1 Introduction

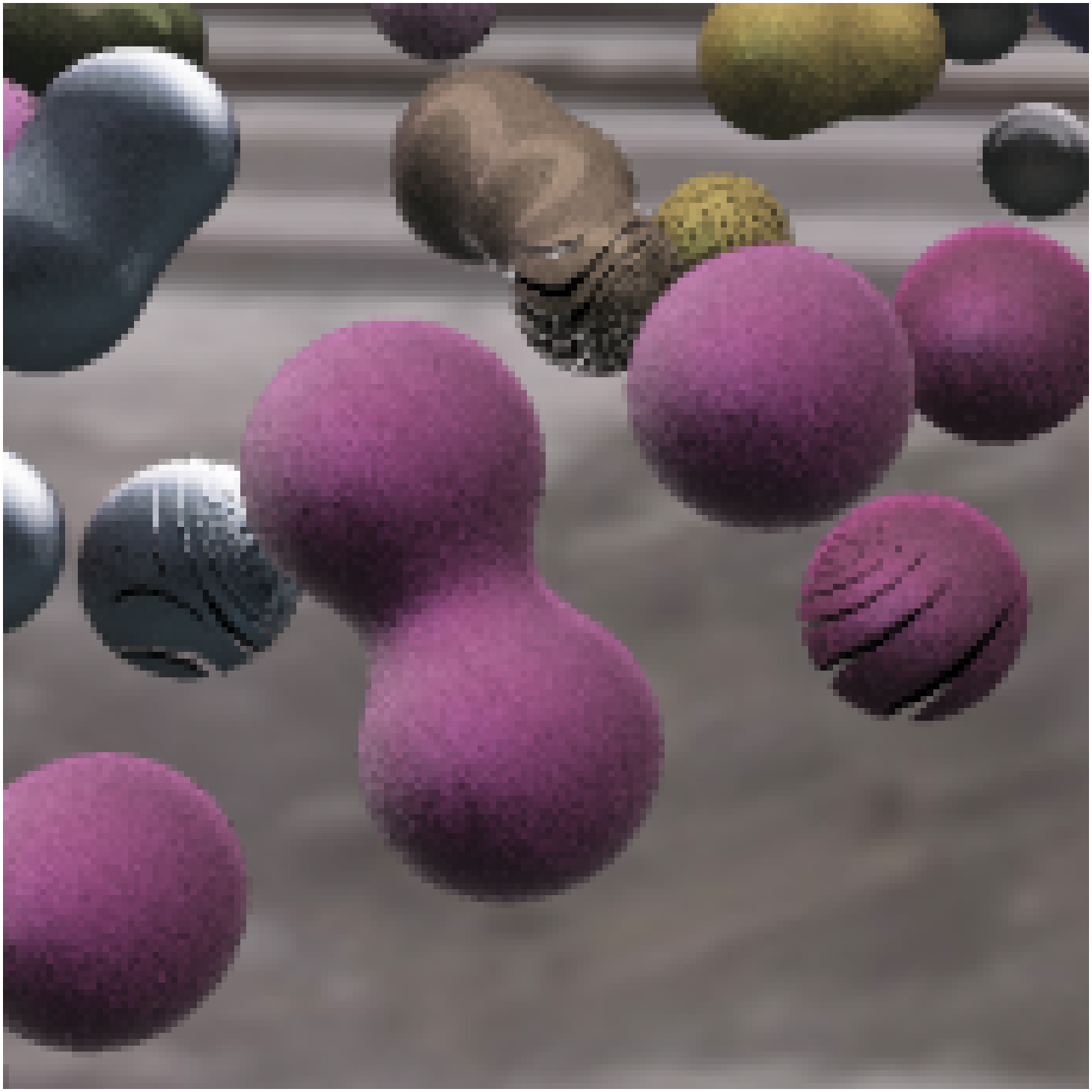
2 Signed Distance Fields

$$\| O \| - R$$

$$S(P, R) = \| P \| - R \qquad \text{Sphere with Radius}$$

$$S(P, N) = P \cdot N \qquad \text{Plane with Normal}$$

$$S(P, H, R) = < \| P_{x,z} \| - R,\ P_y > -H \qquad \text{Torus with Radius and Hole}$$



$$\frac{(f(x+h)-f(x))}{h}$$

$$f(x+h) - f(x-h)$$

ϵ

3 OpenCL

4 Light Transport Introduction

5 Bidirectional Path Tracing

$$\int f(x) \approx \frac{1}{N} \Sigma_0^N \frac{f(x)}{p(x)} \tag{1}$$

X

X

$$CDF = Pr(X \leq x)$$

Pr

X

x

P

$X \leq x$

p

$$L_e^0(v) = L_o(P,\, \omega_o)$$

$$\Omega = [0,\ 2.0f * \tau * R^2]$$

$$CDF(x) = Pr(X \leq x) = \frac{x}{2.0 * \tau * R^2} \tag{2}$$

$$p(x) = \frac{dCDF(x)}{dx} = \frac{1.0}{2.0 * \tau * R^2} \tag{3}$$

$$\int_0^{\Omega} p(x)dx = 1.0 \tag{4}$$

$$L_o(P,\omega_o) = L_e(P,\omega_o) + \int_S f_s(P,\omega_i,\omega_o) L_i(P,\omega_i) |cos\theta_i| d\omega_i \tag{5}$$

$Lo(P,\, \omega_o)$

P

P

S

ω_i

P

B

f_s

ω_i

ω_i

$P0$

$P0$

f_s

N

$$\int f(x) \approx \frac{1}{N} \Sigma_0^N \frac{f(x)}{p(x)} \tag{6}$$

1.0

$$\omega_o = reflect(\omega_i, N)$$

$(P,\, \omega_i,\, \omega_o)$

$(P,\ \omega_i)$

$(P,\, \omega_i,\, \omega_o)$

$$f_s(v \to \dot{v} \to \ddot{v}) = f_s(P, \omega_i, \omega_o) \tag{7}$$

$$L_e(v \to \dot{v}) = L_e(P, \omega_o) \tag{8}$$

$$L_e(v \to \dot{v}) = L_e^0(v) L_e^1(v \to \dot{v}) \tag{9}$$

P

$(\omega_i,\ \omega_o)$

P_{-1}

v

P_{+1}

$\ddot{v}$

L_e

$$L_e(P, \omega_o) \equiv L_e(P) \qquad [\text{ for area lights }] \tag{10}$$

$$L_e(v \to \dot{v}) = L_e^0(v) \tag{11}$$

v

$\dot{v}$

$$cos\theta_n = v \cdot N(v) \tag{12}$$

$$G(v \leftrightarrow \dot{v}) = V(v \rightarrow \dot{v}) \frac{(cos\theta_n cos\dot{\theta_n})}{||v - \dot{v}||^2} \tag{13}$$

V

$$L(v \to \dot{v}) = L_e(v \to \dot{v}) \int_M L(v \to \dot{v}) G(v \leftrightarrow \dot{v}) f_s(v \to \dot{v} \to \ddot{v}) d_A \tag{14}$$

M

M

M

P

$$\left|map(P)\right| < \epsilon$$

M

$$I_j = \int_{\Omega} f_j(\bar{v}) d\mu(\bar{v}) \tag{15}$$

$\overline{v}$

$$z_0 \rightarrow z_s \rightarrow y_t \rightarrow y_0(eye \rightarrow light)$$

μ

$\overline{v}$

$$I_j \approx \frac{1.0f}{N} \Sigma_0^N F \tag{16}$$

$$F = \Sigma_s \Sigma_t \frac{f_j(\bar{v}_{s,t})}{p(\bar{v}_{s,t})} \tag{17}$$

S

t

$s + t \leq DEPTH$

$\overline{v}$

c

$$\frac{f_j(\bar{v}_{s,t})}{p(\bar{v}_{s,t})} \equiv \frac{f^L(\bar{y})}{p(\bar{y})} c(\bar{y}_s \leftrightarrow \bar{z}_t) \frac{f^E(\bar{z})}{p(\bar{z})} \tag{18}$$

$$F = \Sigma_s \Sigma_t \alpha_s^L c_{s,t} \alpha_t^E \tag{19}$$

α_i

$i = 0$

wo

wi

$$\alpha_i^{L|E} = \begin{cases} 1.0 & i = 0, \\ \frac{L_e^0(V_0 \to V_1)}{p_A(V_1)} | 1.0 & i = 1, \\ \frac{f_s(V_0 \to V_1 \to V_2)}{p_\sigma(V_0 \to V_1)} & i > 1 \end{cases} \tag{20}$$

$i = 0$

$i = 1$

pv

$s = 1$

$t > 1$

$s > 1$

$t = 0$

$$c_{s,t} = \begin{cases} L_e(L_0 \to L_1), & s = 0, t > 1, \\ f_s(L_0 \to L_1 \to L2)G(E_1 \leftrightarrow L_1)f_s(L_1 \to E_1 \to E_0), & s > 0, t > 1 \end{cases} \tag{21}$$

$s = 0, t > 1$

$s = 1$

$L0$

$s = 0$

$$s = s, t = 0 | 1$$

$t = 0$

$$MIS_{st}(\bar{x}) = \frac{P_s(\bar{x})}{\Sigma_i P_i(\bar{x})} \tag{22}$$

$$r_i(\bar{x}) = \begin{cases} 1.0f, & i = s, \\ \frac{\overleftarrow{P}(\bar{x_i})}{\overrightarrow{P}(\bar{x_i})} * r_{i+1}(\bar{x}), & i < s, \\ \frac{\overrightarrow{P}(x_{i^-1})}{\overleftarrow{P}(x_{i^-1})} * r_{i-1}(\bar{x}), & i > s \end{cases} \tag{23}$$

$$\mathcal{W}_i(\bar{x}) \equiv r_i(\bar{x}) \tag{24}$$

$$\mathcal{W}_i(\bar{x}) = \begin{cases} 1.0f, & i = 0, \\ \frac{\overleftarrow{p_i}(\bar{x_i})}{\overrightarrow{p_i}(\bar{x_i})} * \mathcal{W}_{i-1}(\bar{x}), & i > 0 \end{cases} \tag{25}$$

$\mathcal{W}_i(\bar{x})$

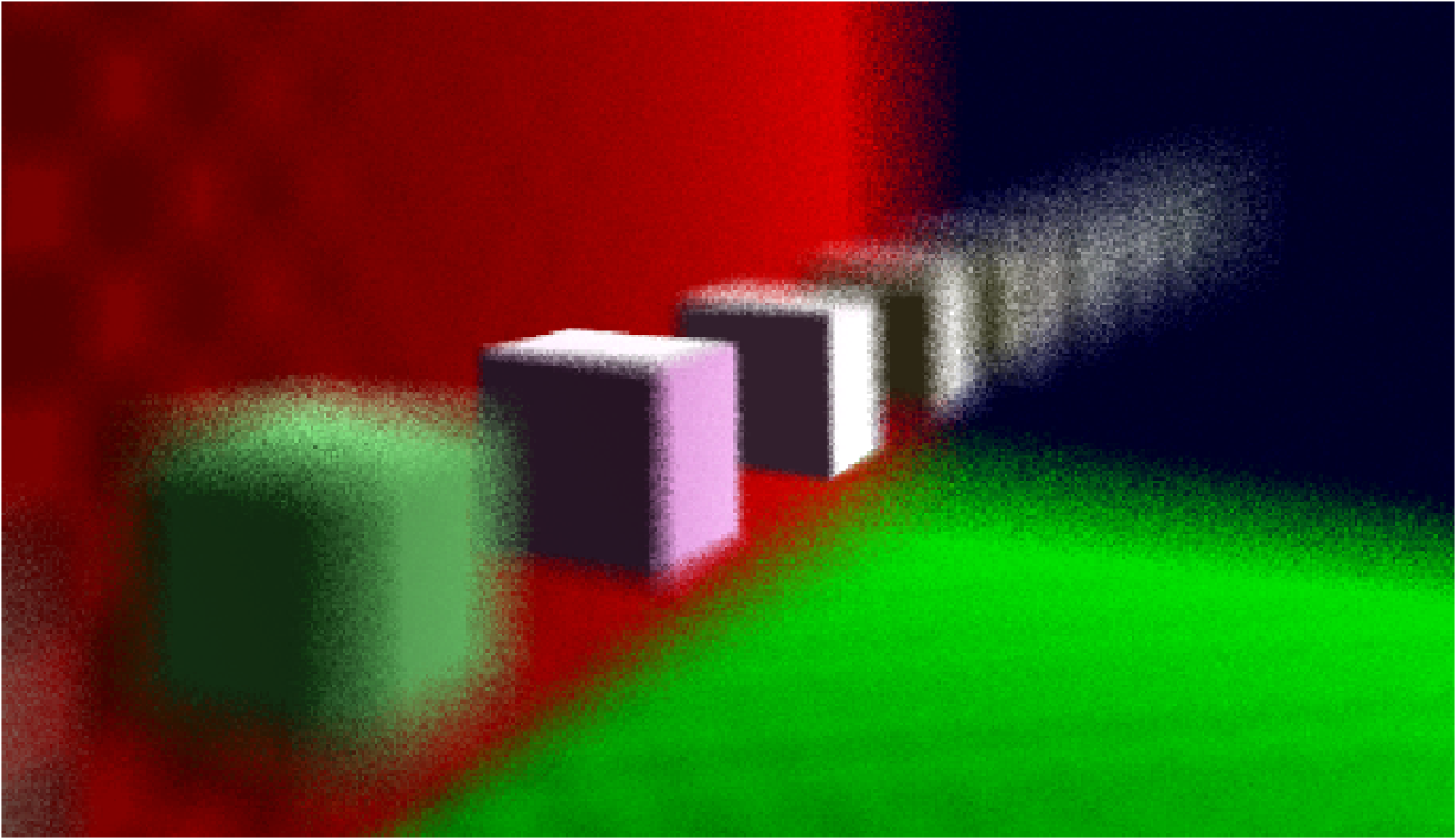
$$\mathcal{W}_i(\bar{x}) = \Pi_{n=2}^{i}\left(\frac{\overleftarrow{p_\sigma}(x_n)\overleftarrow{G}(x_n)}{\overrightarrow{p_\sigma}(x_n)\overrightarrow{G}(x_n)}\right) * \frac{\overleftarrow{p_A}(x_1)}{\overrightarrow{p_A}(x_1)} \tag{26}$$

$$MIS_{s,t}(\bar{y}, \bar{z}) = \frac{1.0f}{\mathcal{W}_s(\bar{y}) + \mathcal{W}_t(\bar{z}) + 1.0f} \tag{27}$$

$$P = \frac{1.0f}{N} \Sigma_0^N \Sigma_{s \leq 0} \Sigma_{t \leq 0} \alpha_s^L c_{s,t} \alpha_t^E MIS_{s,t}(\bar{y}, \bar{z}) \tag{28}$$

$$P_i(\bar{x}_{s,t}) = P_s^L p_t^E \tag{29}$$

$$p_i^{L|E}(\bar{x}) = \begin{cases} 1.0f, & i = 0, \\ P_A(x_i), & i = 1, \\ P_\sigma(x_{i-1} \to x_i) G(x_{i-1} \leftrightarrow x_i) P_{i-1}^{L|E}, & i > 1 \end{cases} \tag{30}$$



6 DTOADQ BRDF

$$H = \| L + V \|$$

metallic

Modified Disney DF90 with Fresnel and diffusive component

Geometry, Heits SmithGGXCorrelated with half vec and anisotropic

$$\frac{(M-1)\,(\sqrt{2})^{2\,S\,-\,2}}{\pi\,R^2\,cos^4\theta\,(2+\frac{tan^2\theta}{M^2})^M} \tag{31}$$

Hyper-Cauchy Distribution

$$\frac{F * G * D}{4\left(H \cdot V\right)\left(\left(N \cdot L\right) \vee \left(N \cdot V\right)\right)}$$

$\alpha^{0.5} * \frac{1}{\pi}$

$$\frac{m(1-r^2)}{4\pi}\,\frac{1}{(1+r^2-2\,r\,(H\cdot V))^{3/2}} \tag{32}$$

7 Video/Image Emitter

8 Future Improvements

$$p_l = \frac{\phi_l r_l}{\sum_i \phi_i r_l}$$

9 Bibliography