RelightableHands: Efficient Neural Relighting of Articulated Hand Models
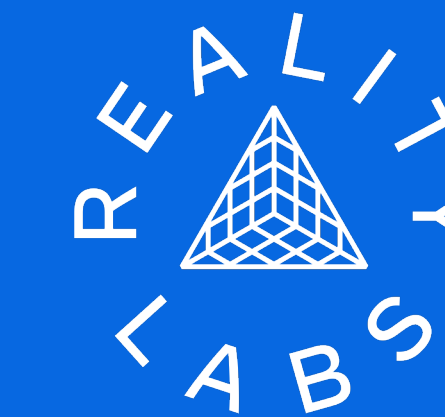
Shun Iwase[1,2] Shunsuke Saito[2] Tomas Simon[2] Stephen Lombardi[2] Timur Bagautdinov[2]

Rohan Joshi[2] Fabian Prada[2] Takaaki Shiratori[2] Yaser Sheikh[2] Jason Saragih[2]

[1]Carnegie Mellon University   [2]Reality Labs Research at Meta

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https://sh8.io/#/relightable_hands

Introduction
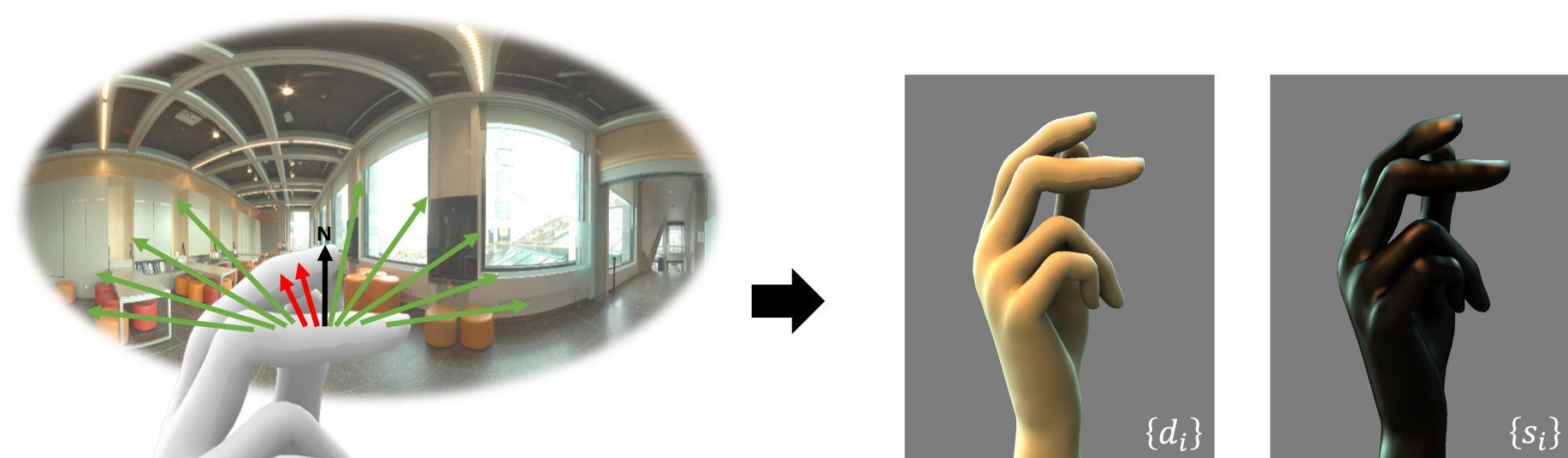
Goal: Learn personalized hand models which are
- Photorealistic
- Real-time Renderable
- Animatable
- Relightable

Problems:
- Generalization to unseen and diverse poses and illuminations
- Encoding of visibility (shadow) information

Key Ideas

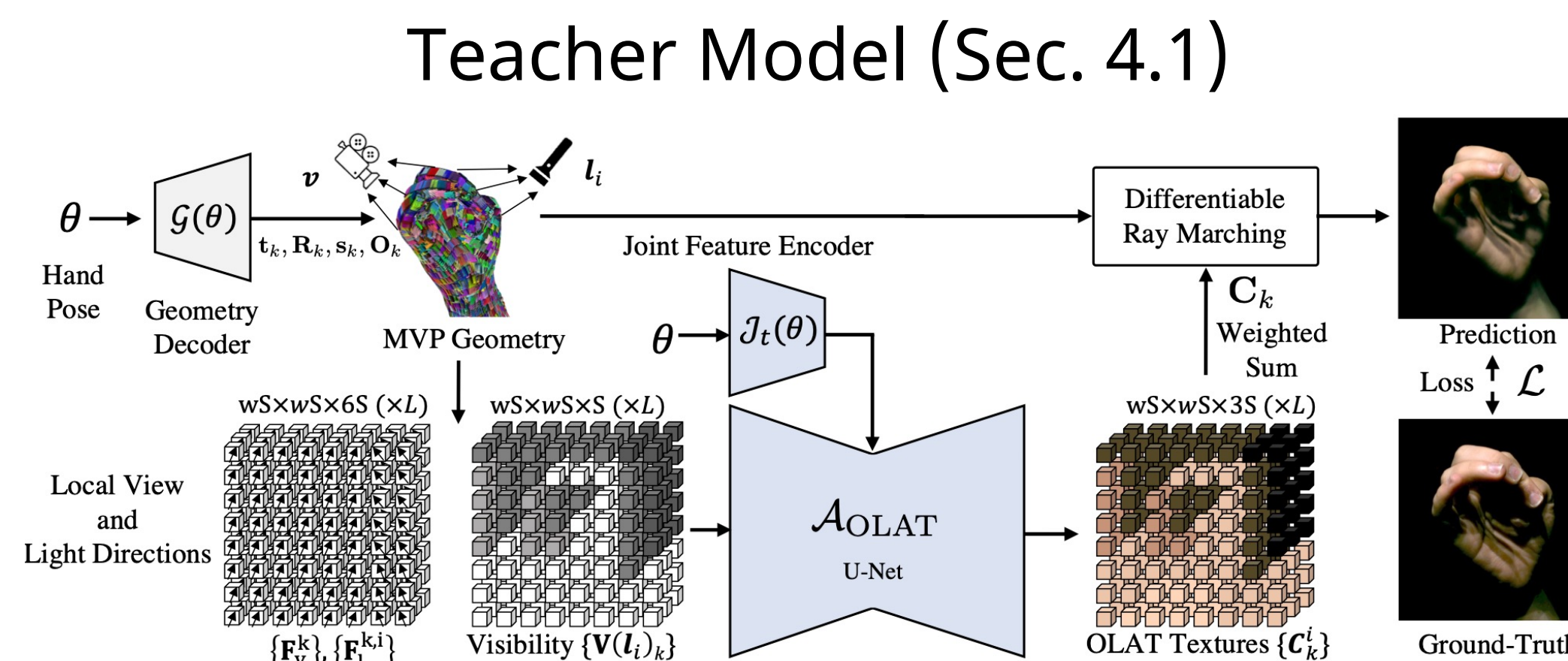### Visibility-Aware Diffuse and Specular Features
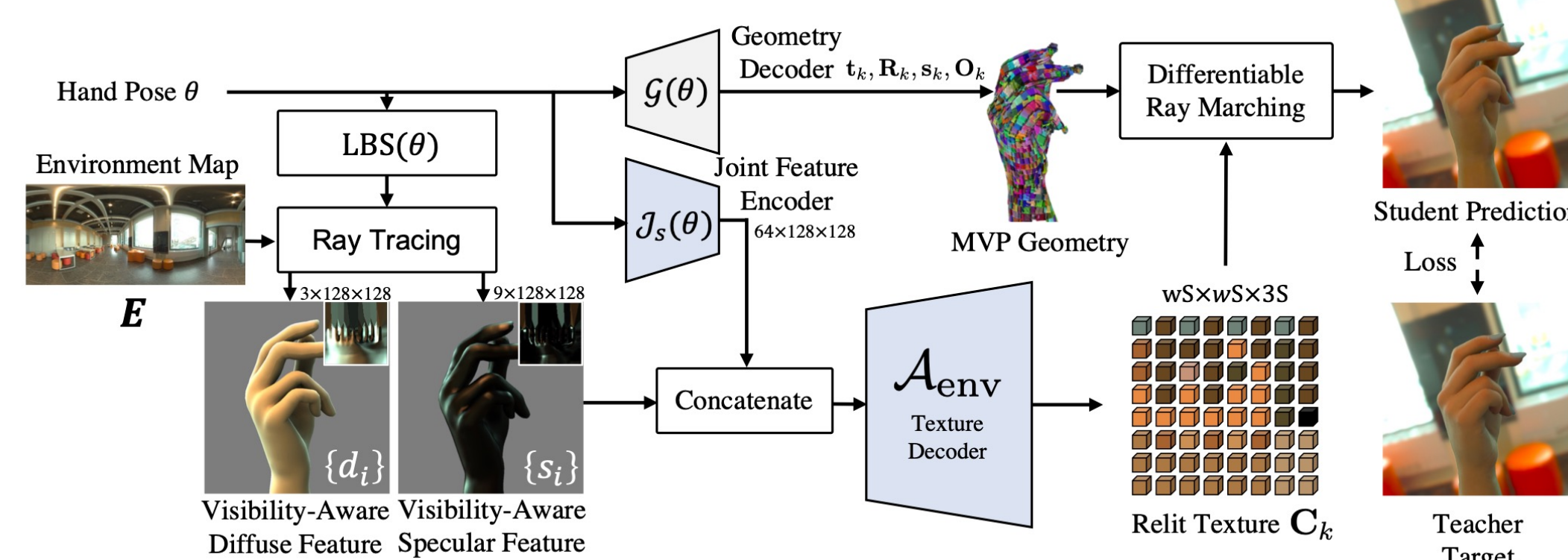

Real-Time Ray Tracing on Coarse Mesh → $\{d_i\}$ Visibility-Aware Diffuse Feature $\{s_i\}$ Visibility-Aware Specular Feature
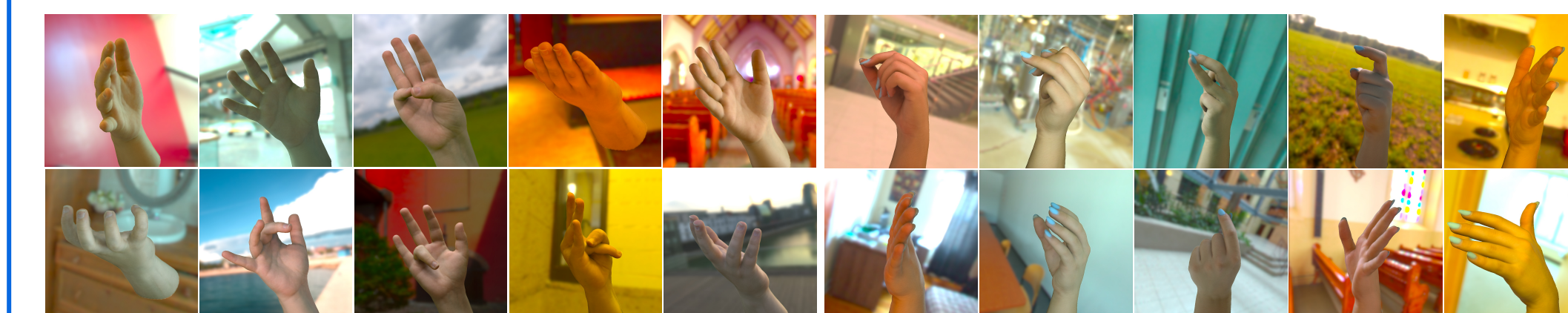
Teacher-Student Framework

512 (=16×32) Lights

Teacher Model (OLAT-based relighting)

Environment Map — Viewpoint — Visibility-aware Illumination Features — $\mathcal{A}_{env}$ Student Decoder — Student Prediction — Teacher Target

Student Model

Method

Teacher Model (Sec. 4.1)

Student Model (Sec. 4.2)

Teacher Model (OLAT-based relighting)
→ **Slow (30s)** but generalizable to any illuminations

Student Model
→ **Real-time (21ms)** image-based relighting is achieved by using **visibility-aware spatially aligned diffuse and specular features**
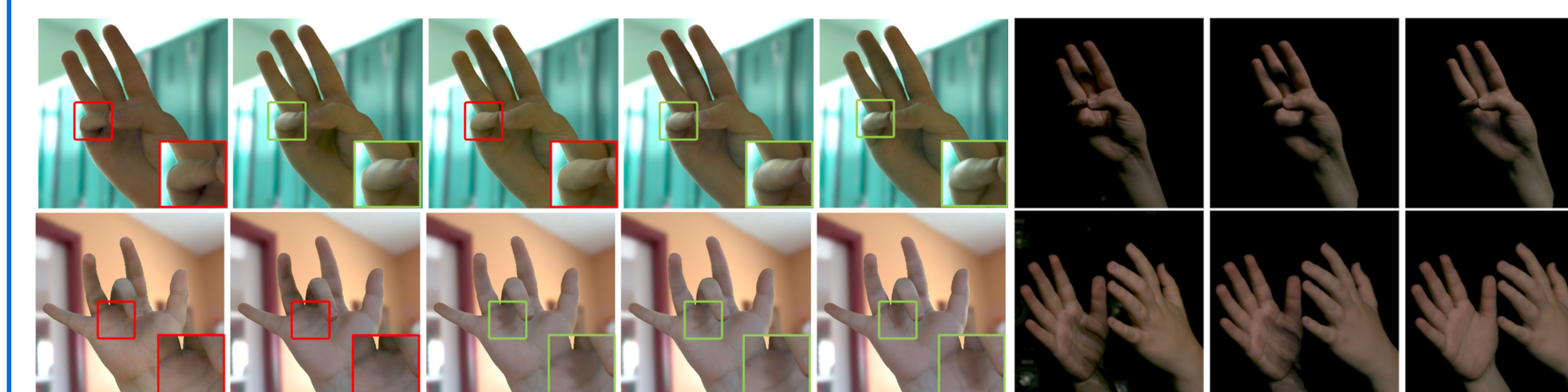
Qualitative Results

Qualitative results of the teacher model with environment map lighting

Qualitative results of the student model with environment map lighting

DRAM [1]   w/o Visibility   w/o Specular   Ours   GT (Teacher)
Qualitative comparison of the student model

GT   w/ Visibility   w/o Visibility
Ablation on visibility conditioning of the teacher model

Quantitative Results

	Subject 1						Subject 2					
	MSE (×10⁻³)↓			SSIM↑			MSE (×10⁻³)↓			SSIM↑		
	Right	Left	Both	Right	Left	Both	Right	Left	Both	Right	Left	Both
Ours	**4.9126**	**5.8608**	**15.7589**	**0.9790**	**0.9805**	**0.9536**	**8.8205**	**7.9357**	**22.3559**	**0.9541**	**0.9559**	**0.9075**
w/o Visibility	7.3201	7.8870	22.8308	0.9773	0.9792	0.9488	9.7104	9.9781	26.5647	0.9536	0.9543	0.9050

Quantitative comparison of the teacher model

	Subject 1						Subject 2					
	MSE (×10⁻³)↓			SSIM↑			MSE (×10⁻³)↓			SSIM↑		
	Right	Left	Both	Right	Left	Both	Right	Left	Both	Right	Left	Both
DRAM [1]	31.1372	24.4368	64.2035	0.9904	0.9927	0.9752	30.6582	24.7238	70.4215	0.9901	0.9898	0.9665
Ours	5.4076	5.9600	4.3474	0.9961	0.9960	0.9915	5.7977	7.2598	4.5196	0.9952	0.9954	0.9881
w/o Specular	5.7660	7.2631	5.0732	0.9956	0.9952	0.9914	7.1569	7.4892	4.9008	0.9948	0.9943	0.9881
w/o Visibility	6.6110	8.1886	11.6771	0.9955	0.9948	0.9893	7.8589	8.5550	9.1859	0.9938	0.9938	0.9862

Quantitative comparison of the student model

[1] Sai Bi, Stephen Lombardi, Shunsuke Saito, Tomas Simon, Shih-En Wei, Kevyn Mcphail, Ravi Ramamoorthi, Yaser Sheikh, and Jason Saragih. Deep relightable appearance models for animatable faces. TOG, 2021.