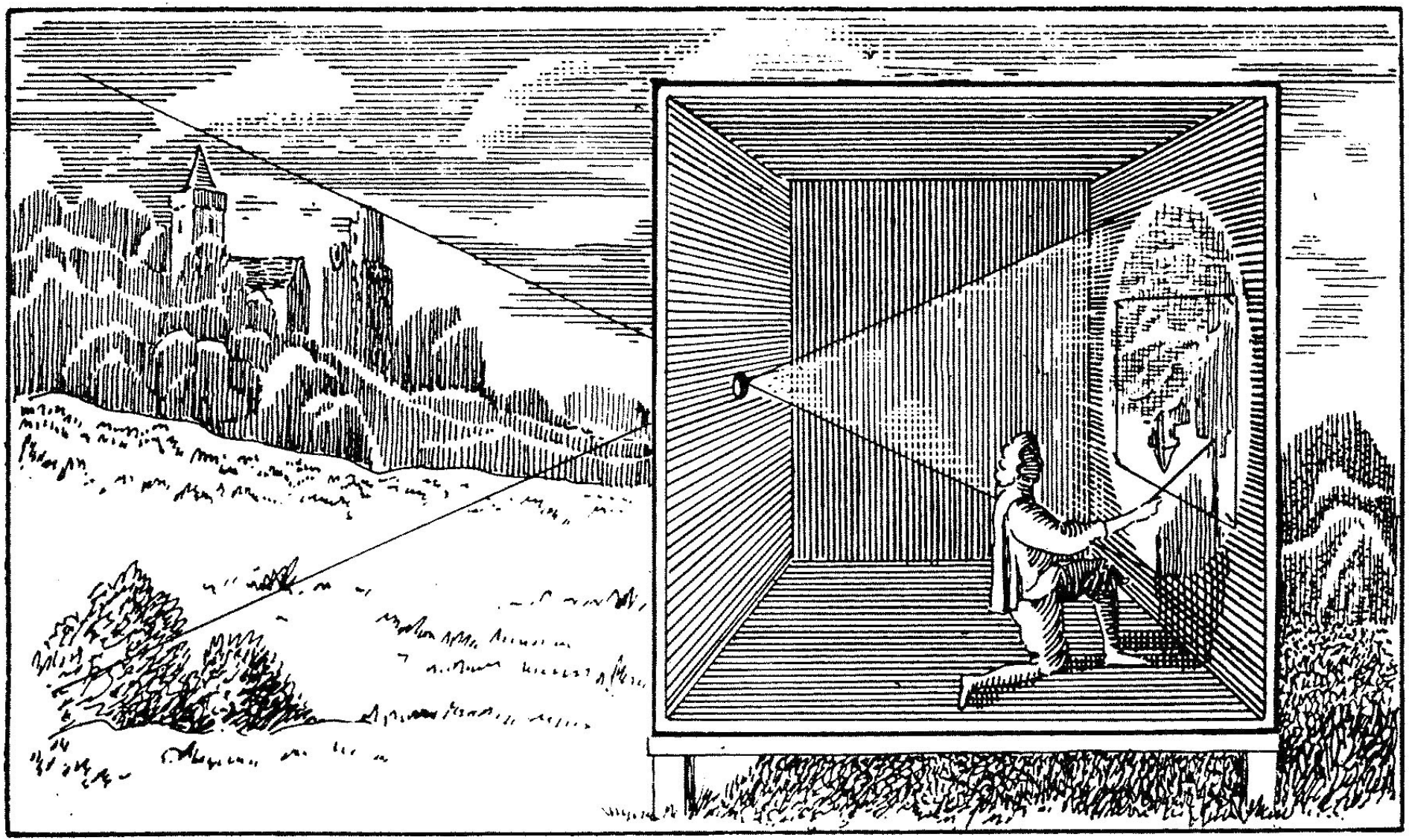
Field of View | Depth of Field

Tracing the projection inside a Camera Obscura



Staring Into the Soul of the Catskills Through a Pinhole

With his camera obscura, Shi Guorui reinterprets the landscapes of the Hudson River School painter Thomas Cole.

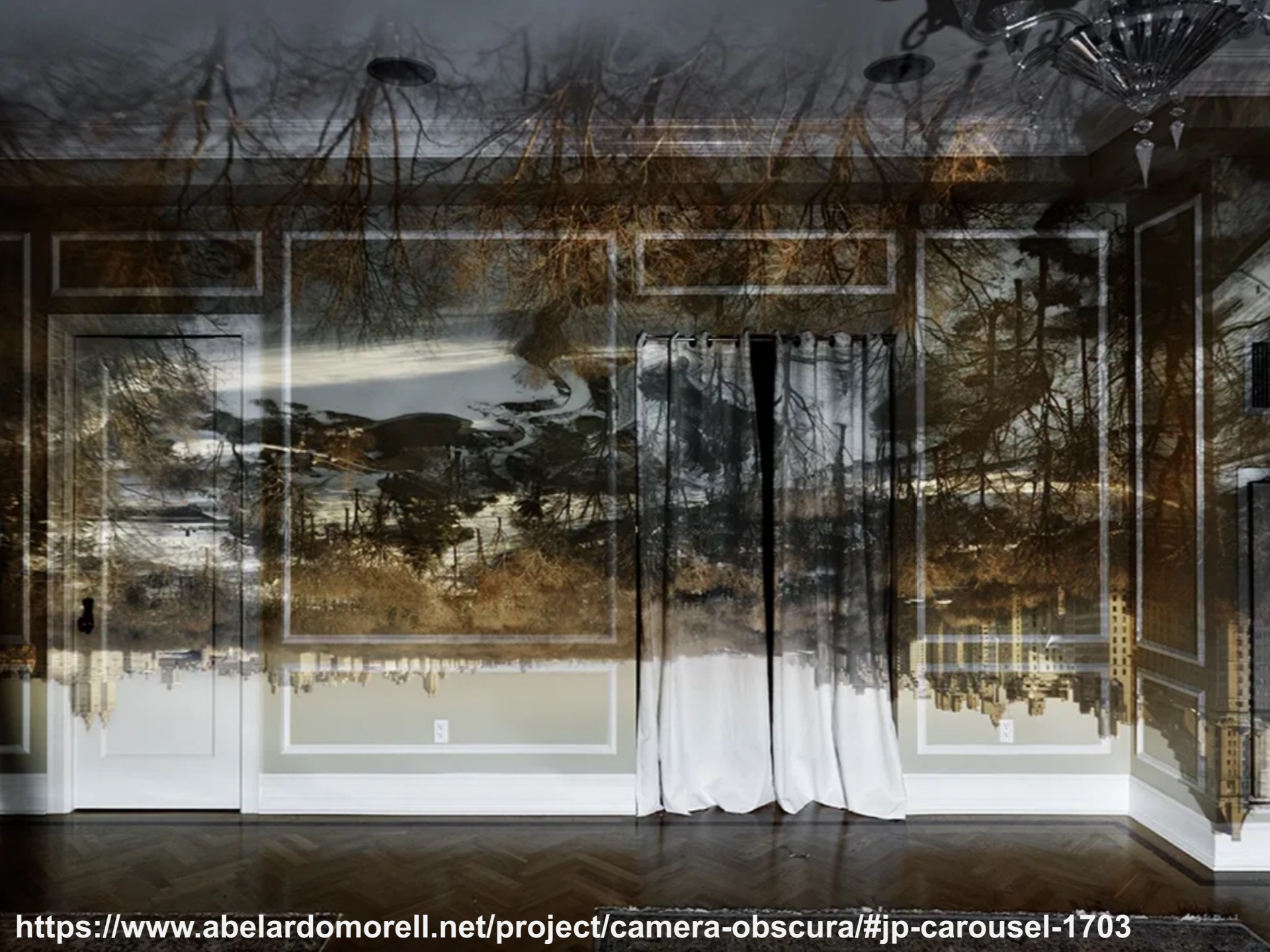
The artist Shi Guorui building his camera obscura out of a tent in a forest near Kaaterskill Falls, in the Hudson River Valley. He has transformed a weather station and even a watchtower at the Great Wall of China into pinhole cameras. Nathan Bajar for The New York Times

Mr. Shi was inspired by “Falls of the Kaaterskill,” an 1826 painting by Thomas Cole (1801-1848).

https://www.nytimes.com/2019/10/24/arts/shi-guorui-catskills-photography.html

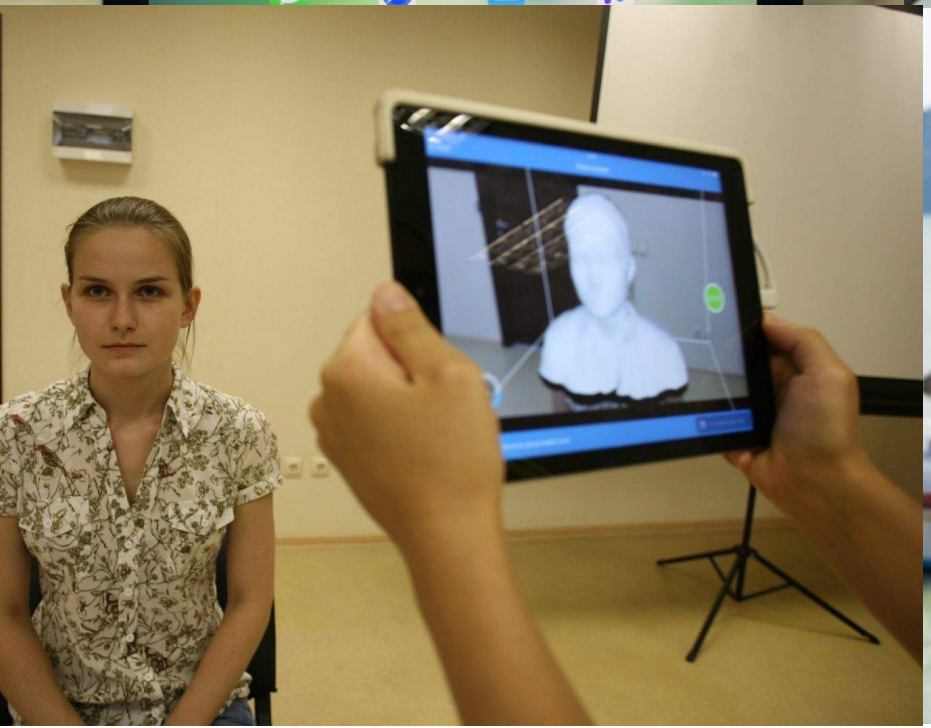
The **Hockney–Falco thesis** advanced by artist David Hockney and optics physicist Charles M. Falco: Advances in realism based on use of optical instruments

Johannes Vermeer, "The Geographer" (1668/1669), the "Astronomer" (1668)



https://www.abelardomorell.net/project/camera-obscura/#jp-carousel-1703

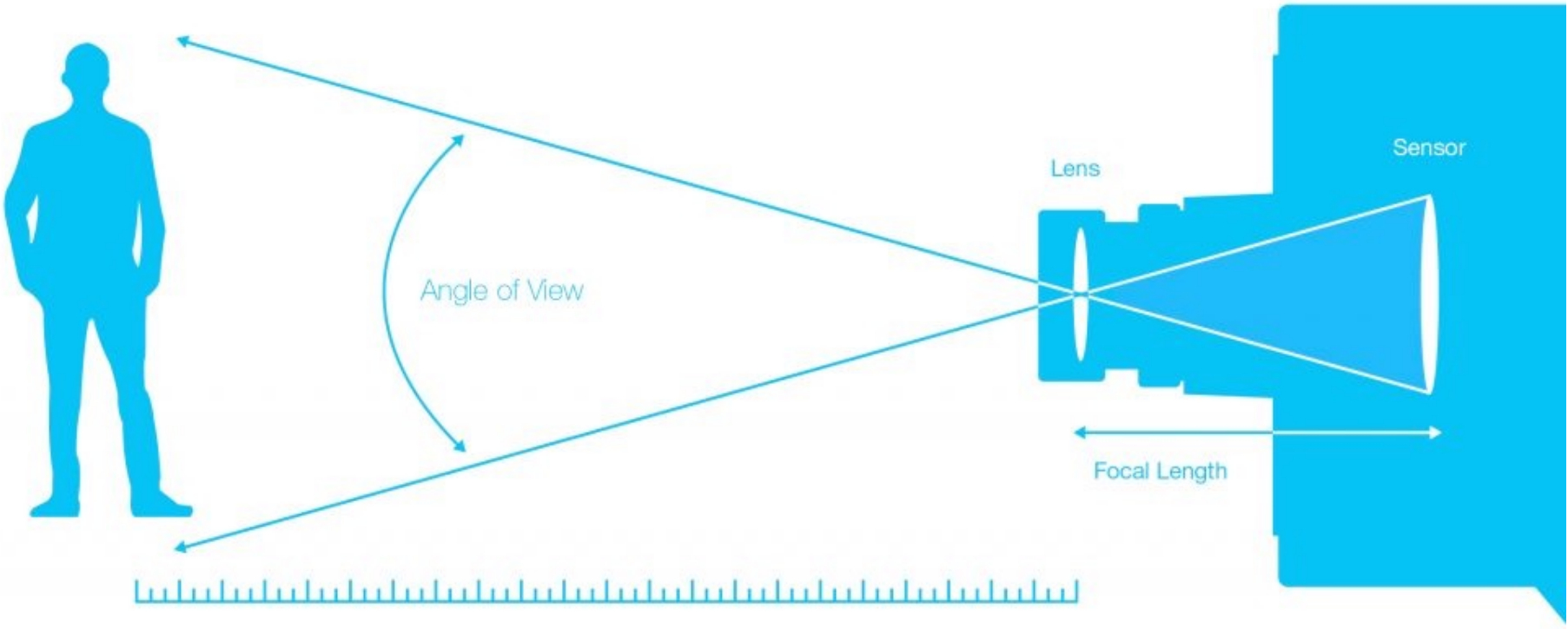
The Computer Screen as a Camera Screen



Basic optical-mechanial camera format

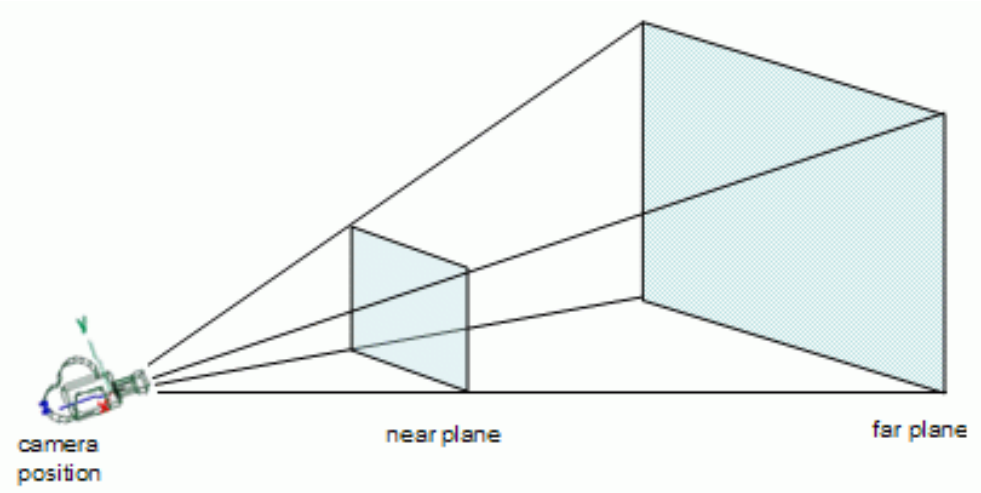
Focal Length and Angle of View

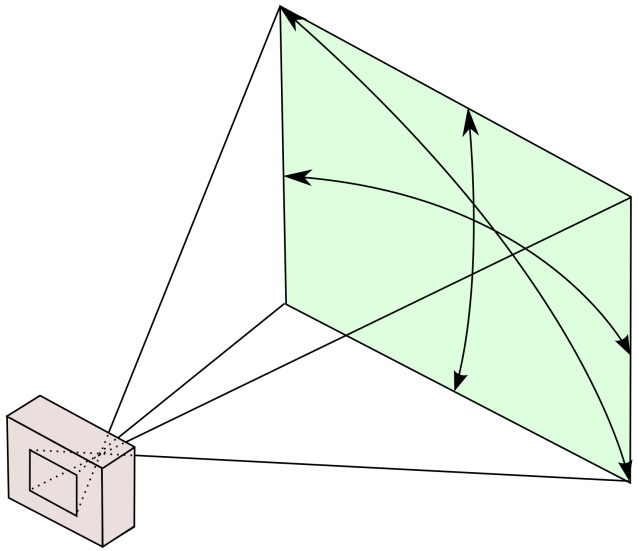
Longer focal length = NARROWER angle of view
Shorter focal length = WIDER angle of view



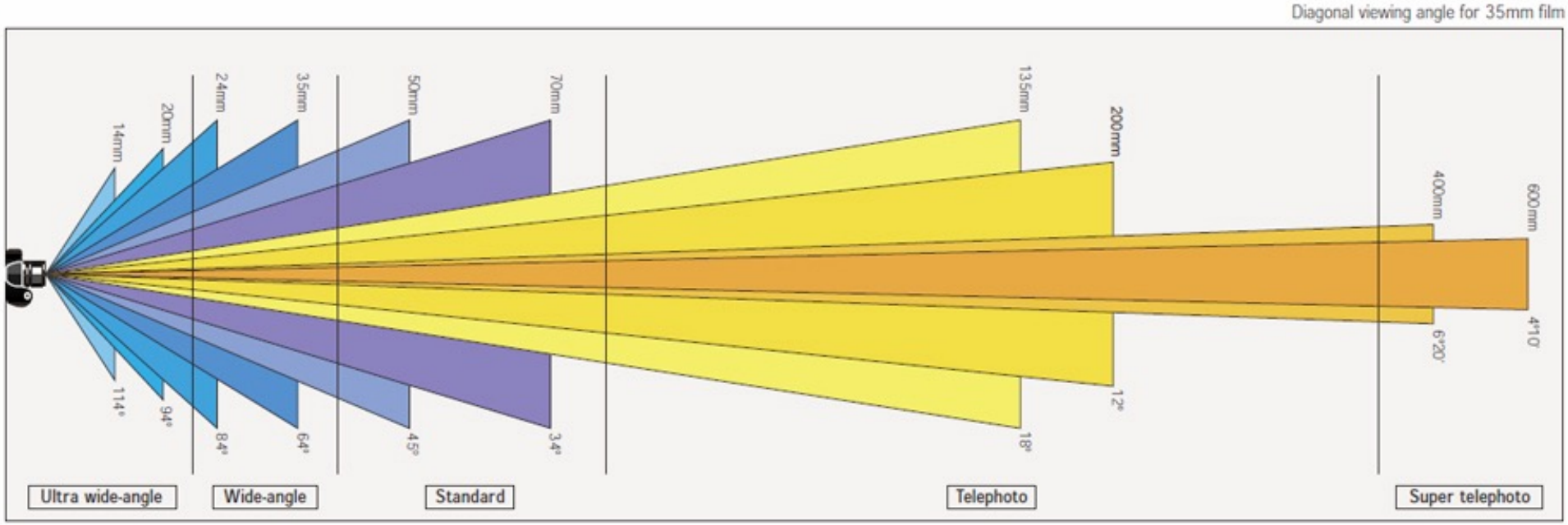
Terminology

- **Field-of-View**: What is seen at a given moment
- **Angle of view**: Angular extent of a scene imaged by a camera
- **Vantage point**: The location where the photo is taken from
- **Frustum**: 3D region viewed on the screen





Focal lens – the distance between the lens and the image sensor



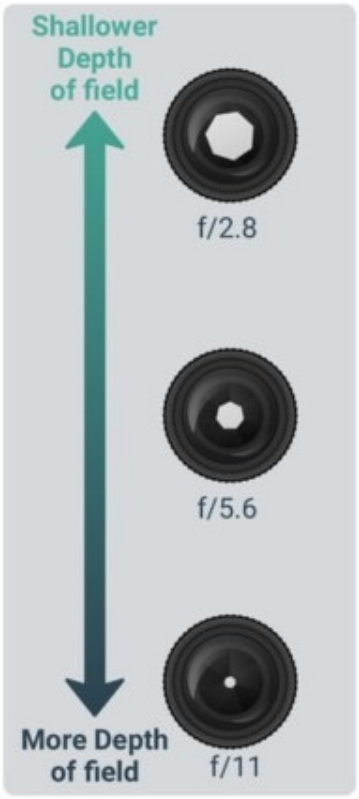
Normal view seen by the human eye

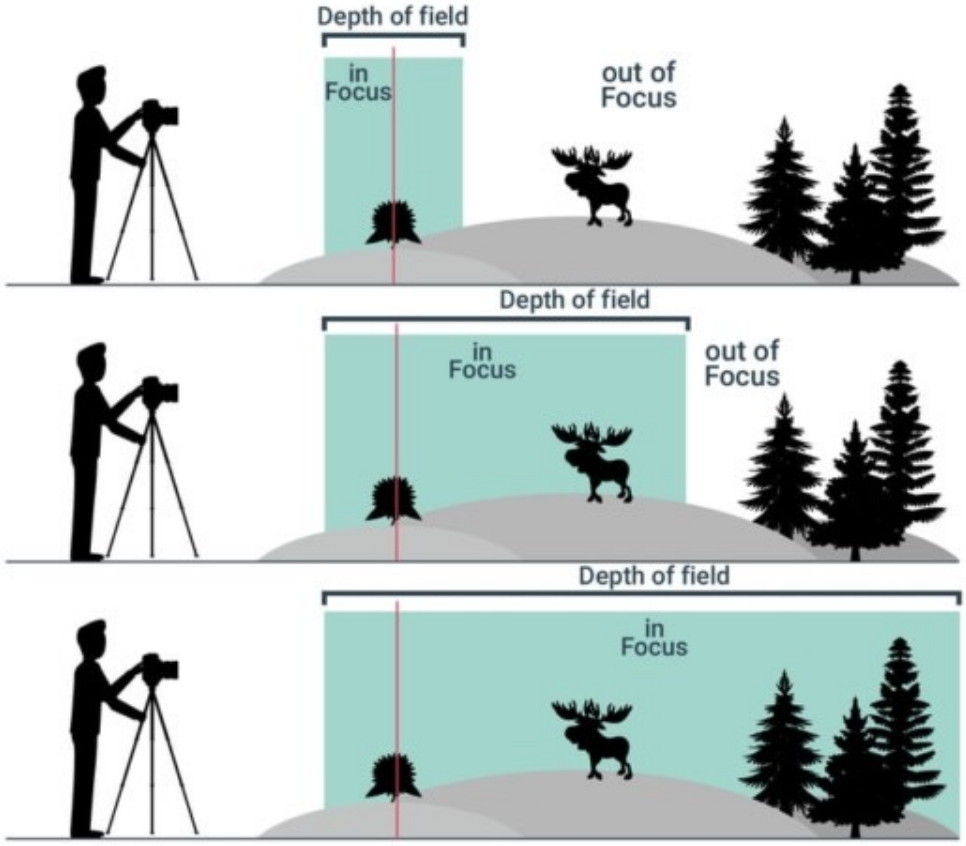
Fisheye Lens

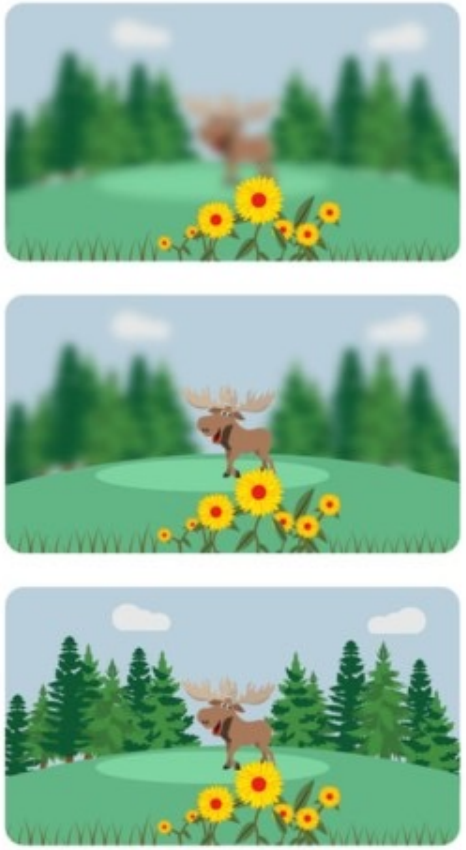
Depth of Field – The Range of focus in a scene based on lens opening

APERTURE

DEPTH OF FIELD





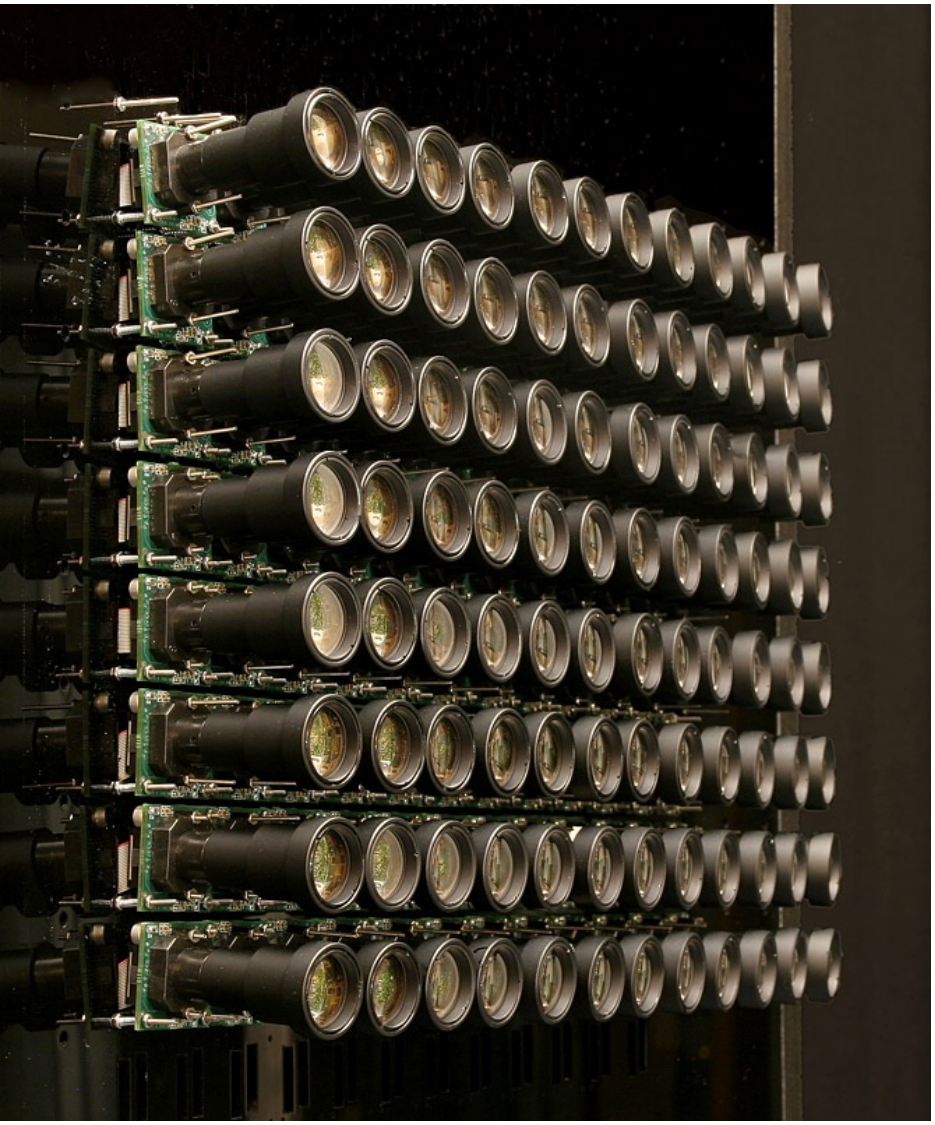


Depth of Field

László Moholy-Nagy, *Photograph (Self-Portrait with Hand)*, 1925/29, printed 1940/49

HUMAN STATUE OF LIBERTY
18,000 OFFICERS AND MEN
AT
CAMP DODGE, DES MOINES IA.
COL. WM. NEWMAN, COMMANDING
COL. RUSH S. WELLS, DIRECTING.

Marc Levoy, Computer Science Lab, Stanford



Camera Overview
A Lytro camera is made up of two sections. An anodized aluminum shell contains the lens assembly, while the electronics are housed within a silicone rubber grip.

LENS ASSEMBLY
Features an 8x optical zoom and a constant f/2 lens.

LIGHT FIELD SENSOR
Records the rays of light entering the camera as data.

USB POWER BOARD

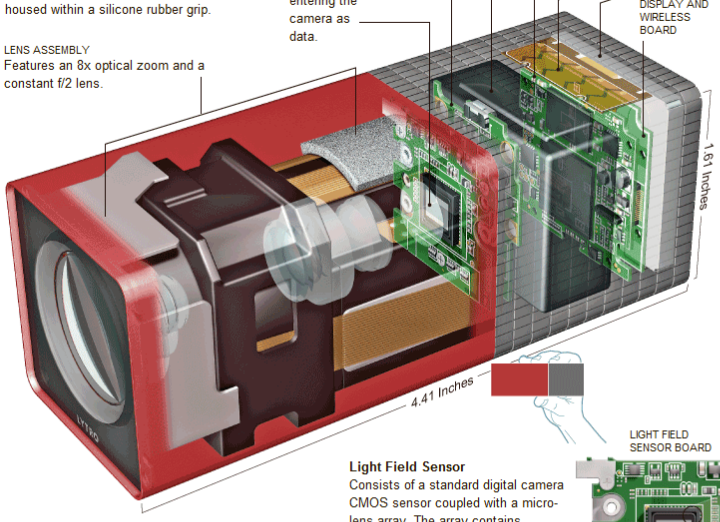
LITHIUM-ION BATTERY

MAIN PROCESSOR BOARD

ZOOM CONTROL SENSOR

LCD DISPLAY

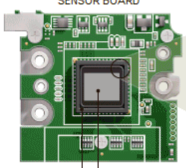
DISPLAY AND WIRELESS BOARD

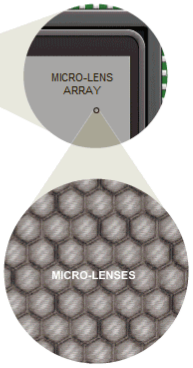


Controlling the Camera
Lytro uses a 1.46-inch touch screen. Swiping back and forth allows you to view previous or later photos, while swiping up brings up a menu bar. The shutter button and a slider for the zoom are molded into the top of the unit, while the power button and a USB connector are on the bottom.

Light Field Sensor
Consists of a standard digital camera CMOS sensor coupled with a micro-lens array. The array contains thousands of miniature lenses.

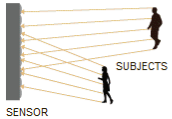
LIGHT FIELD SENSOR BOARD





Micro-Lens Array
Tiny lenses divide the CMOS sensor's pixels into multiple areas, each showing the image at a slightly different angle. Software uses this data to triangulate the image in 3-D space.

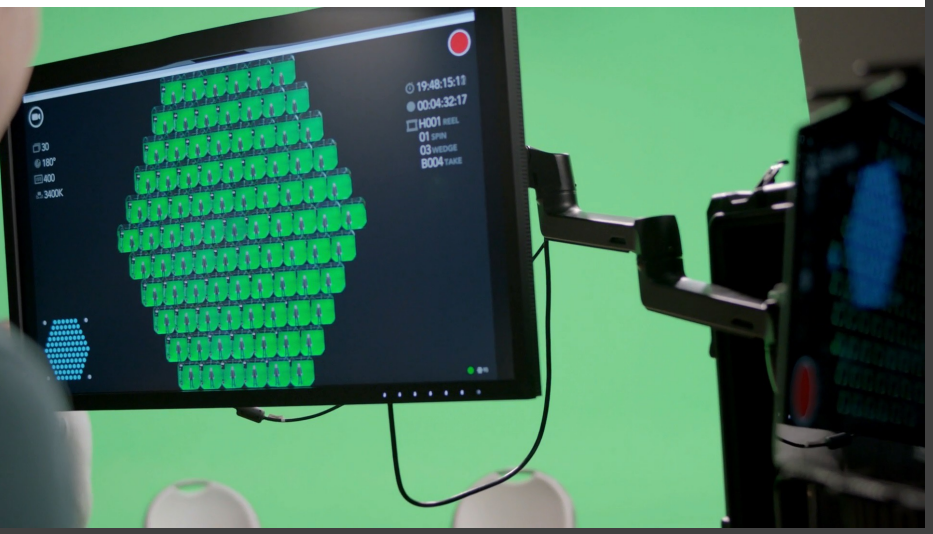
Capturing Light
Lytro's light field sensor captures not only the color, intensity and position of the light, but also its direction, which is lost in traditional cameras.



Changing Focus
Because all the directional information of the entering light is captured, software can change the focal plane. Clicking any point on the image brings that area into focus, whether raindrops on the surface of a window or buildings beyond.

http://graphics.stanford.edu/projects/lightfield/

Lytro – variable depth-of-field



https://en.wikipedia.org/wiki/Lytro

Anamorph Transformation

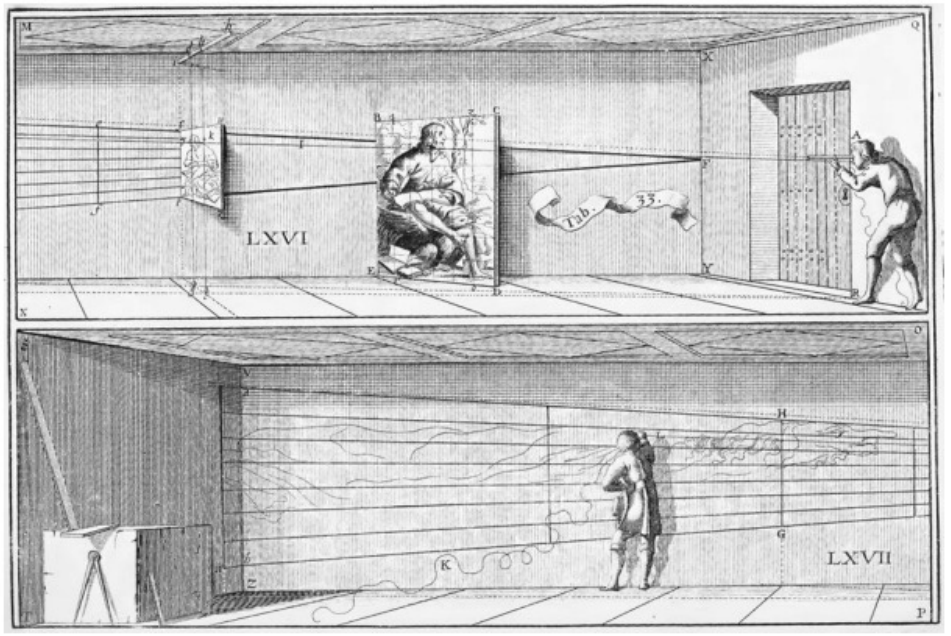


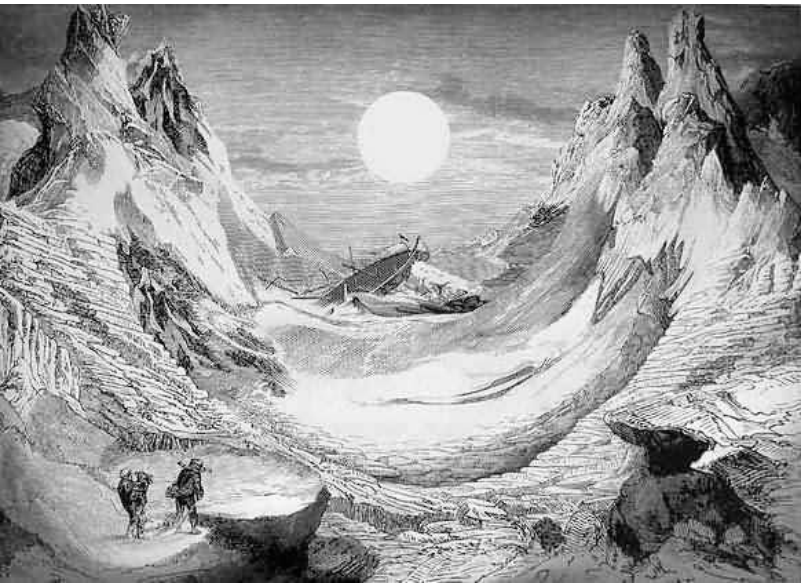
FIG. 5 – Anamorphic structure by J.F. Niceron, Thaumaturgus Opticus (Tab. 33, Fig. LXVI and LXVII), Paris, 1646.

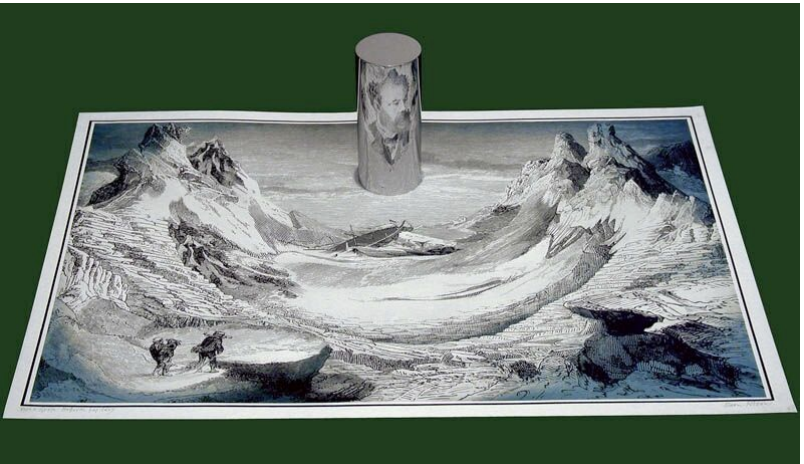
Fig. 3. Hans Holbein, 1533, The Ambassadors, oil on panel with an anamorphic image of a skull in the bottom of the image

Fig. 4. The Skull – visualisation of the **flat surface** anamorph from *The Ambassadors*

Catoptric anamorphic images – Istvan Orosz, William Kentridge

(*Catoptric – phenomena of reflected light as in mirrors*)



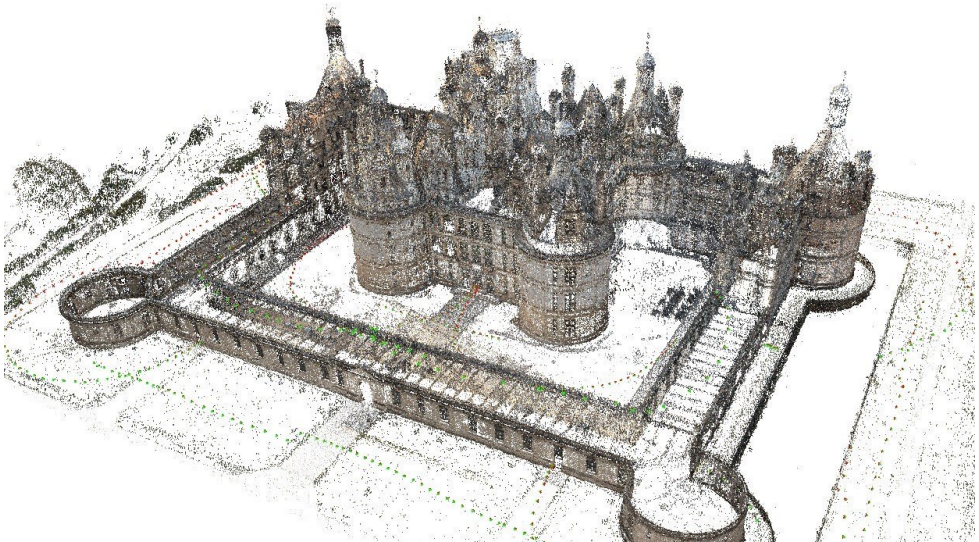


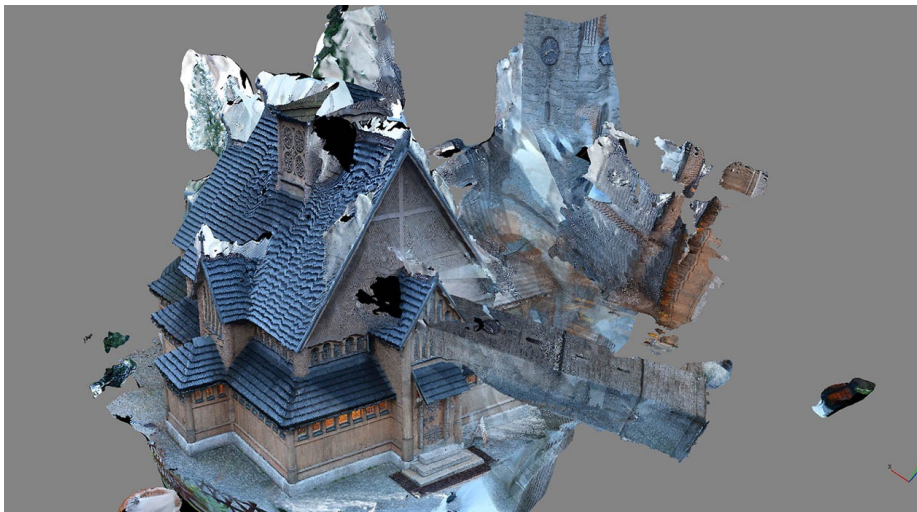
Andrea Pozzo, church of St.Ignazio, 1690. 3D illusion on flat surface

Full Sphere camera– iCinema, UNSW https://vimeo.com/2831635

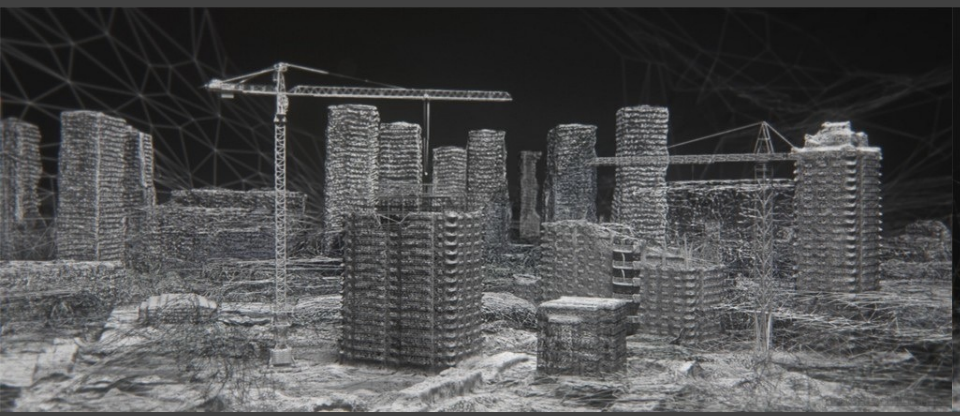
Photogrammetry – Making measurements from photographs

The input to photogrammetry is photographs, and the output is typically a map, a drawing, a measurement, or a 3D model of an object or scene. The *3-D co-ordinates* define the locations of object points in the 3-D space





Ghost Cell



http://www.antoinedelach.com/GHOST-CEL/

3D Depth Sensing

Microsoft Kinect: Licensed from PrimeSense (2010)

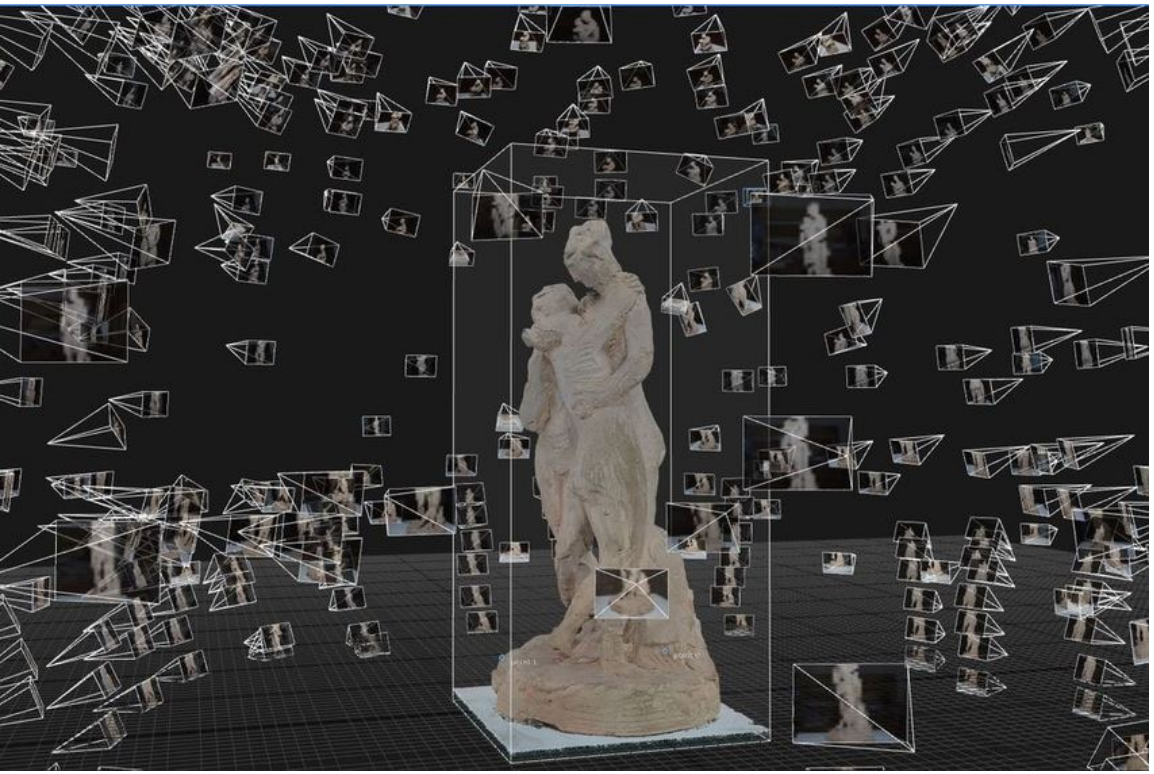
Motion sensing input device (infrared projection/detector)

Analyses projected pattern to measure depth (structured light)

Realtime gesture recognition, body skeletal detection (up to 4 people). Natural user interface

Apple acquired PrimeSense in 2013. Integrated features into iphone

Point Cloud Photogrammetry in Cultural Heritage



Photogrammetry is a 3D recording technique that employs 2D images to create a 3D model of an object or surface. It involves taking hundreds of overlapping photographs of an object from many different angles and processing them using specialised software such as RealityCapture (RC) or Agisoft PhotoScan. The digital 3D model can be used for study or outputted as a physical object via 3D printing or CNC milling.

https://www.factumfoundation.org/pag_fa/1345/photogrammetry

Iphone 13

Telephoto

77 mm focal length
3x optical zoom
ƒ/2.8 aperture
Focus Pixels
6-element lens
OIS

Ultra Wide

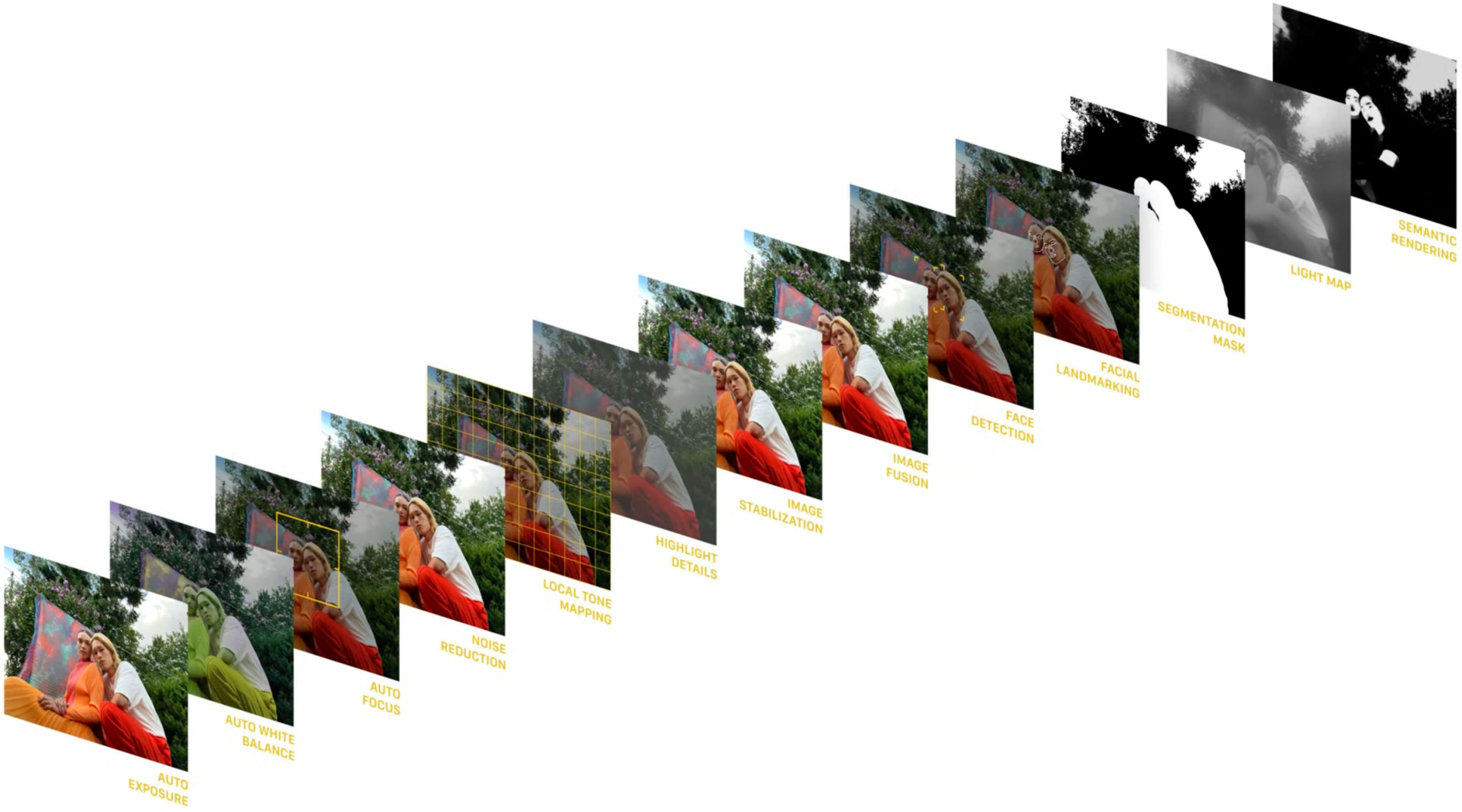
13 mm focal length
ƒ/1.8 aperture
Faster sensor
Focus Pixels
6-element lens

Wide

26 mm focal length
1.9 µm pixels
ƒ/1.5 aperture
100% Focus Pixels
7-element lens
Sensor-shift OIS

https://www.dpreview.com/files/p/articles/6780391159/iPhone13Pro-3CameraModules.jpeg

Image processing in the iphone 13



https://www.dpreview.com/files/p/articles/6780391159/iPhone13-MultiFrameImageProcessingPipeline.jpeg

Wikipedia was used extensively to collect material for this presentation.