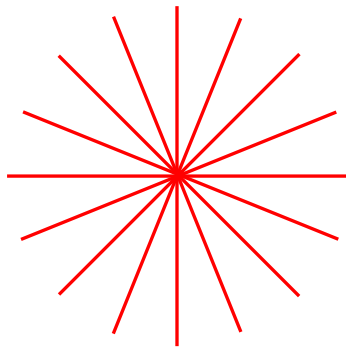
stereo & head rotation



Panorama v Stereo Movie v Stereo Panorama

Panorama

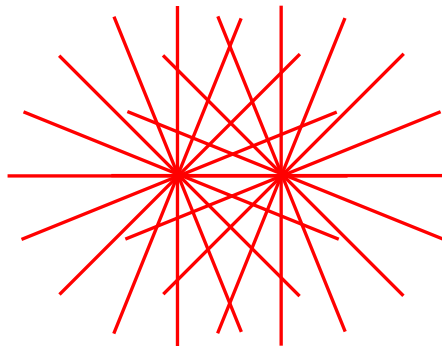
mono & head rotation



1 center of projection!

Stereo

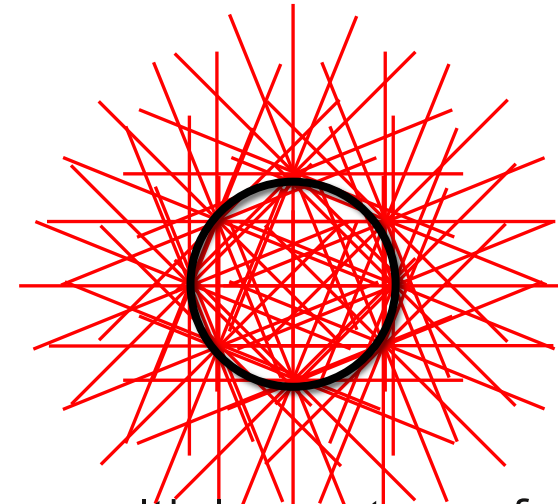
stereo & no head rotation



2 centers of projection!

Stereo Panorama

stereo & head rotation

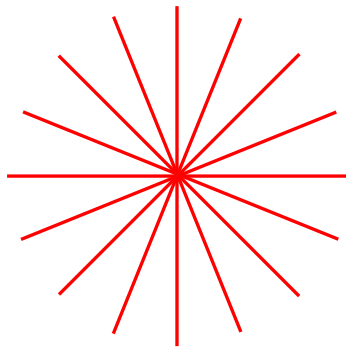


multiple centers of projection

Panorama v Stereo Movie v Stereo Panorama

Panorama

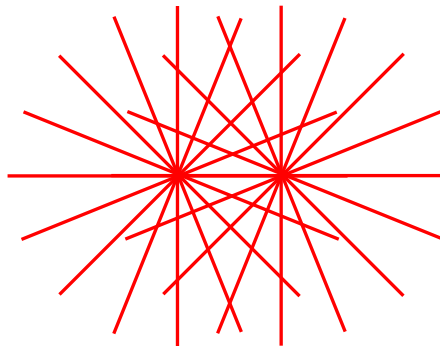
mono & head rotation



1 center of projection!

Stereo

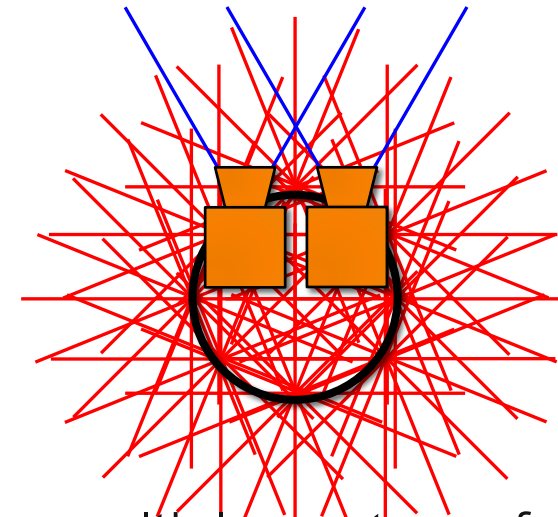
stereo & no head rotation



2 centers of projection!

Stereo Panorama

stereo & head rotation

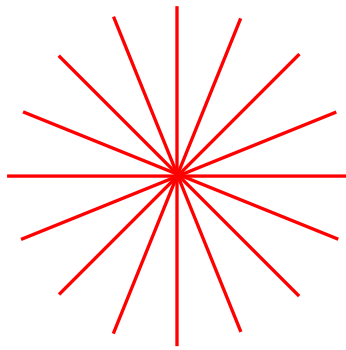


multiple centers of projection

Panorama v Stereo Movie v Stereo Panorama

Panorama

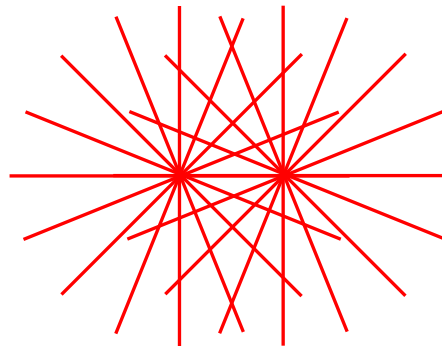
mono & head rotation



1 center of projection!

Stereo

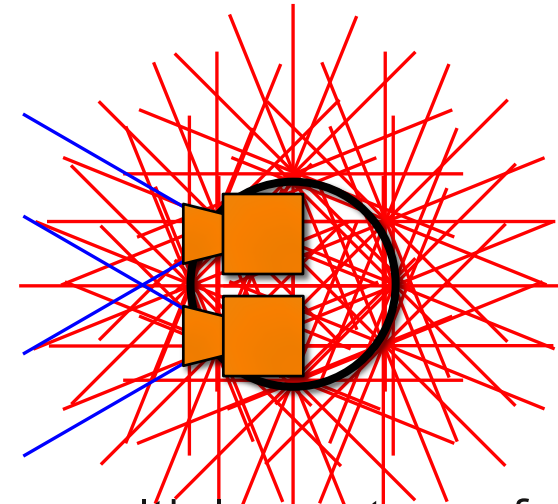
stereo & no head rotation



2 centers of projection!

Stereo Panorama

stereo & head rotation



multiple centers of projection

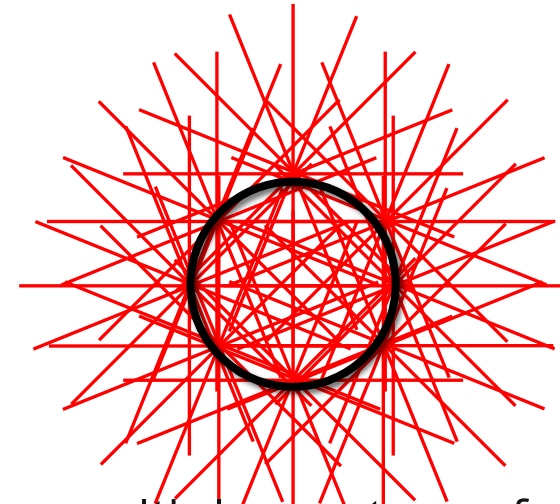
Panorama v Stereo Movie v Stereo Panorama



Light Field!

Stereo Panorama

stereo & head rotation



multiple centers of
projection

Panorama v Stereo Movie v Stereo Panorama

Panorama

mono & head rotation



Stereo

stereo & no head rotation



Stereo Panorama

stereo & head rotation



horizontal-only
parallax

Stitching

Panoramas

Slides from Marc Levoy's excellent CS 178 course

Stitching images together to make a mosaic



Panoramas

Slides from Marc Levoy's excellent CS 178 course

What kind of transformation do we need?



translation?



rotation?



perspective!

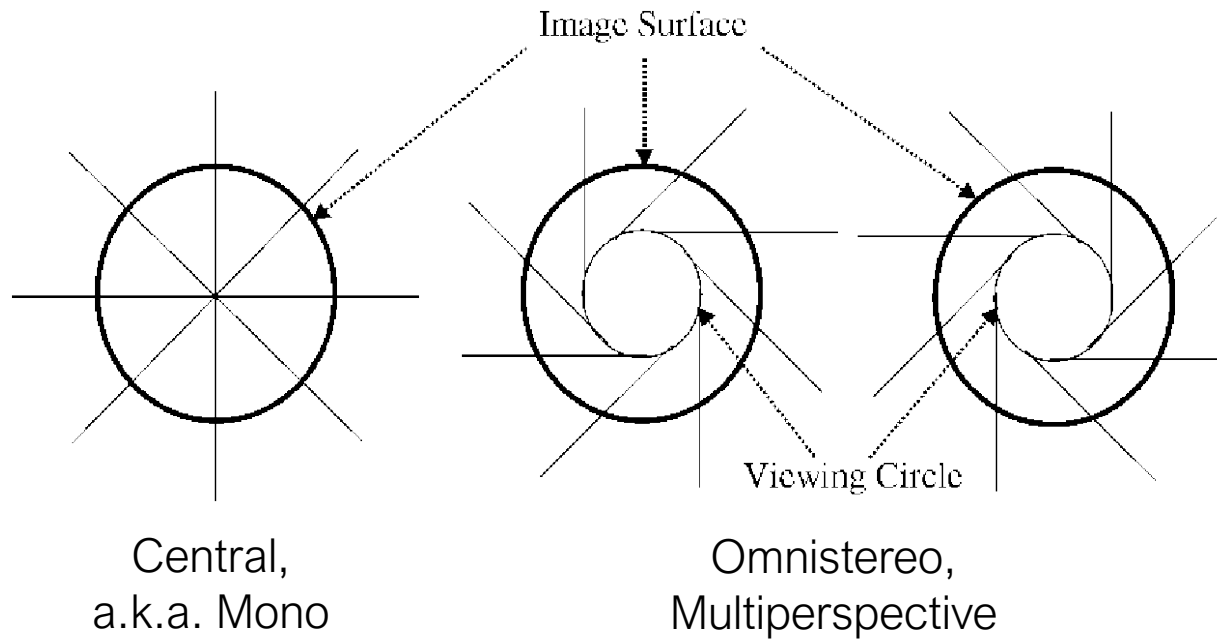
Stitching images together to make a mosaic



- ♦ step 1: find corresponding features in a pair of image
- ♦ step 2: compute perspective from 2nd to 1st image
- ♦ step 3: warp 2nd image so it overlays 1st image
- ♦ step 4: blend images where they overlap one another
- ♦ repeat for 3rd image and mosaic of first two, etc.

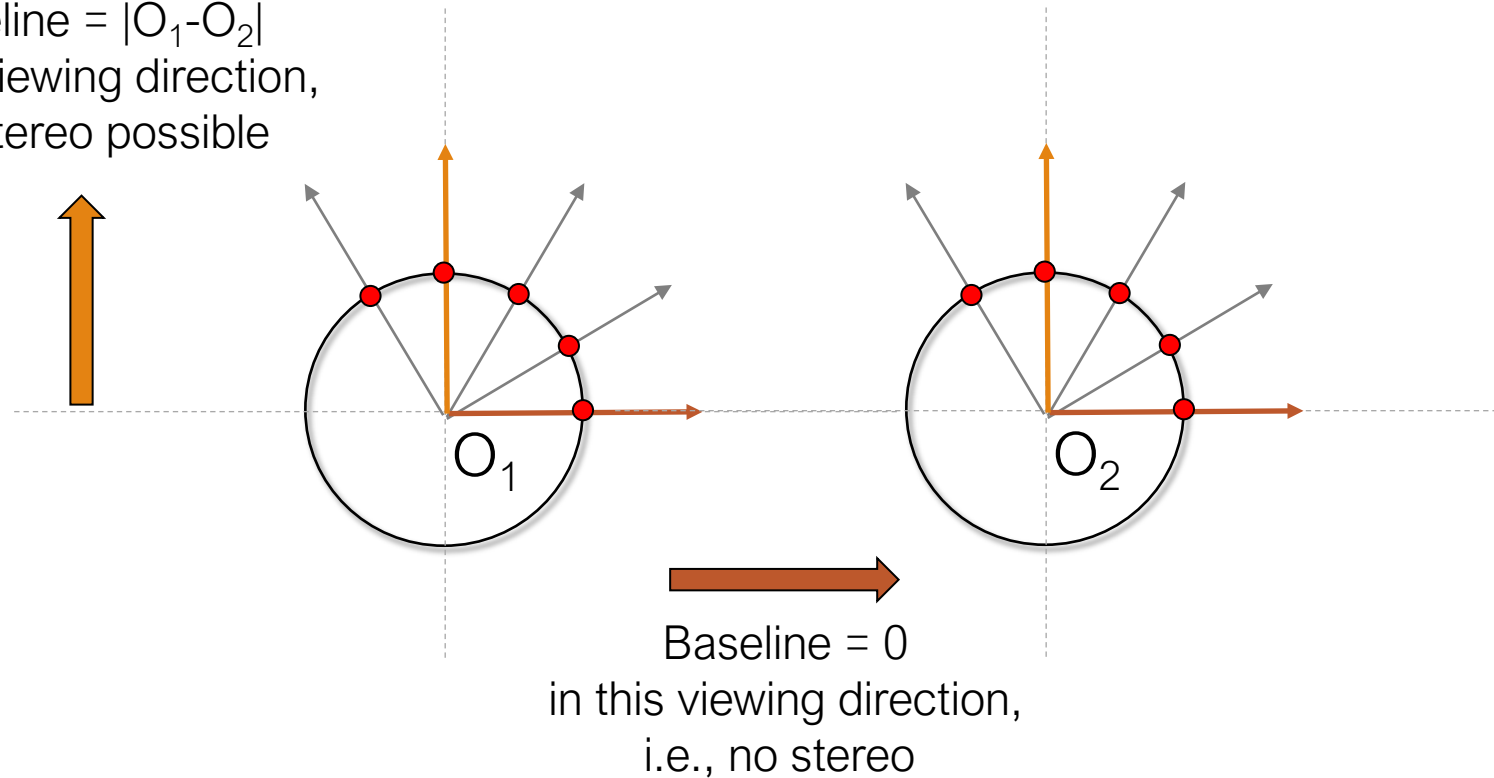
Omnistere

Comparison: Mono and Stereo Panoramas



A Pair of Mono Panoramas

Baseline = $|O_1 - O_2|$
in this viewing direction,
i.e., stereo possible



Head Rotation

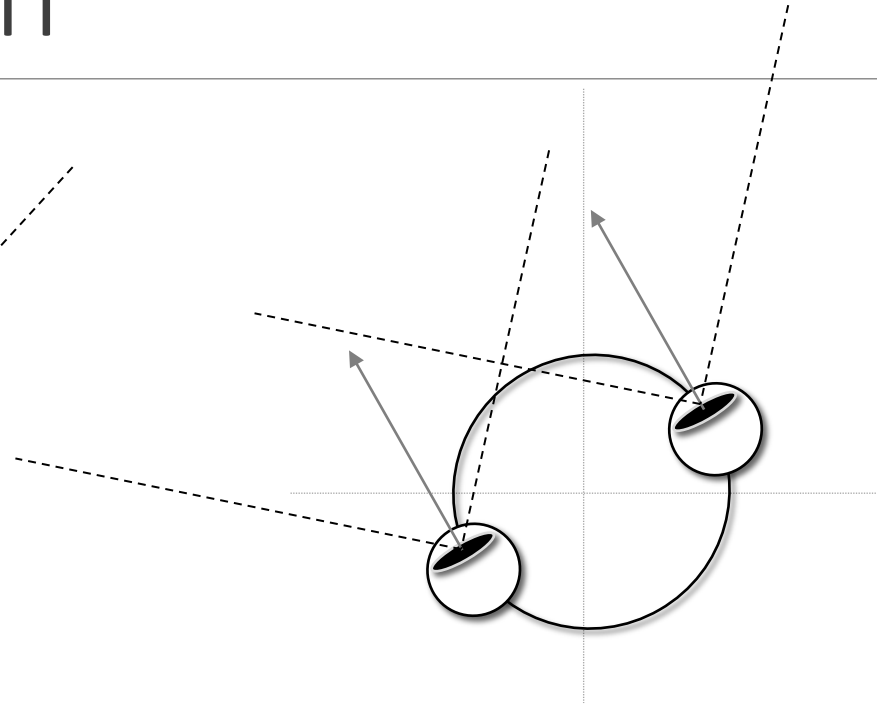
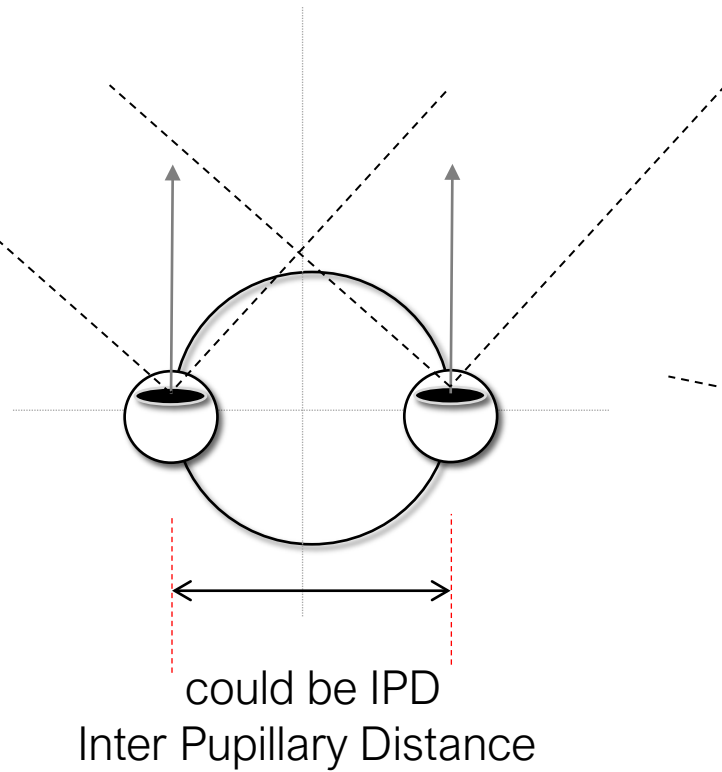
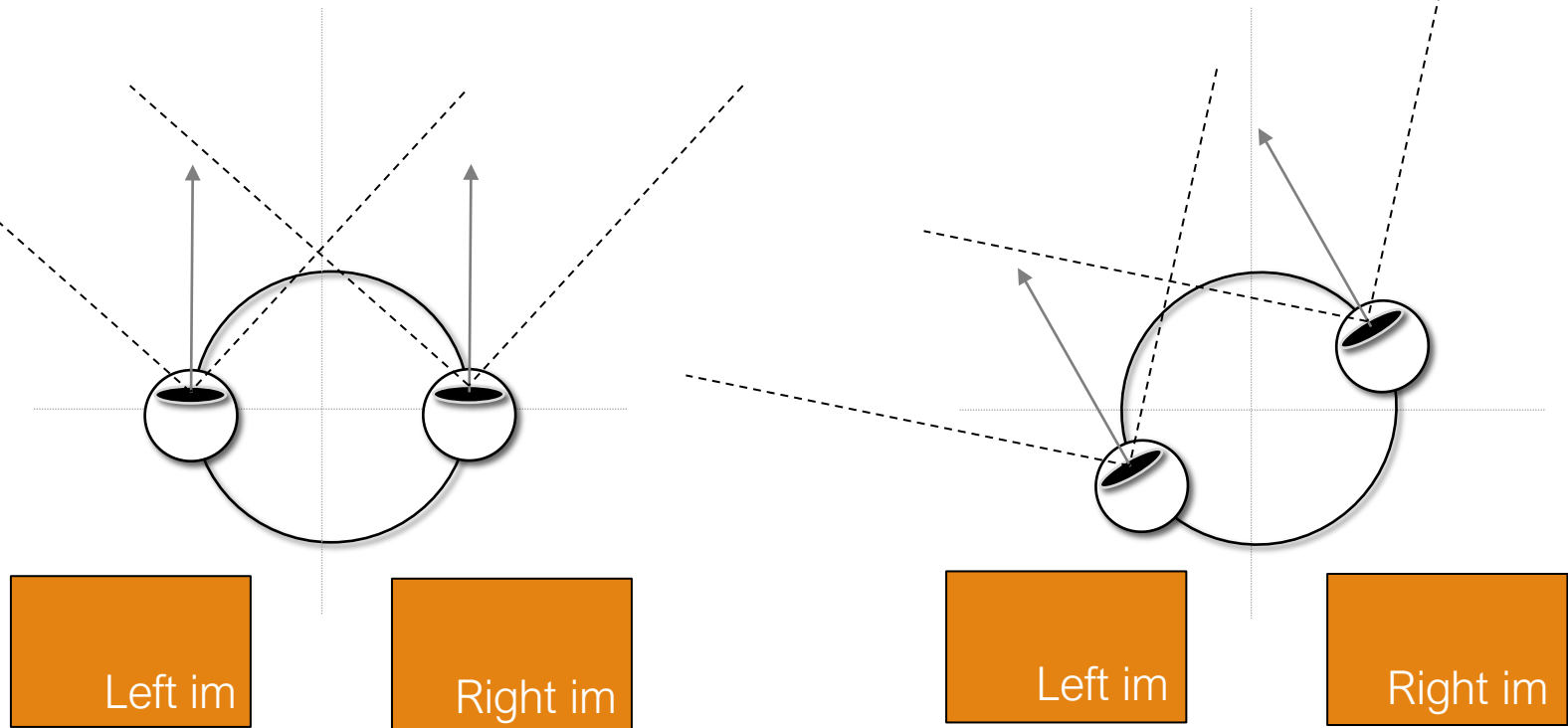


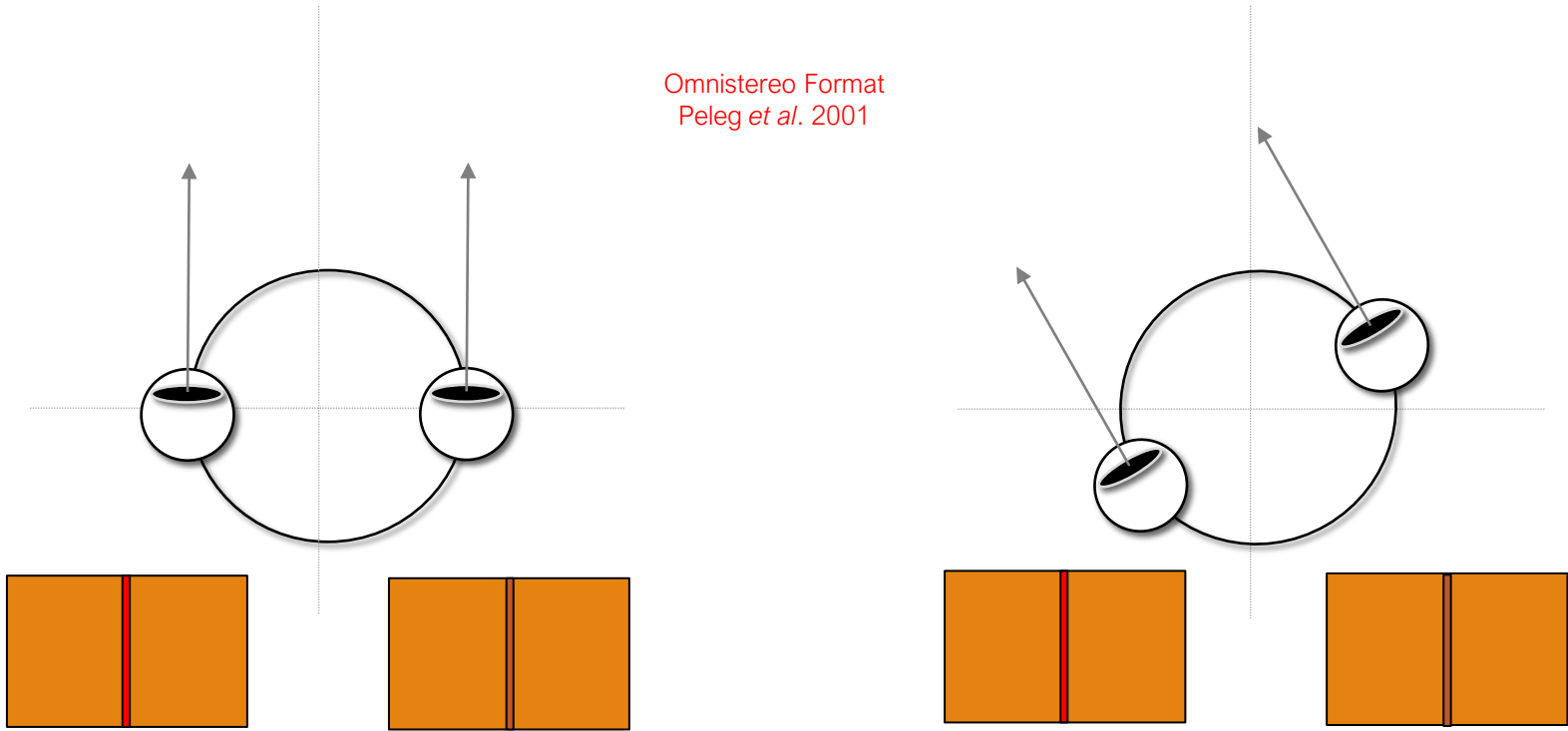
Image Pair for Each Direction



Store image pair for each direction → Problem: Too much data

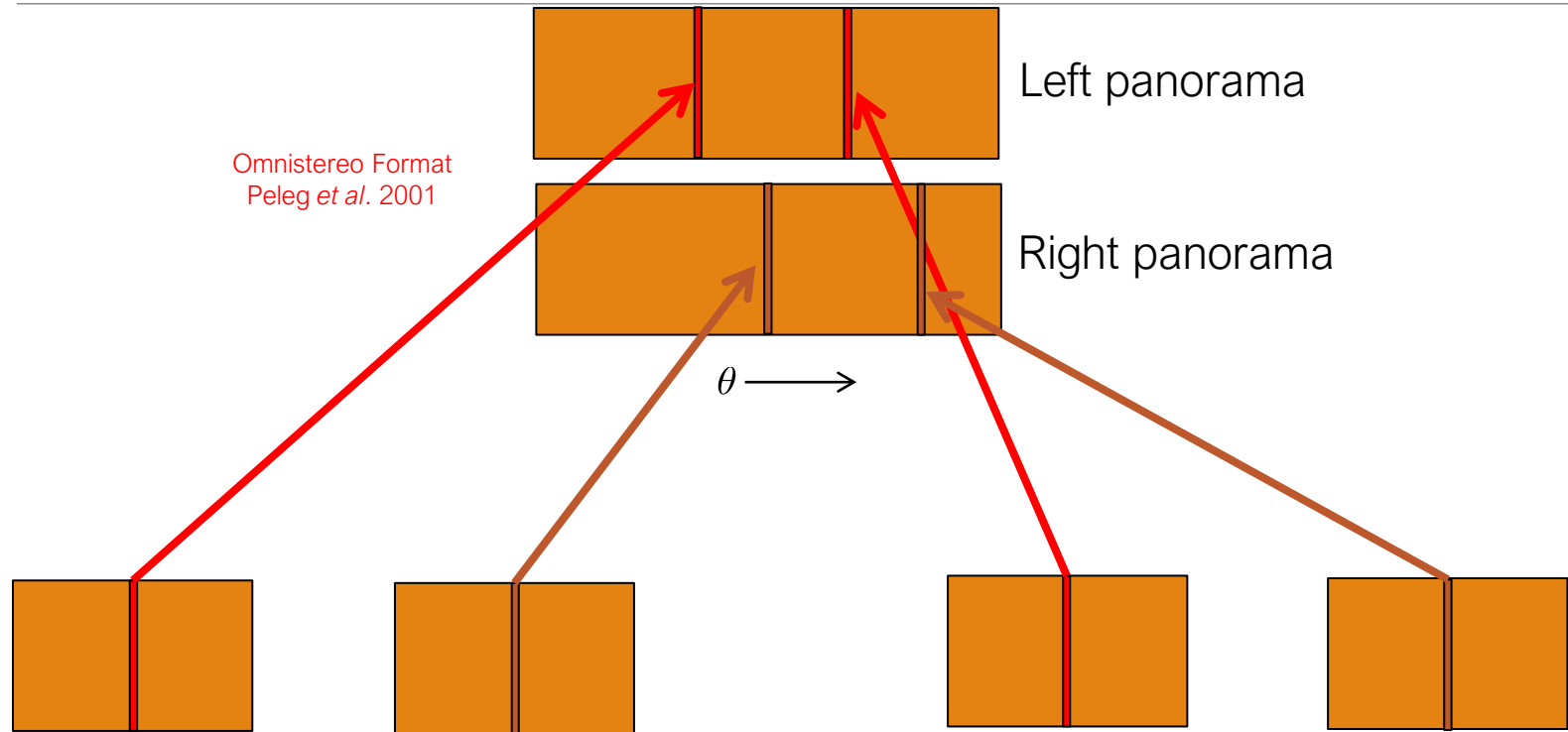
Approximation: Store only Middle Ray

Omnistereo Format
Peleg *et al.* 2001

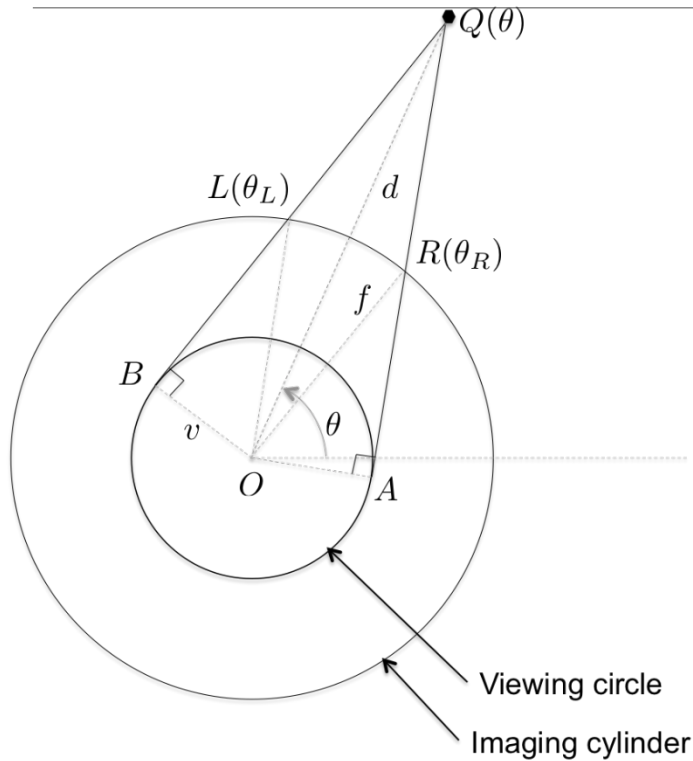


Approximation: store only middle ray for L and R eyes for each direction

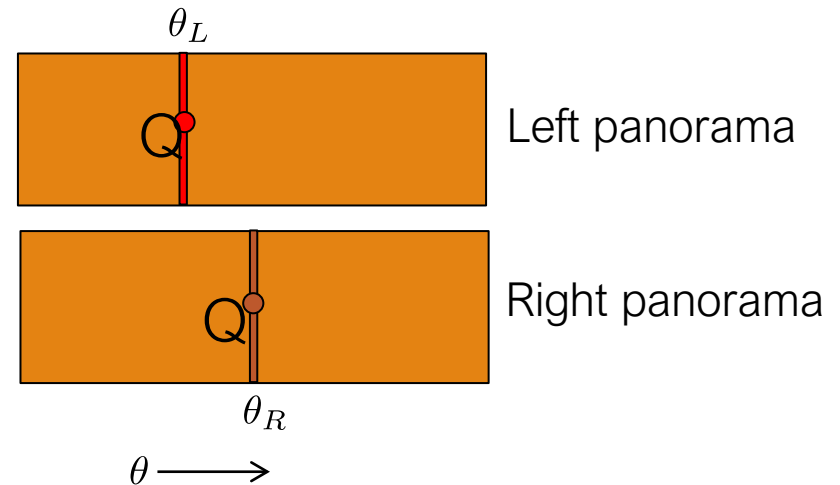
Omnistereo Panoramas



Omnistereo: Geometry Details



Q : scene point
 d : distance to Q from origin
 v : viewing circle radius
 f : imaging cylinder radius
 L, R : coordinates of Q in panoramas

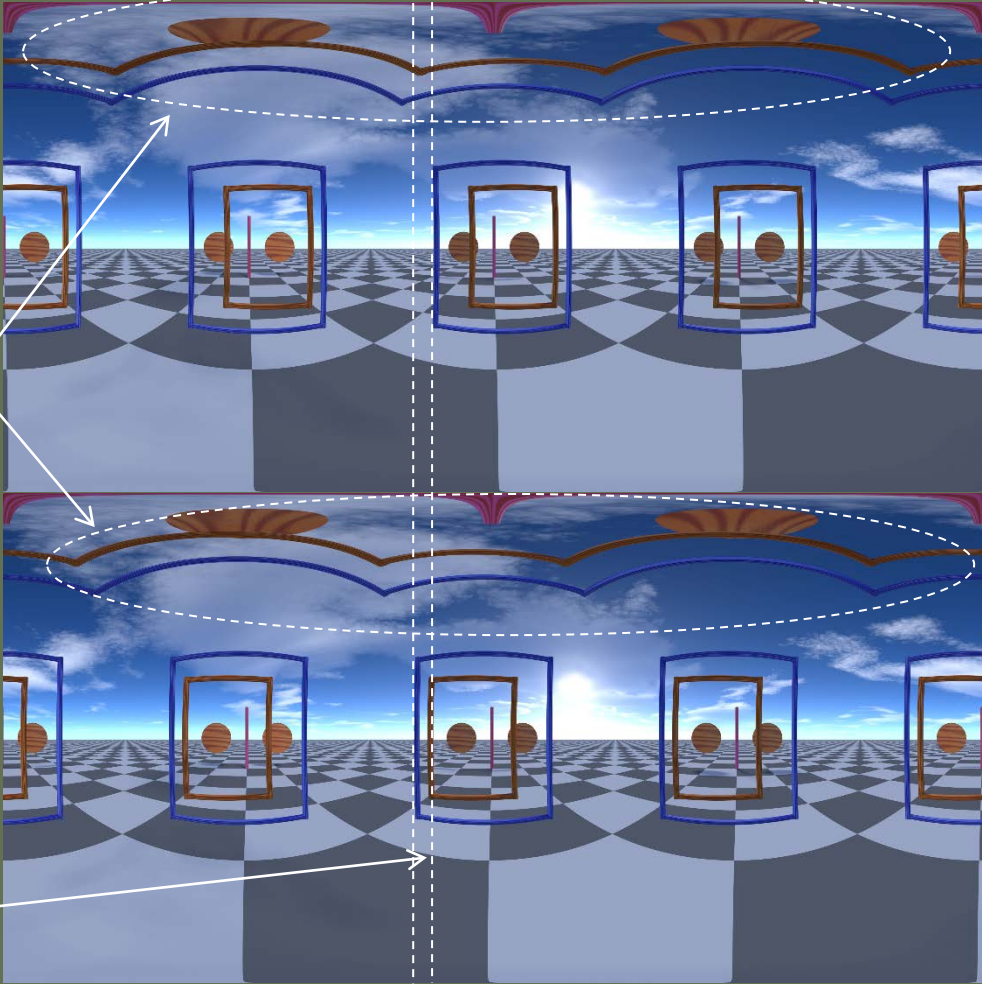


Omnistereo example

Sphere-to-plane distortions

side by Hari Lakshman (EE 368)

Disparity



Left panorama

Right panorama