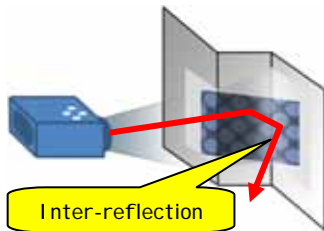# A Fast Compensation Method of Inter-reflection for Pattern Projection onto a Non-planar Surface

Y.Mukaigawa(Osaka University, JAPAN), T.Kakinuma, Y.Ohta (University of Tsukuba, JAPAN)

Purpose

● Pattern Compensation

Inter-reflection

Projection onto a Non-planar surface

● Key features

■ Radiosity

calculating the propagation of energy based on form factors (F_{ij})

$$F_{ij} = \frac{1}{\pi A_i} \int_{A_i} \int_{A_j} H_{ij} \frac{\cos\phi_i \cos\phi_j}{l_{ij}^2} dA_i dA_j$$
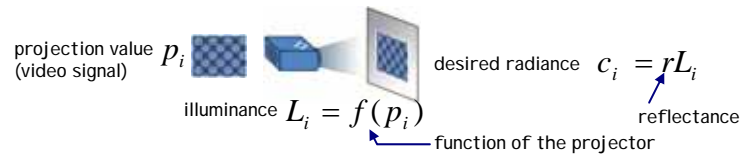
■ Analytical solution

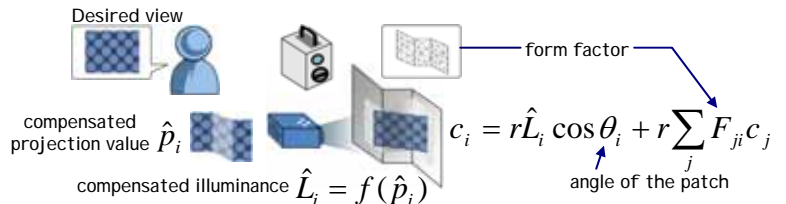no iterative calculation by solving the inverse problem of inter-reflection

Compensation Algorithm

● Modeling of Pattern Projection

■ Ideal reflection: illuminance and radiance

projection value (video signal) p_i

illuminance $L_i = f(p_i)$

desired radiance $c_i = rL_i$

reflectance

function of the projector

■ Actual reflection: Radiosity

Desired view

form factor

compensated projection value $\hat{p}_i$

compensated illuminance $\hat{L}_i = f(\hat{p}_i)$

$$c_i = r\hat{L}_i \cos\theta_i + r\sum_j F_{ji} c_j$$

angle of the patch

● Compensated projection

$$\hat{L}_i = \frac{c_i - r\sum F_{ji} c_j}{r\cos\theta_i}$$
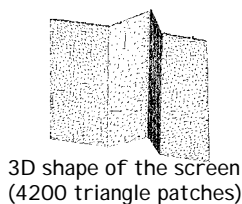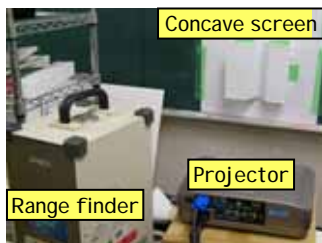
$$= \frac{f(p_i) - r\sum F_{ji} f(p_j)}{\cos\theta_i}$$

$$\hat{p}_i = f^{-1}\left(\frac{f(p_i) - r\sum F_{ji} f(p_j)}{r\cos\theta_i} \right)$$
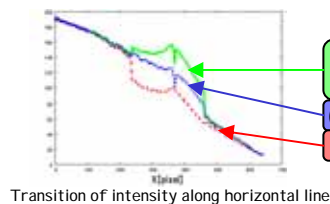
■ No iterative calculation
■ Multi-bounce reflection

Experimental Results

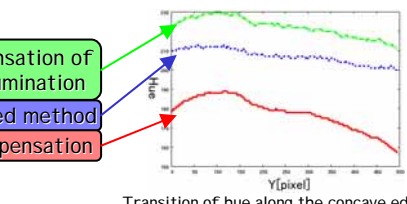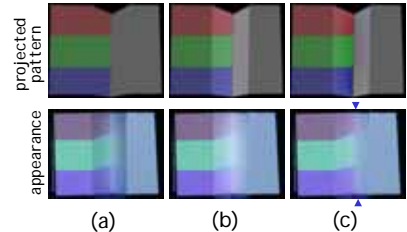### ● System

Concave screen

Projector

Range finder

3D shape of the screen
(4200 triangle patches)

● Gray pattern

projected pattern

appearance

(a)   (b)   (c)

● Color pattern

projected pattern

appearance

(a)   (b)   (c)

(b) compensation of direct illumination
(c) proposed method
(a) no compensation
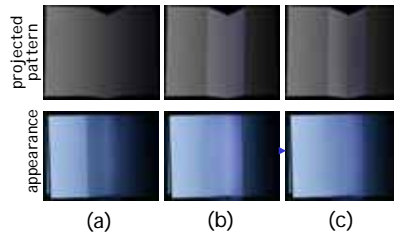
Transition of intensity along horizontal line.
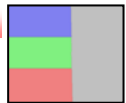
Transition of hue along the concave edge.