

Camera Obscura (18th century)



Earliest Surviving Photograph (c.1826)



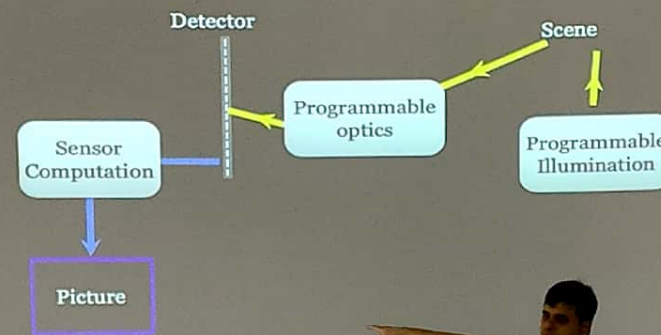
Joseph Nicéphore Niépce. "Le point de vue de la fenêtre" c.1826.
Photo by J. Paul Getty Museum, from [Wikimedia Commons](#)



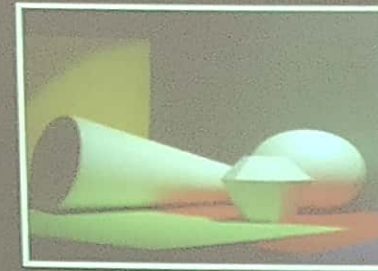
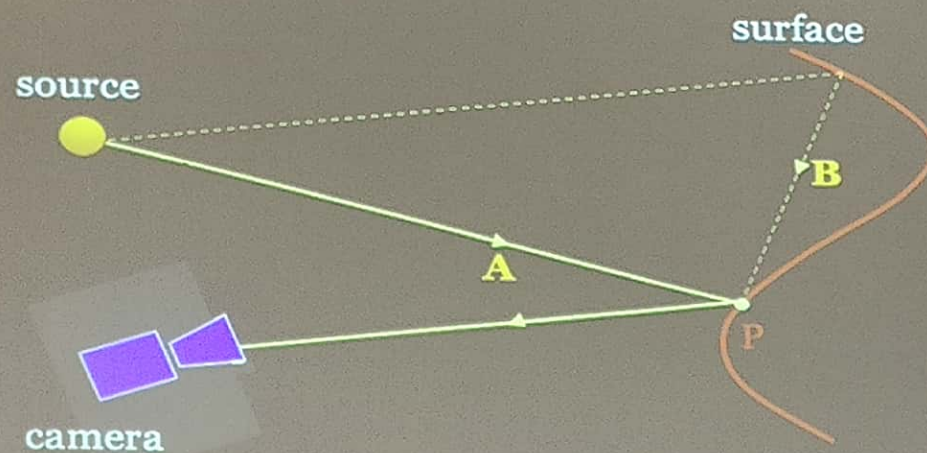
Joseph Nicéphore Niépce. "Le point de vue de la fenêtre"
Enhanced by Helmut Ger



Computational Photography

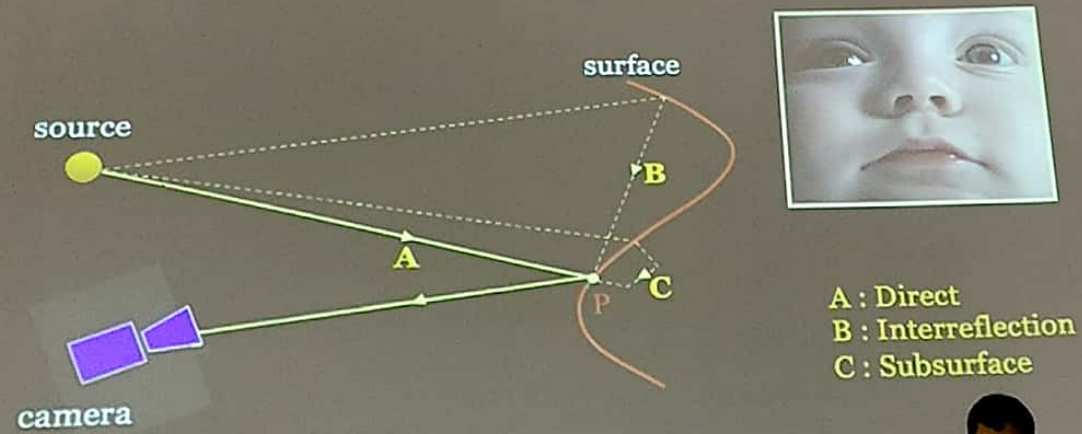


Direct and Global Illumination

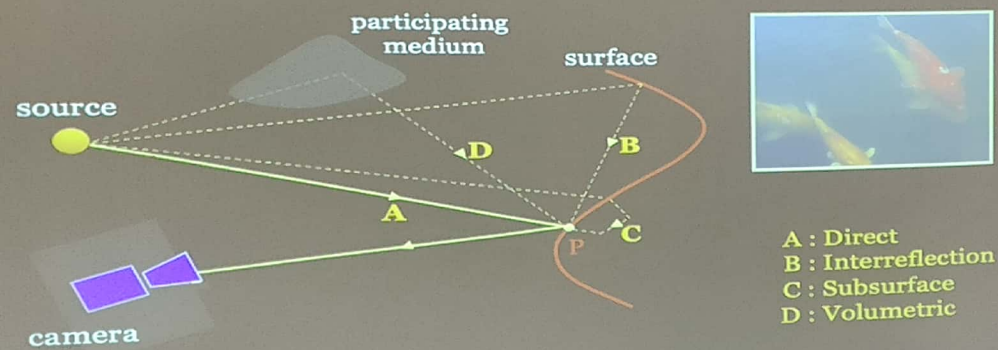


A : Direct
B : Interreflection

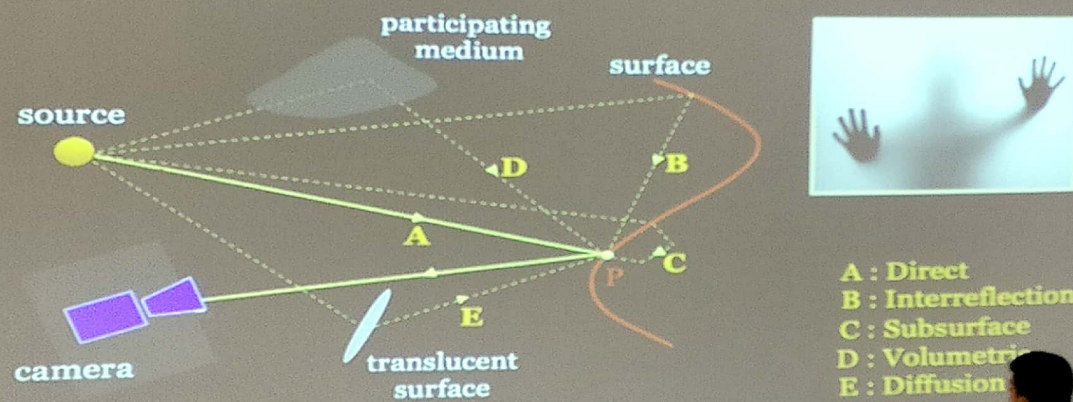
Direct and Global Illumination



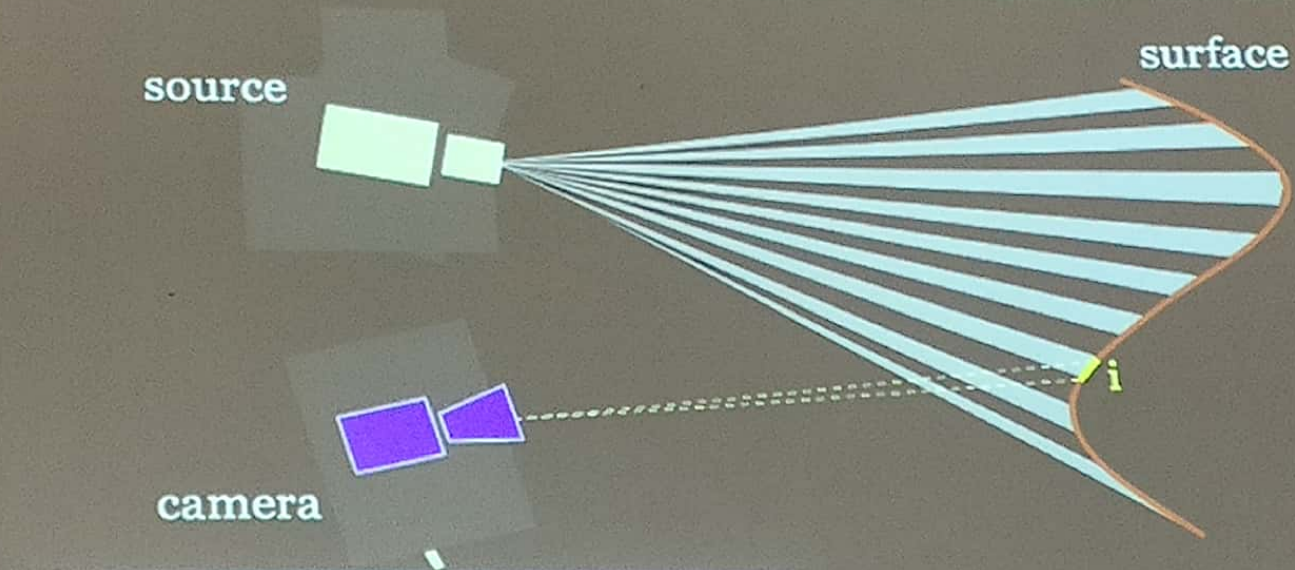
Direct and Global Illumination



Direct and Global Illumination



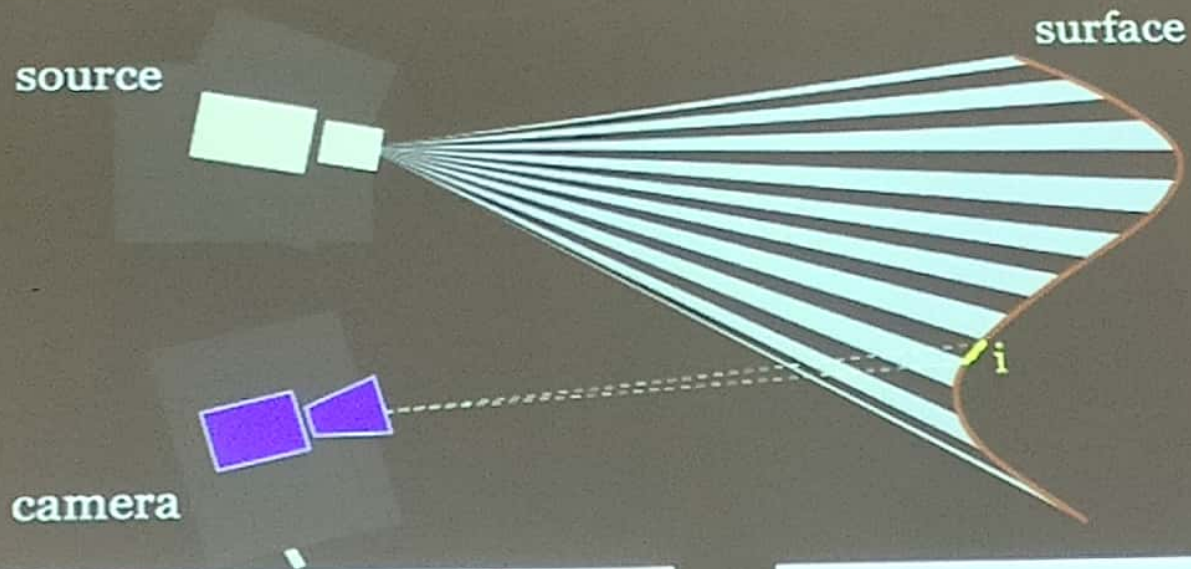
High Frequency Illumination Pattern



$$L^+[c, i] = L_d[c, i] + \alpha L_g[c, i]$$

fraction of activated source elements

High Frequency Illumination Pattern



$$L^+[c, i] = L_d[c, i] + \alpha L_g[c, i]$$

$$L^-[c, i] = (1 - \alpha) L_g[c, i]$$

fraction of activated source elements

Separation from Two Images

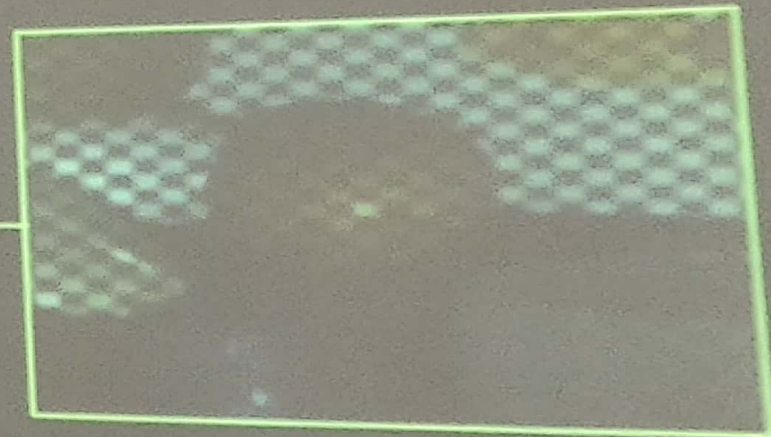
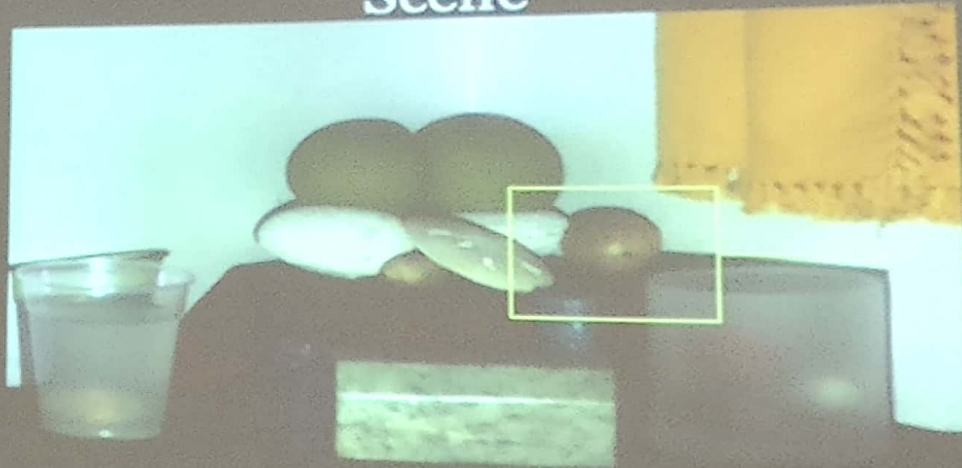
$$\alpha = \frac{1}{2}:$$

$$L_d = L_{\max} - L_{\min}, \quad L_g = 2L_{\min}$$

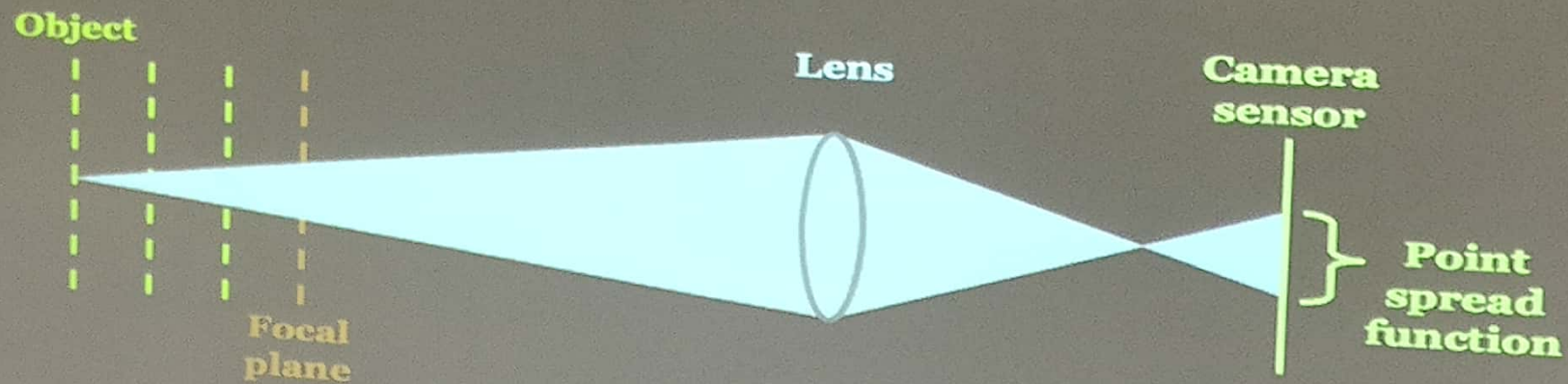
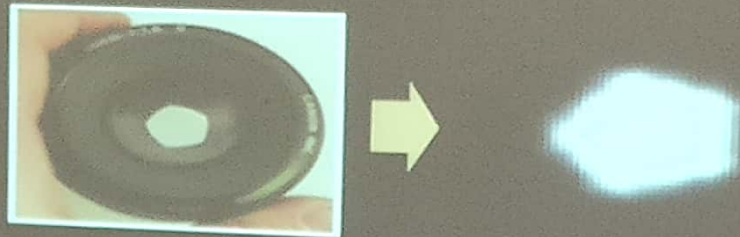
direct

global

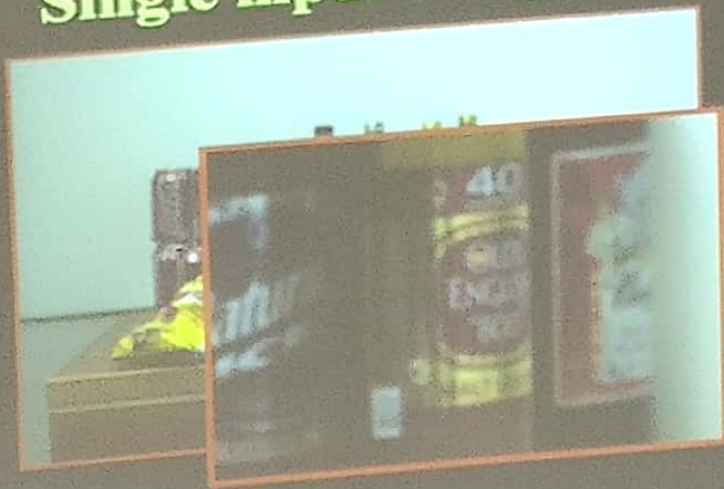
Scene



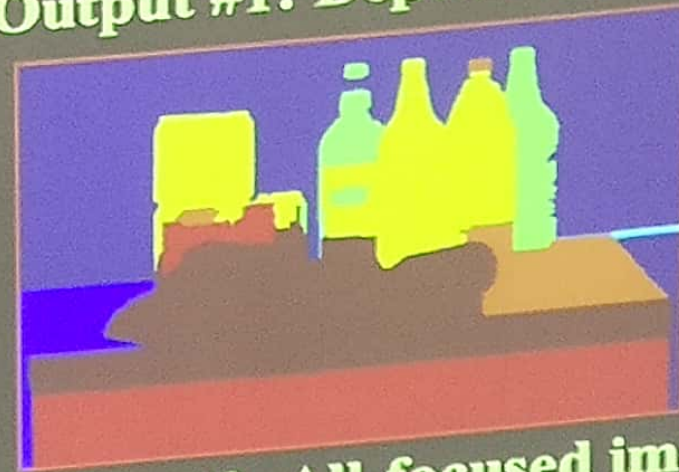
Lens and defocus



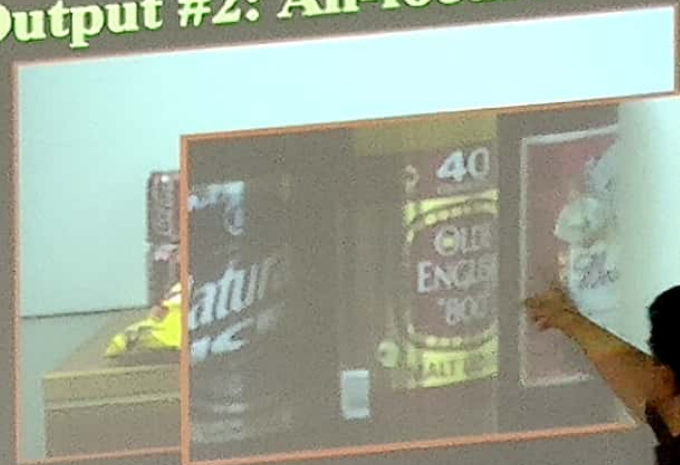
Single input image:



Output #1: Depth map



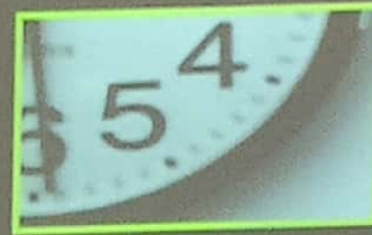
Output #2: All-focused image



Key Ideas

- **Exploit prior on natural images**

- Improve deconvolution
- Improve depth discrimination



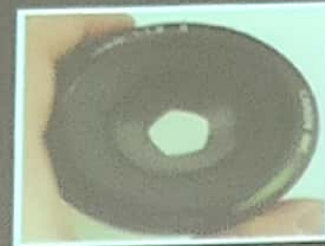
Natural



Unnatural

- **Coded aperture (mask inside lens)**

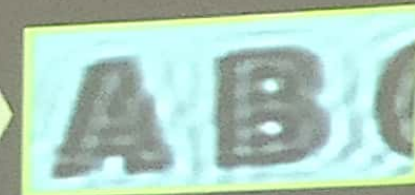
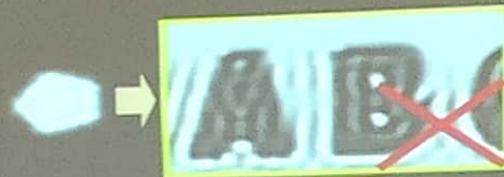
- make defocus patterns different from natural images and easier to discriminate



Why coded?

Coded aperture- reduce uncertainty in scale identification

Larger scale



Correct scale

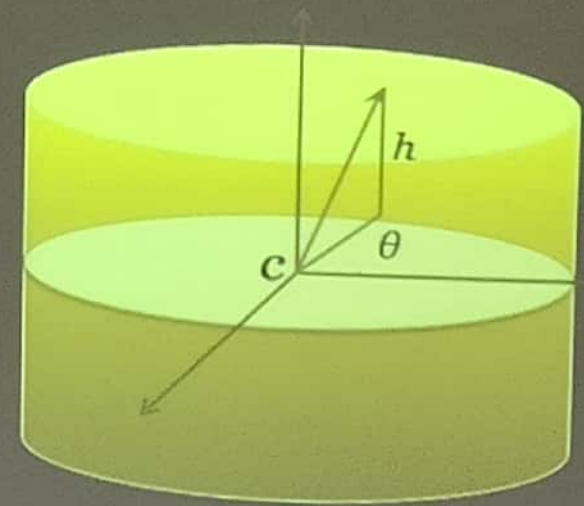


Smaller scale



Omnidirectional Image

- A 2-D function $I(\theta, \phi)$ in terms of the polar and azimuthal angles
- Cylindrical projection is more common for panoramas



Omnidirectional Stereo

- For every pair of points: $((\theta_i, \phi_i), (\theta_j, \phi_j))$ on a sphere, we need to capture a light ray

