Light field photography

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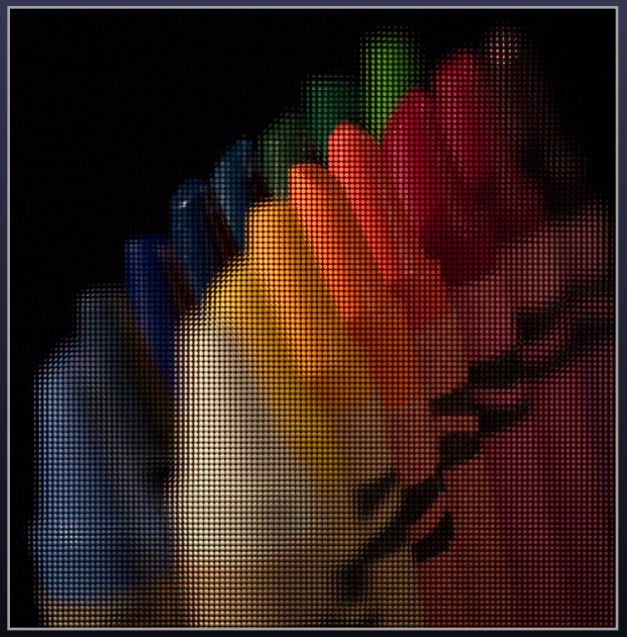
Computer Science Department
Stanford University

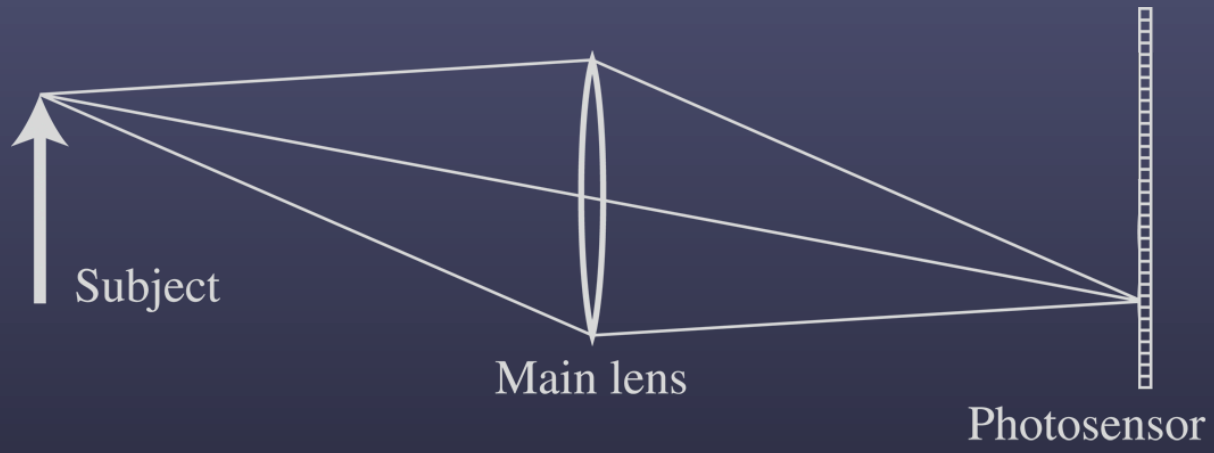
“Light field photography using a handheld plenoptic camera”

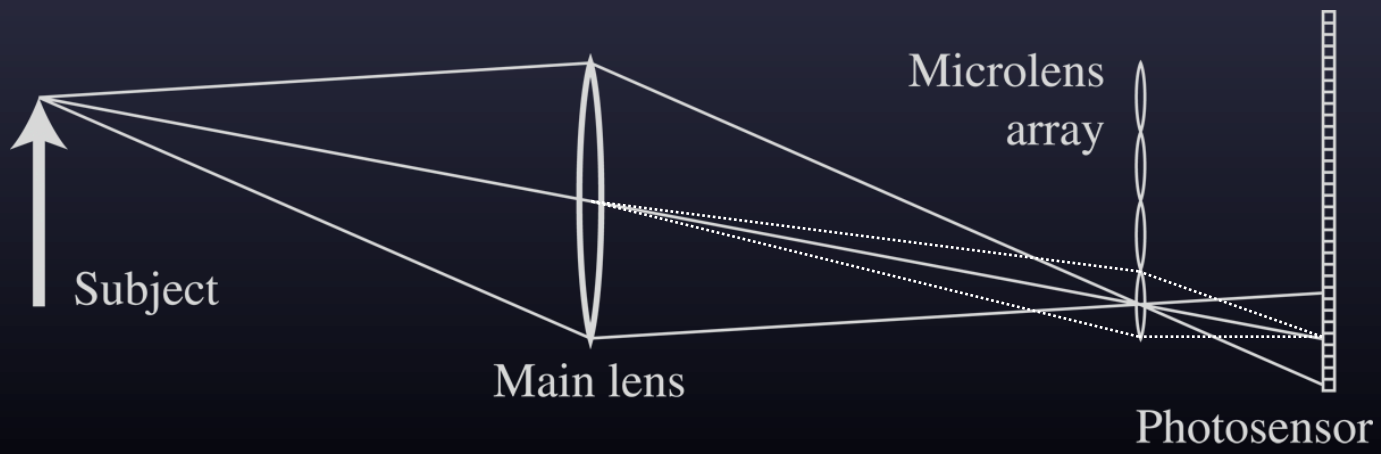
Ren Ng, Marc Levoy, Mathieu Brédif,
Gene Duval, Mark Horowitz and Pat Hanrahan

(Proc. SIGGRAPH 2005
and TR 2005-02)



Conventional versus plenoptic camera





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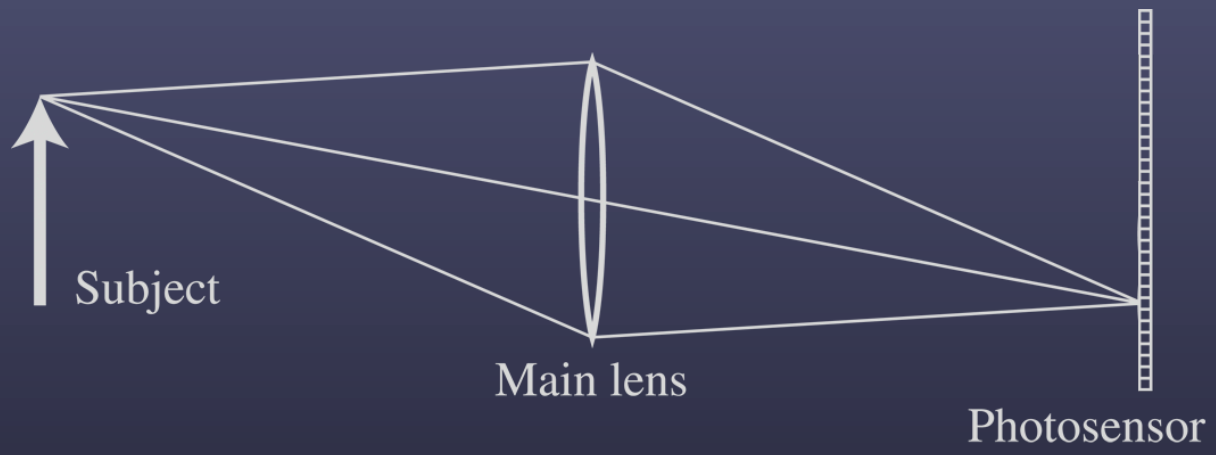
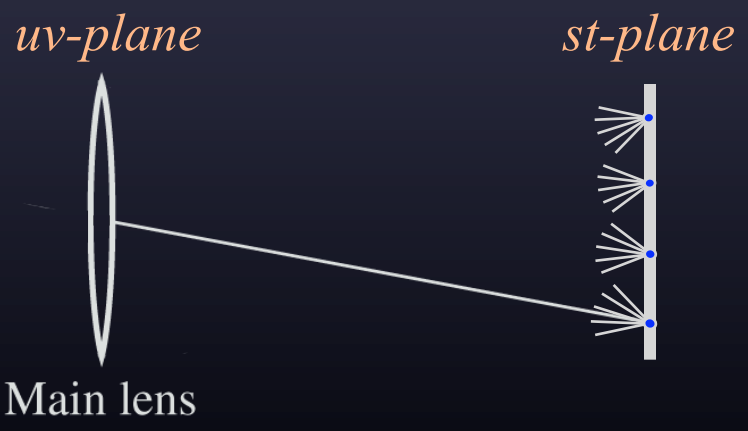
Conventional versus plenoptic camera





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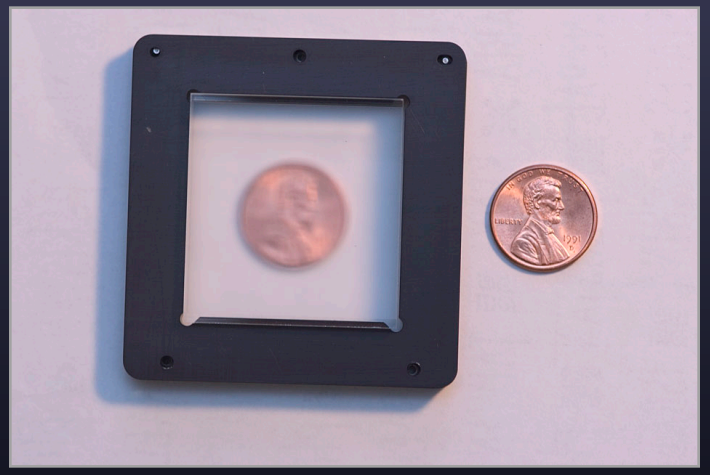
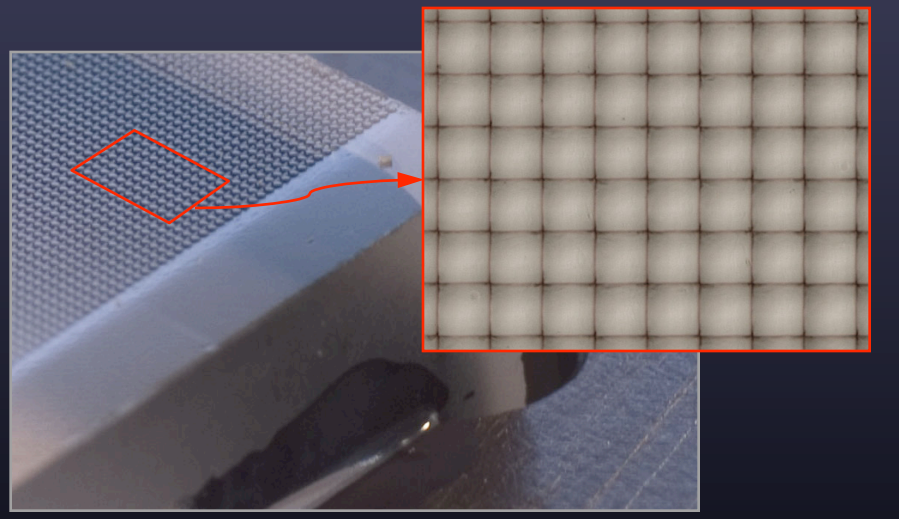
Prototype camera

Contax medium format camera

Kodak 16-megapixel sensor

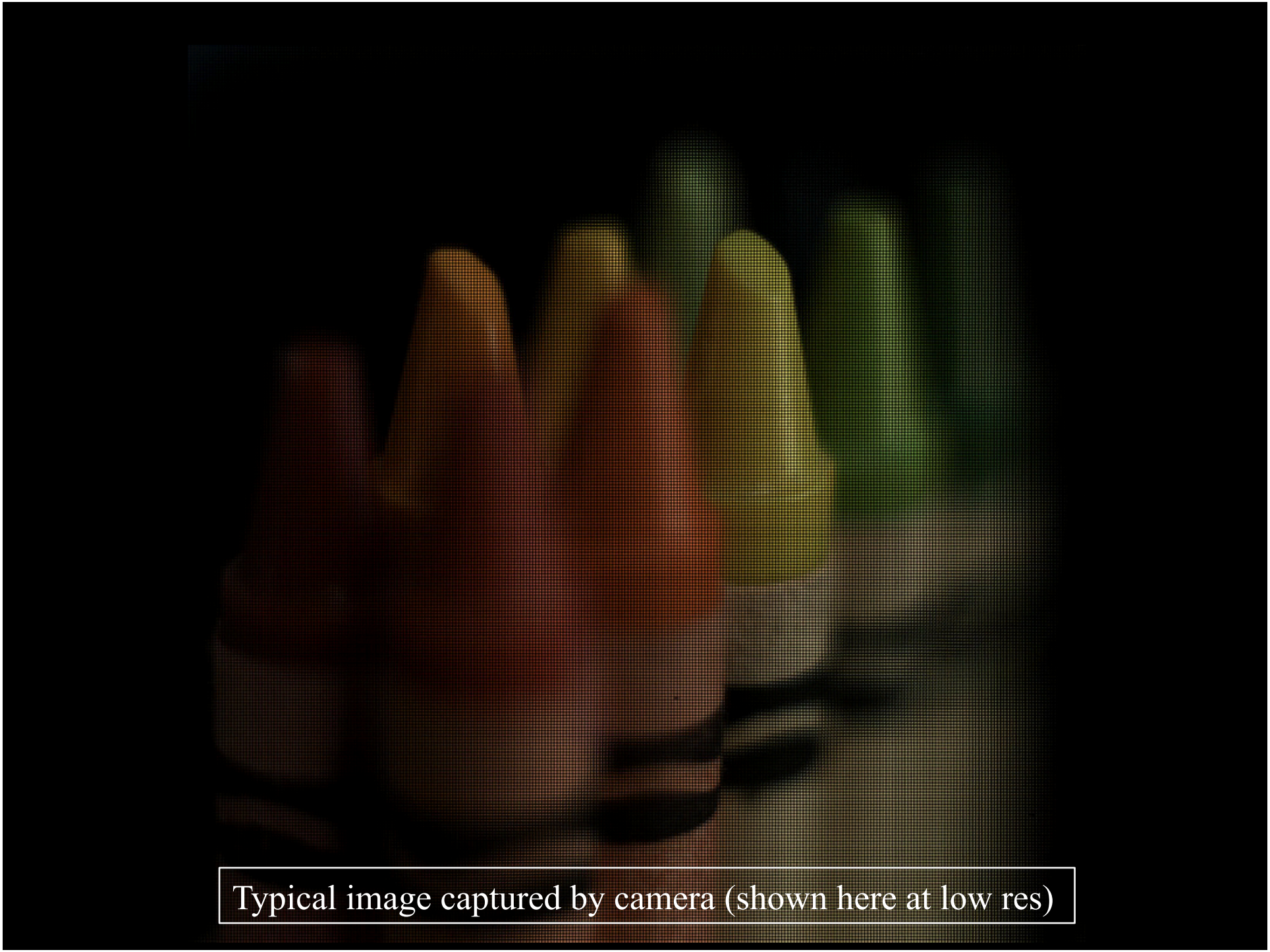


Adaptive Optics microlens array

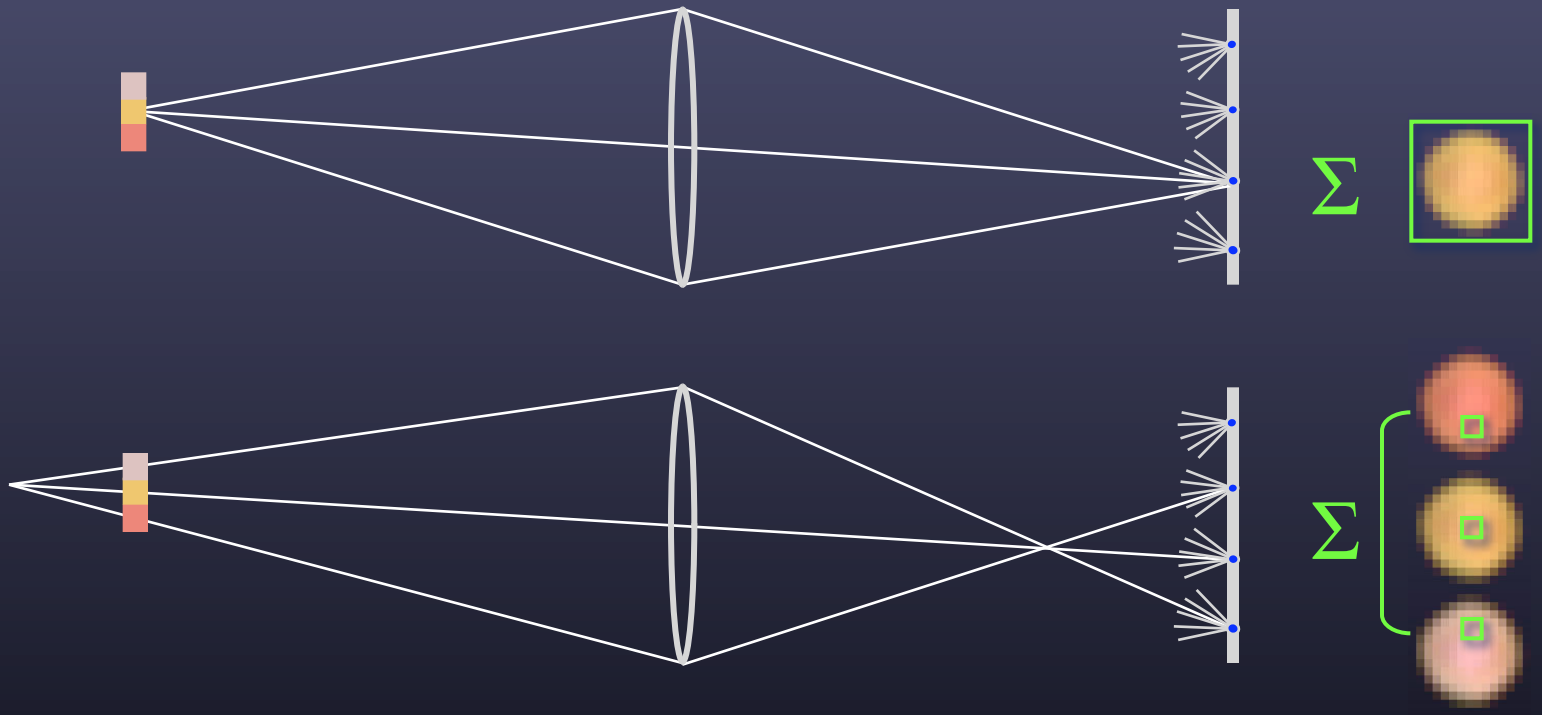


125µ square-sided microlenses

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


Typical image captured by camera (shown here at low res)

Digital refocusing



- refocusing = summing windows extracted from several microlenses

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Example of digital refocusing

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Example of digital refocusing

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Example of digital refocusing

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Example of digital refocusing

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Example of digital refocusing

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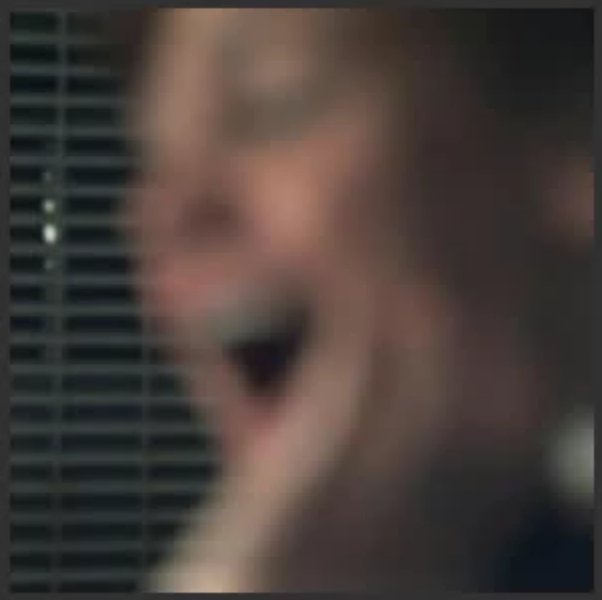
Refocusing portraits



(movie is available at http://refocusimaging.com)

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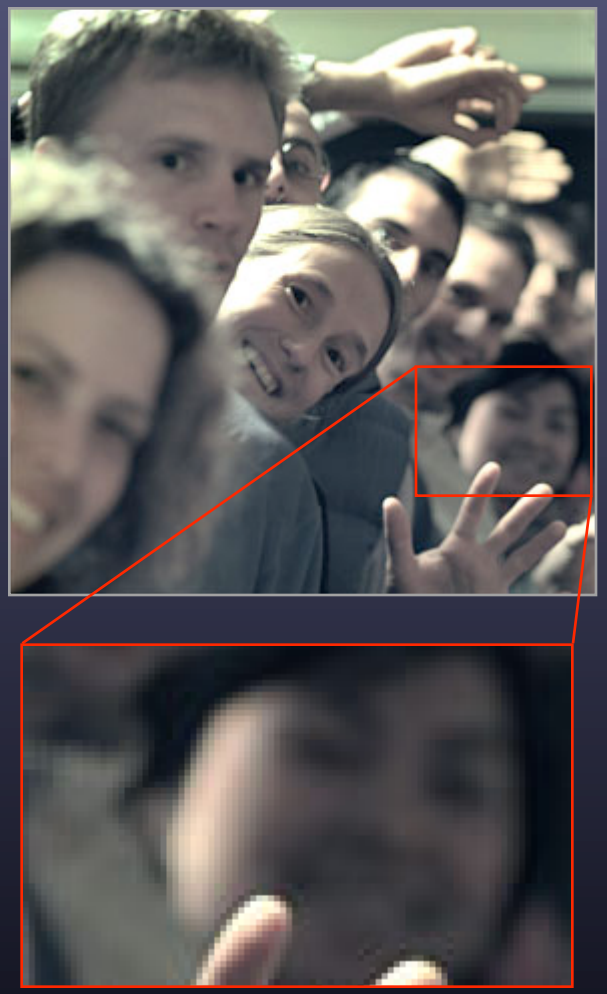
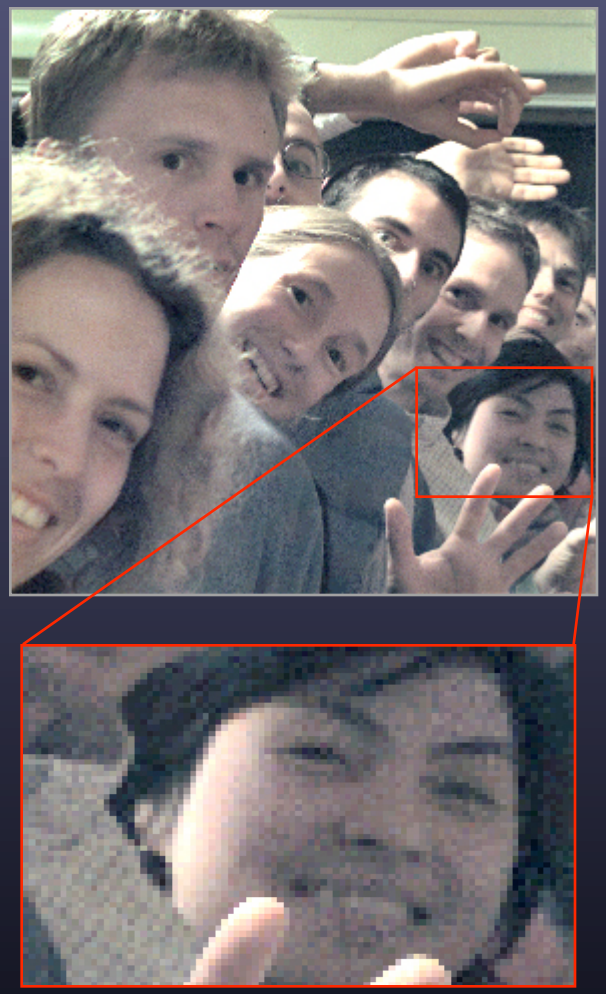
Extending the depth of field



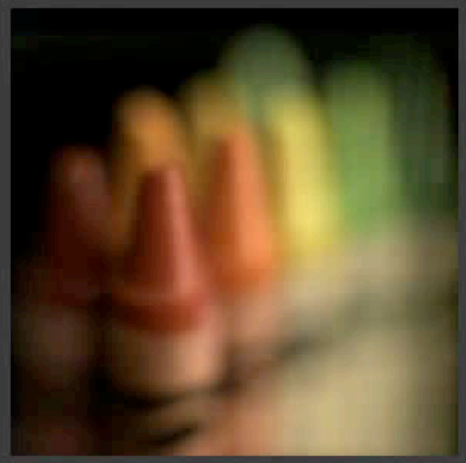
conventional photograph, main lens at f / 4



conventional photograph, main lens at f / 22

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

Macrophotography



(movie not available online)

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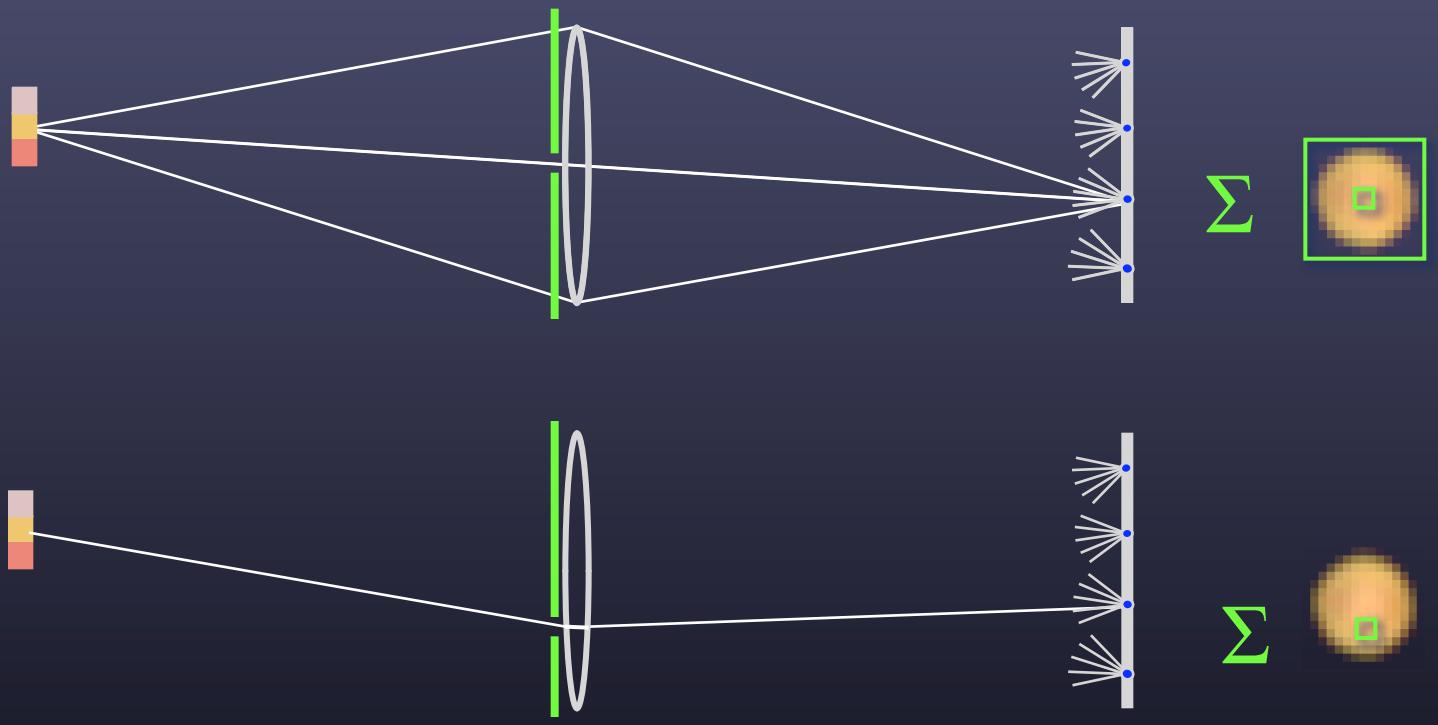
Digitally moving the observer



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

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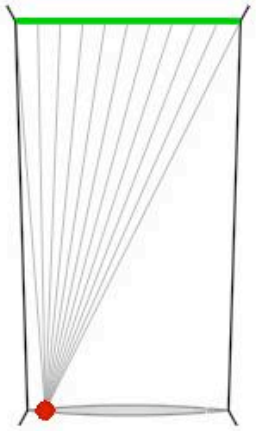
Example of moving the observer



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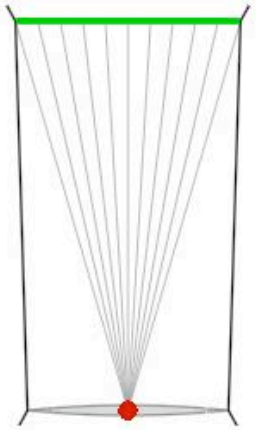
Example of moving the observer



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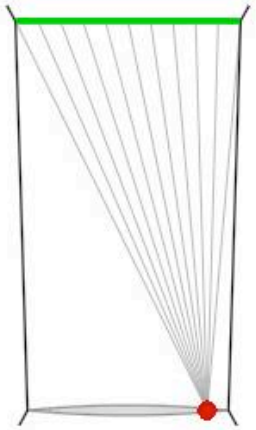
Example of moving the observer



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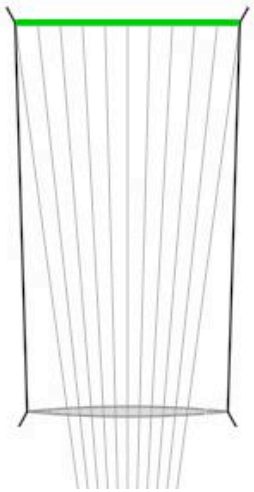
Moving backward and forward



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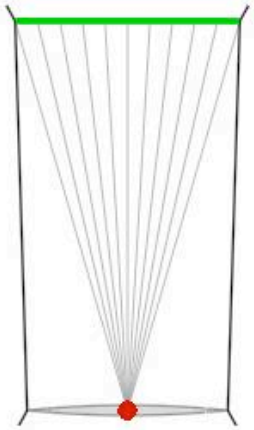
Moving backward and forward



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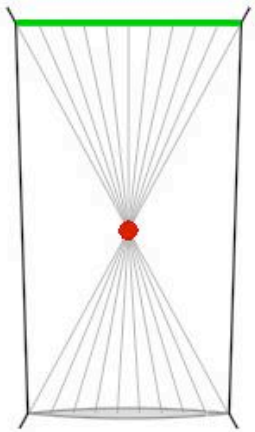
Moving backward and forward



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Implications / commercialization
(see refocusimaging.com)

- cuts the unwanted link between exposure (due to the aperture) and depth of field
- 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

  4000 × 2666 pixels × 20 × 20 rays per pixel

or

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

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