

Digital omnidirectional stereoscopic camera

Slides will be placed here

<http://paulbourke.org/dodsc2020/>

Presented by Paul Bourke, 8 July 2020

Camera development and deployment in conjunction with Sarah Kenderdine and Jeffrey Shaw

Agenda

Project introduction - Atlas of Maritime Buddhism

Camera specification goals - ODSF, resolution, field work ...

Roundshot camera (Seitz)

Digital implementation

Comparisons

The Atlas of Maritime Buddhism

- World touring exhibition based upon the spread of Buddhism through the maritime silk road.
- 2018, 2019 were busy field work years: Singapore, Hong Kong, China, Taiwan, Cambodia, Burma, Sri Lanka, India ...
- Four key digital assets
 - Stereoscopic panoramas (topic for today)
 - High quality 3D reconstructions of objects (mostly statues)
 - Gigapixel equirectangular images (temple interiors)
 - 360 video using InstaPro2 and Titan (cultural events, worship, etc)



Digital Roundshot



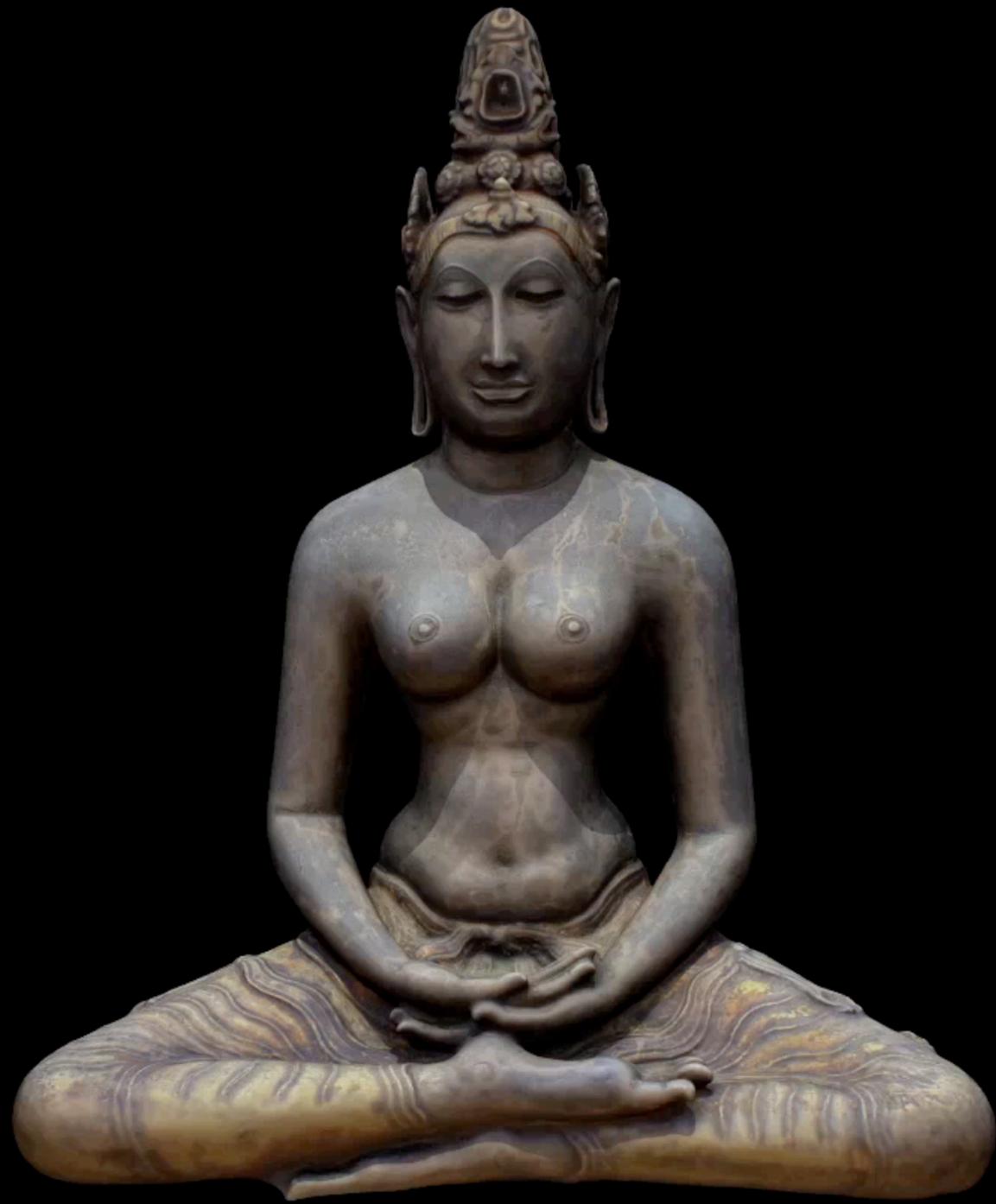
Film Roundshot



Insta360 Pro2 or Titan

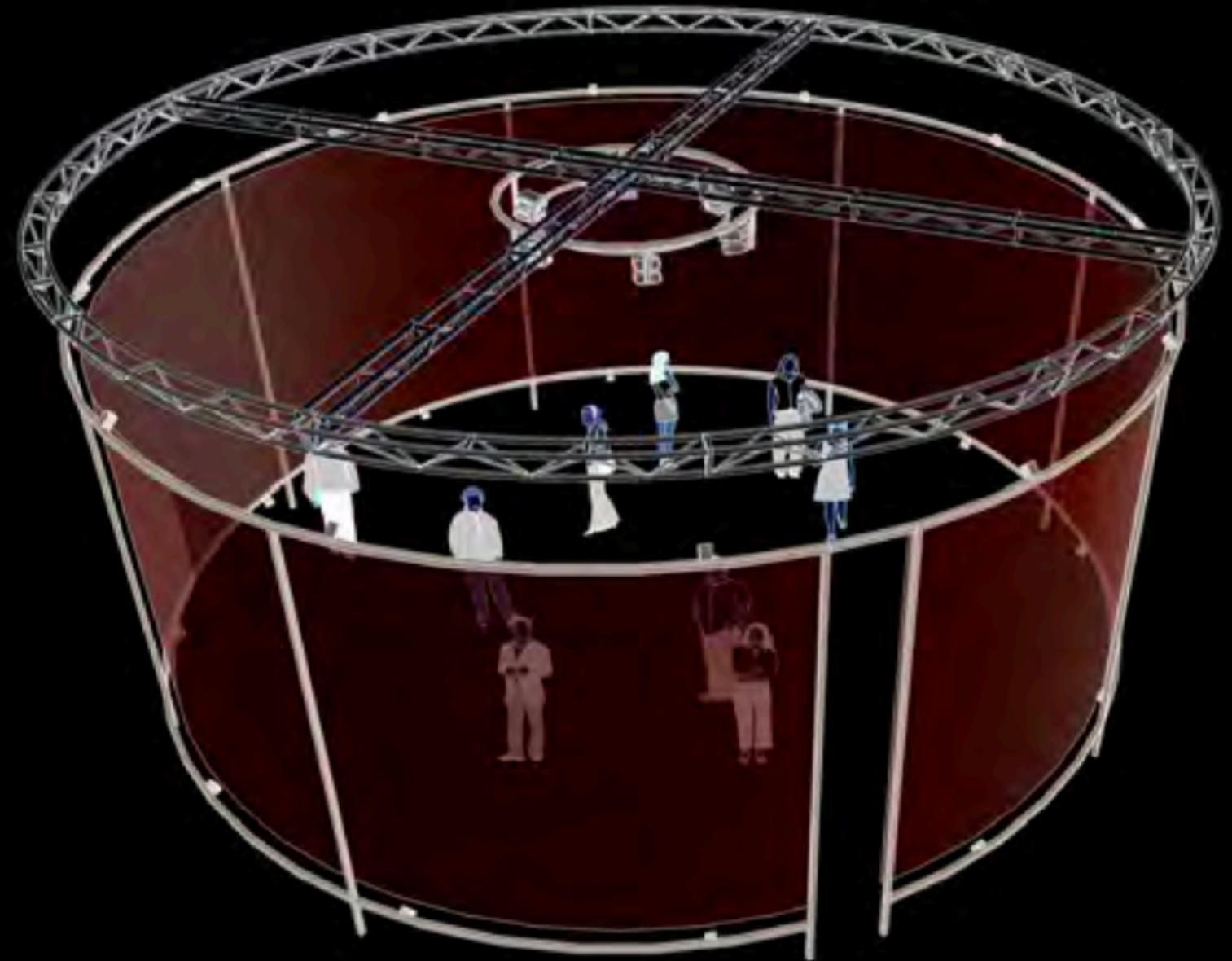


Canon 5D MK IV + Seitz motor



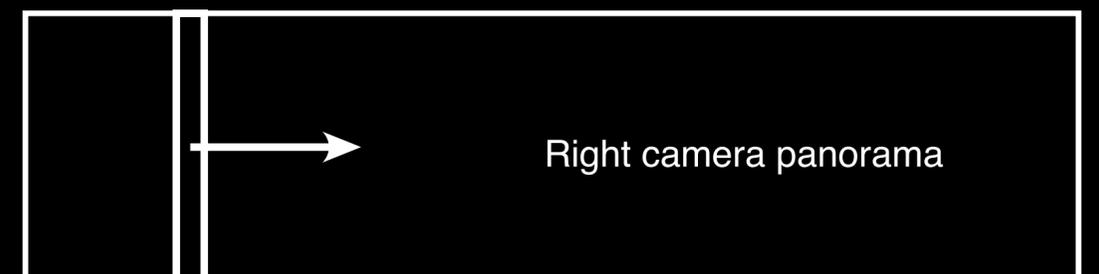
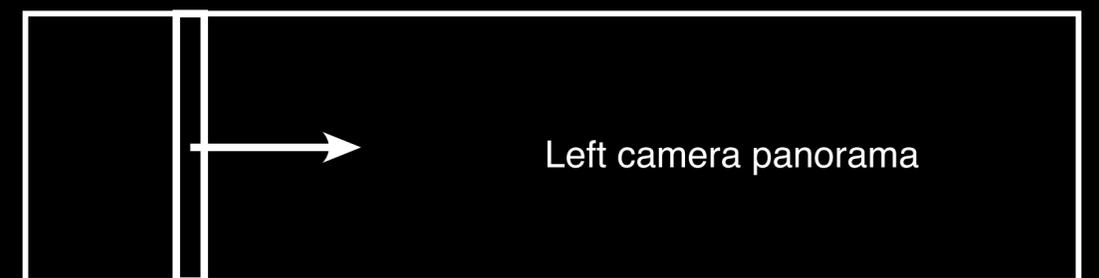
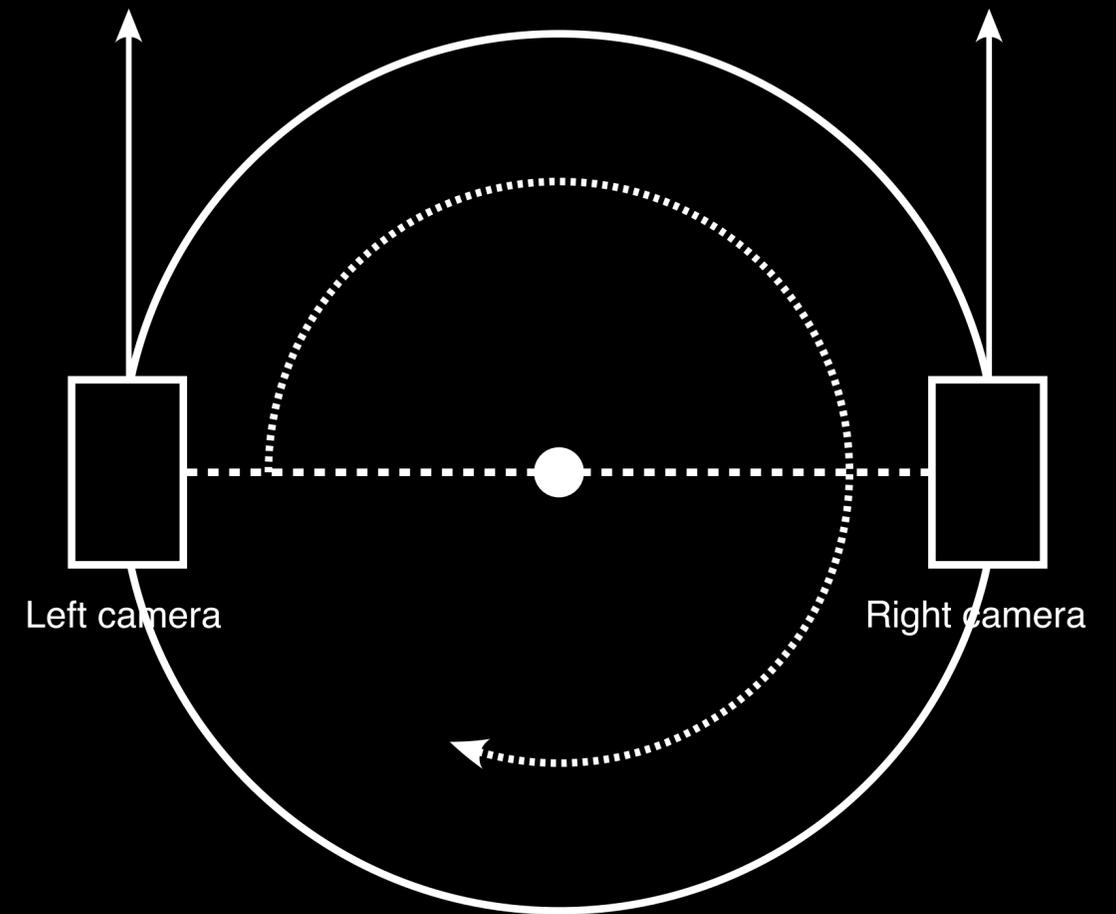
Main viewing environment

- AVIE: Advanced Visualisation and Interaction Environment
- Typically 10m diameter
- 6 x 4K projectors
- Native resolution 20K+ pixels horizontal
- Typically 10:1 aspect ratio
- Can be active or passive stereoscopic projection



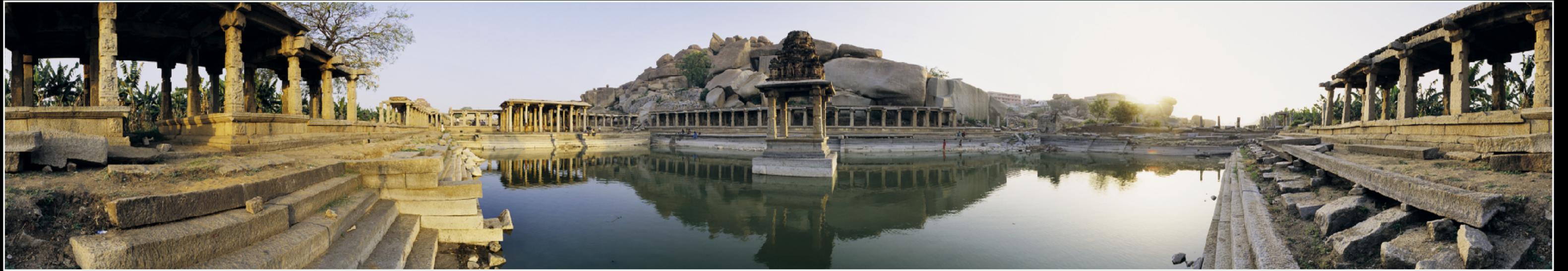
Camera specification goals

- Omnidirectional stereoscopic panoramas
 - Allows multiple viewers, all potentially looking in different directions to get an approximation to the correct stereo pairs.
- 20K pixel resolution across 360 degrees
 - so in reality want perhaps 2 times that
- Capture time under 30 seconds
 - heritage sites are rarely unpopulated
- Small enough for small team field work
 - camera and tripod carried by 1 person
- Require artefact free ODSP
 - Large scale projection stereoscopic environments are not the same as HMDs
- Prefer not to rely on feature point stitching









Roundshot camera

We have a solution

- Manufactured by Seitz.
- This is a film camera, two rolls of 70mm film.
- Shutter opens, camera rotates, each roll of film gets exposed.
- Just under 8cm interocular.
- Only 5 were made, client owns 2, we travel with both.
- Exposure controlled by rate of rotation, fast in high light, slow in low light. Fixed slit width and only one film stock, only other exposure control is lens aperture.



Postproduction

- Develop each roll of film
 - Increasingly difficult
- Drum (or otherwise) scan each roll
 - Increasingly difficult
- Perform warping to correct for scanning defects (stretch and rotate). Also perform a blend across the left and right edge.
 - panoalign (Custom software)
- Apply colour and other edits
 - PhotoShop







First digital implementation

- Rig based upon a pair of GH5s (2018).
- 10.5mm Voigtlander lens, f/0.9
= 75 degree vertical FOV
- 8cm interocular, wider than we would like.
- 10 bit 4:2:2 All-I (long GOP) recording mode.
- 24fps recording.
- 4K high in portrait orientation.
- Syrup motorised rig.





Parameters

T - the rotational period (120s)

f - the video frames per second (24 fps)

ϕ - total rotational angle (720 degrees)

$vfov$ - vertical field of view of lens

$hfov$ - horizontal field of view of slit

w - slit width

W - panorama width

$$h_{fov} = \phi / Tf$$

$$w = H \frac{\tan\left(\frac{h_{fov}}{2}\right)}{\tan\left(\frac{v_{fov}}{2}\right)}$$

$$W = \frac{\pi H}{\tan\left(\frac{v_{fov}}{2}\right)}$$

Postproduction

- Extract frames from each movie
Typically between 2000 and 3000 frames across 720 degrees
- ffmpeg
- Extract and align narrow vertical strips from each panorama
Typically slits are between 5 and 10 pixels wide, usually a 2 pixel blend
- spanosample (custom solution)
- Apply correction edits, colour adjustments
- PhotoShop
- Clip to 360, aligning zero parallax edge blending between 0 and 360
(possibly correcting for imperfect levelled rig)
- panoalign (custom solution)
- Entire pipeline is in 16 bit

Left camera



Lead in: Camera recording, rotation not started

Right camera



Lead out: Camera recording, rotation finished

720 degrees





Vaishali



Advantage, film

- Main advantage of film Roundshot is that in good light it can rotate in 6 seconds. This allows moving (within reason) subjects in the scene.

The digital version always takes 30s otherwise get motion blur.

- The film Roundshot is superior in very dark spaces assuming we have time for the slow rotation.

30 minute rotation is not unusual.



Advantages, digital

- Dynamic range and colour quality is superior.
- Camera is lighter and easier to setup and operate.
- Images can be processed almost immediately so you know if you “have the shot”.
- The deciding factor may be the increasing problem of transporting film through airports and convincing authorities that the film cannot be passed through the scanners.

No clear winner!

So we shot in India (6 weeks), Thailand and China with both!

Future

On the lookout for the camera to base the second revision of the rig on. Next improvement will probably being able to move to 60fps @ 4K (or better), 10 or 12 bit. Cameras exist with those specs but with unacceptable interocular.

Questions?

