DISCO – Acquisition of Translucent Object

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Past Work – Acquisition

- BRDF Acquisition – cannot model subsurface scattering
- Image Acquisition – Captured with fixed viewpoints [Debevec 01], fixed lighting [Wood 00], or both [Levoy 96]
- [Jensen 01] allows arbitrary modeling of only homogenous materials

Past Work – Rendering

- Rendering with BSSRDFs
  - Expensive and slow
- Dipole Approximation
  - Physically correct for homogenous, infinite half-space
- Most methods not based on measured data

Goals

- Capture the exact behavior of real translucent objects
  - Heterogenous properties (eg. cracks, hollow objects, volumetric variations)
- Allow for modeling in arbitrary lighting with arbitrary viewpoints
- Integration into rendering systems ([Lensch 03])

DISCO method

- Digital Imaging of Subsurface sCattering Objects
- Want to measure $R_d(x_i; x_o)$ per color channel for all x_i and x_o.

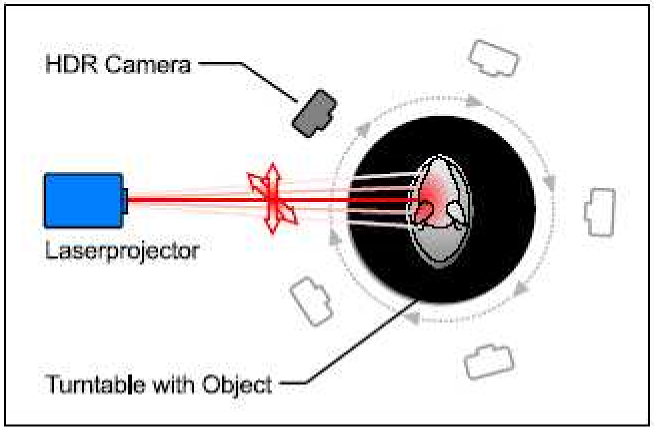
DISCO (cont.)

$$L^{\rightarrow}(x_o, \omega_o) = \int_A \int_{\Omega_+(x_i)} L^{\leftarrow}(x_i, \omega_i) S(x_i, \omega_i; x_o, \omega_o) d\omega_i dx_i.$$

$$L^{\rightarrow}(x_o, \omega_o) = \frac{1}{\pi} F_{t,o}(\eta, \omega_o) \int_A R_d(x_i, x_o) \cdot \int_{\Omega_+(x_i)} L^{\leftarrow}(x_i, \omega_i) F_{t,i}(\eta, \omega_i) \langle N_i \cdot \omega_i \rangle d\omega_i dx_i.$$

- Illuminate at a single surface point x_i with known incident radiance $L^{\leftarrow}(x_i;\omega_i)$, observe $L^{\rightarrow}(x_o;\omega_o)$
- Invert to find $R_d(x_i; x_o)$

DISCO (cont. again)

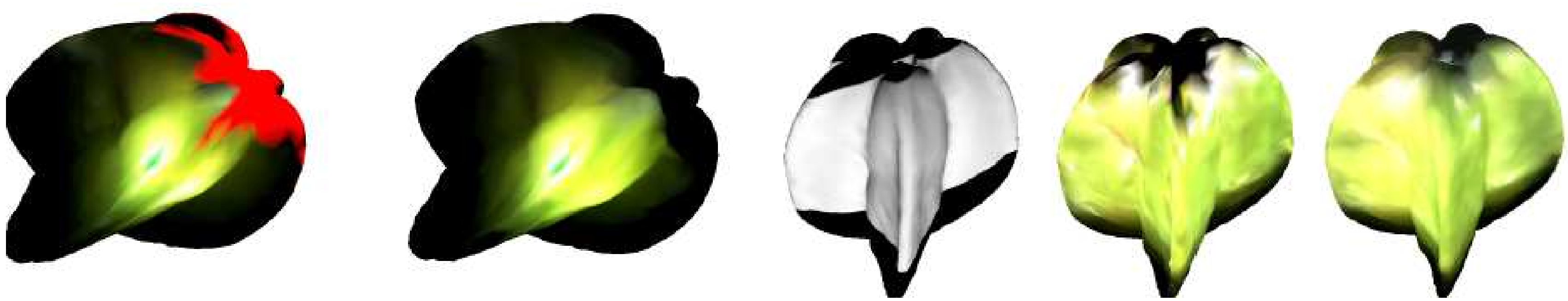



```
for all camera positions
 for all turntable rotations
  record silhouette image
  for all laser colors
   for all projector positions
     record impulse response image
```

- Finite width beams that can enter at large angle of incidence ω_i
  - Omit samples with ω_i larger than some threshold

Data Storage and Access

- Raw data is several hundred gigabytes
- High sampling density around incident, more coarse sampling further away
  - Global response – matrix *F* of throughput factors; interpolate vertices data does not fill



Throughput Interpolation

- Some vertices are never lit
- Case $F_{k,c,}$ k far from point of illumination c
  - Interpolate iteratively from neighboring vertices
- Case $F_{k,c,}$ k close to point of illumination c
  - Use distanced-weighted avg. response of neighbors

Interpolation (cont.)

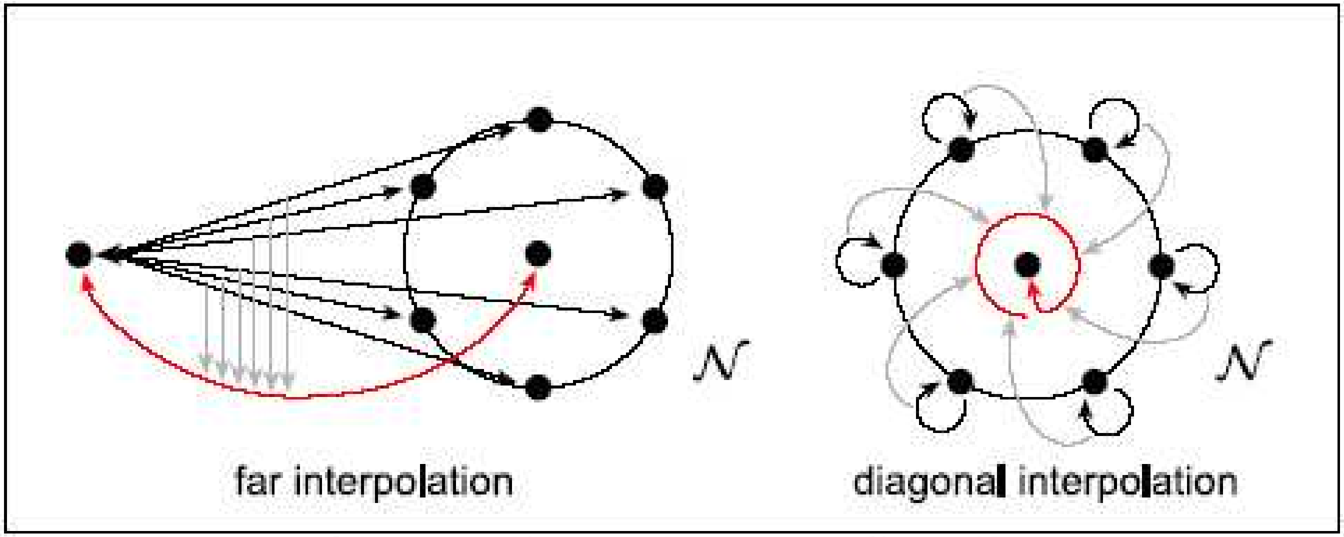


Figure 6: Far and diagonal interpolation of throughput factor matrix F. The throughput factor shown in red is interpolated based on the neighboring factors shown in black.

Local Response

- Store filter kernals a la [Lensch 03]
- Most laser peaks between discrete texels
  - Shift peak to all 4 neighboring texels weighted by $m(d) = c_1 \bullet e^{\alpha_1 d} + c_1 \bullet e^{\alpha_2 d}$, d is distance to peak location
- Interpolate filter kernels with same method as throughput factors

Rendering

- Direct port into Lensch et al.’s approach
- Can substitute for dipole approximations, Monte Carlo/Photon Mapping evaluations

Pretty Pictures! (and results)

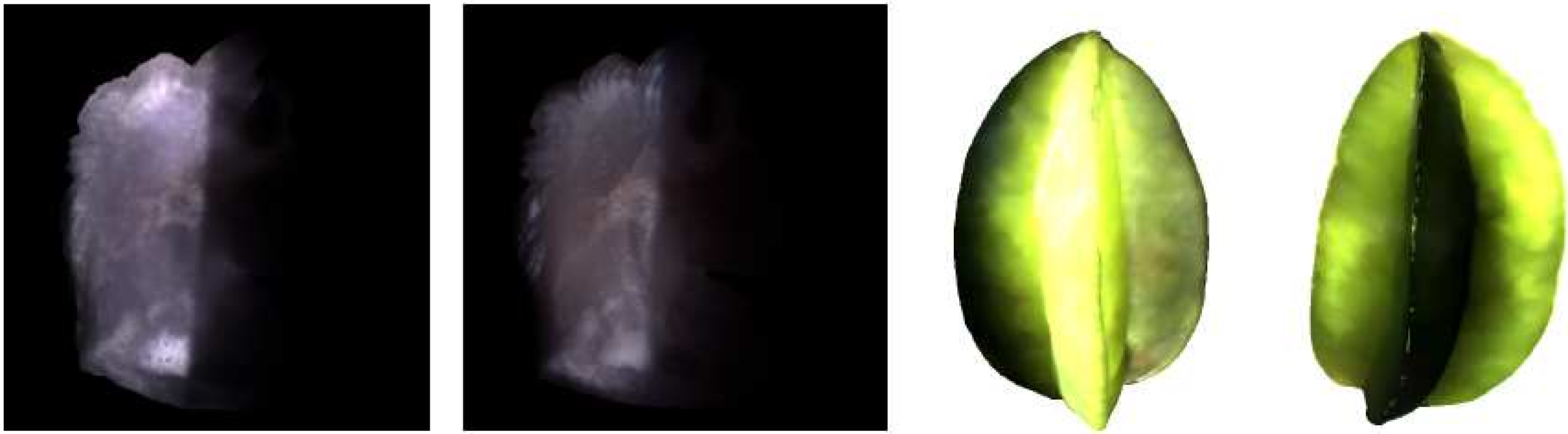
	Horse	Duck	Starfruit
# input views	24	25	20
# input images	1.065.744	541.125	401.220
input size (compressed)	31G	14G	12G
acquisition time	20.5h	11.25h	8h
# vertices	8924	5002	5001
# filter kernels	82.390	115.151	112.538
processing time (resampling)	7.8h	3.6h	3.4h

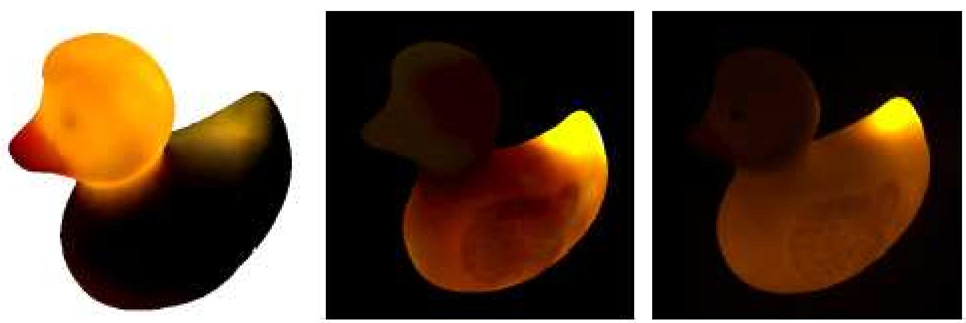
Table 1: Some statistics about the acquired models.

Pretty Pictures! (and results, take 2)

Figure 9: The test objects under indoor illumination (top row) and illuminated by all three lasers (bottom row).

Pretty Pictures! (and results, take 3)





Conclusions

- Surface coverage limited by occlusion
- Additional imagery vs. Acquisition time
- Could try to plan acquisition images
  - Pre-determine lit surface positions