Novel Visualisation Technologies: Projects in the Humanities

Paul Bourke

In collaboration with

Centre for Rock Art Research and Management, UWA

Archaeology, UWA

Western Australia Maritime Museum

ALIVE (Applied Laboratory for Interactive Visualisation), City University of Hong Kong

Centre for Creative Content & Digital Innovation, University Malaya

Ananguku Arts - Australian National University

iVEC @UWA

Outline

- Introduction to iVEC
- Introduction to science/data visualisation
- Present three data capture technologies in science/engineering and their deployment in projects in the humanities:

- **High resolution image capture and display**
  Projects: Beacon Island - Rock Art
- **Automatic 3D reconstruction from photographs**
  Projects: Rock Art - Dragon Gardens - Ngintaka story
- **360 degree video recording in cultural heritage**
  Projects: Ngintaka story - Mah Meri rituals

Introduction to iVEC

http://ivec.org

- A partnership between the 5 key research organisations in Western Australia.
  - Curtin University
  - Murdoch University
  - Edith Cowan University
  - Commonwealth Scientific and Industrial Research Organisation
  - The University of Western Australia

- Facilitates research at the partners by providing advanced computing: hardware and expertise.

- Five programs
  - **Education**
    Provides year-round training modules and runs an interns program each summer.
  - **eResearch**
    Supporting researchers maximise the benefits of digital technology within their discipline.
  - **Industry and government uptake**
    Facilitate relationships between iVEC and government and industry.
  - **Supercomputing technology and applications**
    Collaborates with and encourages the uptake of supercomputing by researchers.
  - **Visualisation**
    Supports visualisation through expertise and specialist infrastructure.

Visualisation

- Definition:
  Visualisation is the process of applying advanced computing techniques to data in order to provide insight into the underlying structures, relationships and processes.

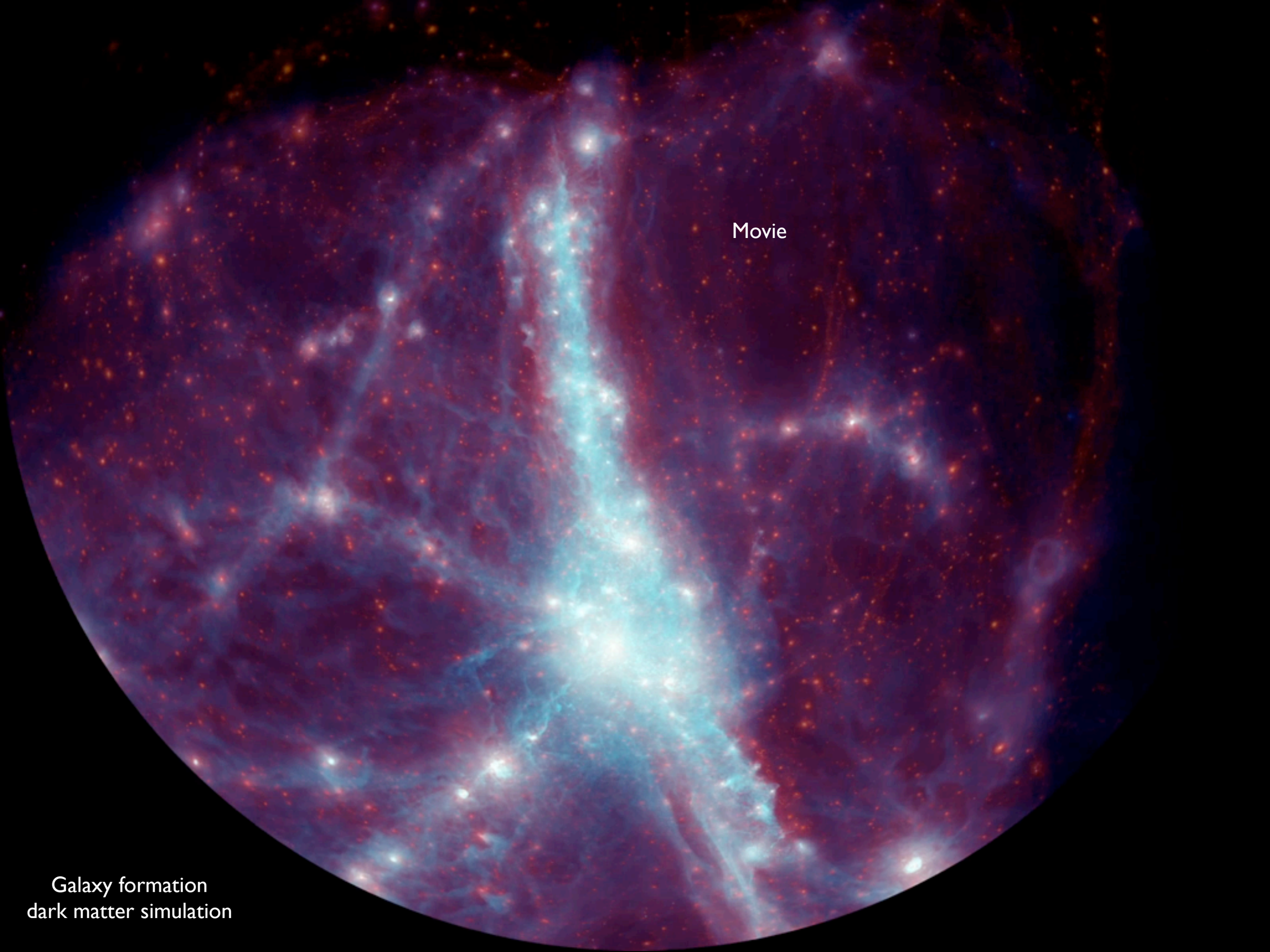
- Definition for my mother to tell her friends:
  “Turning data into images and animations in order to help understand the data”.

- Requires skills including
  - computer programming
  - algorithms in computer graphics
  - mathematics
  - realtime / interactive APIs and technologies
  - human / computer interfaces
  - knowledge of human perception theory
  - creativity and design

Movie

Tornado simulation

Pausiris mummy
Museum of New and Old Art, Hobart



Galaxy formation
dark matter simulation

Displays

- As the name suggests, visualisation most most often uses the sense of vision to convey information to the human brain.
- As such it makes sense to leverage the capabilities of the human visual system, three main areas:

- Stereopsis: the sense of depth we perceive due to having horizontally displaced eyes.

- Peripheral vision: the sense of "being there", of being immersed.

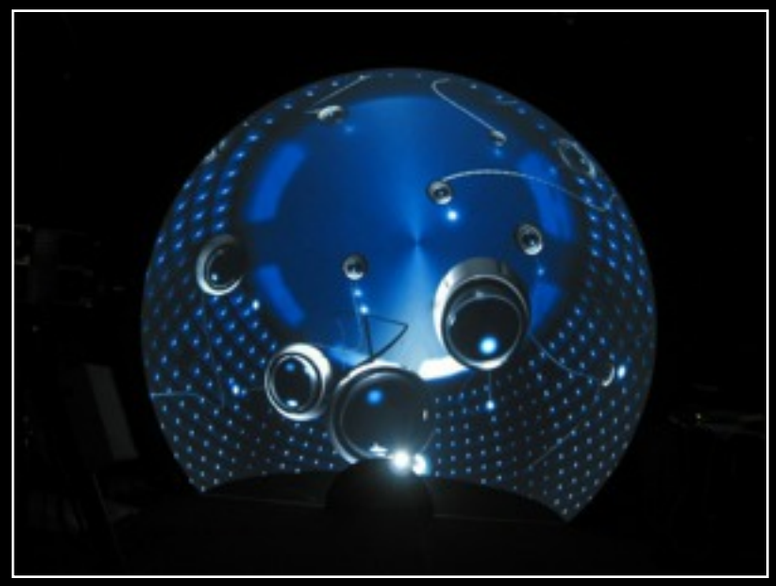
- Visual fidelity: ability to resolve detail at scale.

Tiled display (Fidelity)

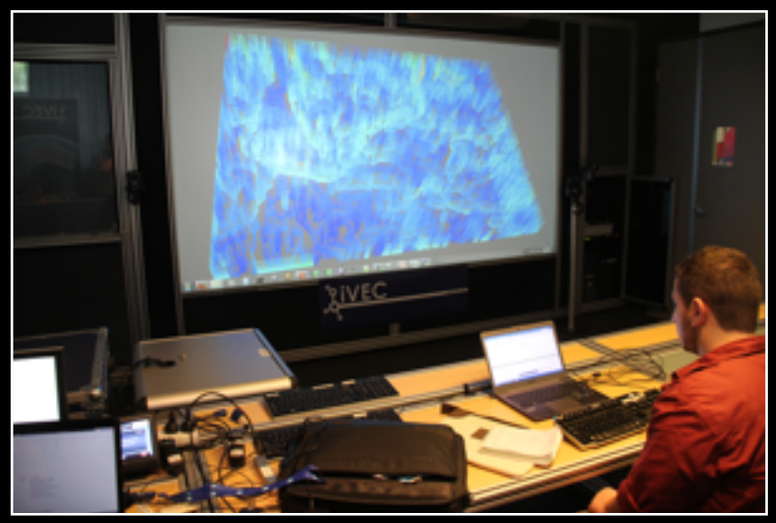
iDome (Immersion)

Visualisation @ iVEC

- Three 1/2 FTE funded positions: UWA - Curtin - CSIRO
- Budget to support visualisation activities of researchers at any of the iVEC partners.
- Compute infrastructure dedicated or optimised for challenging visualisation projects.
  Workstations and Pawsey visualisation nodes.
- Displays to support visualisation.



Curtin & ECU



CSIRO

UWA

Murdoch

ECU

Visualisation @ iVEC

- Capture infrastructure: Stereo3D video camera, high resolution video cameras - camera rigs - structured light cameras.
- Unique displays.
- Software tools and expertise.

Specialist cameras

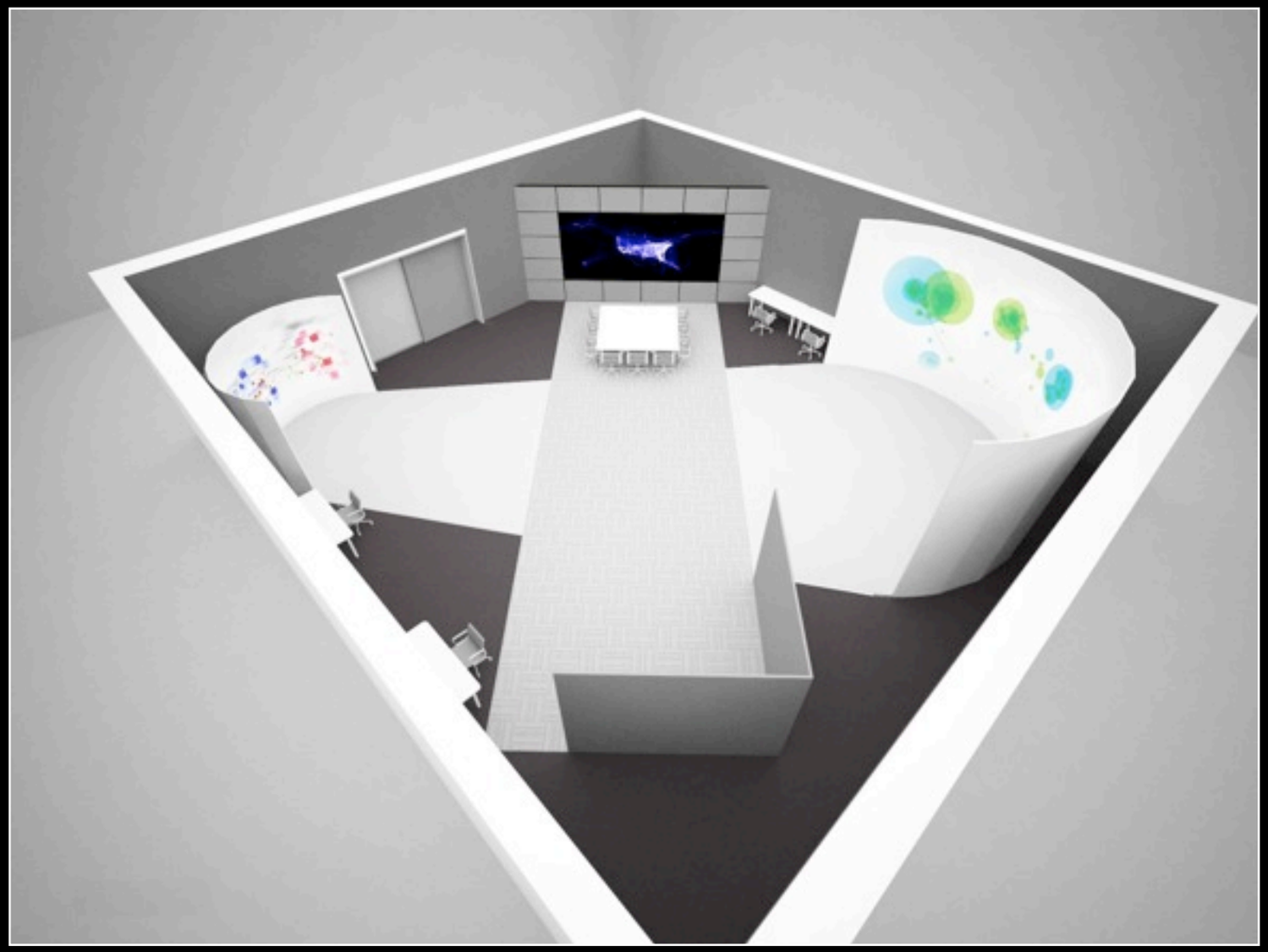
3D cameras

Unique displays

3D scanners

CDVF - Curtin Data and Visualisation Facility

- Exciting new facility being created “right now”.
- Located in the John Curtin Gallery.
- Consist of 4 display technologies
  - Hemispherical
  - Cylindrical (Stereo3D)
  - Wedge (Stereo3D)
  - Tiled panel
- Able to operate in both a research and exhibition mode.
- Key application areas
  - Data visualisation
  - Virtual environments
  - Visual arts
- Planned opening in November 2013



High resolution image capture and display

- Imaging sensor resolution is only growing modestly.
  Current commodity SLR cameras are around the 20 to 30 MPixel range.

- Arbitrary high sensor density means the lens quality may be the final limiting factor to higher resolution.

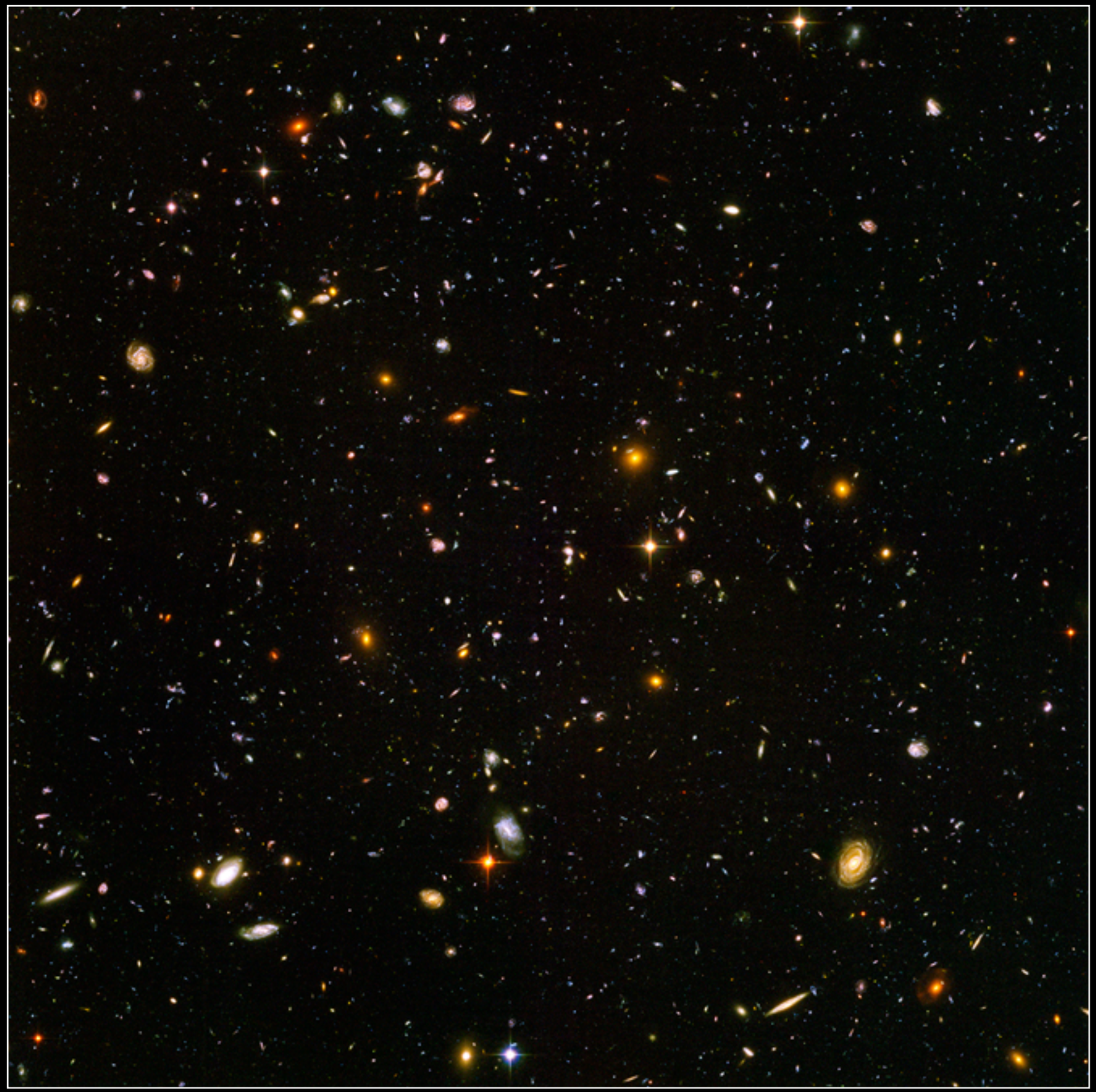
- How does one capture imagery at higher than sensor resolution?

- Solution is to join a large number of photographs, each of a smaller area, together.
  A widely used technique from astronomy to microscopy.

- Motivations
  - Capture imagery from site where access is problematic.
  - Capture imagery of greater research value.
  - Acquire as image of the entire object as well as detail.

Hubble ultra deep field (HUDF)

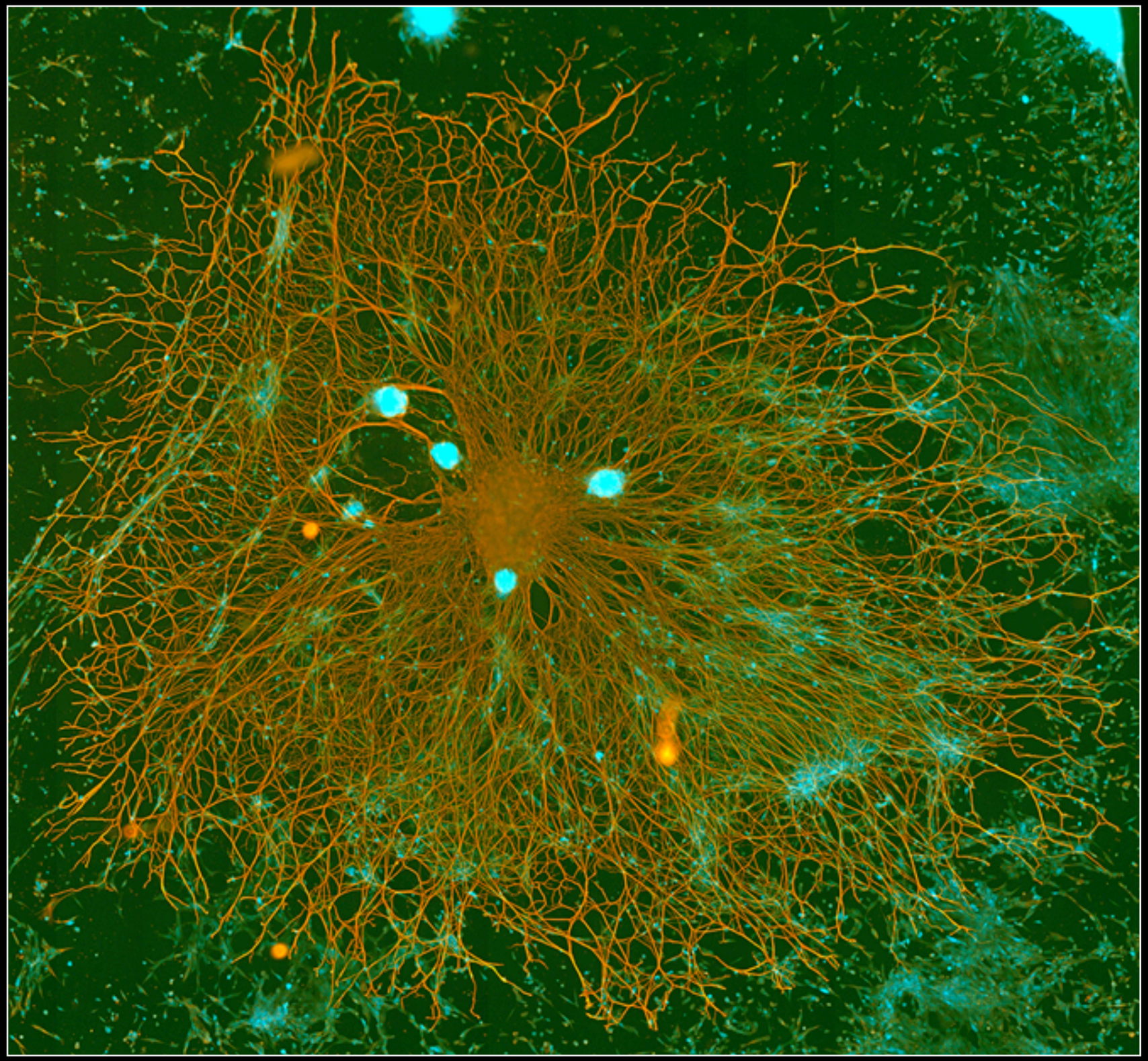
- 10,000 galaxies
- 1mm x 1mm @ 1m
- 7000 x 7000 pixels



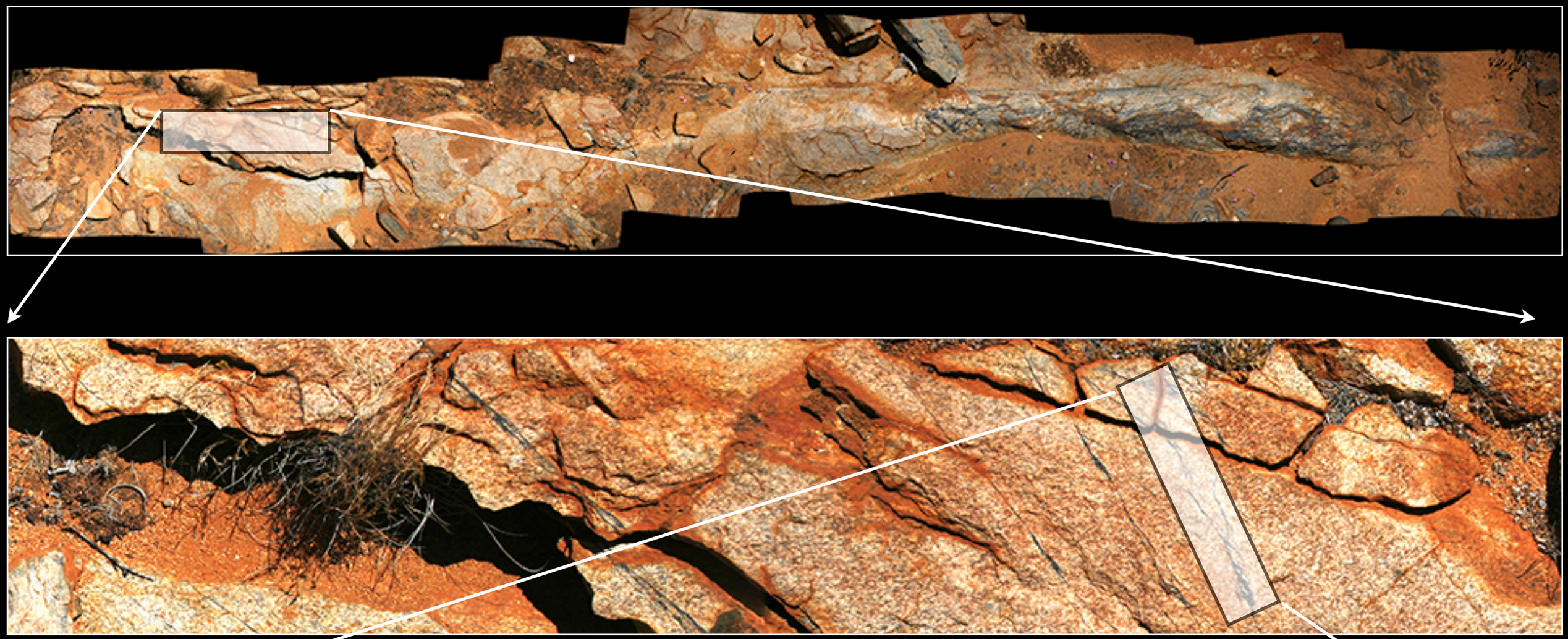
Optical microscopy

- Rat neuron
- 11,000 x 10,000 pixels
- 4x4 tile

CMCA, UWA



Geology



Wanmanna

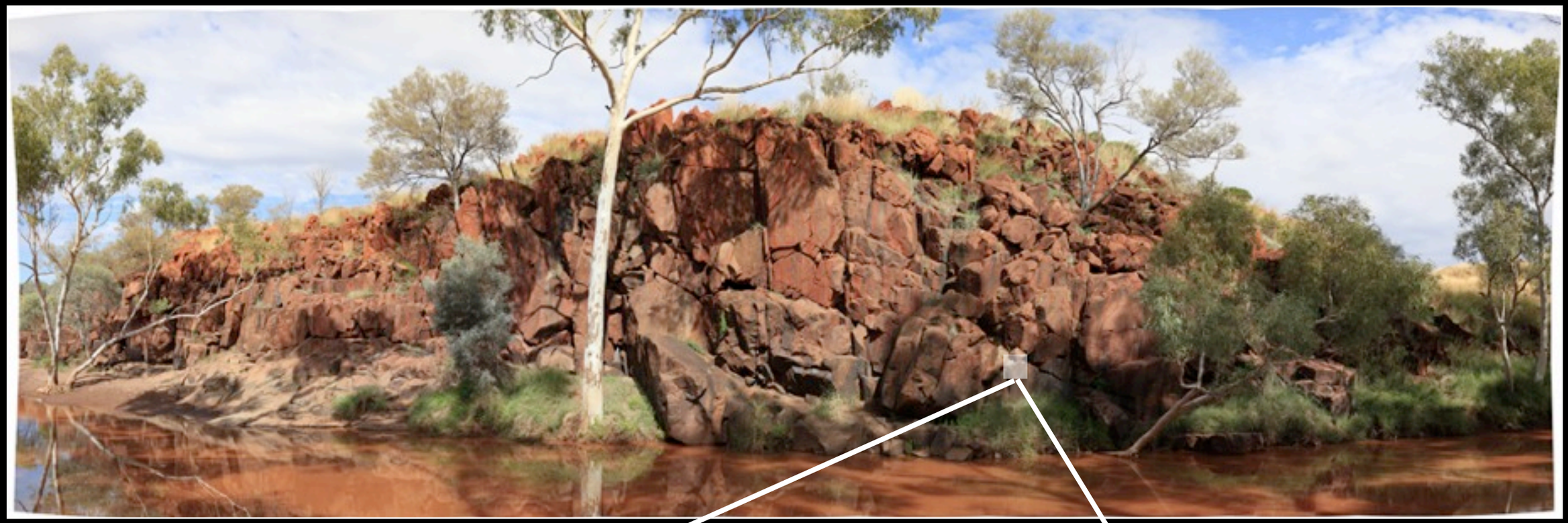
- Project in 2012 in collaboration with the Centre for Rock Art Research + Management, UWA.

Basic technique

- Motorised camera rigs save the time of manual shoot and move camera.
- Final resolution only limited by zoom lens field of view and camera distance.

13 x 3 grid

40,000 x 10,000 pixels



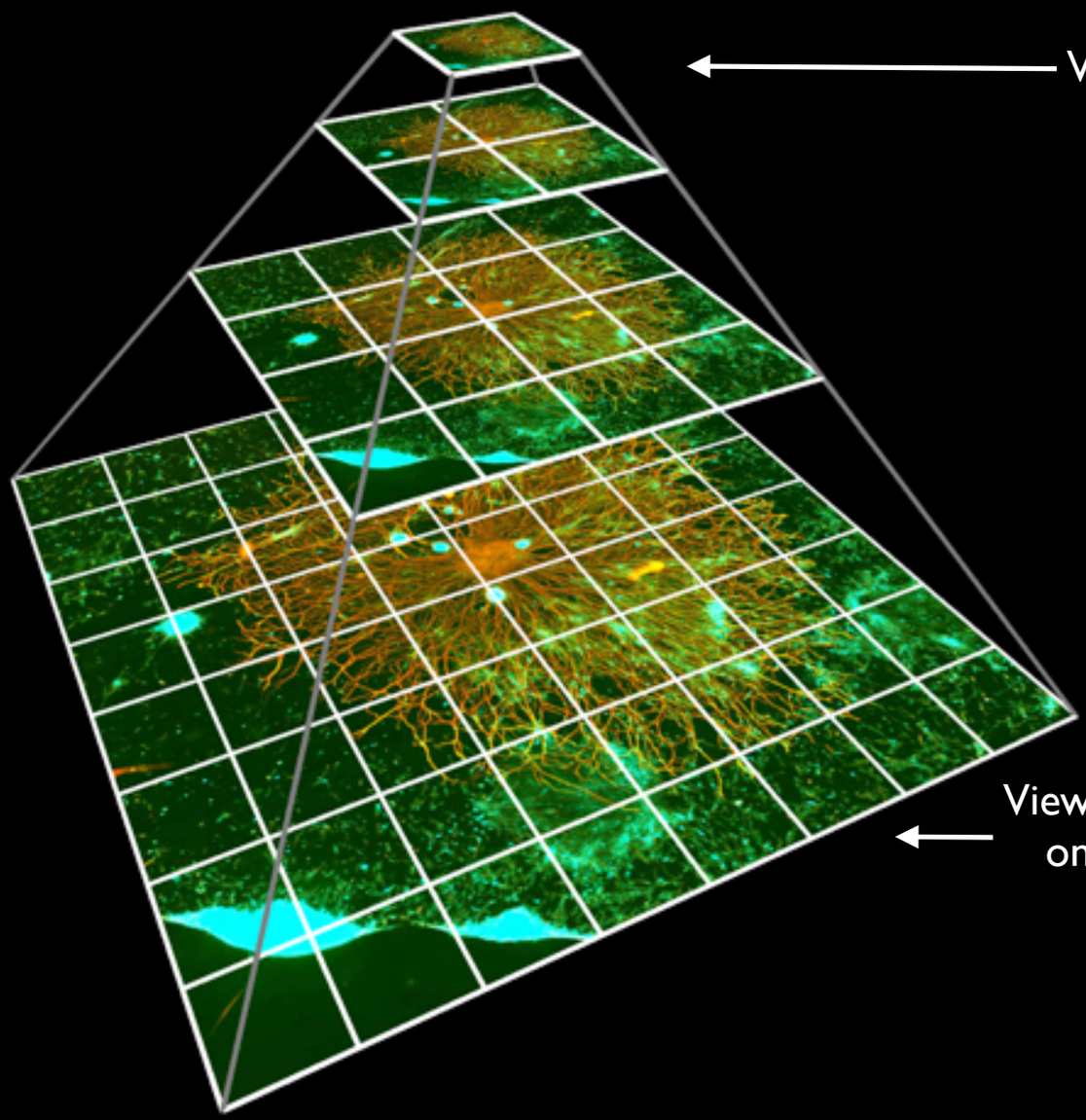
15 x 4 grid

Single 20MPixel image

Movie

Software challenges

- Are some issues with software to view/edit these images.
- Most image file formats for example don't support more than 32,000 pixels in width or height.
- Most viewers expect all the image to be in memory, may not be possible.
- There are "large image formats" and viewers capable of pyramidal multi-resolution formats.

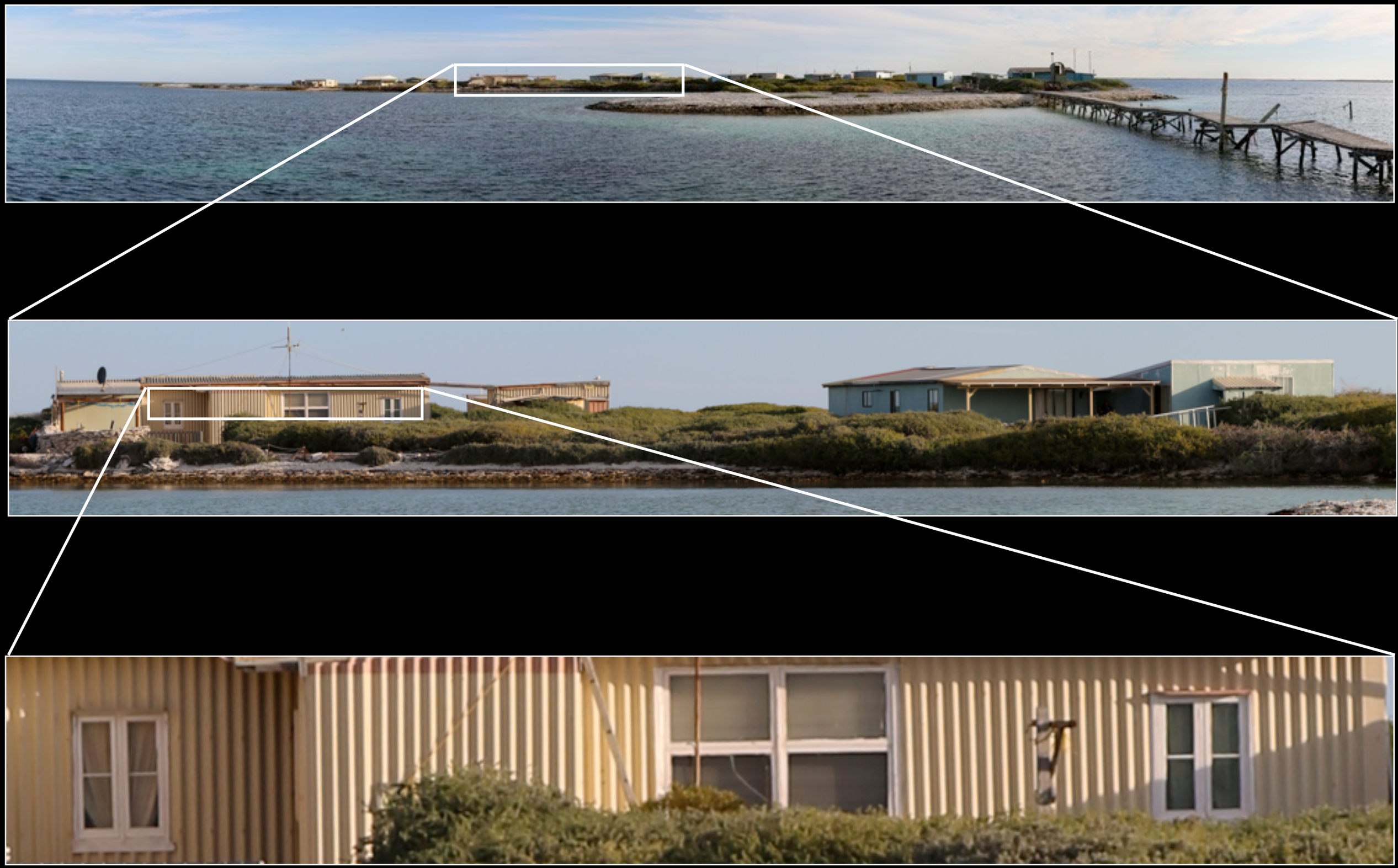


Viewing the entire dataset zoomed out

Viewing a portion of the dataset zoomed in,
only need a subset of the available tiles.

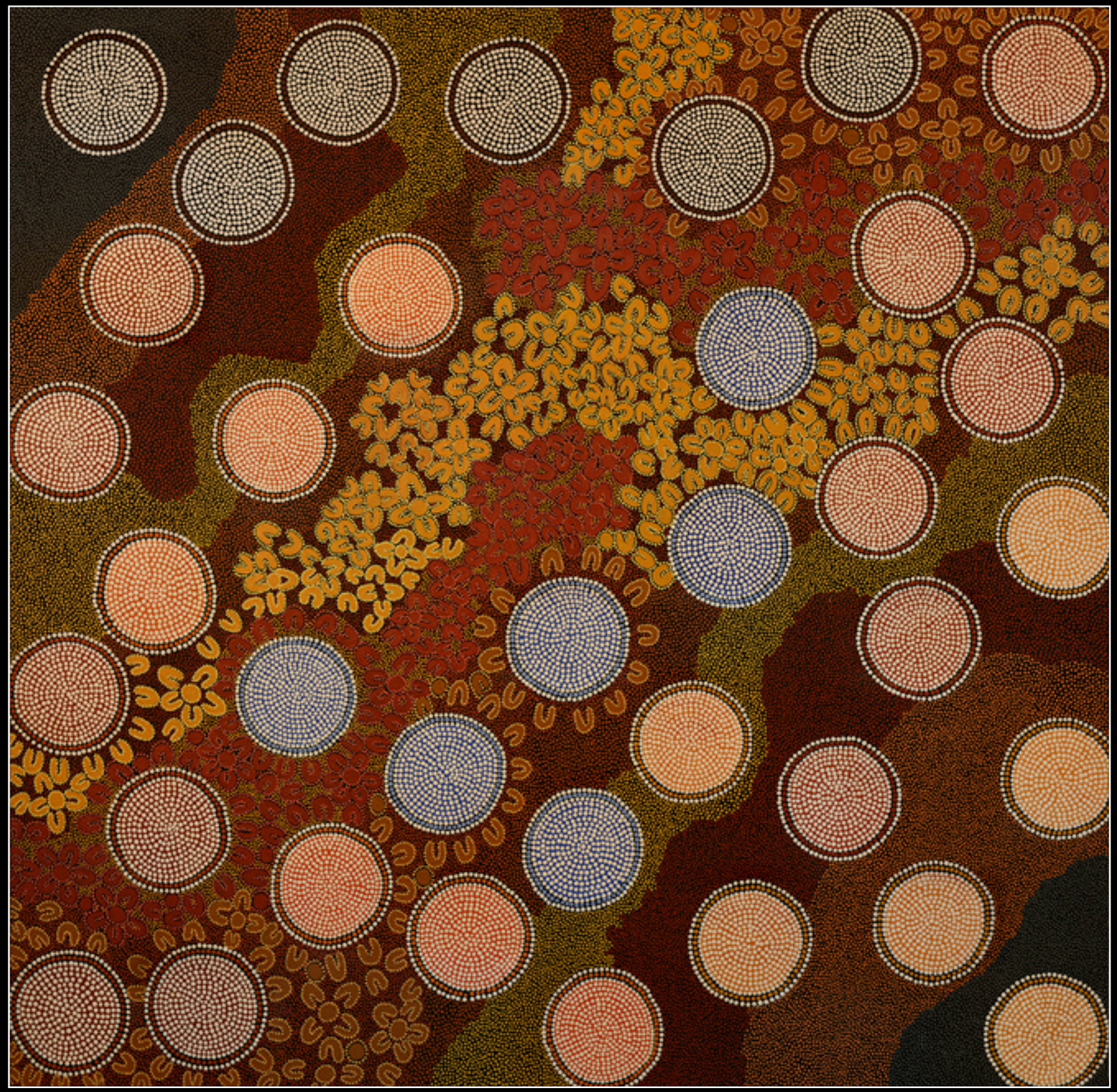
Beacon Island

- Site where the Batavia ship wreck survivors/victims came ashore.
- Project to record the site as it currently stands before fisherman huts are removed.
- Expect additional grave sites under the concrete slabs.

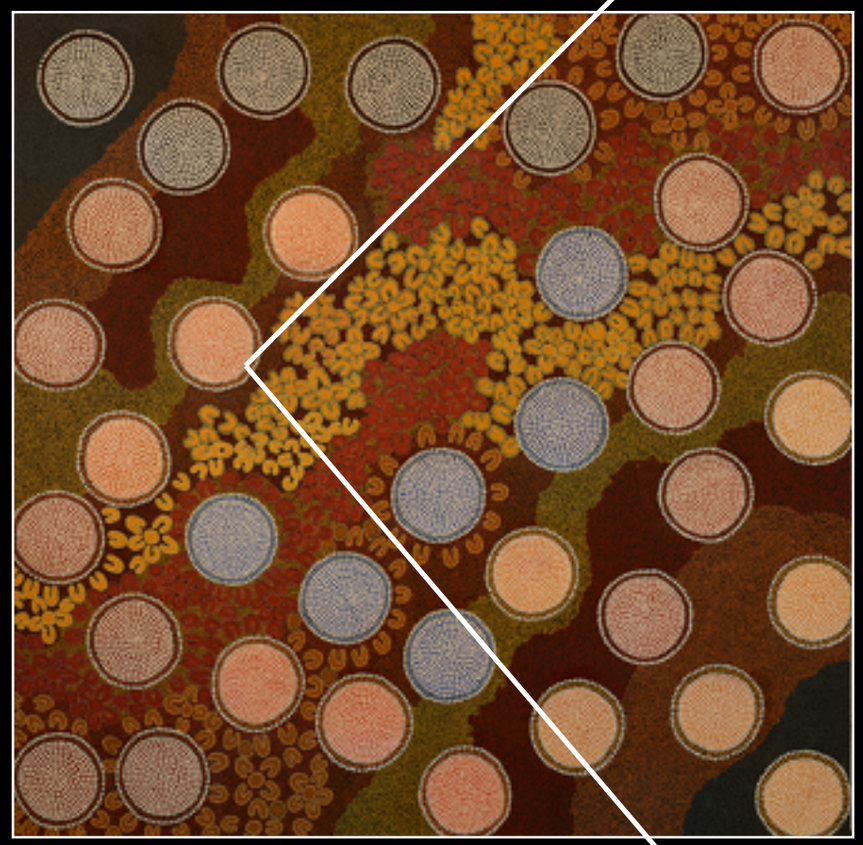


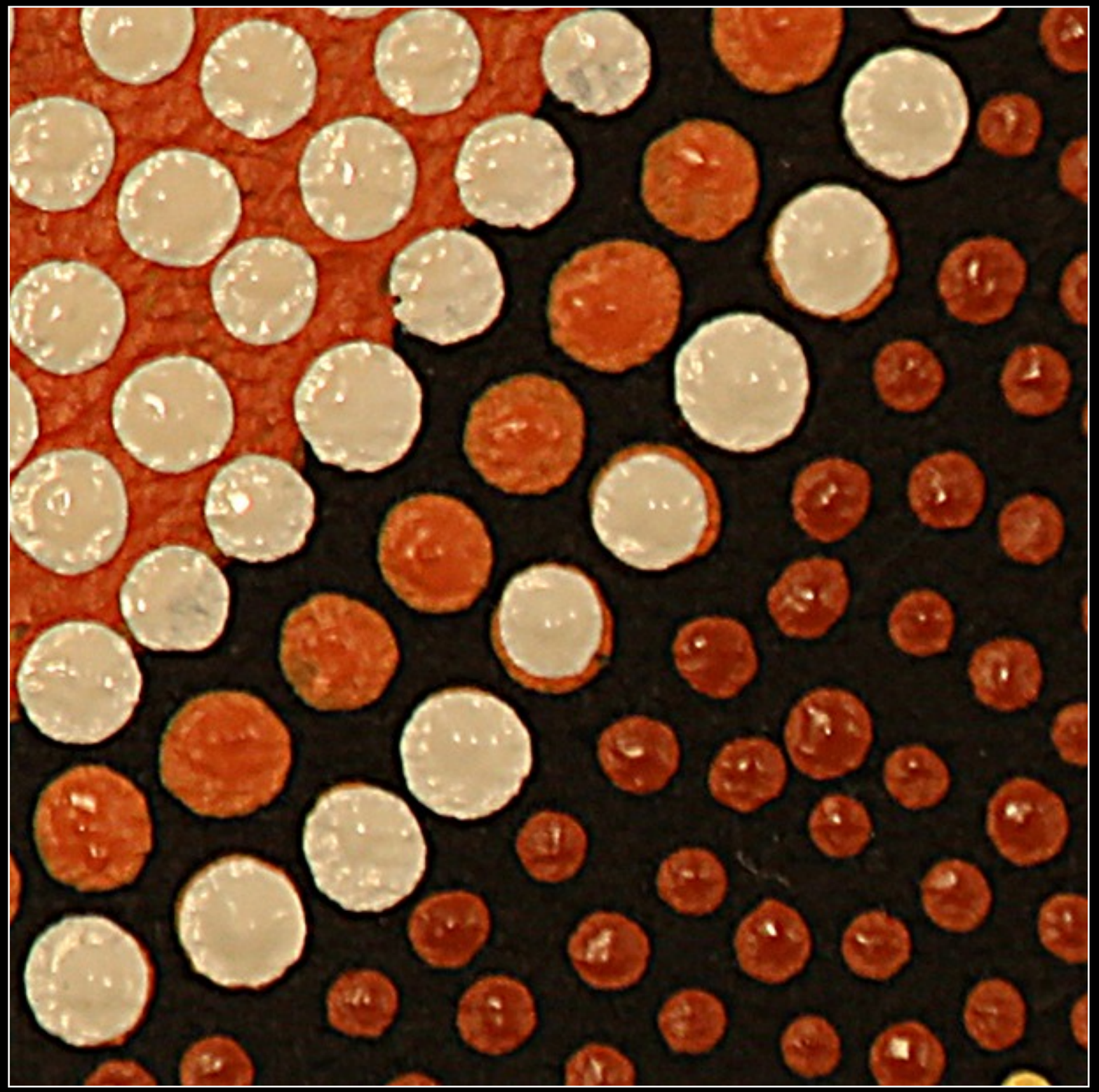
Paintings - pure 2D scans

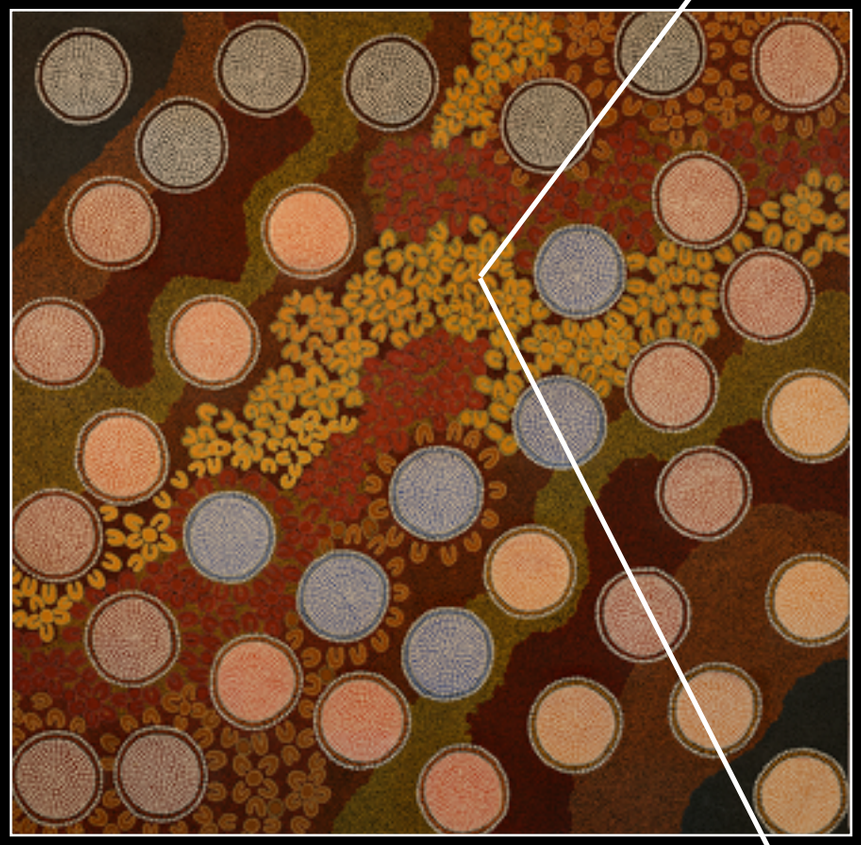
- Margaret Whitehut
- Yamaji Art
- 40,000 x 40,000 pixels

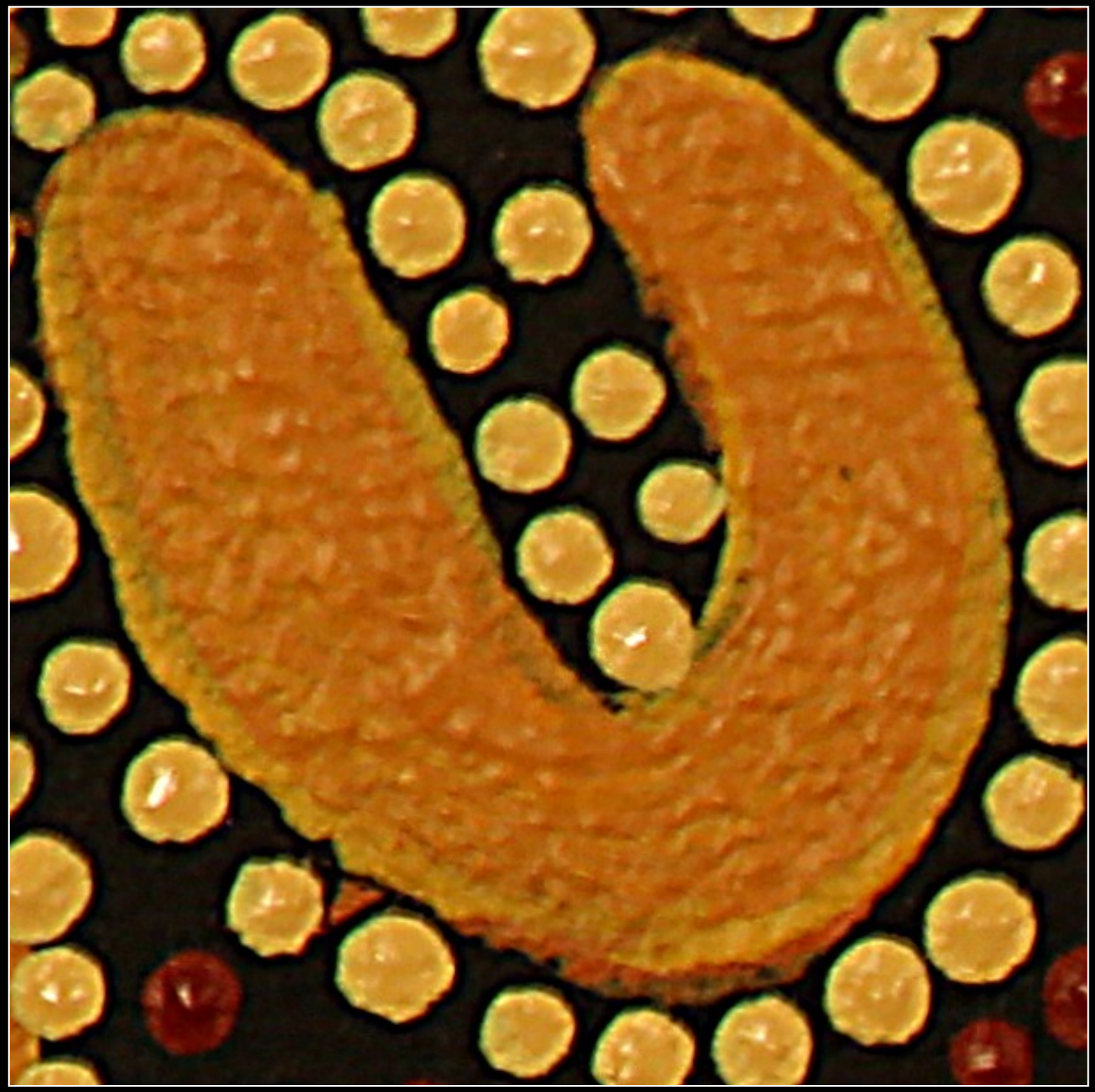


Low tech









Automatic 3D reconstruction from photographs

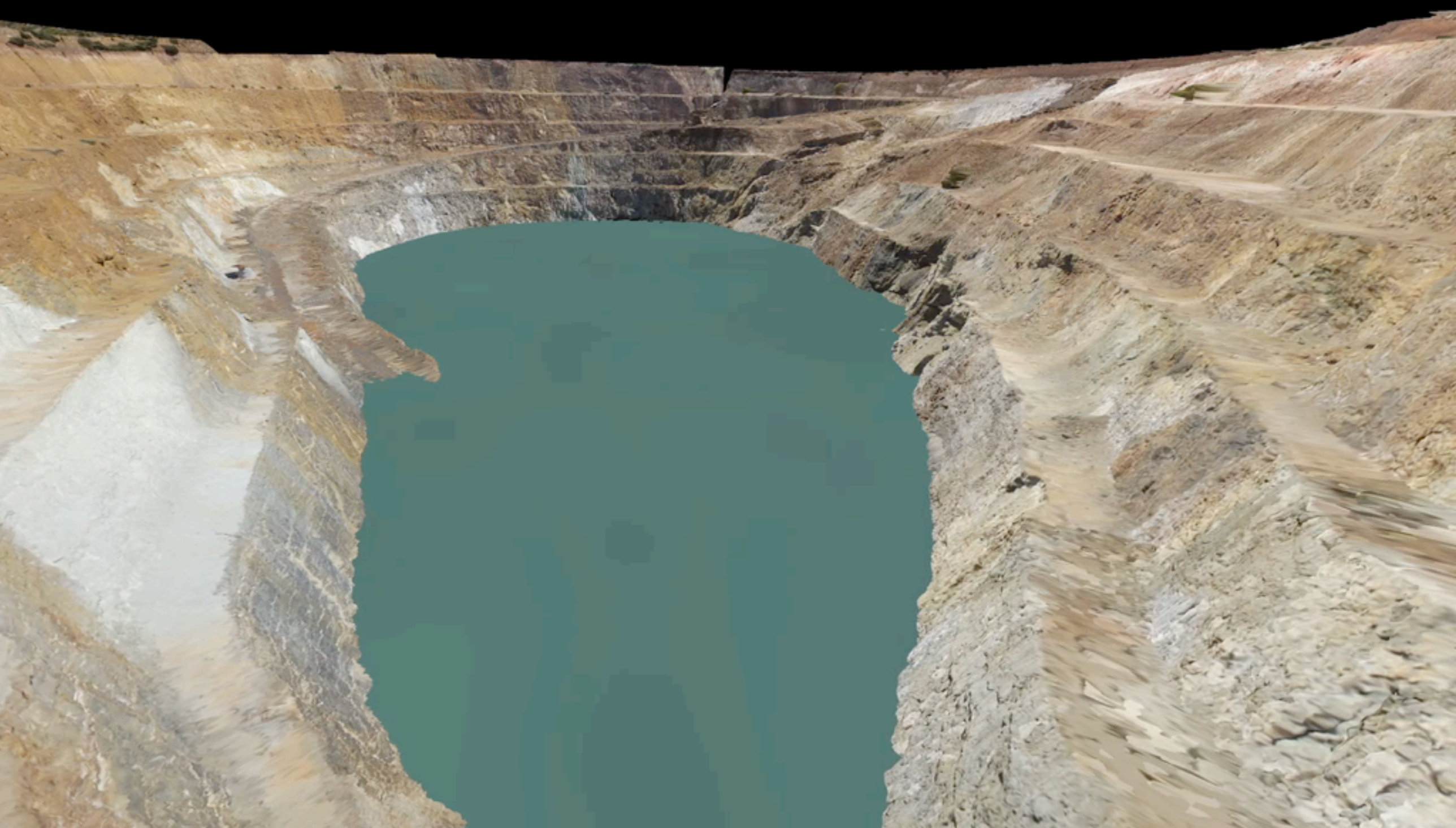
- Photogrammetry: the general term give to deriving some 3D quality from a series of images.
- Traditionally used in landscape mapping, mostly 2.5 structure.
- Due to a number of recent algorithms it is being applied to the capture of full 3D objects.

- Fairly old history in Western Australia in mining and geology.
  For example, a cost effective way of determining volume of rock extracted in mining.

- Motivation and characteristics
  - Capturing 3D models of significant objects, richer data than just photographs.
  - Non-intrusive capture.
  - No specialist capture hardware.
  - Delivers texture and structure.
  - Fast acquisition of objects to populate virtual worlds.

Mine pit modelling

Movie

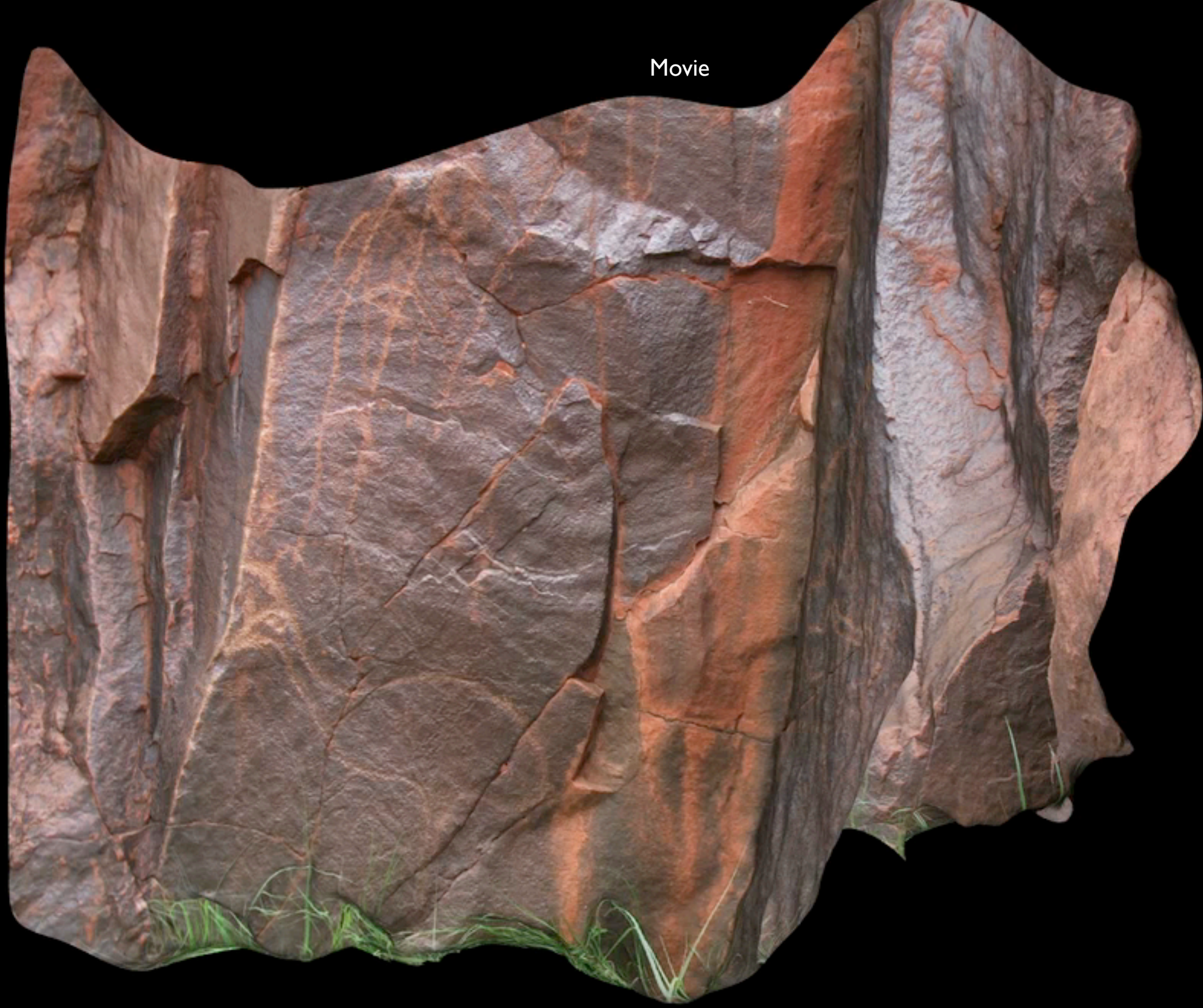


Geology

Movie

Rock Art: Wanmanna

Movie



Just 3 photographs!

Movie

Dragon gardens

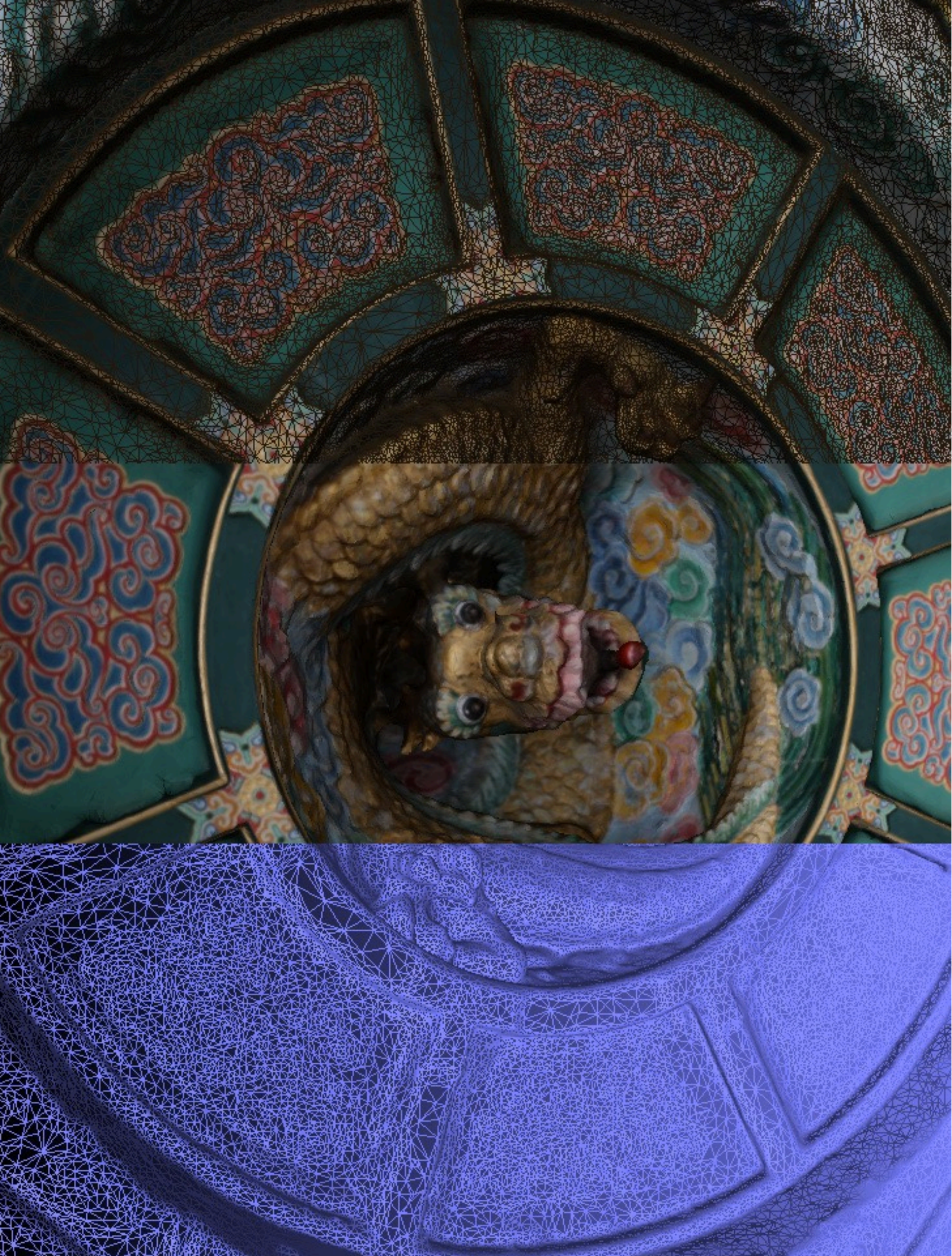
- Heritage gardens in Hong Kong.
- Built by industrial Wing Fat.
- Largely know as the site for the 1974 James Bond movie “The man with the Golden Gun”.

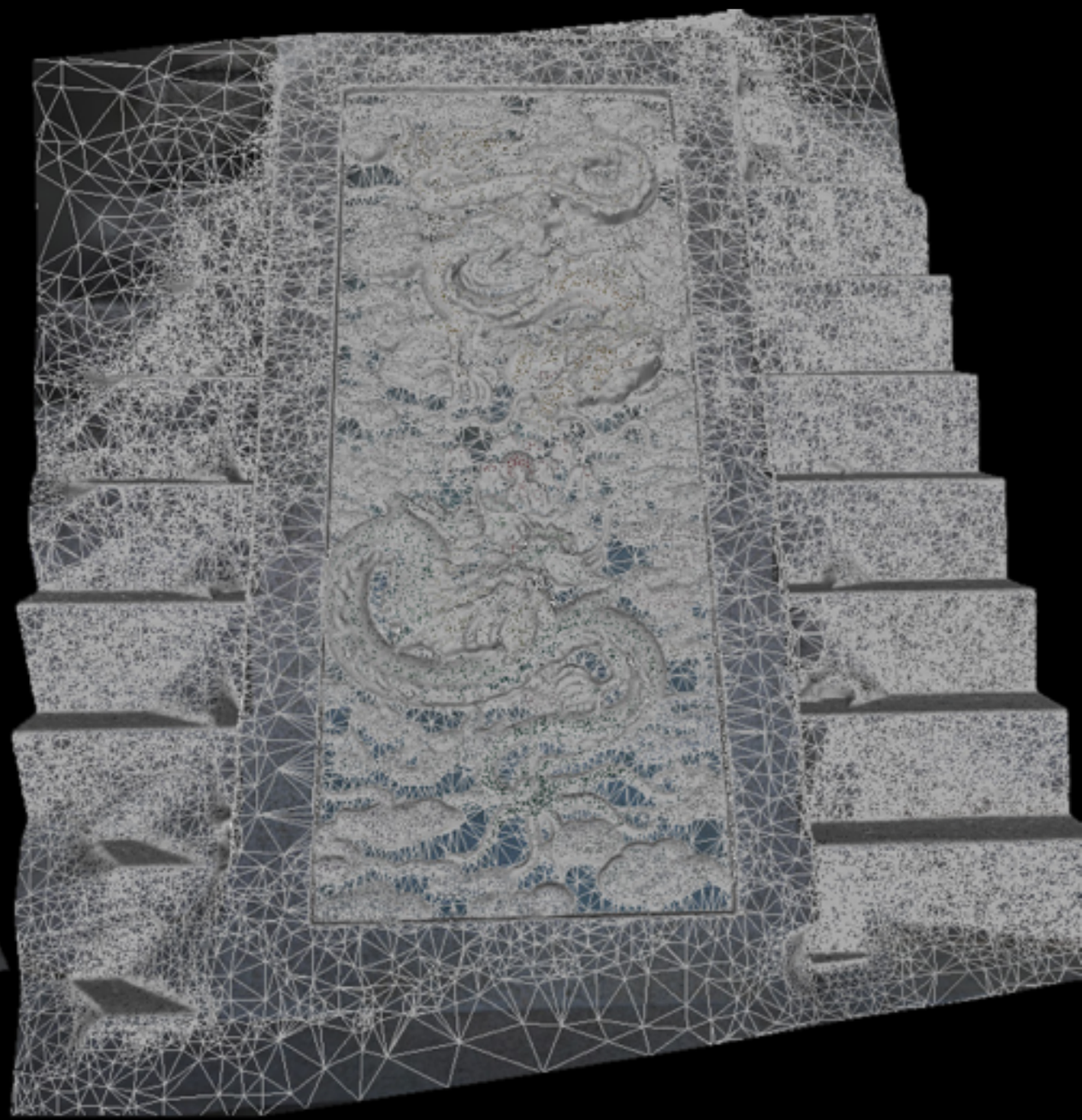
Scene from the movie

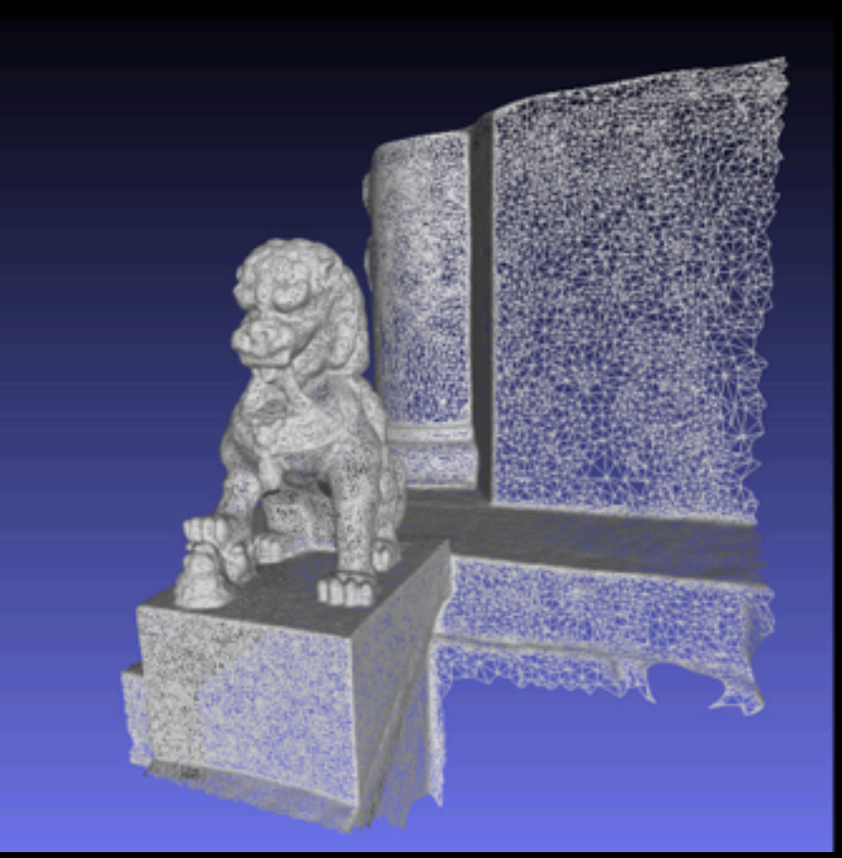
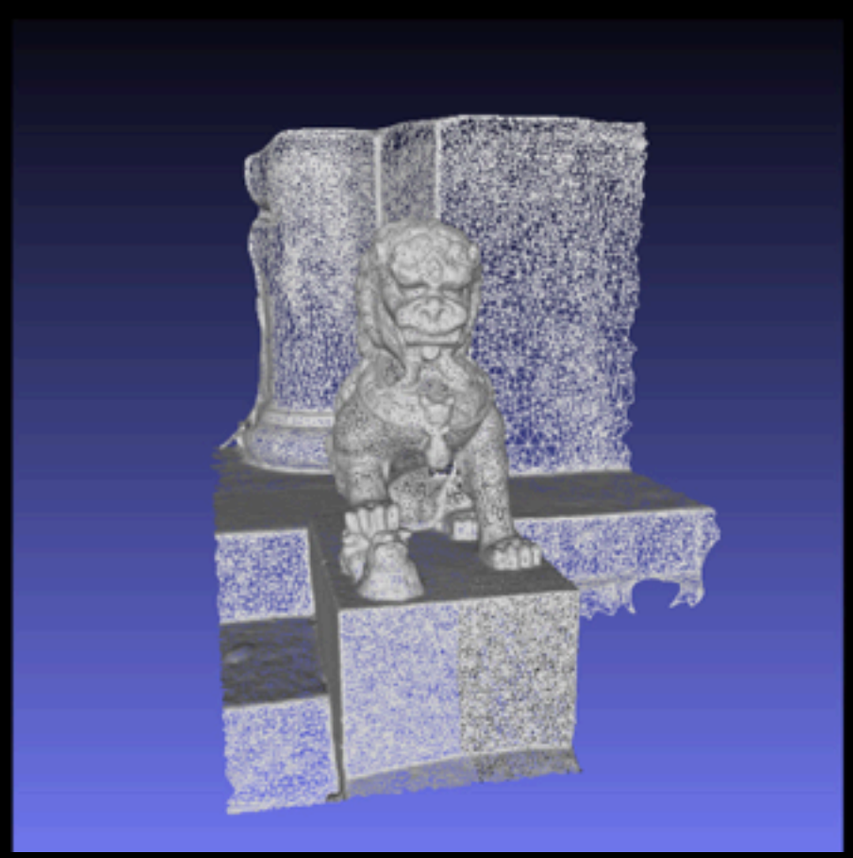
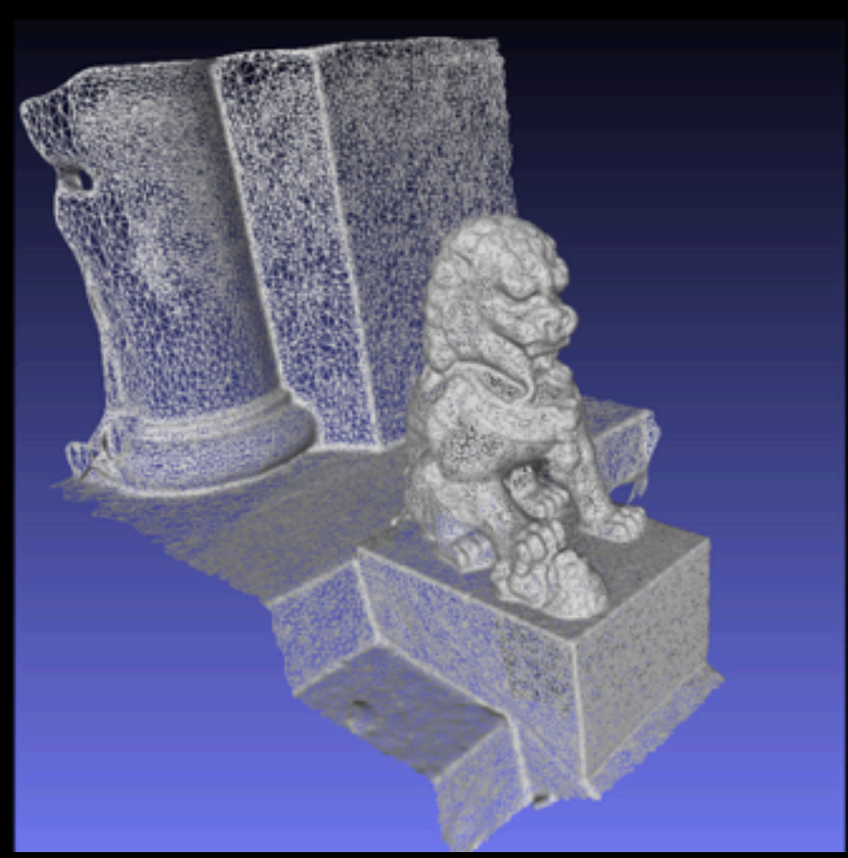
Gardens today

Scene from the movie

Developer/industrialist buried in the dome





Ngintaka

- Story of grinding stone stolen by Ngintaka (A lizard).
- The story of Ngintaka is told at places across the landscape.

Grinding stone

Movie

Headdress

Movie

360 degree video recording and presentation

- Motivations:
  - Record everything occurring around a central point, nothing "off camera".
  - To capture data that can presented in a way as to create the sense of being there.

- Two requirements
  - To capture the underlying video asset.
  - To present in an interactive environment, preferably one that fills the viewers FOV.

- One might imagine HMD (Head Mounted Displays) to be the vehicle but they still present very much a tunnel vision experience, at least for the affordable models.

- The approach often used for this work is a hemispherical or cylindrical display.

- A hemisphere or 1/2 hemisphere still requires navigation, a full cylinder doesn't, the video happens all around the viewer.

- Two examples
  - Ngintaka indiginous story/dance
  - Mah Meri dance/ritual

LadyBug camera

- PtGrey has produced 360 degree x 150 degree video cameras for some time.
  Distinction with most other 360 capture devices is the resolution.
- Target security and surveillance applications.
  Operator can see a full 360 field of view in a single camera shot.
- Remote operations.
- Performance recording and analysis.
- Sports science, presenting scenarios that more fully engage the human visual field.

Performance - Anatomy of a spherical projection

5400 x 2700 pixels

0 degrees longitude

360 degrees longitude

North pole, latitude: 90

Lower 40 degrees
not captured.

South pole, latitude -90

Cylindrical projection

Can derive cylindrical projection of any vertical field of view

Fisheye projections (Infinite number)

Remote operations

Movie

Sports science

Example: Ngintaka

- One location for the Ngintaka story after the grind stone has been recovered is in a cave.
- The belly of Ngintaka.

360 x 140 degree video example

Movie

Navigable example in the iDome

Movie

Mah Meri

- Tribe in West Malaysia.
- Traditional healing involves a priestess determining the form of the sickness.
- A carver fashions a mask representing that entity.
- A ritual dance is performed around the patient who wears the mask.
- The mask is then released into the river, taking the illness with it.
- As such, not many masks in existence.
- A repertoire of up to 400 illness spirits.

Masks reconstructed

- 10 years ago saw the rise of the 360 panorama tourist.
- Soon we will have the 3D tourist.
- Capturing 3D models as a record of objects found during travels.

Sample LadyBug footage

Movie

Movie

Fisheye view

Fisheye view

Movie

Movie

Ritual area

Priestess building

Sure enough, came down with an as yet undiagnosed illness the next day, throat still not back to normal.

Closing Message: Don’t mess with the local spirits!

Questions and discussion