360 video

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Presentation slides here
http://paulbourke.net/ecu2018/

Contents

Pioneering days	Hobbyist	Current commercial solutions	Future
< 2010	Massive camera development from 2014-2015	Low cost twin lens cameras	Solving the parallax issue
Pre VR head mounted displays	Mirror based single camera	Higher end multiple camera solutions	Scaling up resolution and frame rate
Large unwieldy	Ultrawide angle fisheye	Software evolution	Plenoptic function
Data storage difficult problematic	Home made rigs using GoPros	Optical flow algorithms to solve the parallax problem.	Volumetric video
Design mainly for large scale displays	Google camera		Light field capture

Pioneering days

Cylindrical panorama

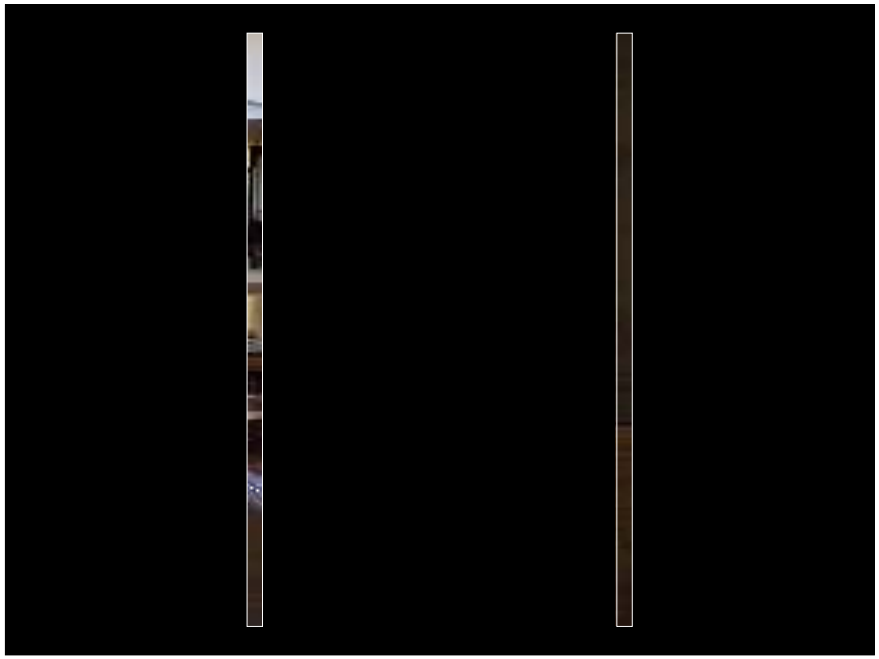
iCinema

iCinema, UNSW

Monash

University of the Sunshine Coast

Roundshot camera



Left eye

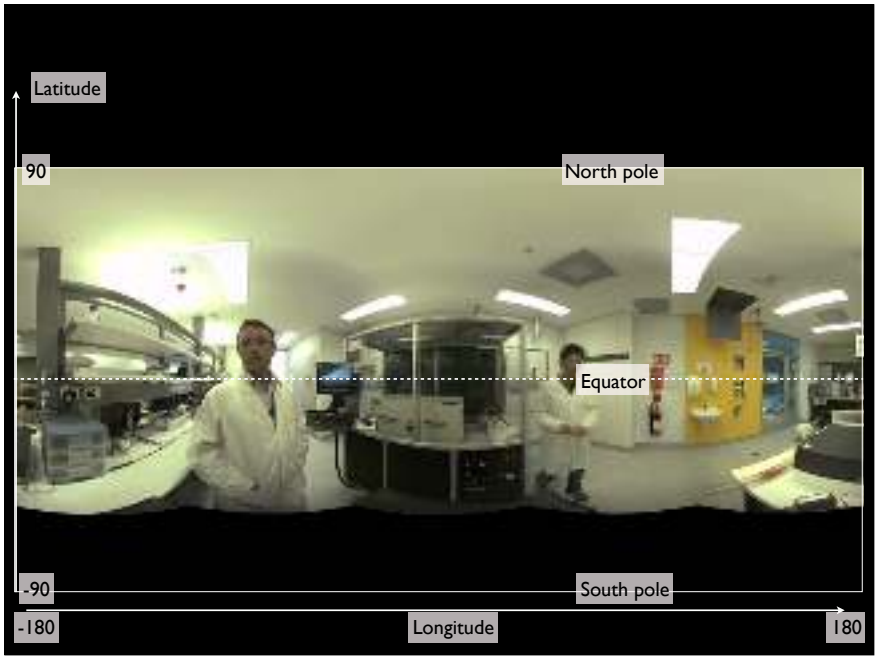
Right eye

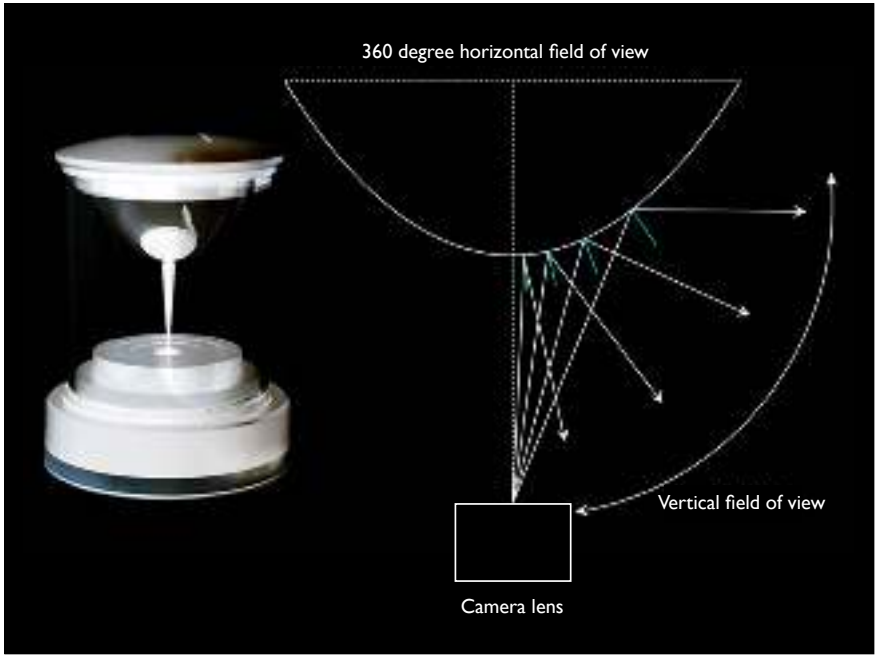
Left eye

Right eye

Turkiye, Sarah Kenderdine

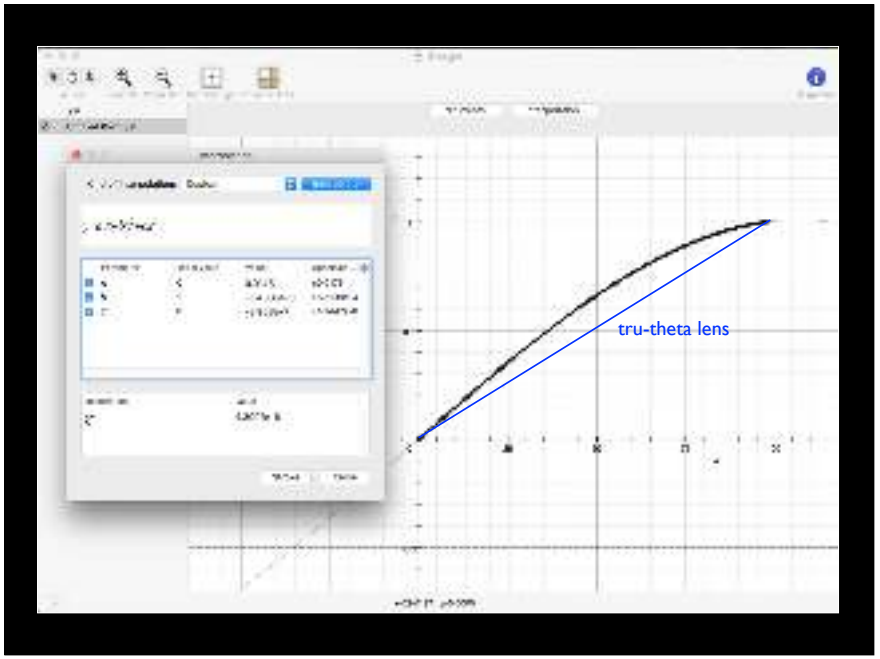
Hobbyist

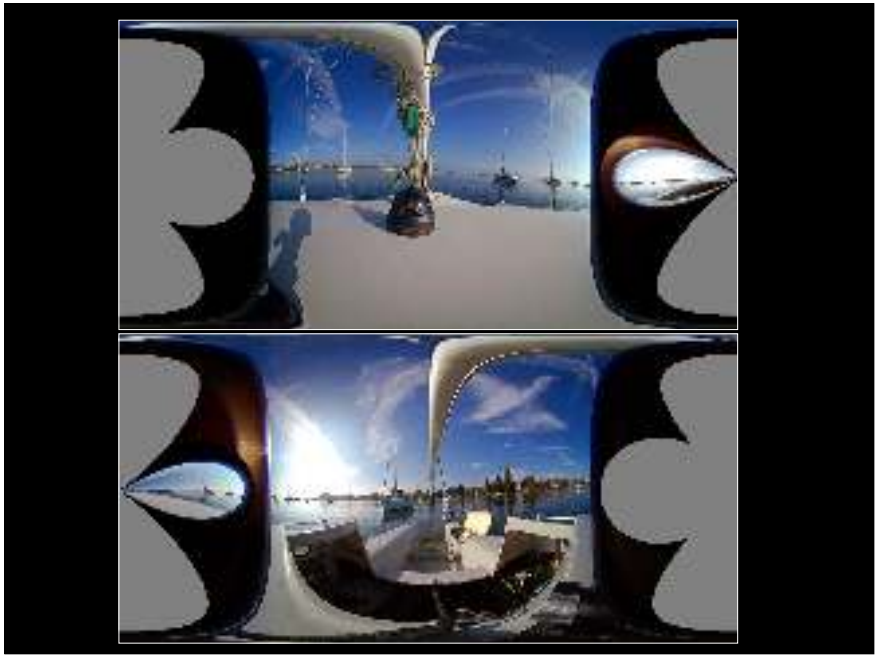

Latitude
90
North pole
Equator
-90
South pole
-180
Longitude
180

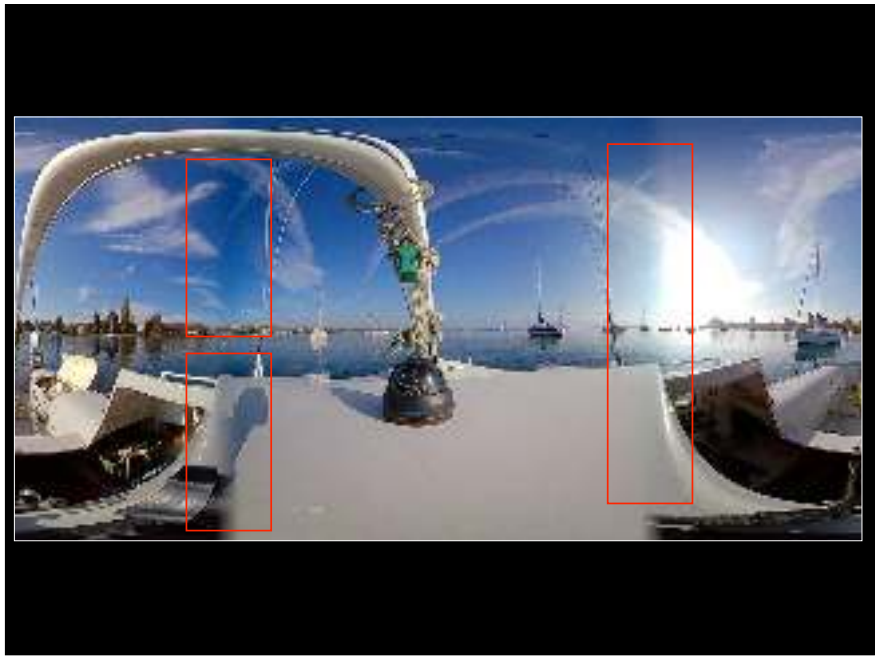

360 degree horizontal field of view
Vertical field of view
Camera lens

Entaniya 250 degree fisheye

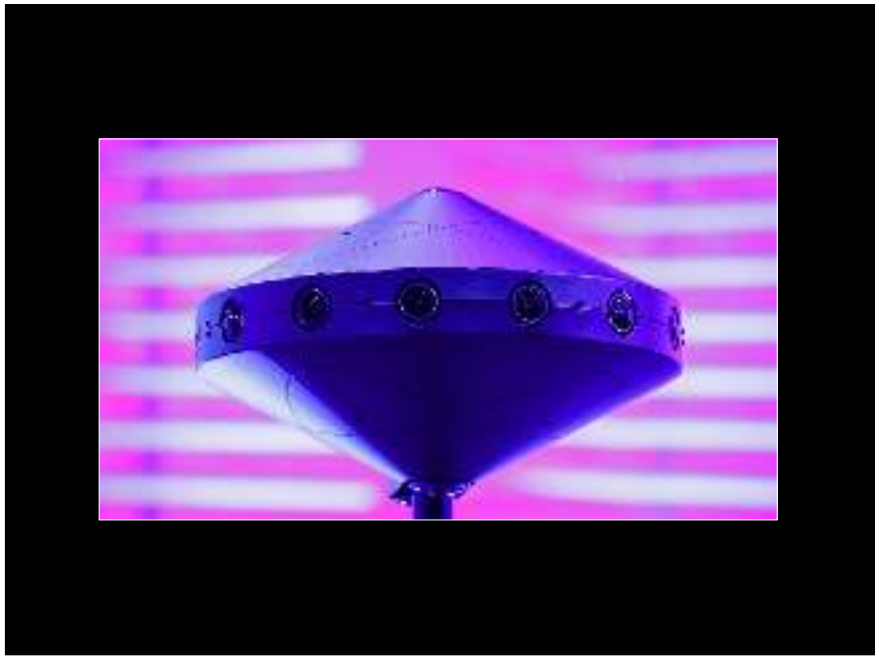
Homido workflow


tru-theta lens





Simplest stereo video rig



Jaunt One

Nokia Ozo

Current commercial solutions

LadyBug-3

LadyBug-5

Standard dome

iDome

Insta360 pro

Vuze

Samsung 360 Round

Kando Pioneer

GoPro Omni

ZCam S1 Pro

And many others …

The future

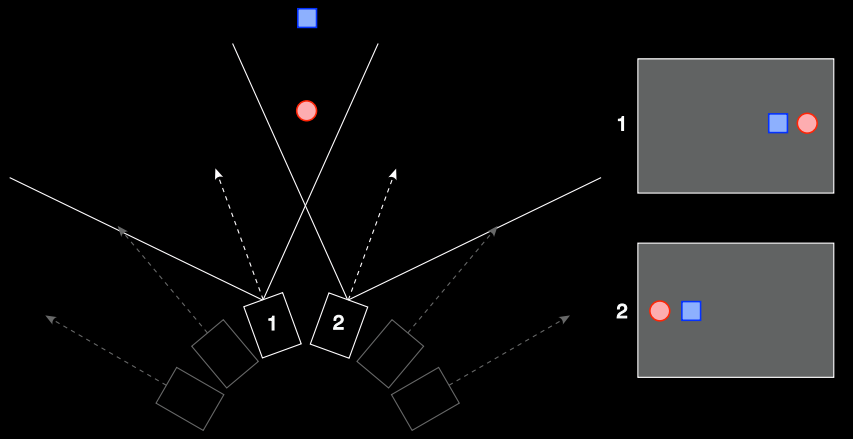
The incremental improvements are:
resolution, frame rate, dynamic range,
minimising compression artefacts….

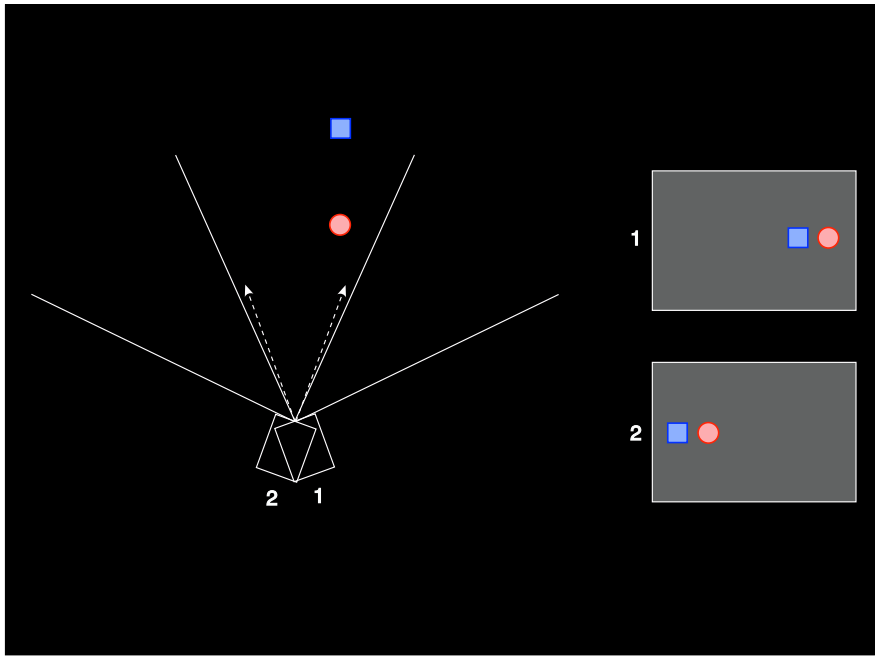
But the bigger picture is

Solving the parallax problem

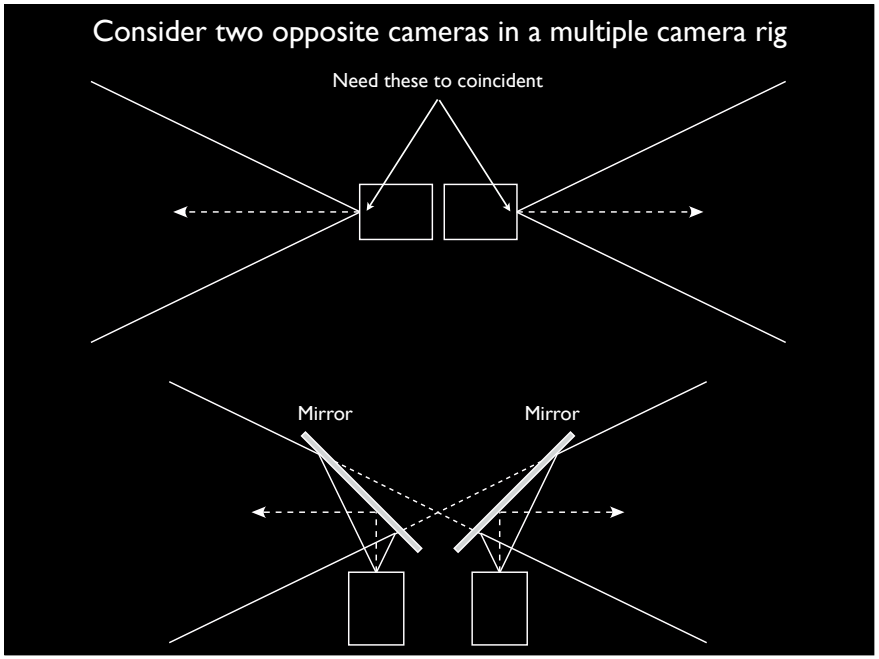
Light fields

The fundamental problem: parallax error!



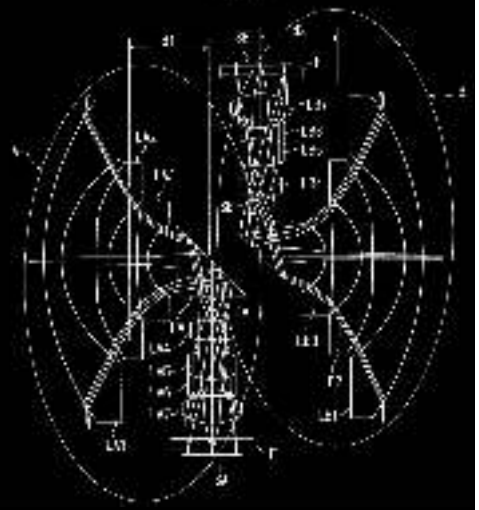


Consider two opposite cameras in a multiple camera rig



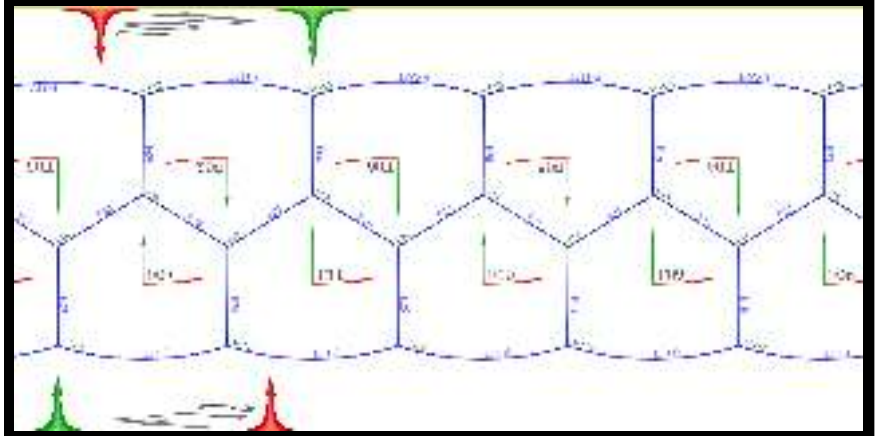
Circlorama camera
(Disney)

FIG. 1



Camera pairs side by side

Camera pairs top and bottom



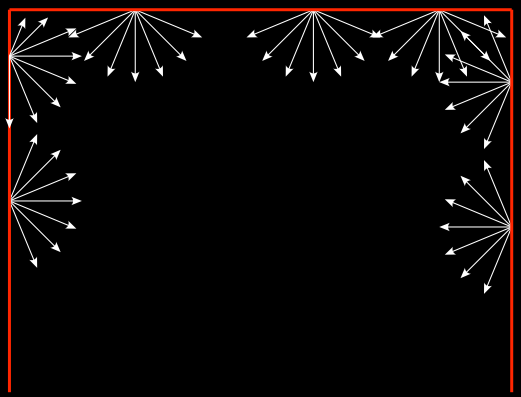
One possible future

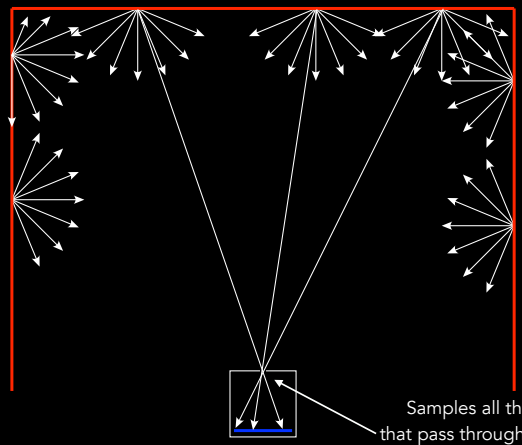
- A single standard camera == view for one eye.
- Two standard cameras == view for two eyes (stereopsis).
- Single camera and fisheye lens == engages peripheral vision for one eye.
- Dual cameras and fisheye lenses == engages peripheral vision for two eyes.
- 360 camera == ability to look around, and engages peripheral vision.
- 360 stereo camera == ability to look around, engages peripheral vision, and stereopsis.

Replace camera with video camera in the above and time component is added.

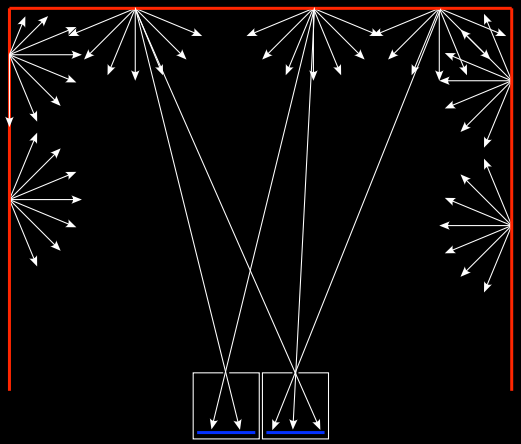
But, they don’t allow the viewer to move around!

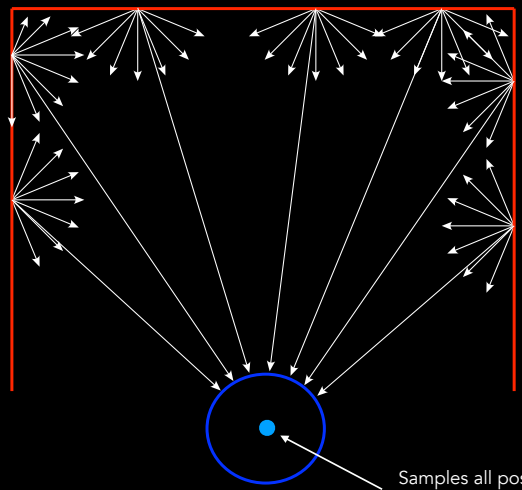
Lightfield and the Plenoptic function





Samples all the light rays
that pass through the aperture.
All other light rays are ignored.





Samples all possible light rays
passing through a single point.

The plenoptic function

- Plenoptic: (optics) Of or relating to all the light, travelling in every direction in a given space.
- The "light field" is the infinity of 3D points through which innumerable light rays (photons) enter and exit every point.
- The part of the light field we observe (in one eye) 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. $L(x, y, z, \theta, \phi, \lambda, t) - ?$

Final slide: Considerations

- Everything and everyone is in shot, where does the director stand?
- No out of camera for a boom mic.
- How do you light the set?

- Equirectangular projections are non-linear, cannot treat them like a rectangle during editing, eg: cannot simply add 2D elements.
- Left edge of the equirectanglar connects to right edge.

- There is no concept of zoom.

Questions and demonstrations