

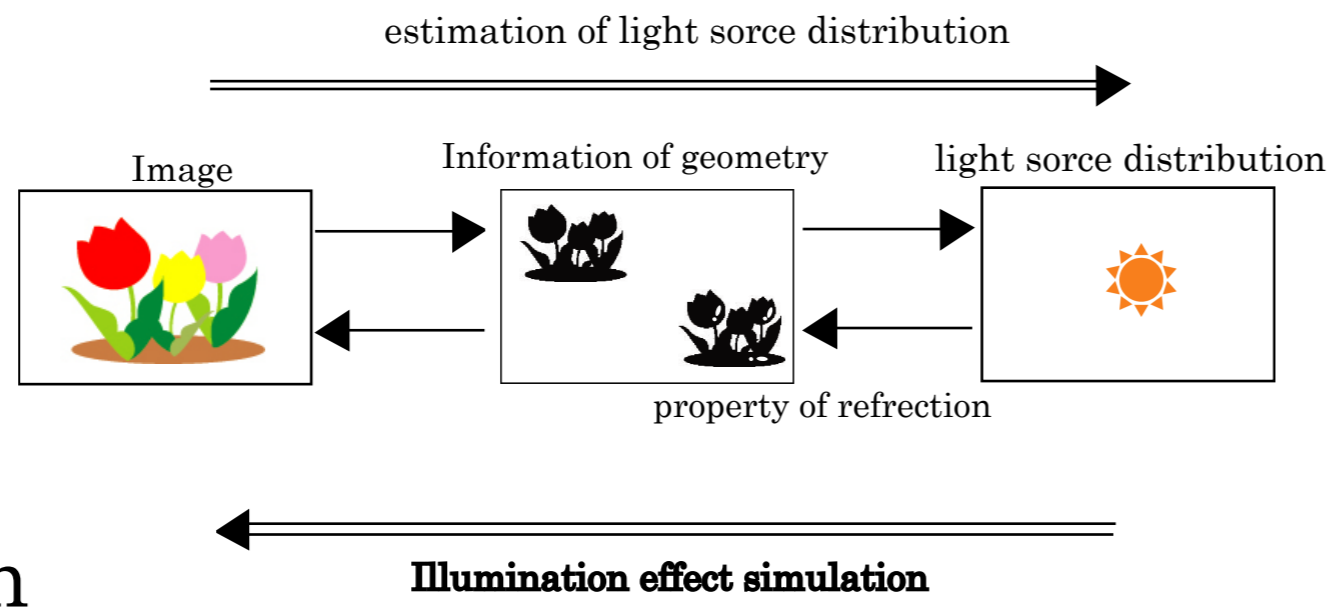
Analysis of Light Transport based on the Separation of Direct and Indirect Components

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Background

Relation between input and output of light in the scene allow us to simulate novel image in any light environment and estimate distribution of light source.



We analysis reflection of light ray in the scene to get relation between input and output of light.

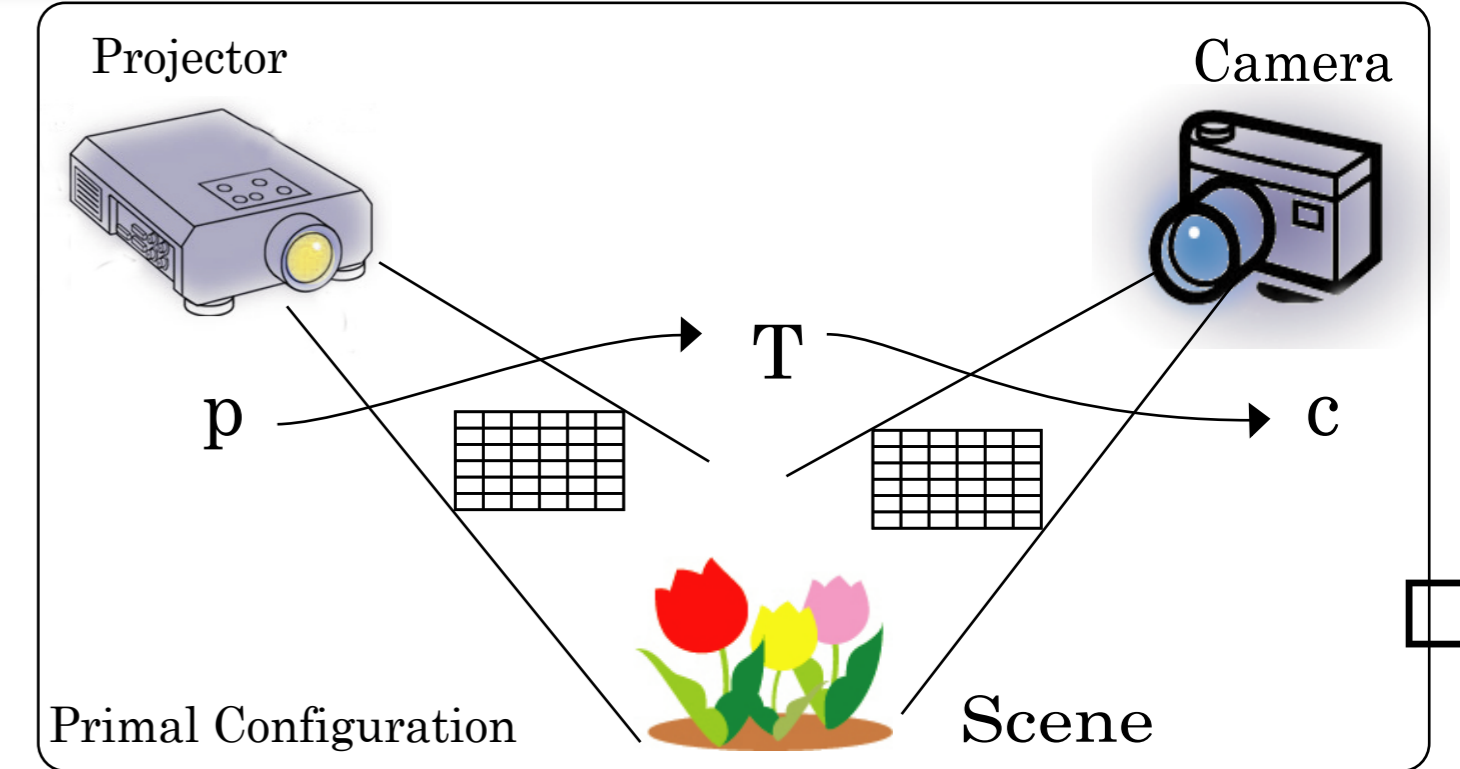
Light reflection model using object's 3D geometry and reflectance property. (Model Based.) But it is difficult to compose the model when occlusion exist or scene is complex.

Light reflection model using various images. (Image Based.) This method can analysis complex scene and a scene include occlusion.

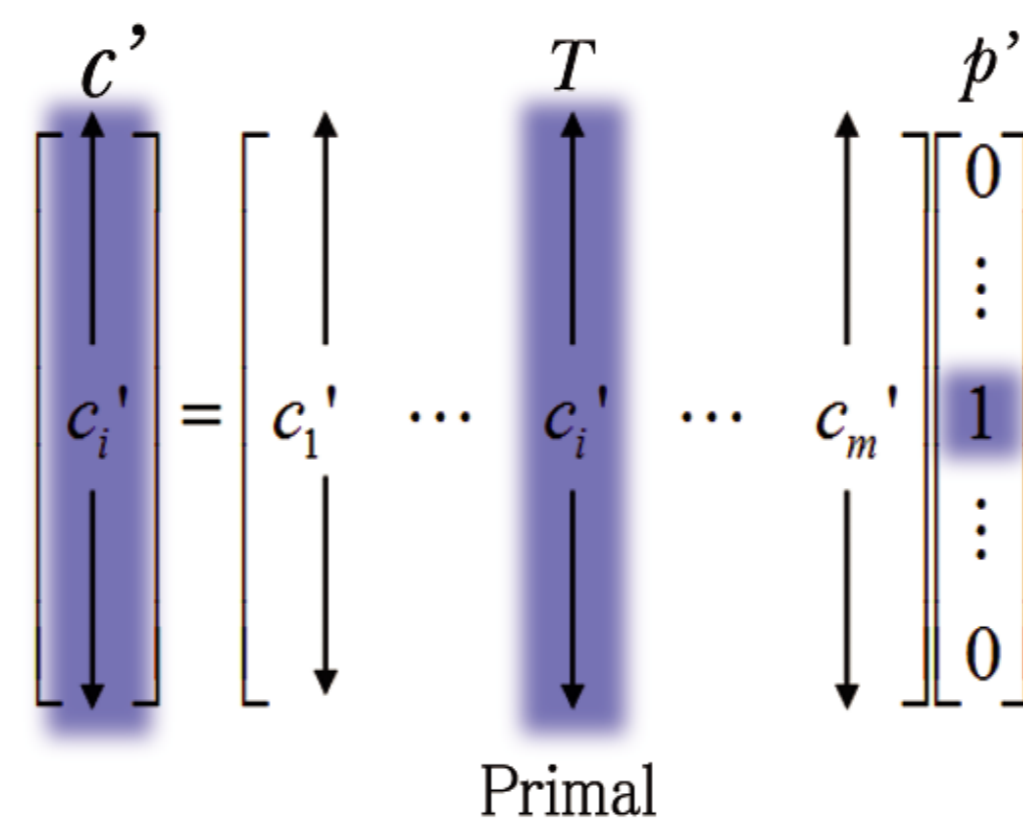
Calculation of Light-transport

Brute Force Scan

Relationship between projector as light source and camera as eye represent by borrow linear equation. c is camera pixel, and p is projector pixel.



$$c = Tp$$



We all conversion matrix T "Light-transport matrix" represent relationship between input from projector and output to camera of light to the scene.

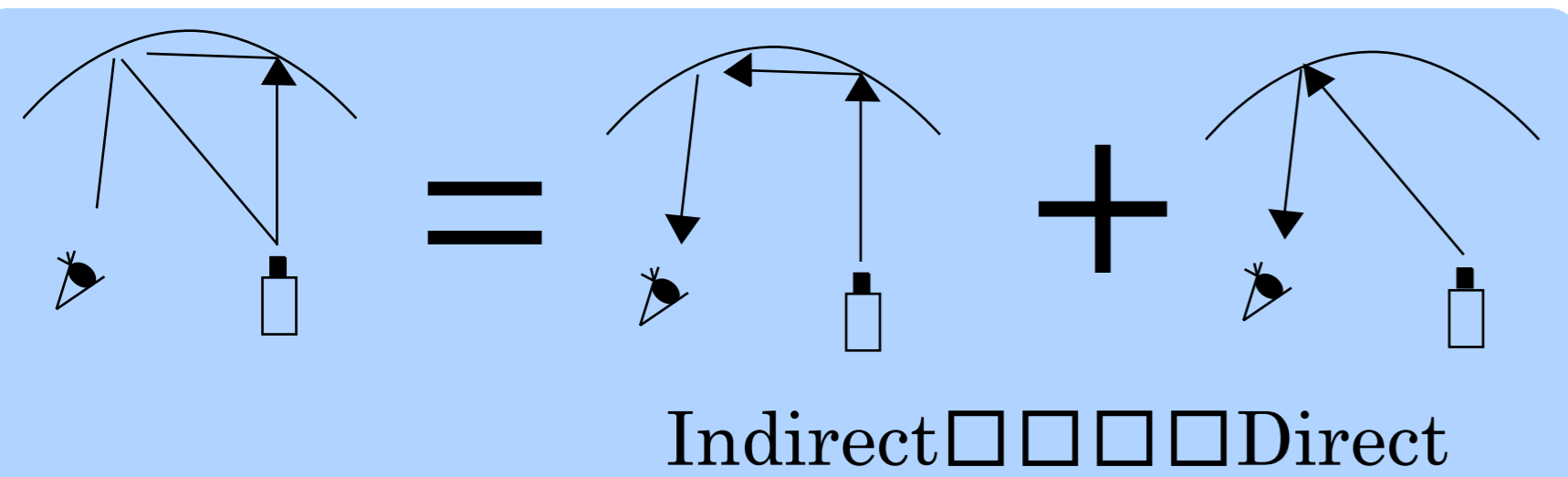
When we turn on only one projector pixel, image captured by camera correspond element of corresponding row of matrix T . We individually turn on projector pixel in rotation, then we can get all elements of matrix T using this predisposition.

Reference: Sen P, Chen B, Garg G, Marscher S, Horowitz M, Levoy M, and Lesch H, "Dual Photography," Transactions on Graphics, vol.24, no.3, pp.745-755, 2005

Direct and Indirect component

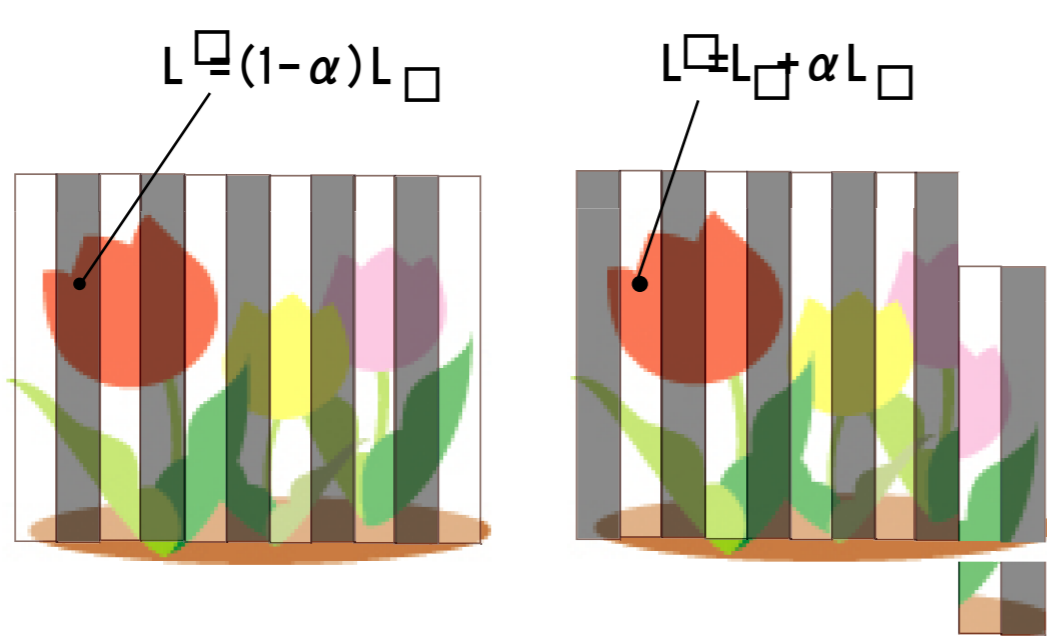
Separation of two component

Generally, luminance on the surface of scene can be classified to two components.



It is very easy to separate direct and indirect components lighting high frequency projection pattern.

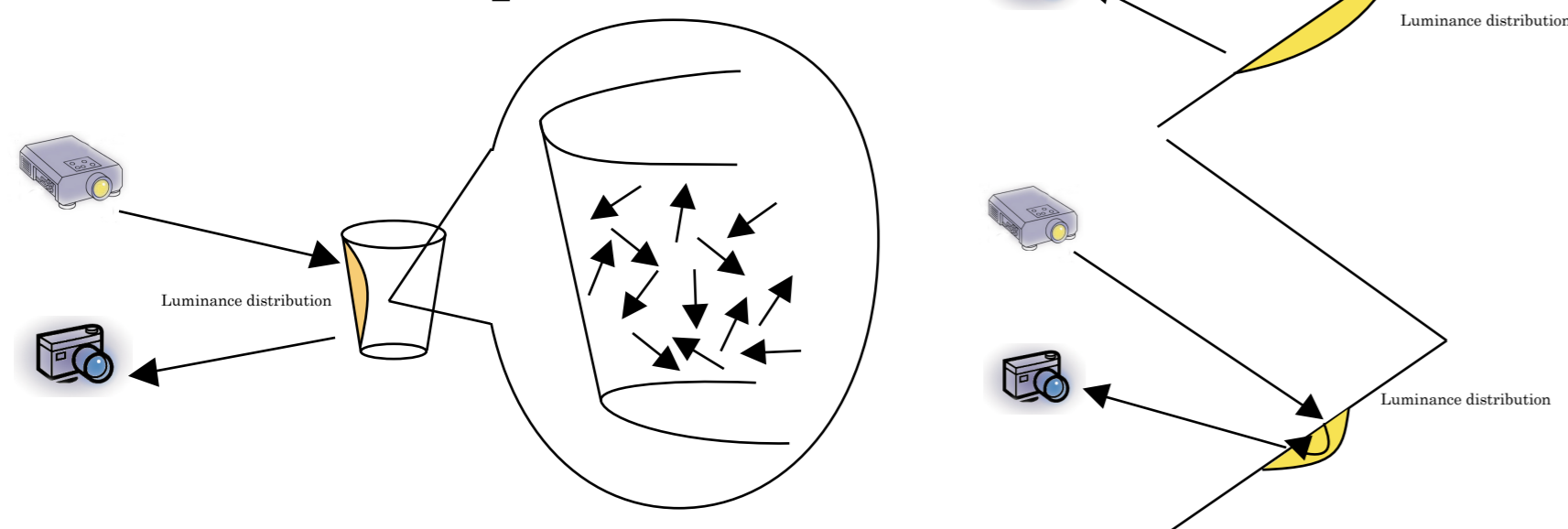
We can observe indirect component only at the pixel not lighted and both direct and indirect component at the pixel lighted.



Property of two component

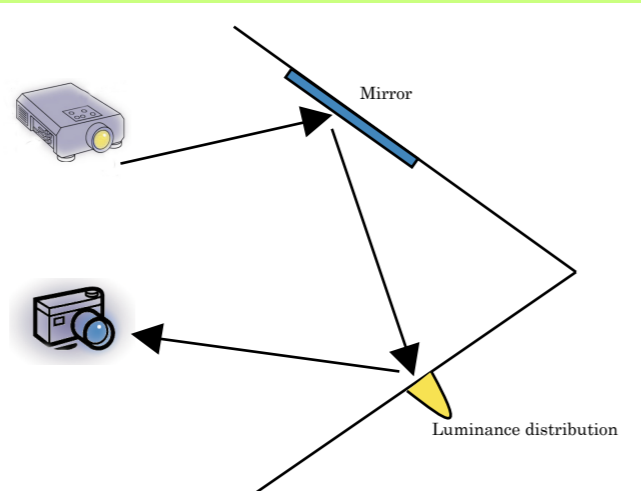
Direct component has definite relationships in the geometry of the projector, camera and scene.

In most cases, indirect component has broad area of weak response.



- Direct : Region of contribution on the projector for each pixel of camera can be limited.
- Indirect : Information in high frequency domain of projection pattern is lost.

If mirror or glass exist in the scene, our assumption (Information in high frequency domain of projection pattern is lost.) don't work out.

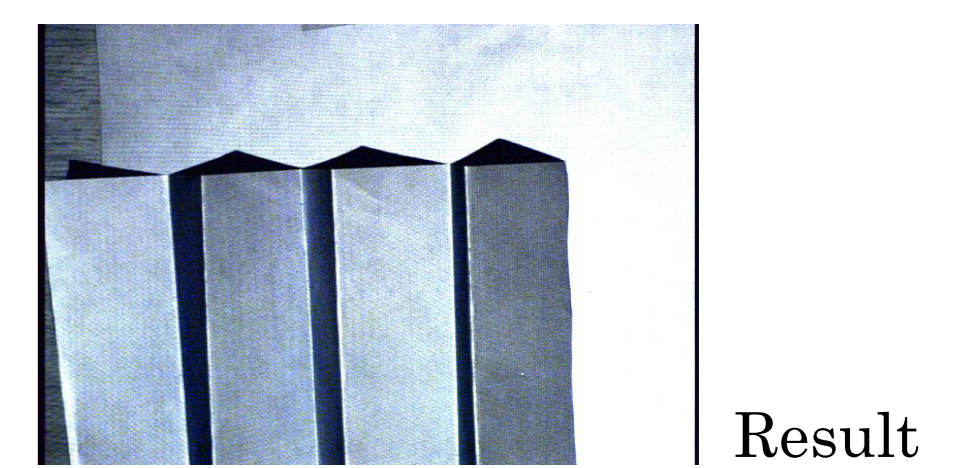
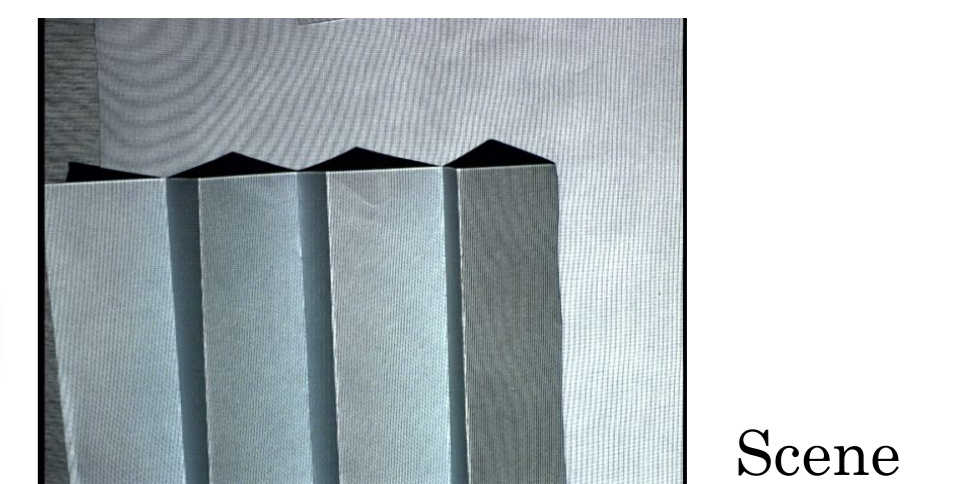
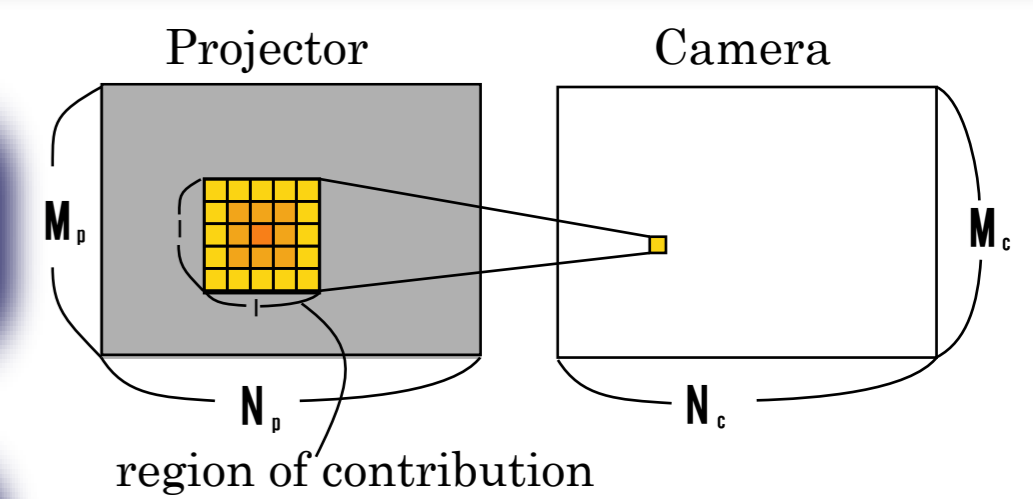
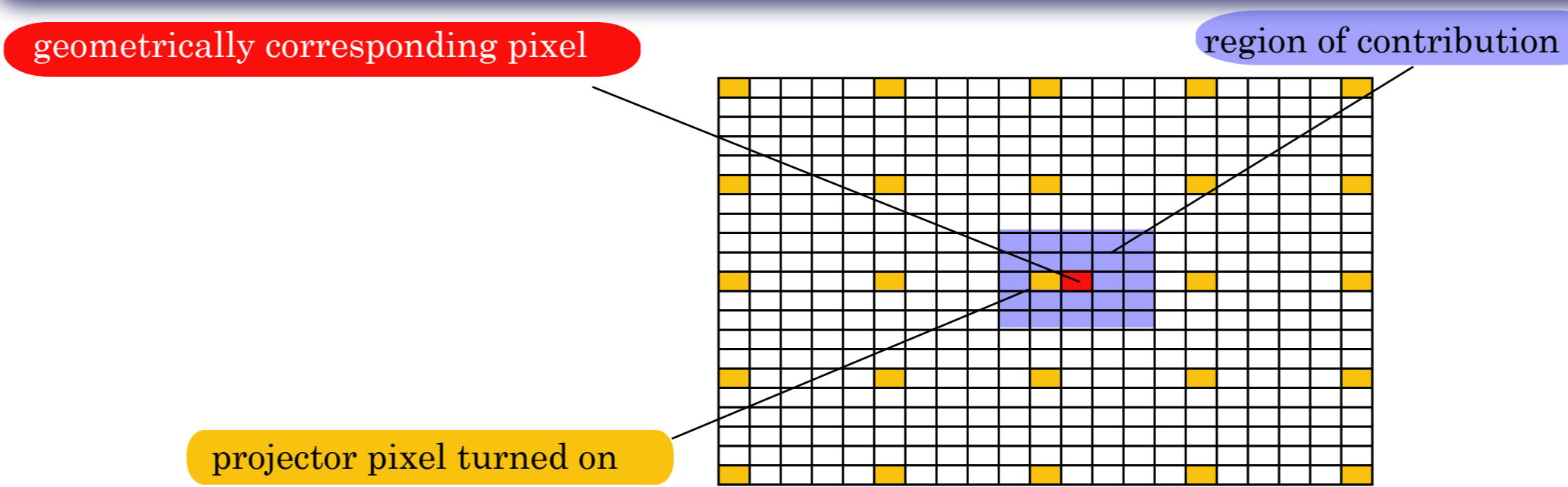


Calculation of direct component

Obtain geometric relationships between pixels of projector and camera using Graycode pattern projection method.

Define small region of contribution on the projector for each pixel of camera.

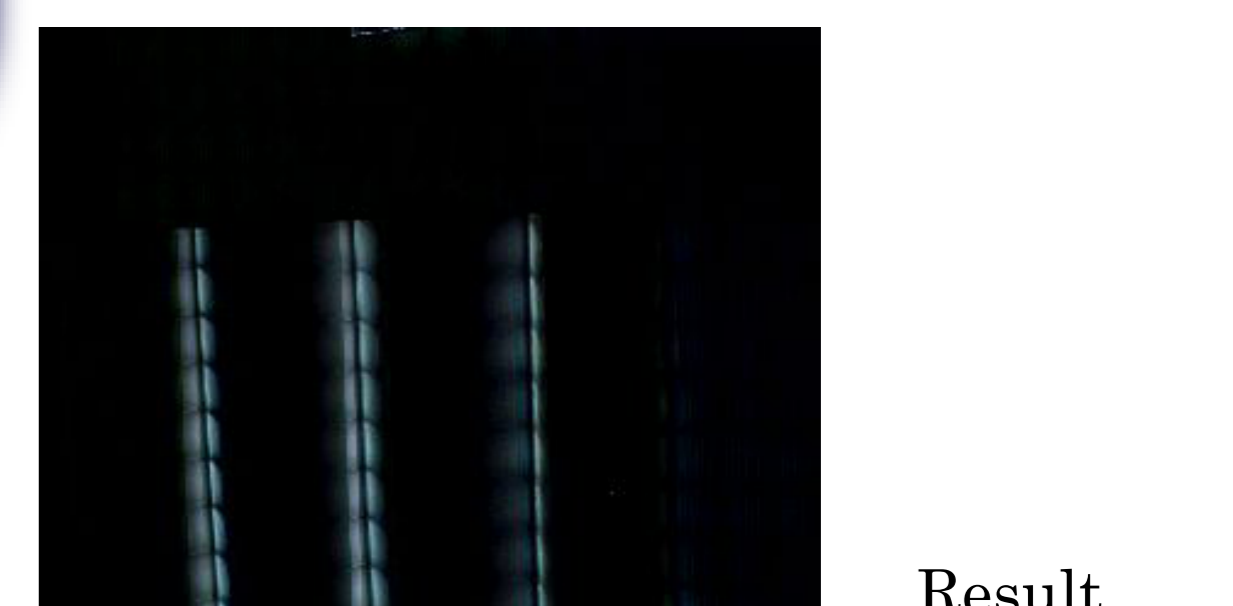
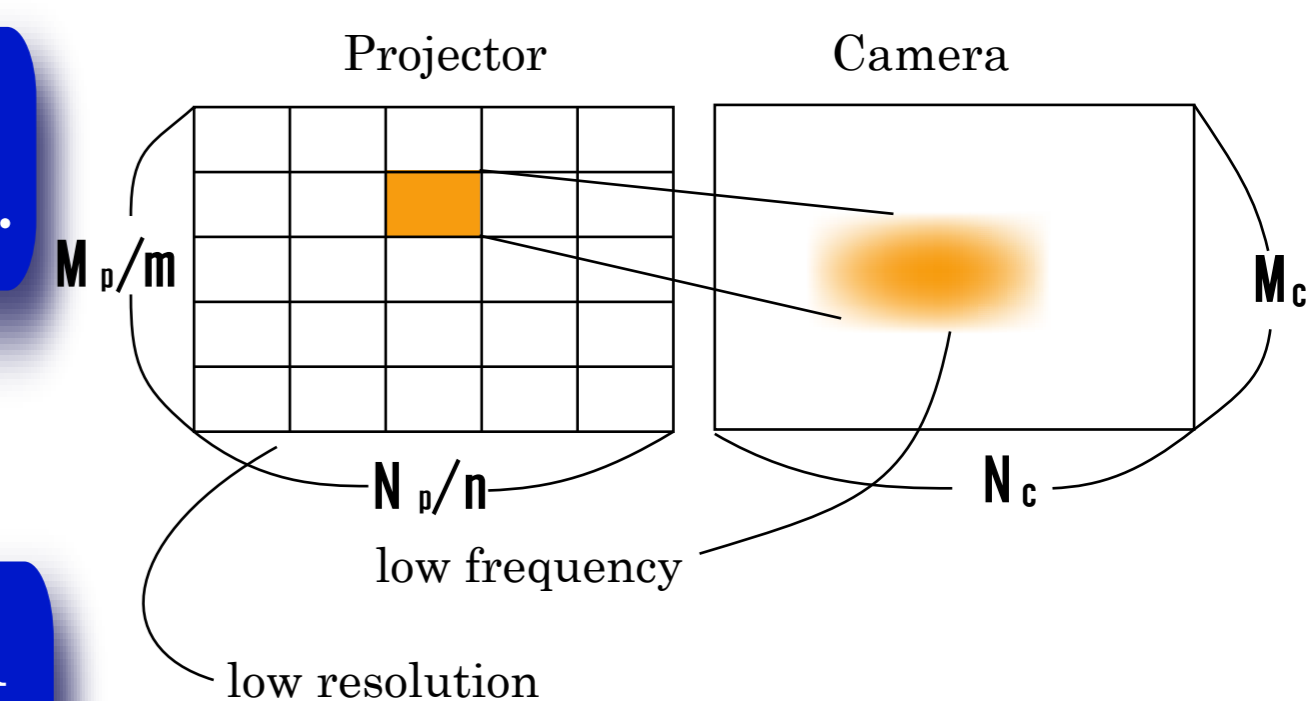
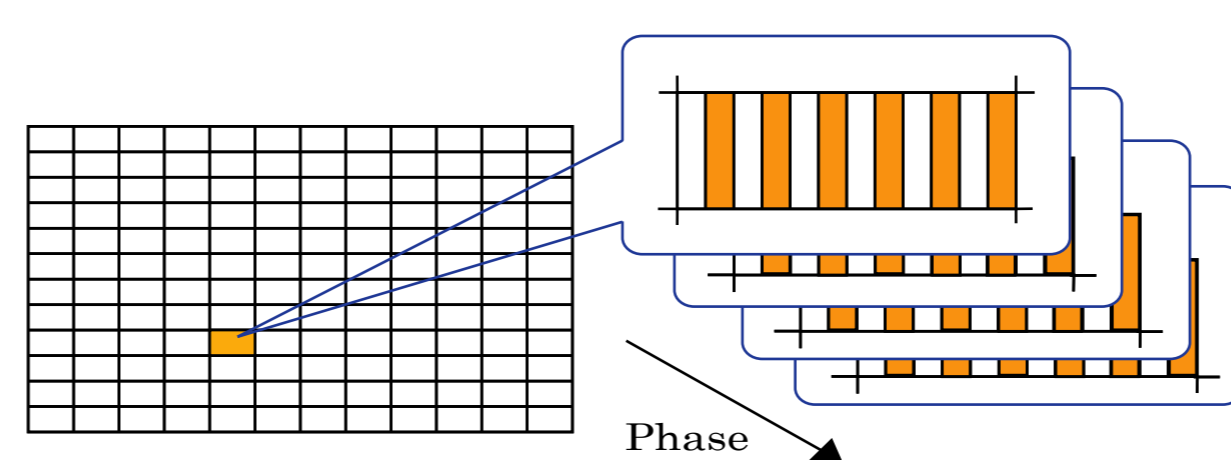
Lighting repetitive dot pattern as shown following image.



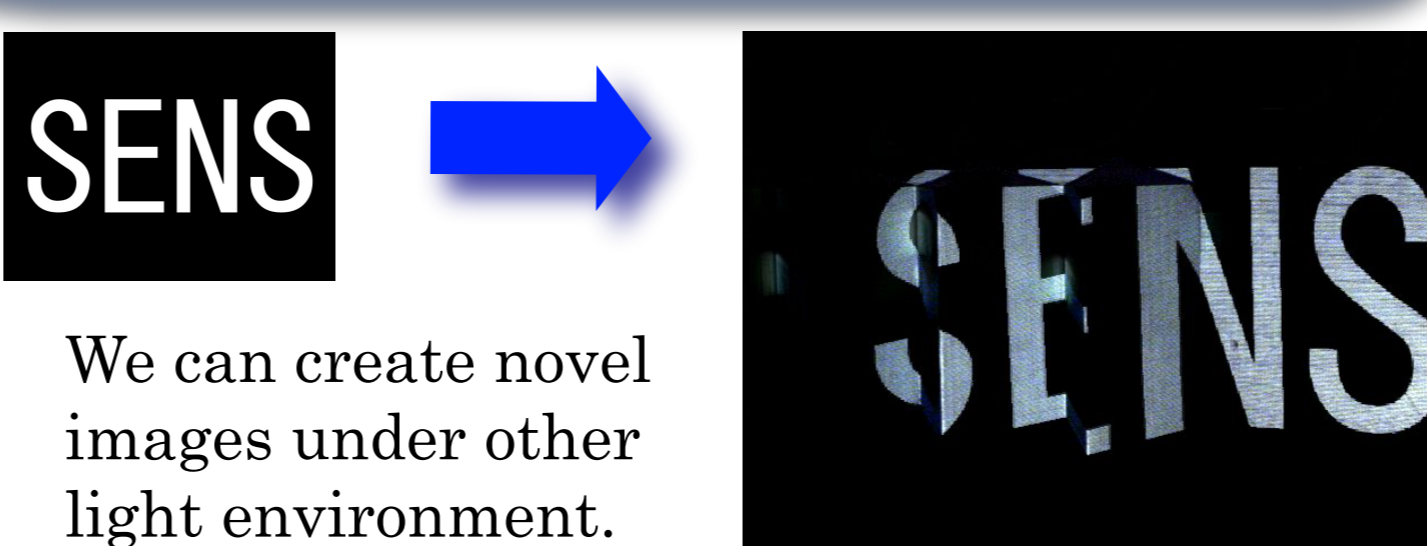
Calculation of indirect component

According to the sampling theorem, use low resolution representation for indirect component.

Perform Brute Force method using phaseshifted stripe pattern in a small rectangle.



Illumination effect simulation



Summary

- 1) We show effective method to obtain light transport matrix.
 - Separated both components (Direct/Indirect).
 - Method for both components property.
- 2) We show novel image using light transport.