Light field photography

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“Light field photography using a handheld plenoptic camera”

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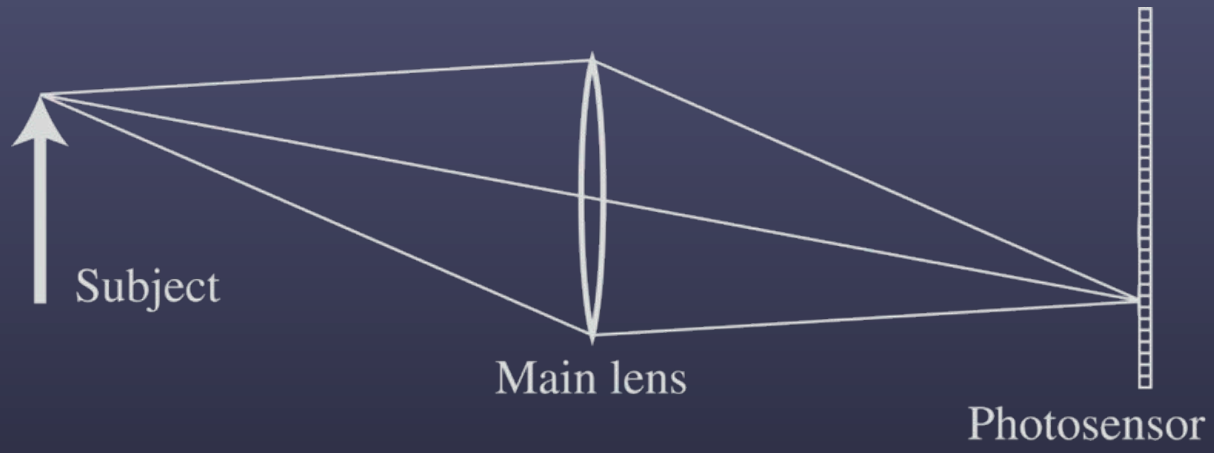
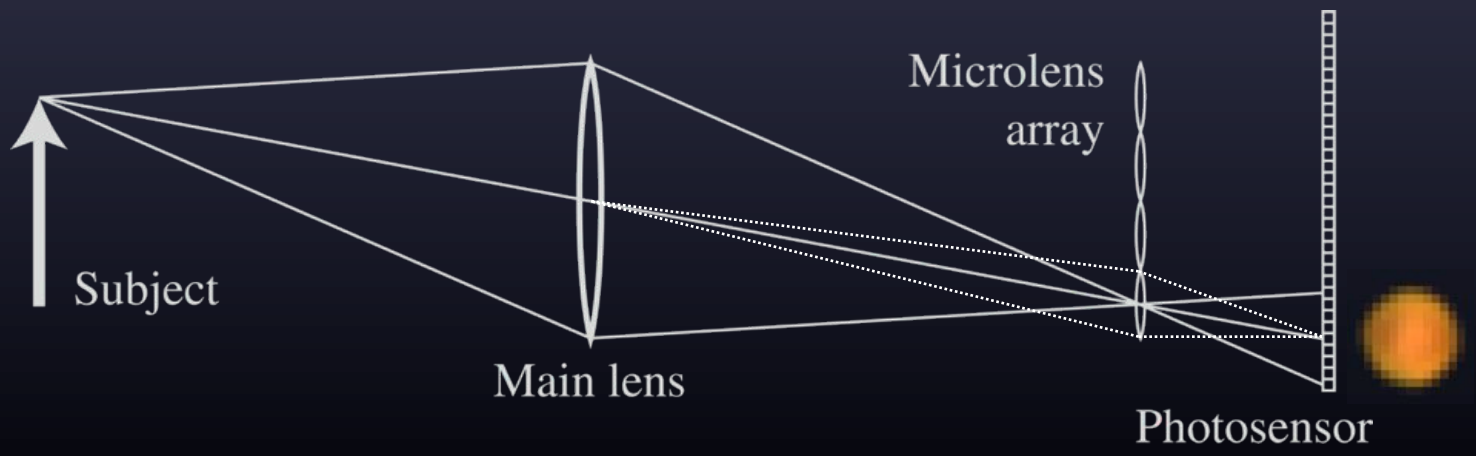
Gene Duval, Mark Horowitz and Pat Hanrahan

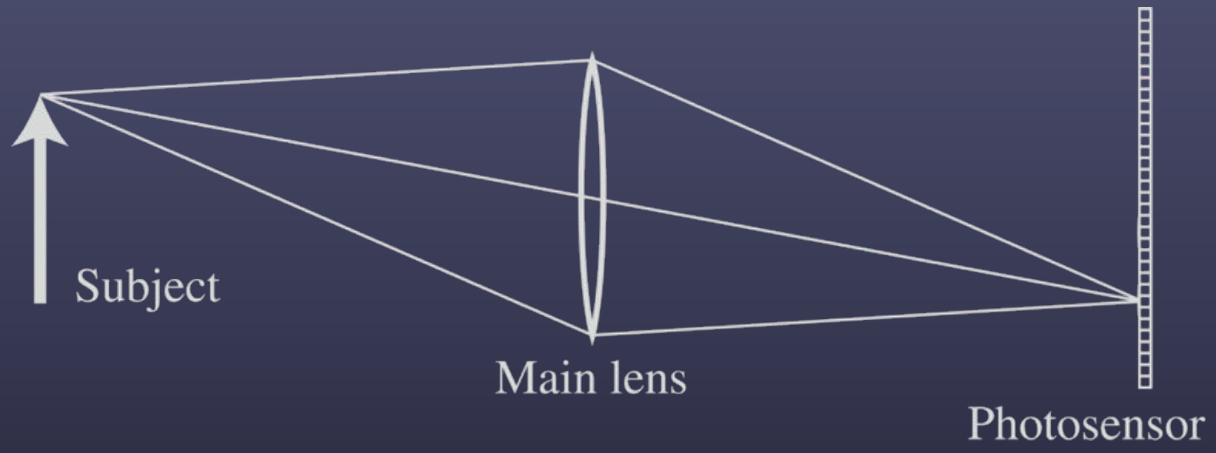
(Proc. SIGGRAPH 2005
and TR 2005-02)

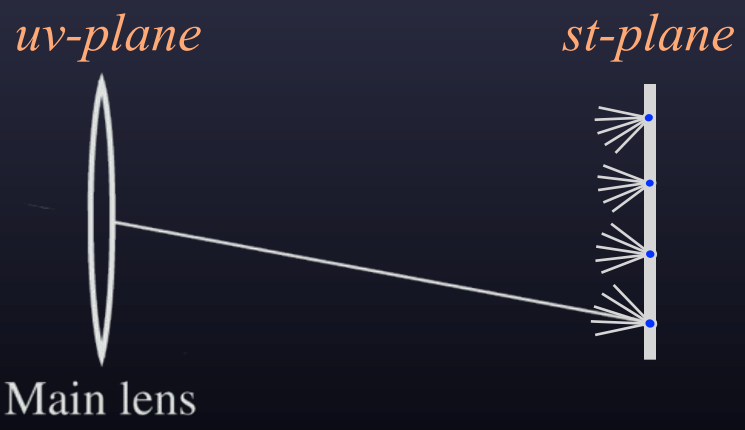
Conventional versus plenoptic camera





Conventional versus plenoptic camera

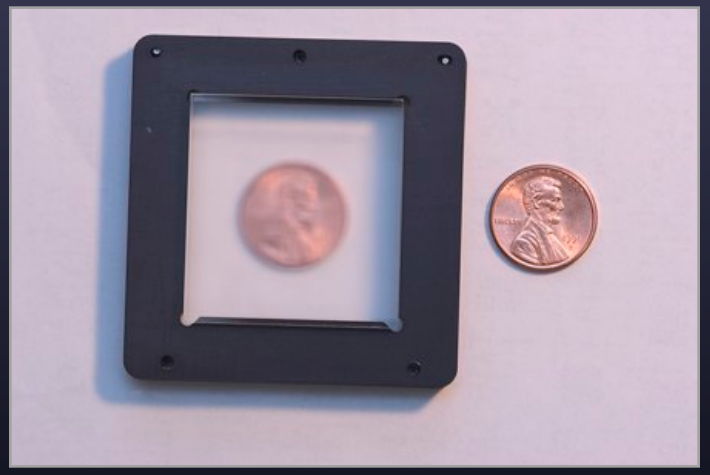




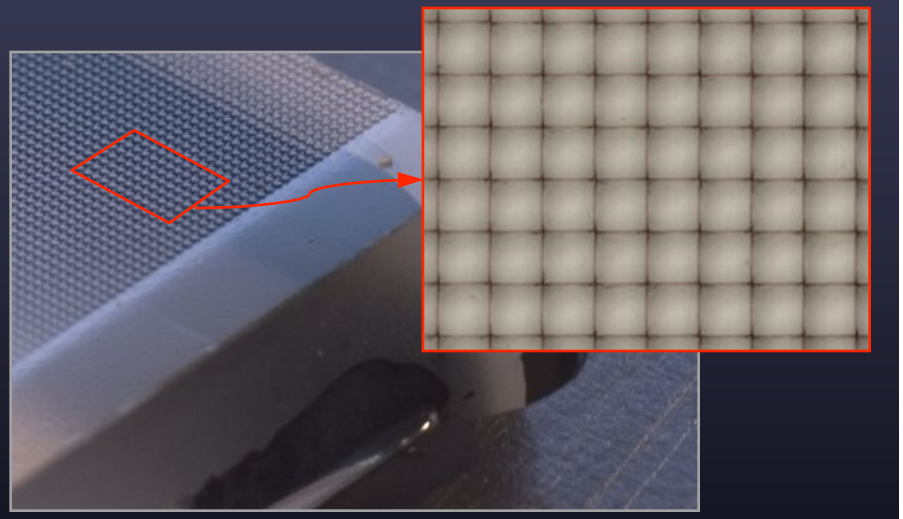
Prototype camera

Contax medium format camera

Kodak 16-megapixel sensor

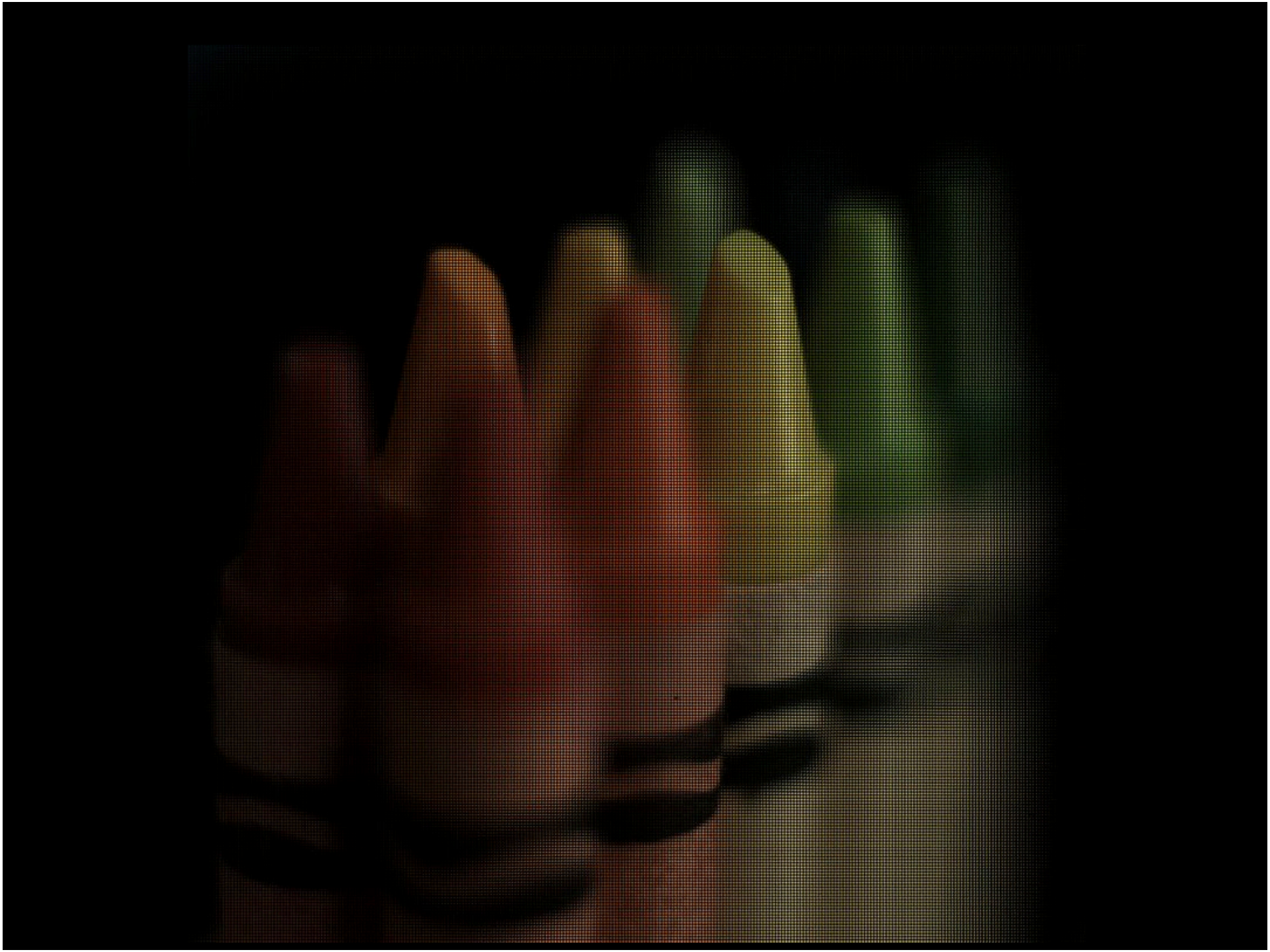


Adaptive Optics microlens array

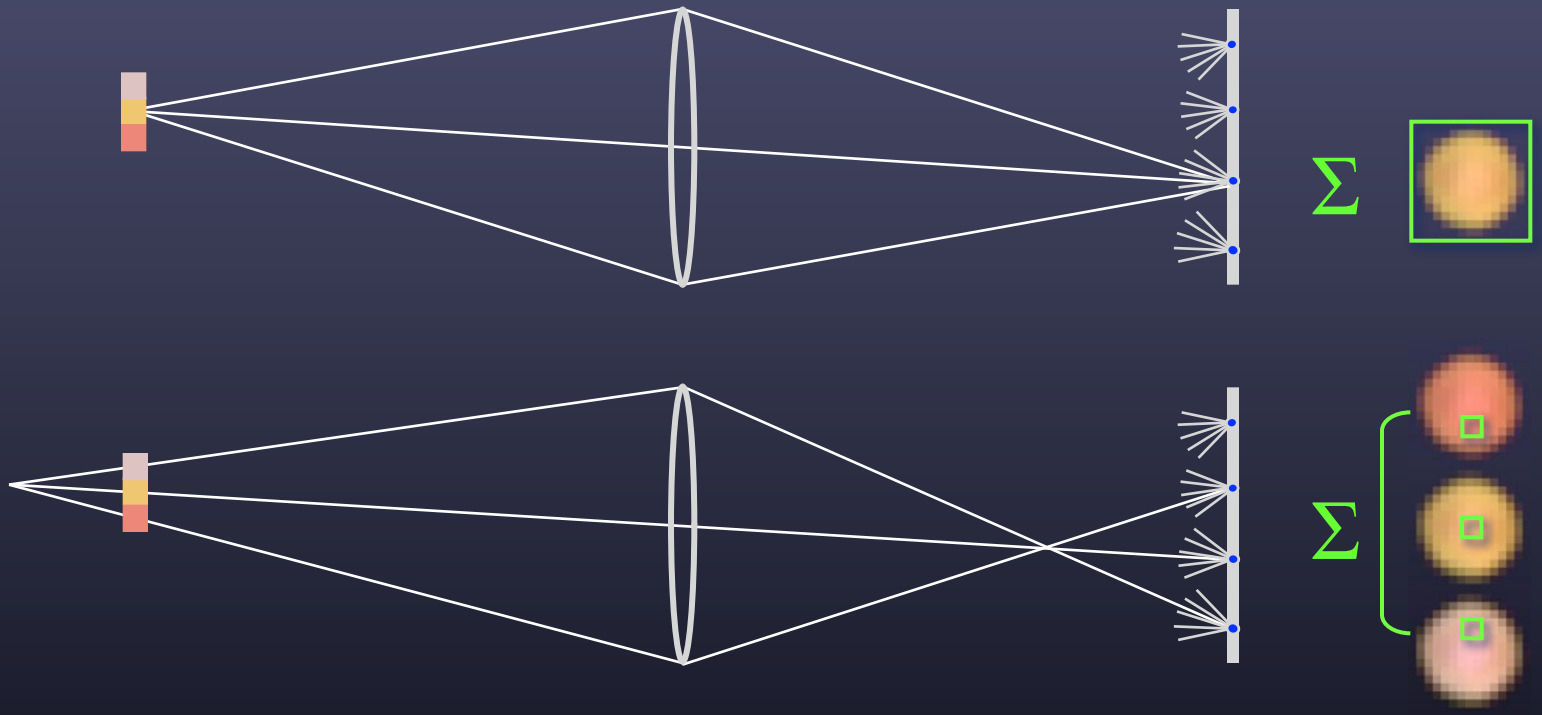


125µ square-sided microlenses

4000 × 4000 pixels ÷ 292 × 292 lenses = 14 × 14 pixels per lens



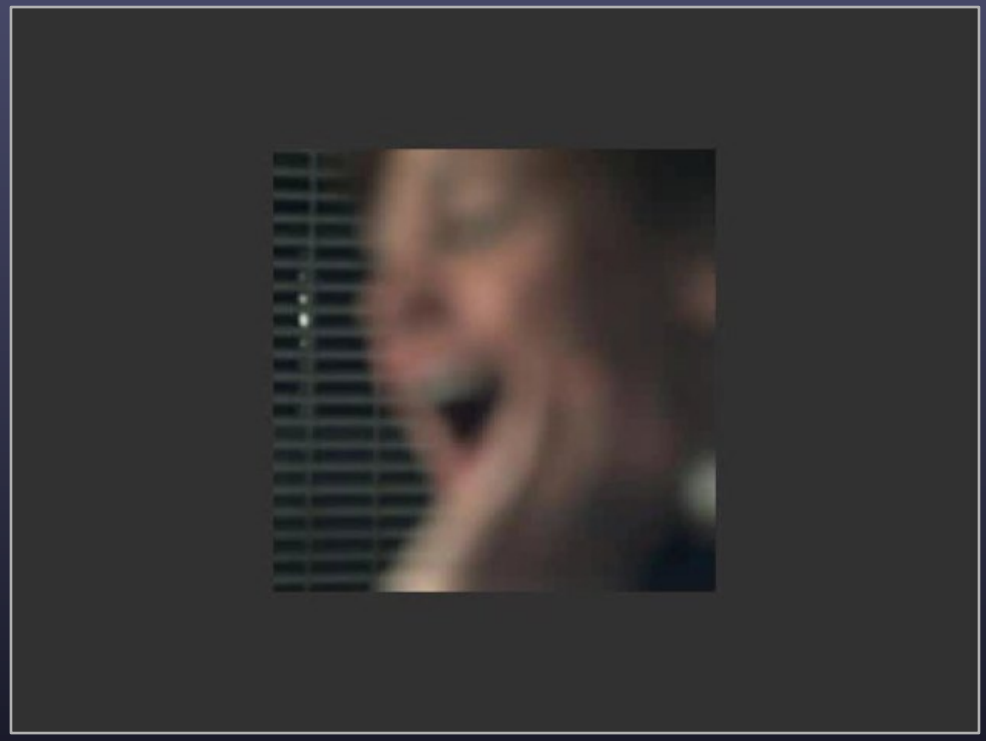
Digital refocusing



- refocusing = summing windows extracted from several microlenses

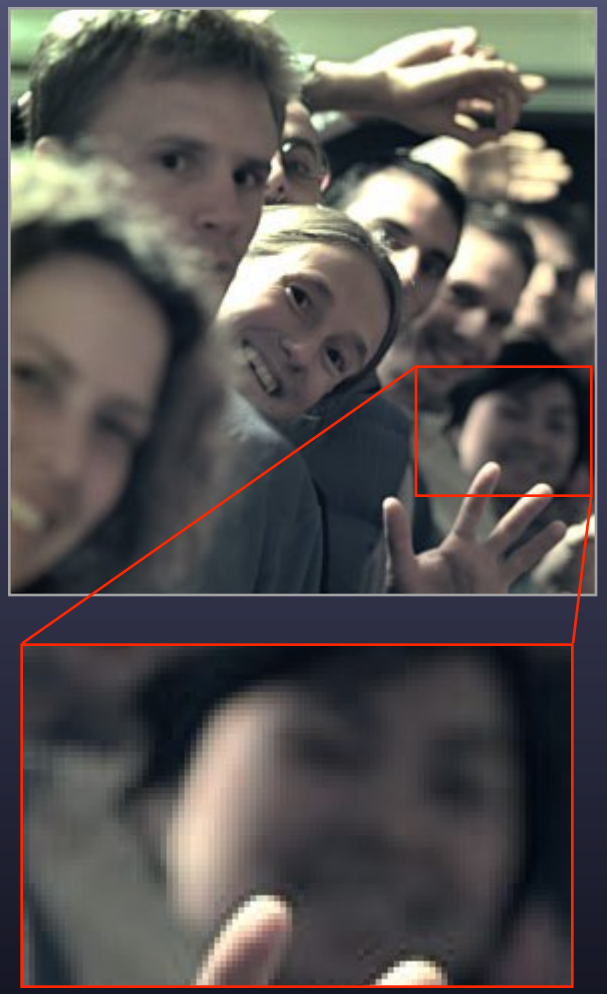
Example of digital refocusing

Refocusing portraits

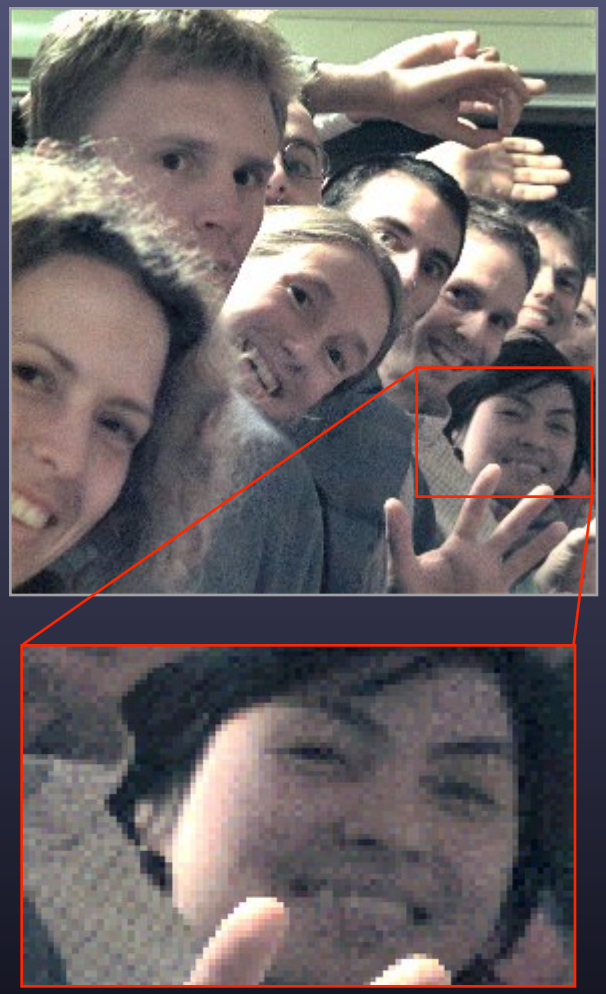


Refocusable sports photography

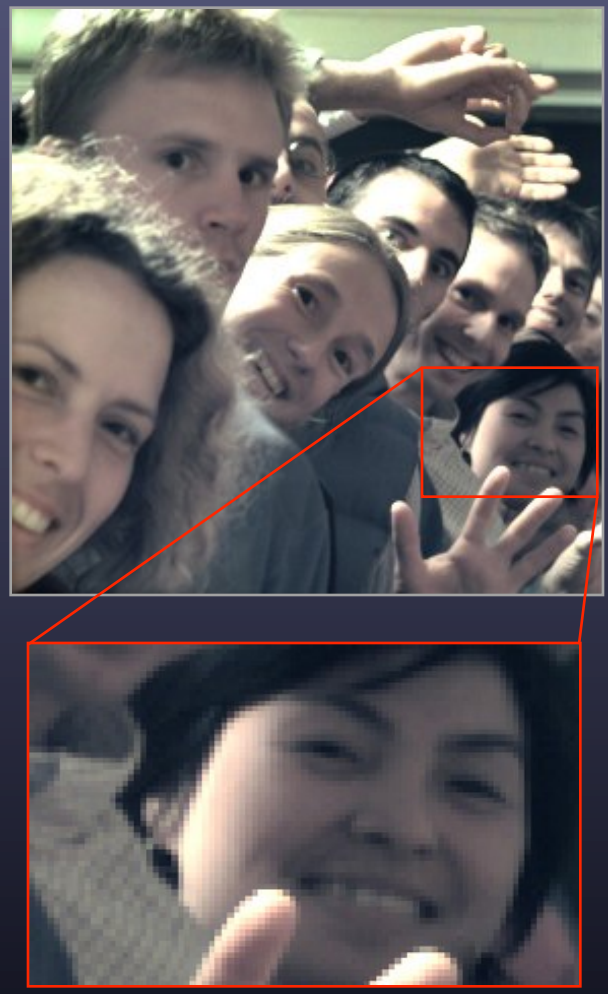
Extending the depth of field



conventional photograph, main lens at f / 4



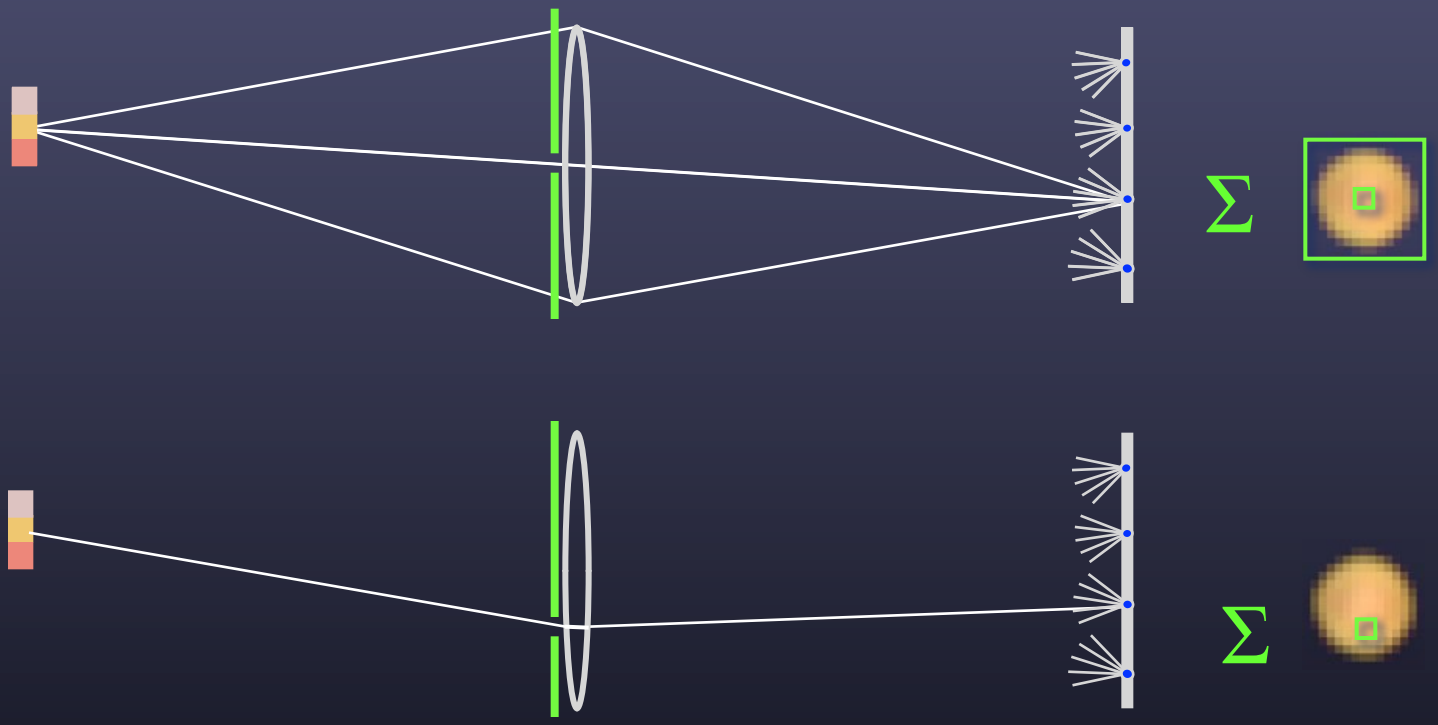
conventional photograph, main lens at f / 22



light field, main lens at f / 4, after all-focus algorithm [Agarwala 2004]

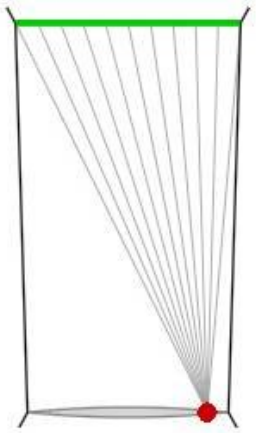
Macrophotography

Digitally moving the observer

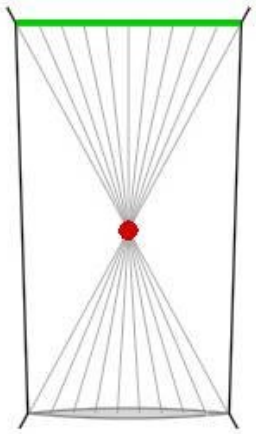


- moving the observer = moving the window we extract from the microlenses

Example of moving the observer



Moving backward and forward



Implications / commercialization

LYTRO™

- trades off (excess) spatial resolution for ability to refocus and adjust the perspective

- sensor pixels should be made even smaller, subject to the diffraction limit

  36mm × 24mm ÷ 2.5μ pixels = 266 Mpix

  20K × 13K pixels

  2000 × 1333 pixels × 10 × 10 rays per pixel

  or

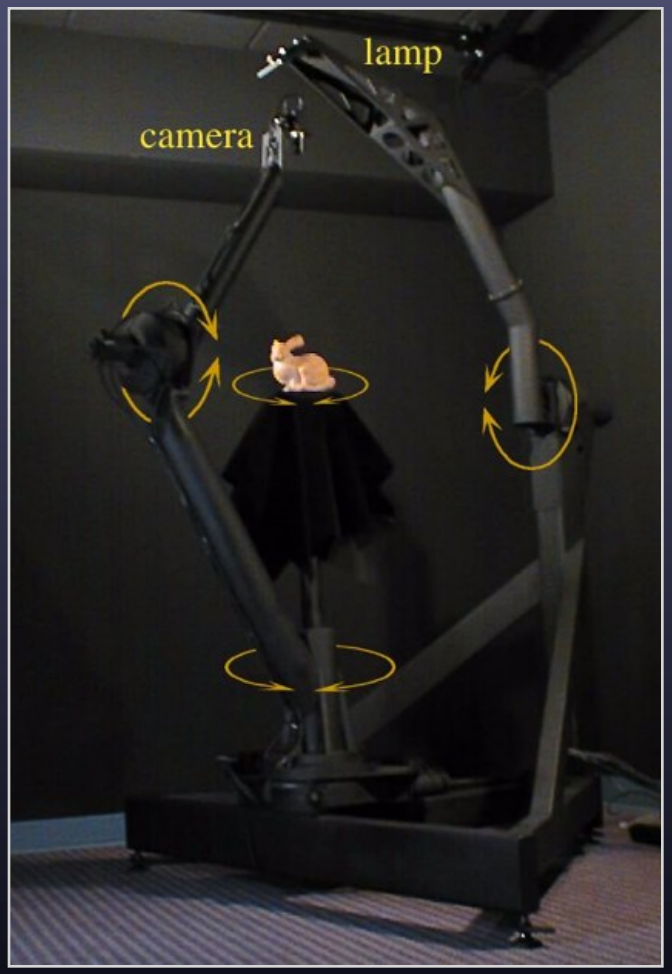
  2000 × 1500 pixels × 3 × 3 rays per pixel = 27 Mpix

Other devices for capturing light fields

Stanford Multi-Camera Array

Manex's bullet time array

Other devices for capturing light fields



Stanford Spherical Gantry

used to measure light scattering
for rendering translucent materials

Lego gantry for capturing light fields
(built by Andrew Adams)

Flash-based viewer for light fields
(written by Andrew Adams)

(see http://lightfield.stanford.edu/lfs.html)

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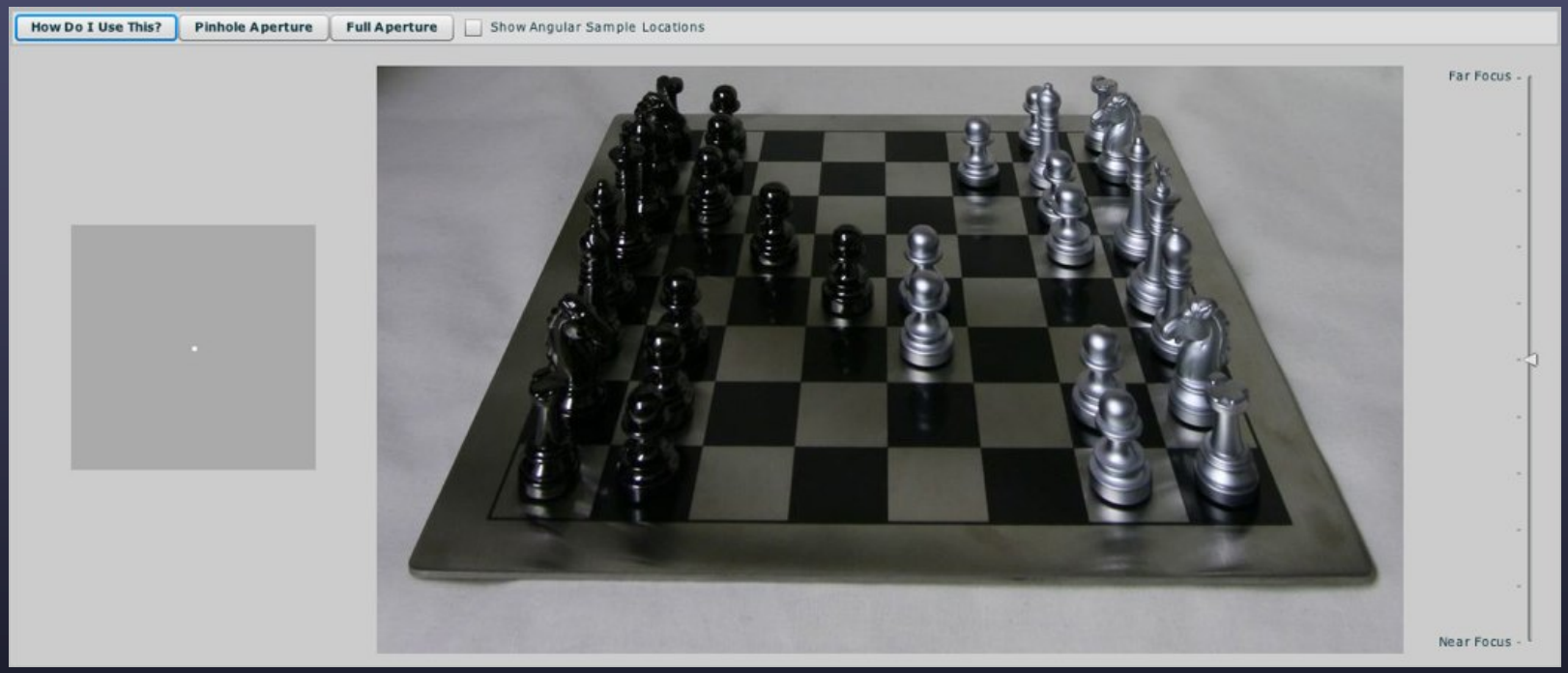

The Lego gantry captures a light field of itself