BiGS: Bidirectional Primitives for Relightable 3D Gaussian Splatting

Supplementary Material

8. Reciprocity of s

We represent s using bidirectional spherical harmonics as in Eq. (4). We intend to prove if $c_{ij} = c_{ji}$, then s is reciprocal, mathematically, $s(\omega_\mathrm{i}, \omega_\mathrm{o}) = s(\omega_\mathrm{o}, \omega_\mathrm{i})$. We rewrite Eq. (4) by merging summation terms of index (i, j) and (j, i), having

$$s(\omega_\mathrm{i}, \omega_\mathrm{o}) = \sum_{i=1}^{n} \sum_{j=i+1}^{n} \left[c_{ij} y_i(\omega_\mathrm{i}) y_j(\omega_\mathrm{o}) + c_{ji} y_j(\omega_\mathrm{i}) y_i(\omega_\mathrm{o})\right] + \sum_{i=1}^{n} c_{ii} y_i(\omega_\mathrm{i}) y_i(\omega_\mathrm{o})$$

The second summation is the same for $s(\omega_\mathrm{i}, \omega_\mathrm{o})$ and $s(\omega_\mathrm{o}, \omega_\mathrm{i})$. To equate the first summation, we need to have $c_{ij} y_i(\omega_\mathrm{i}) y_j(\omega_\mathrm{o}) + c_{ji} y_j(\omega_\mathrm{i}) y_i(\omega_\mathrm{o})$ equal to $c_{ji} y_j(\omega_\mathrm{o}) y_i(\omega_\mathrm{i}) + c_{ij} y_j(\omega_\mathrm{o}) y_i(\omega_\mathrm{i})$. Then $c_{ij} = c_{ji}$ gives us the following:

$$\begin{aligned} & c_{ij} y_i(\omega_\mathrm{i}) y_j(\omega_\mathrm{o}) + c_{ji} y_j(\omega_\mathrm{i}) y_i(\omega_\mathrm{o}) \\ =& c_{ji} y_i(\omega_\mathrm{i}) y_j(\omega_\mathrm{o}) + c_{ij} y_i(\omega_\mathrm{i}) y_j(\omega_\mathrm{o}) \\ =& c_{ji} y_j(\omega_\mathrm{o}) y_i(\omega_\mathrm{i}) + c_{ij} y_j(\omega_\mathrm{o}) y_i(\omega_\mathrm{i}). \end{aligned}$$

□

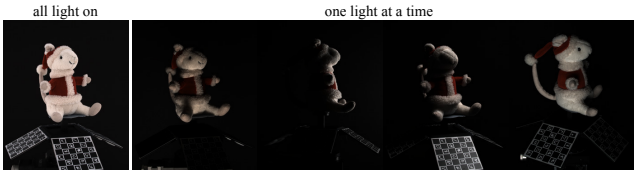

Figure 10. **Example images** of our capture OLAT dataset.

Table 1. The runtime and model size of our examples, sorted by number of primitives. Our relighting step roughly scales linearly with the number of primitives, providing 40–50 fps of relighting and rendering. Each Gaussian primitive costs 1,089 optimizable parameters, amounting to a per-Gaussian 4.254 KB memory cost using 32-bit floating point numbers.

	Time (ms)			Model Size		
Model	Relight	Rasterize	Total Time	# Primitives	# Parameters	Memory (MB)
BUNNYMETAL	1.75	19.38	21.13	16 693	18 178 677	69.35
DRAGON	3.71	20.96	24.67	31 252	34 033 428	129.83
SPOT	3.83	18.52	22.35	33 087	36 031 743	137.45
FURBALLSPECULAR	4.02	19.23	23.25	34 619	37 700 091	143.82
IRIDENSCENCEBALL	4.02	19.20	23.21	35 035	38 153 115	145.54
FURBALLDIFFUSE	5.11	19.63	24.74	44 441	48 306 249	184.62
KNOB	6.23	19.25	25.48	53 429	58 184 181	221.96
HAIRBALL	15.90	19.30	35.20	127 787	139 160 043	530.85
PLUSHY	19.31	17.18	36.49	153 467	167 125 563	637.53

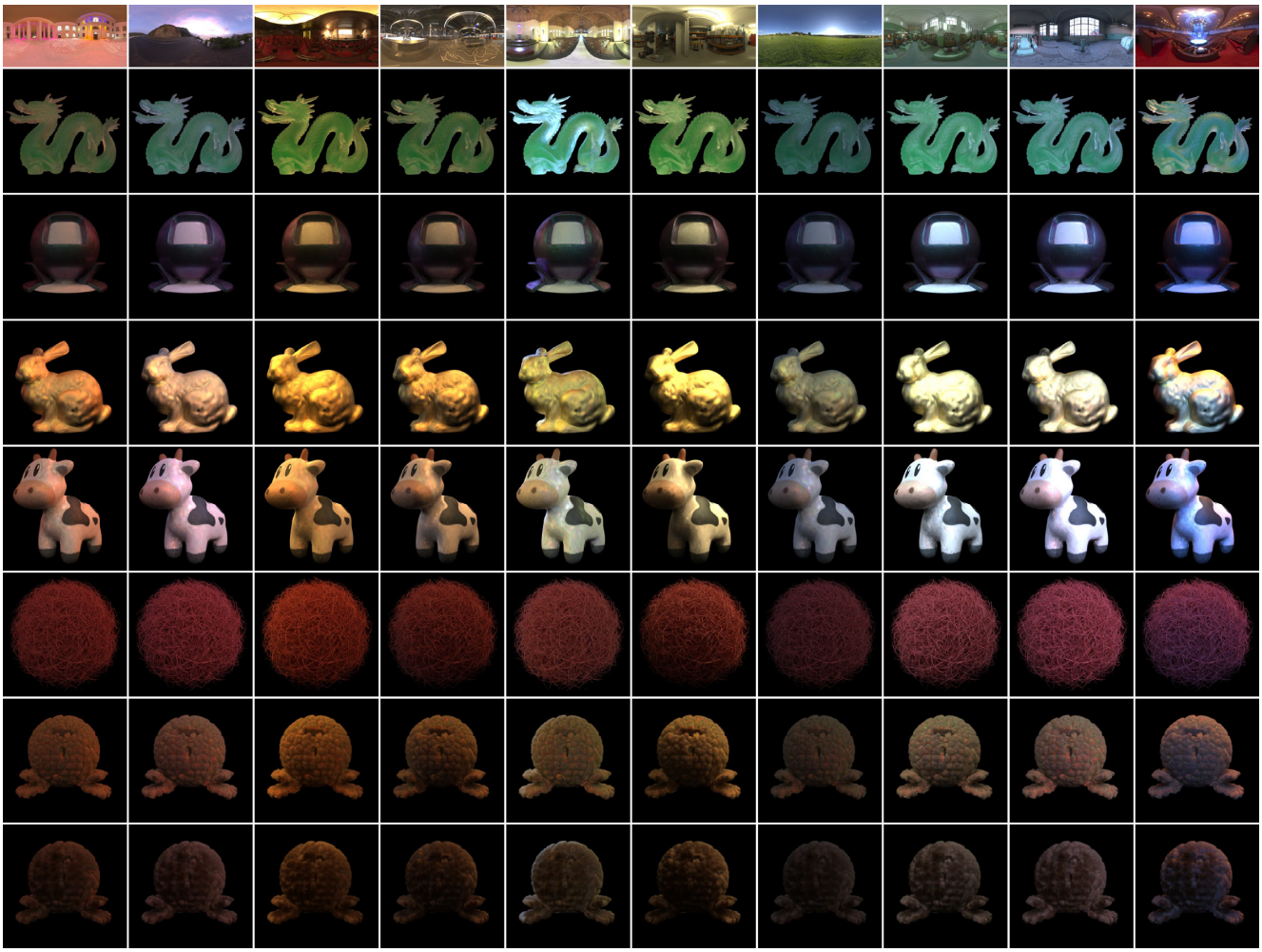

Figure 11. Extra environment light relighting