

# Retrographic Sensing for the Measurement of Surface Texture and Shape

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# Capturing geometry

- Woodham, 1980
- Zickler, 2002
- Goldman, 2005
- Hertzmann, 2005

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See:

- 1) Fig. 10 (baby doll head) in Zickler, T. et al. *International Journal of Computer Vision* 49, no. 2-3 (2002): 215. ([PDF](#))
- 2) Fig. 1 (cast iron teapot) in Goldman, D. B., et al. *Proc. Of ICCV 2005*. ([PDF](#))
- 3) Ceramic cat from Hertzmann, A., and S. Seitz. "[Shape and Materials by Example: A Photometric Stereo Approach](#)." *IEEE PAMI* 27, no. 8 (2005).

# Surface texture and shape



**Cookie**

**Paint**



**Clear Elastomer**





# Elastomers

- Material should be clear, soft, durable, etc.
- Have tried silicones and polyurethanes
- Thermoplastic elastomers (TPEs)



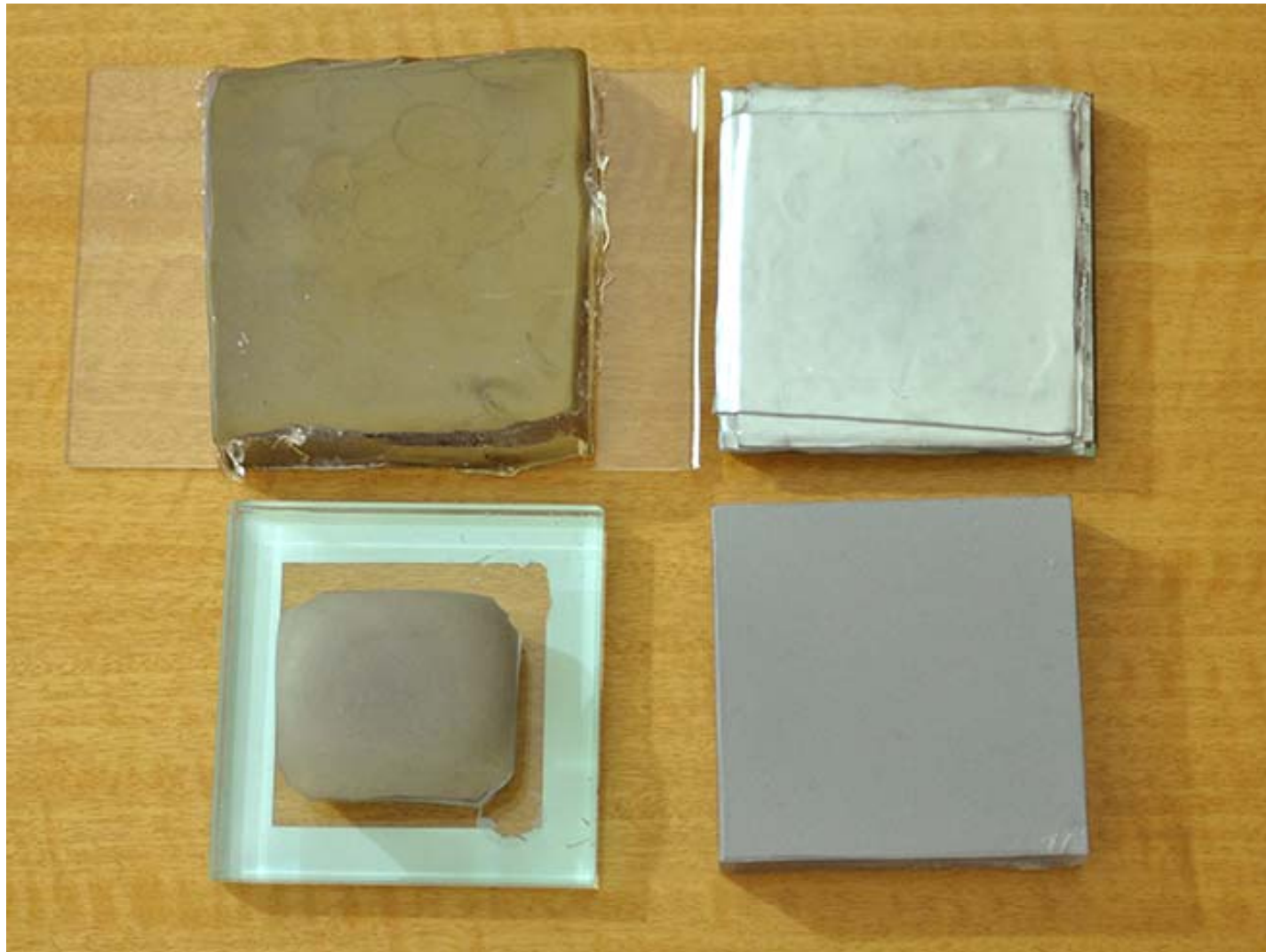
See accompanying video "Thermoplastic elastomers" (lec05\_tpe.mov)

Bake at 350 for 30  
minutes...





# Paint

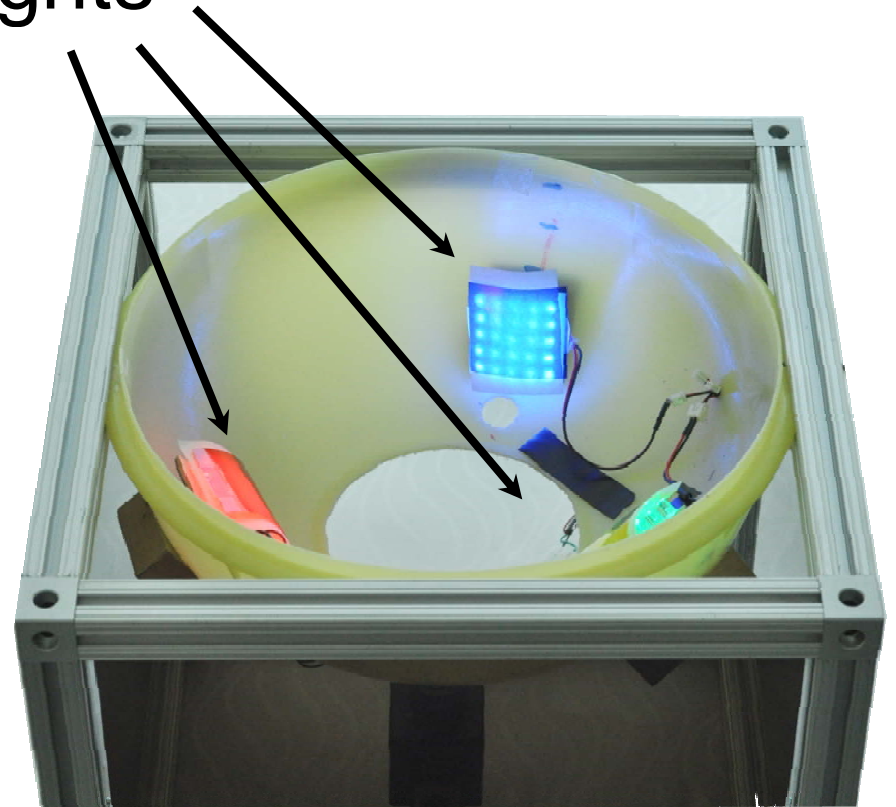


# Lights, camera, action

Sensor



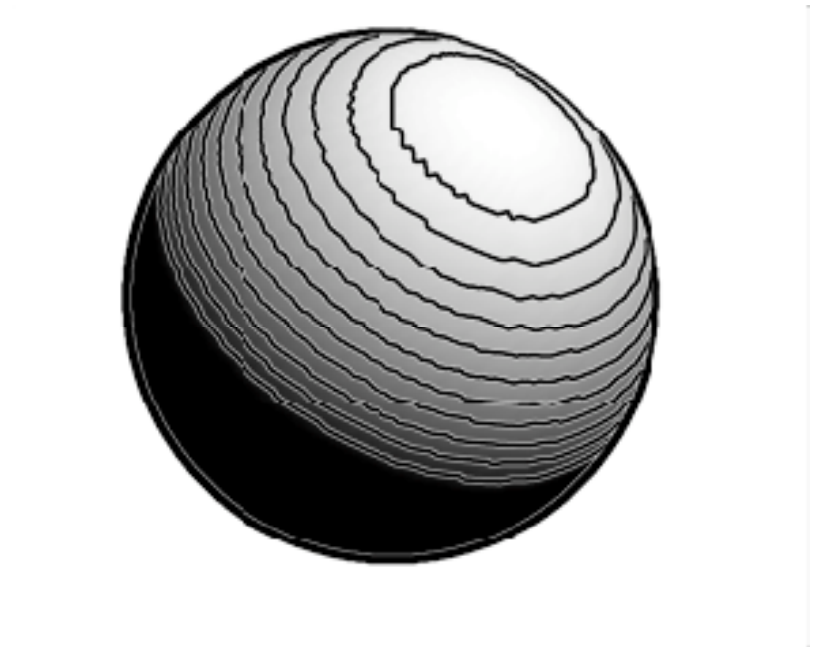
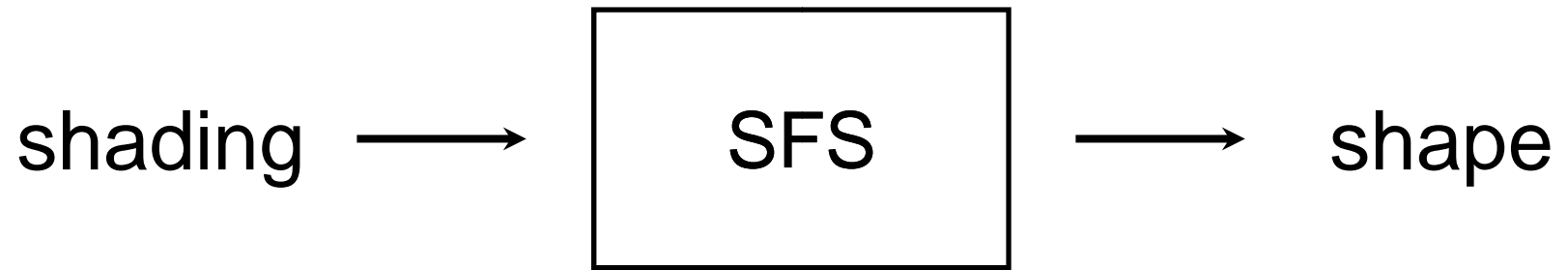
Lights



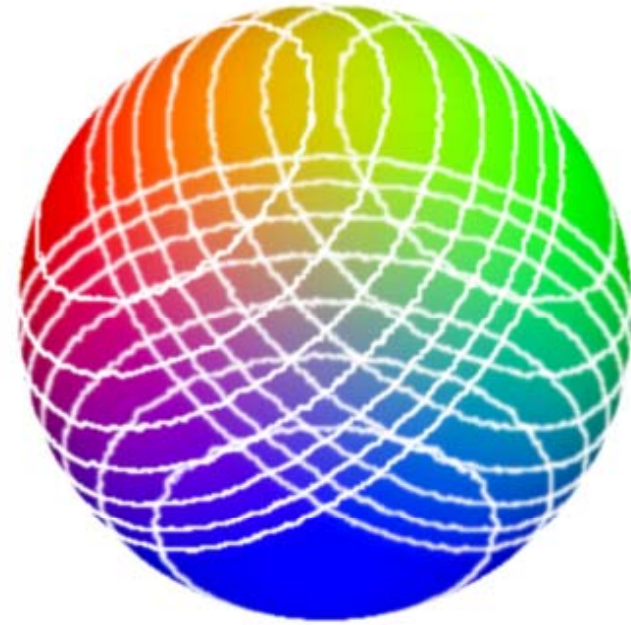
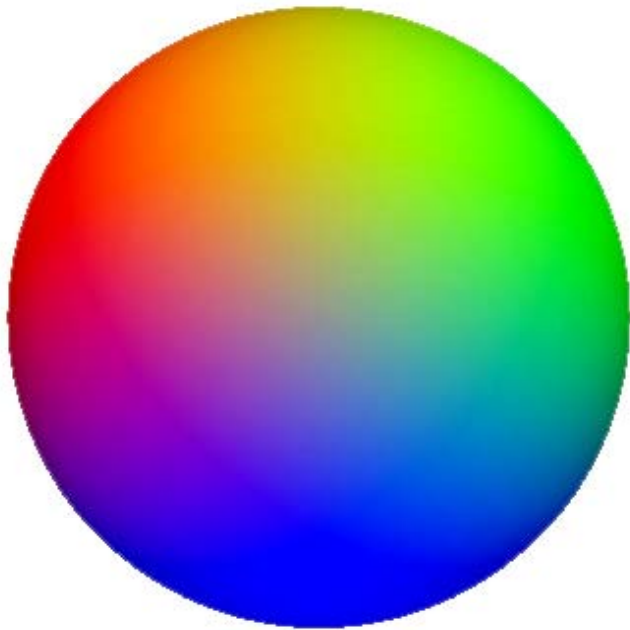
Camera

# Why three lights :

- Shape-from-shading



# Multiple lights: photometric stereo

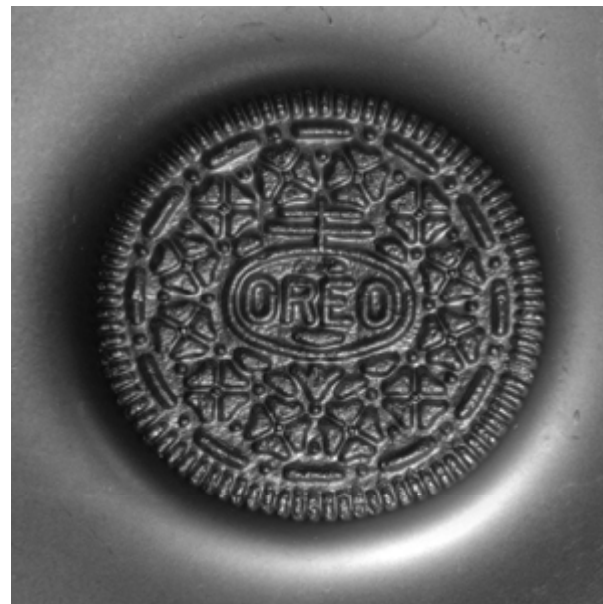


Woodham, 1980

RGB



Red



Green

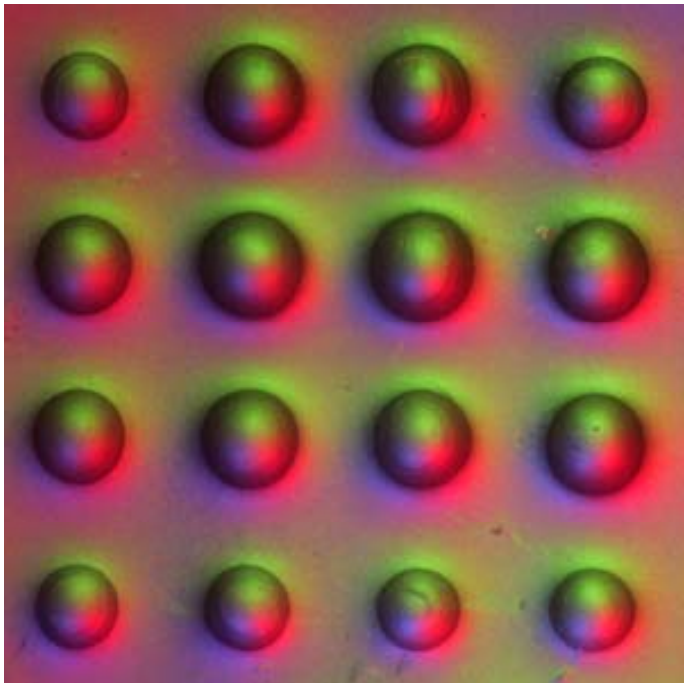


Blue

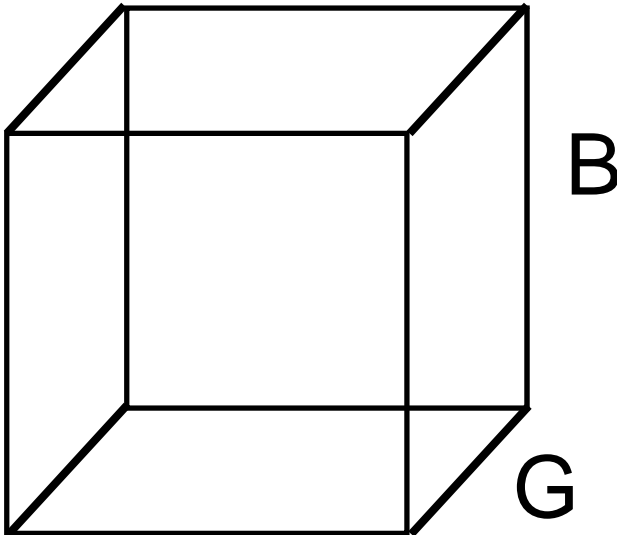


# Calibration





Lookup Table



R

B

G

RGB color

Lookup

Gradient

(10,200,3)



(0,-0.3)

(200,10,3)



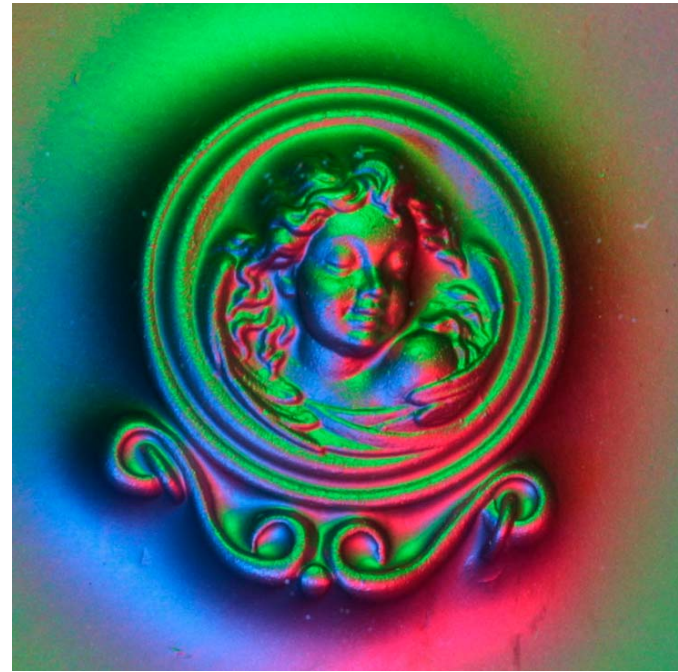
(0.2, 0.2)

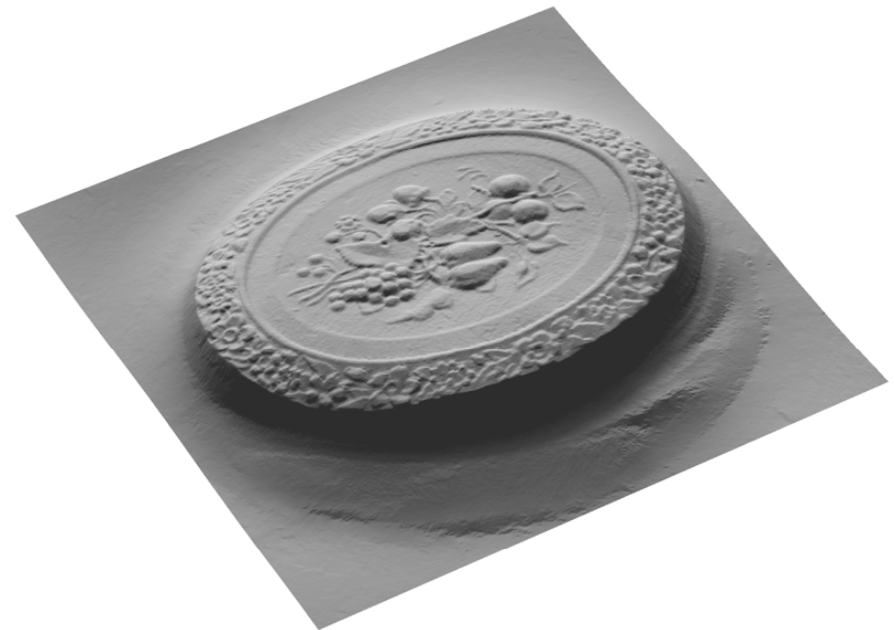
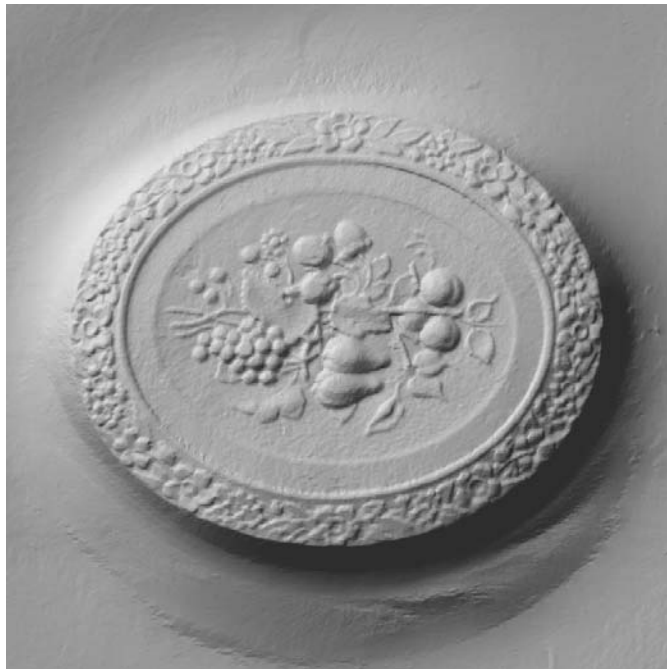
# Surface reconstruction

$$z = f(x, y)$$

$$E(z) = \sum_{x,y} \left( \frac{\partial f}{\partial x} - p \right)^2 + \left( \frac{\partial f}{\partial y} - q \right)^2$$









See accompanying video "20 dollar bill" (lec05\_20.mov)



See accompanying video  
"Fingertip" (lec05\_finger.mov)



See accompanying video  
"Fingertip with lotion" (lec05\_finger2.mov)

# Limitations

- Limited depth - depends on gel
- Some objects distort when pressed
  - fingertips, cloth

# Retrographic sensing

- Inexpensive
- High-resolution
- Simple
- Portable / Interactive
  
- Acknowledgements
  - Funding from NSF and Adobe Systems

MIT OpenCourseWare  
<http://ocw.mit.edu>

MAS.531 Computational Camera and Photography  
Fall 2009

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