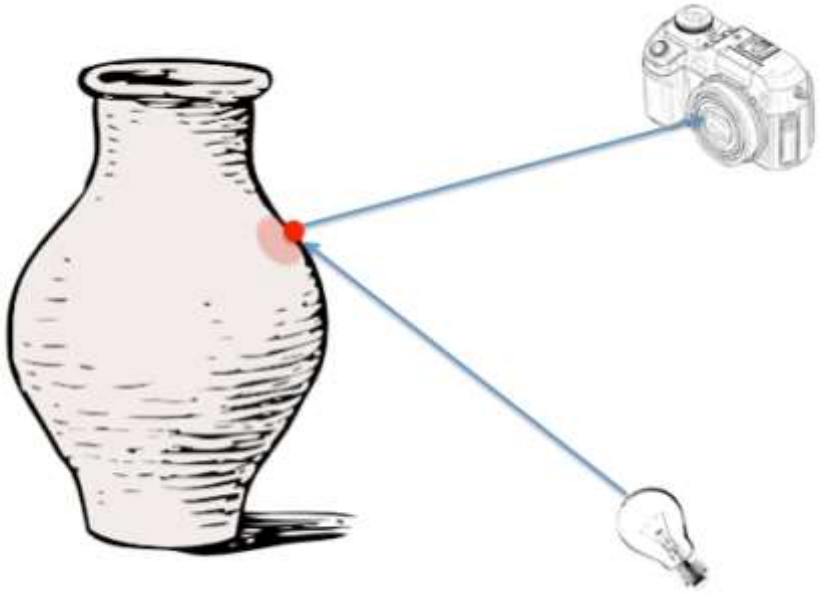
Testing Spatial Patterns for Acquiring Shape and Subsurface Scattering Properties

Yitzchak Lockerman, Samuel Brenner, Joseph Lanzone, Alexander Doronin, Holly Rushmeier

Our Goal

- We are interested in modeling light's interaction with objects for the purpose of creating realistic renderings.
- In particular, we are interested in objects with strong subsurface scattering.



Our Goal

- We focus on low cost solutions, using purely consumer/hobbyist electronics.

Overview

1. Past Work
2. Our Patterns
3. Our System
4. Results
5. Future Work

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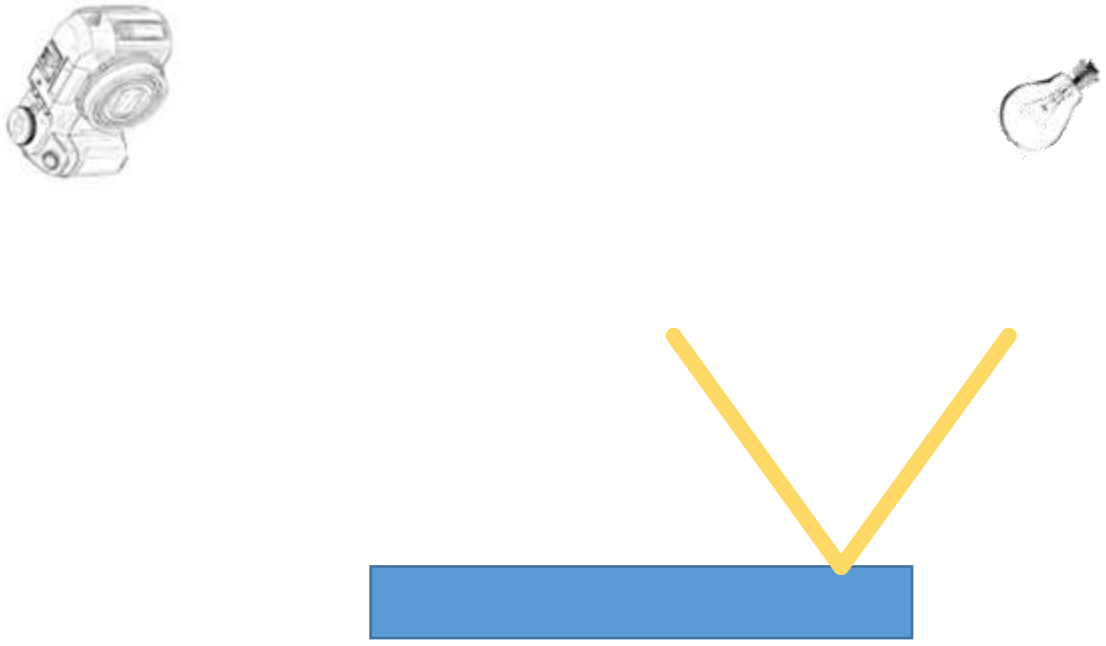
Nayar et al's Method

- Consider the image produced when an object is illuminated by a light source
- The transmitted light is a combination of directly reflected light and light that underwent subsurface scattering



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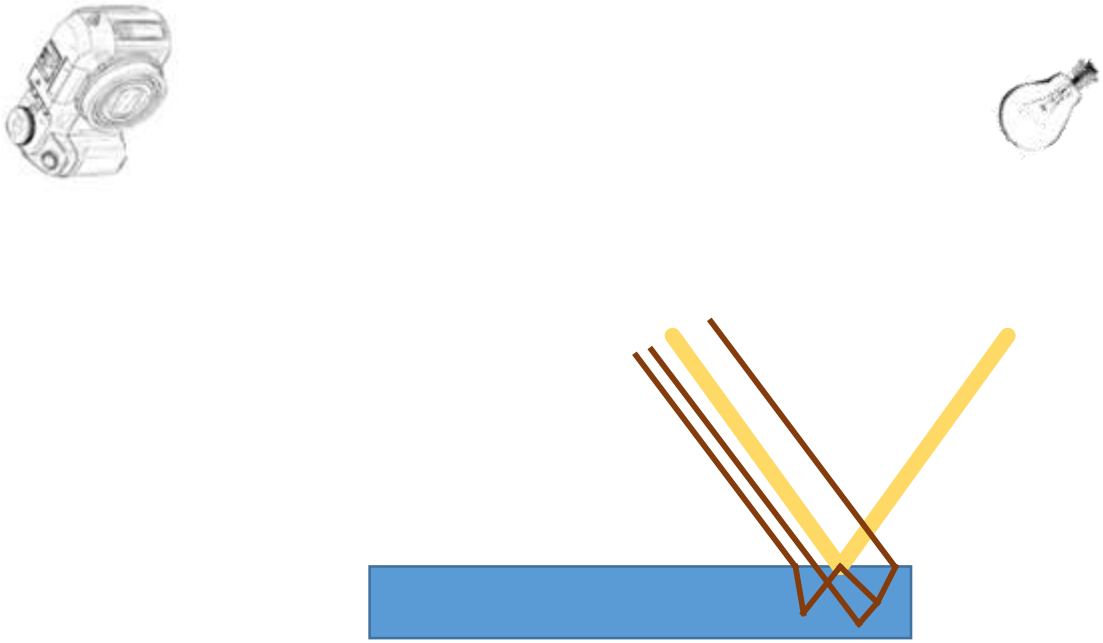

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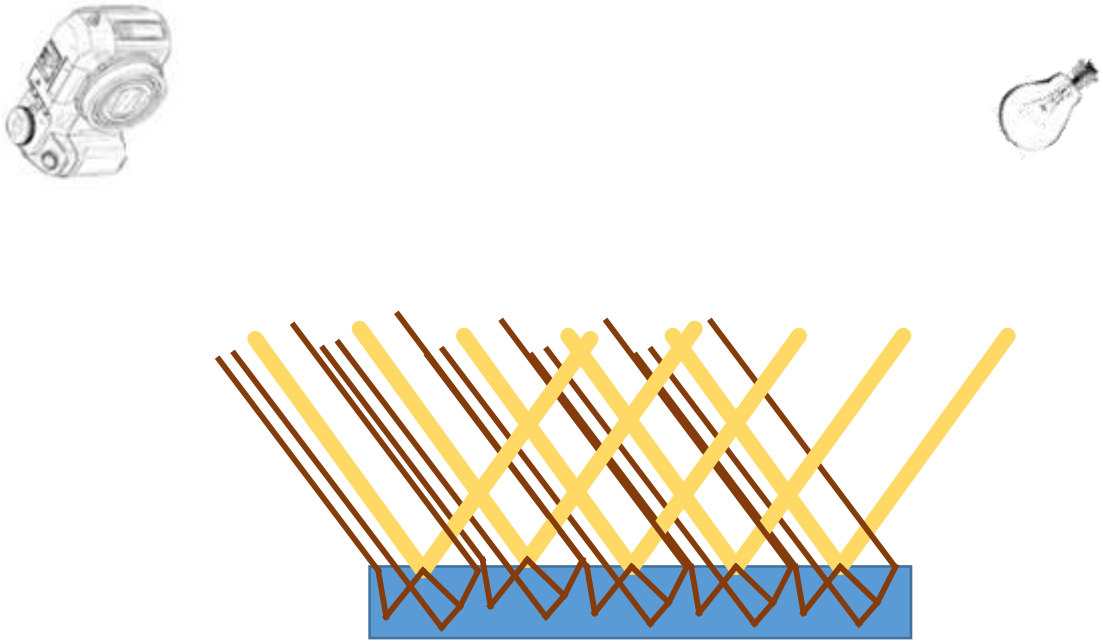
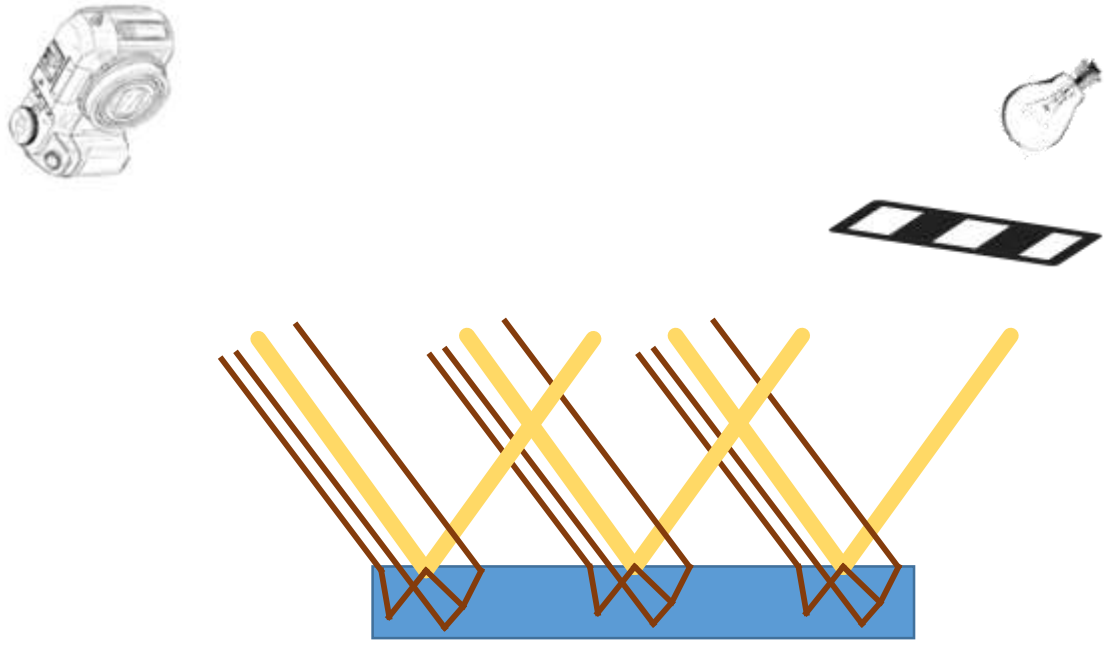


Nayar et al's Method

- By masking the light (or in our case replacing the light source with a projector) we can control the output.



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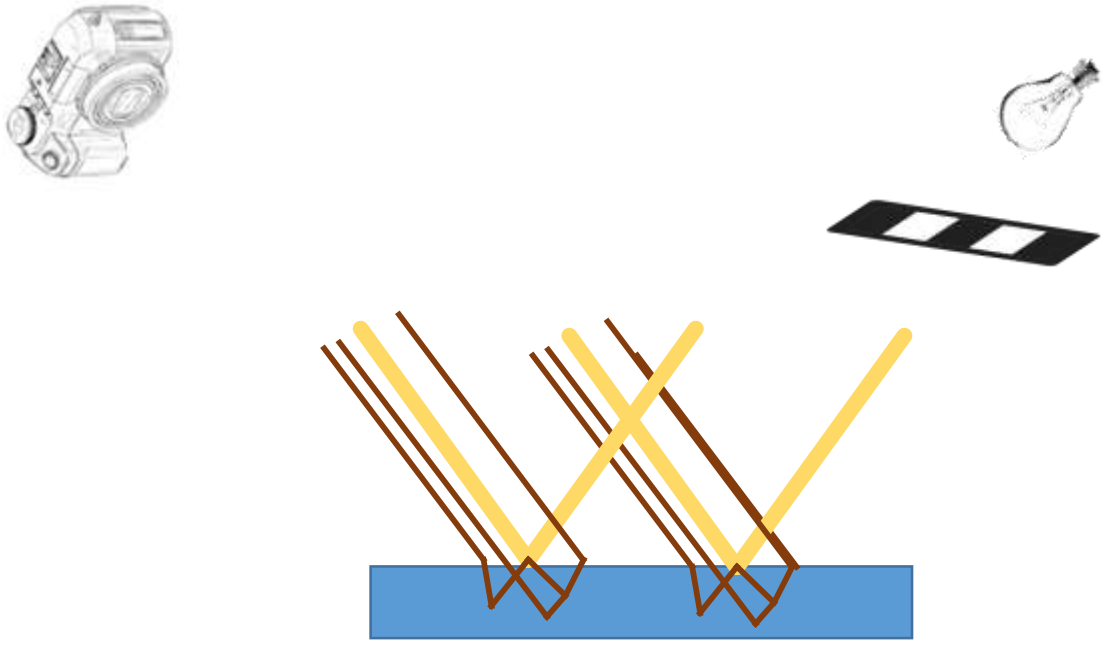
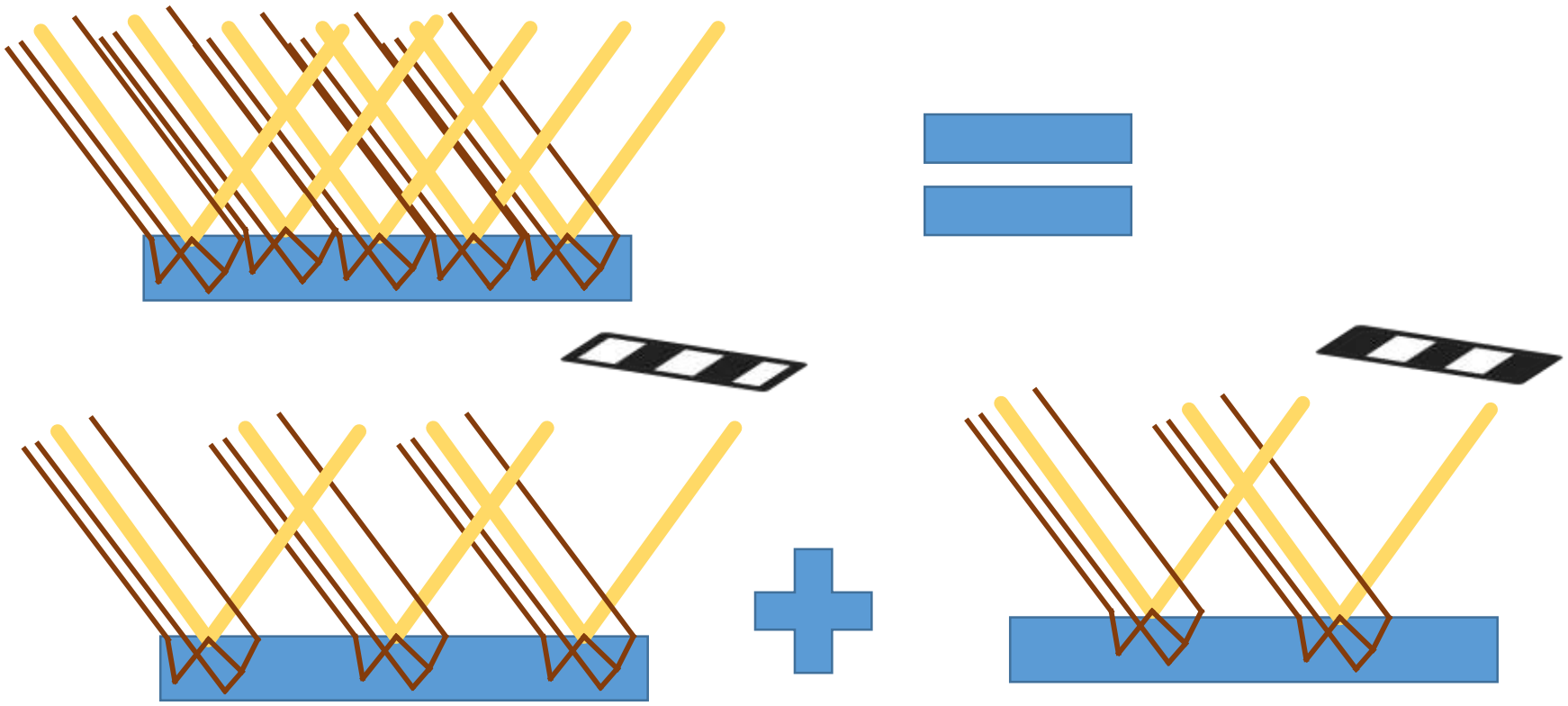


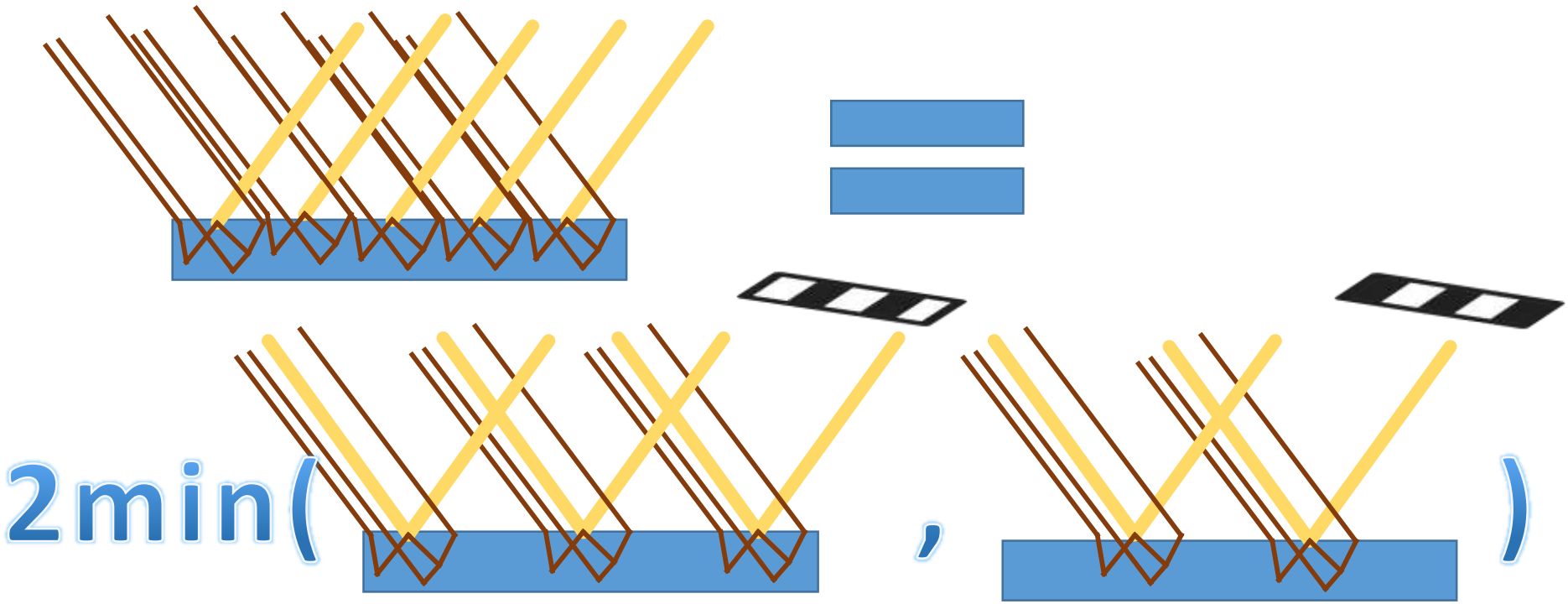
Nayar et al's Method

- We can decompose our light source into a number of components, which allows us to control the type of scattering at each location.

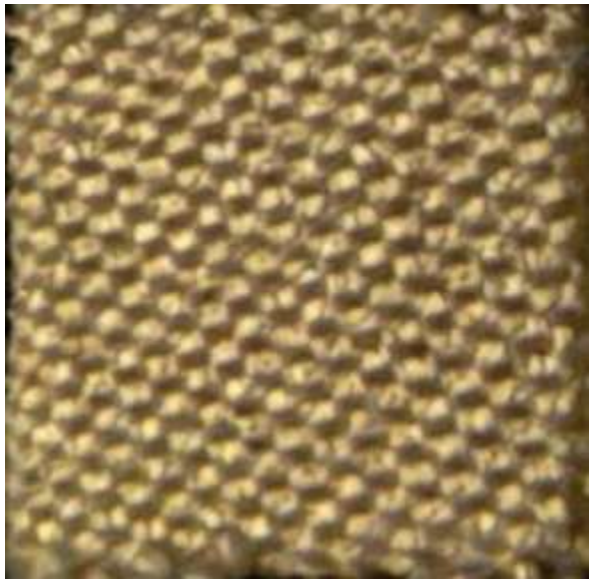


Nayar et al's Method

- By using different light patterns, we can extract the subsurface component.



Direct/Indirect Separation



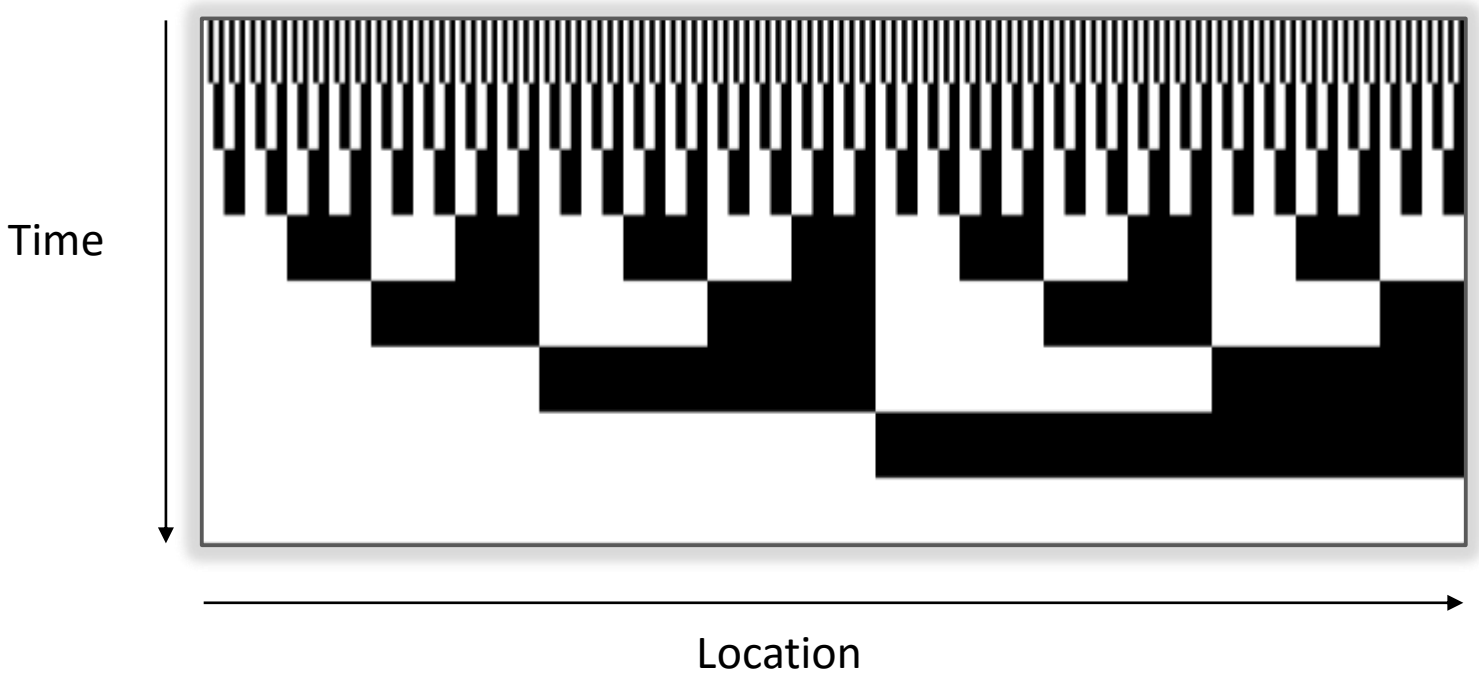
Direct:

Indirect:

From: "Experiments with a low-cost system for computer graphics material model acquisition" Rushmeier et. al.

Binary Patterns

- Binary patterns are often used to find projector camera correspondence.
- Each location is unequally encoded by a binary code.



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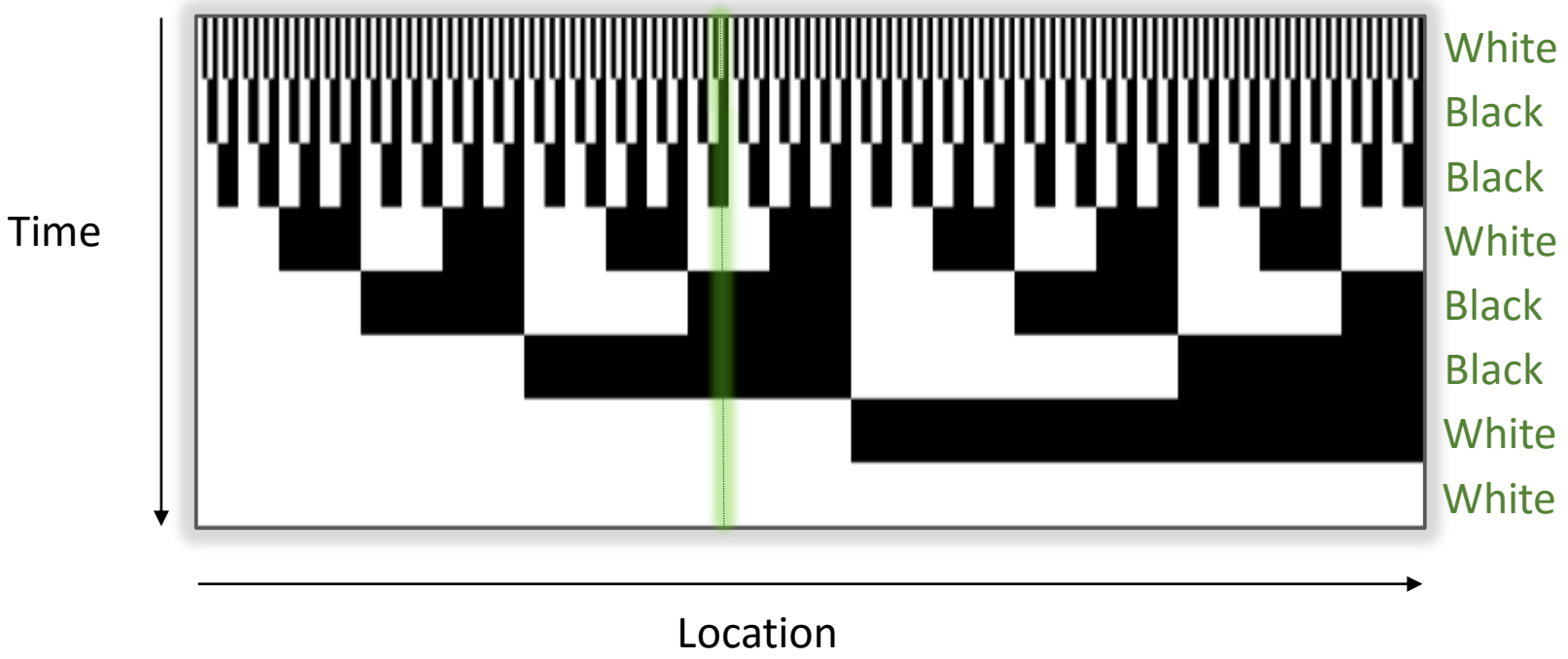

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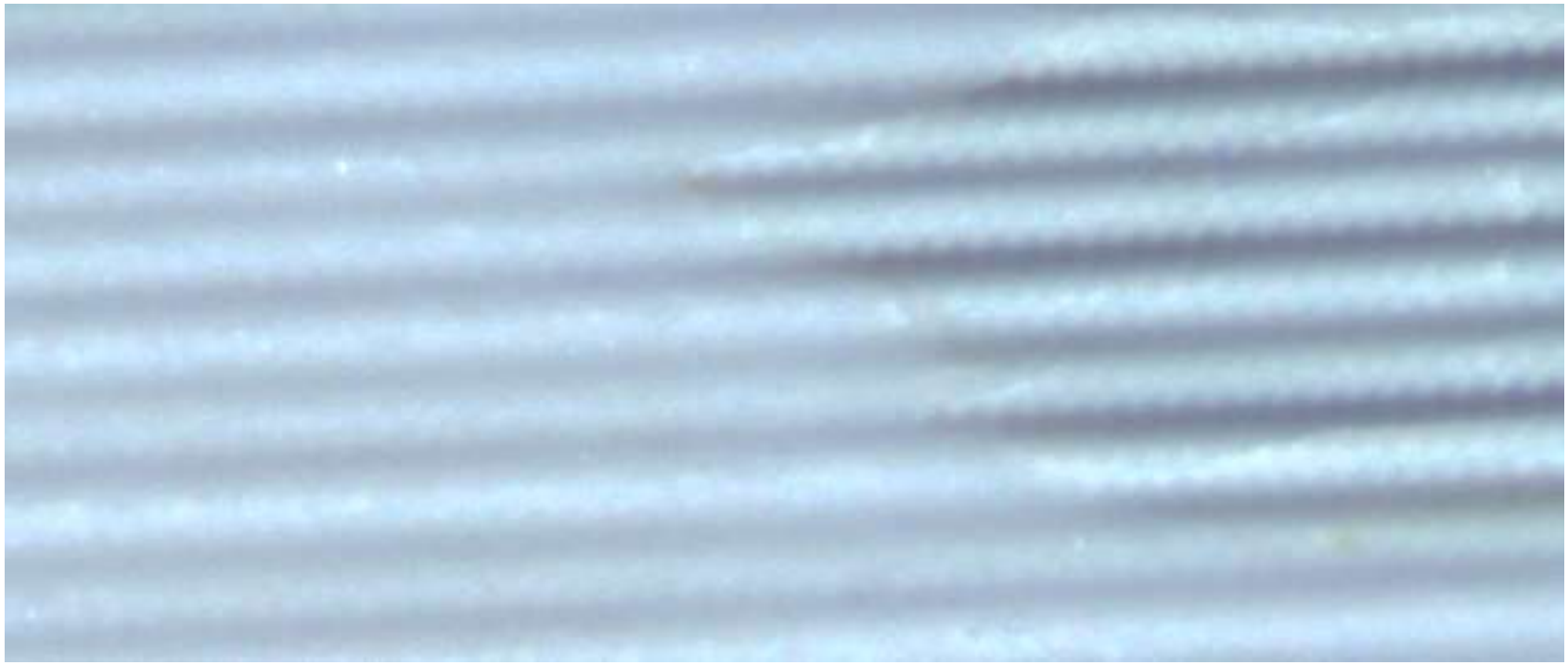
The problem

- In the presents of subsurface scattering, patterns can get “blurred”

Region with strong subsurface scattering

Region with weaker subsurface scattering



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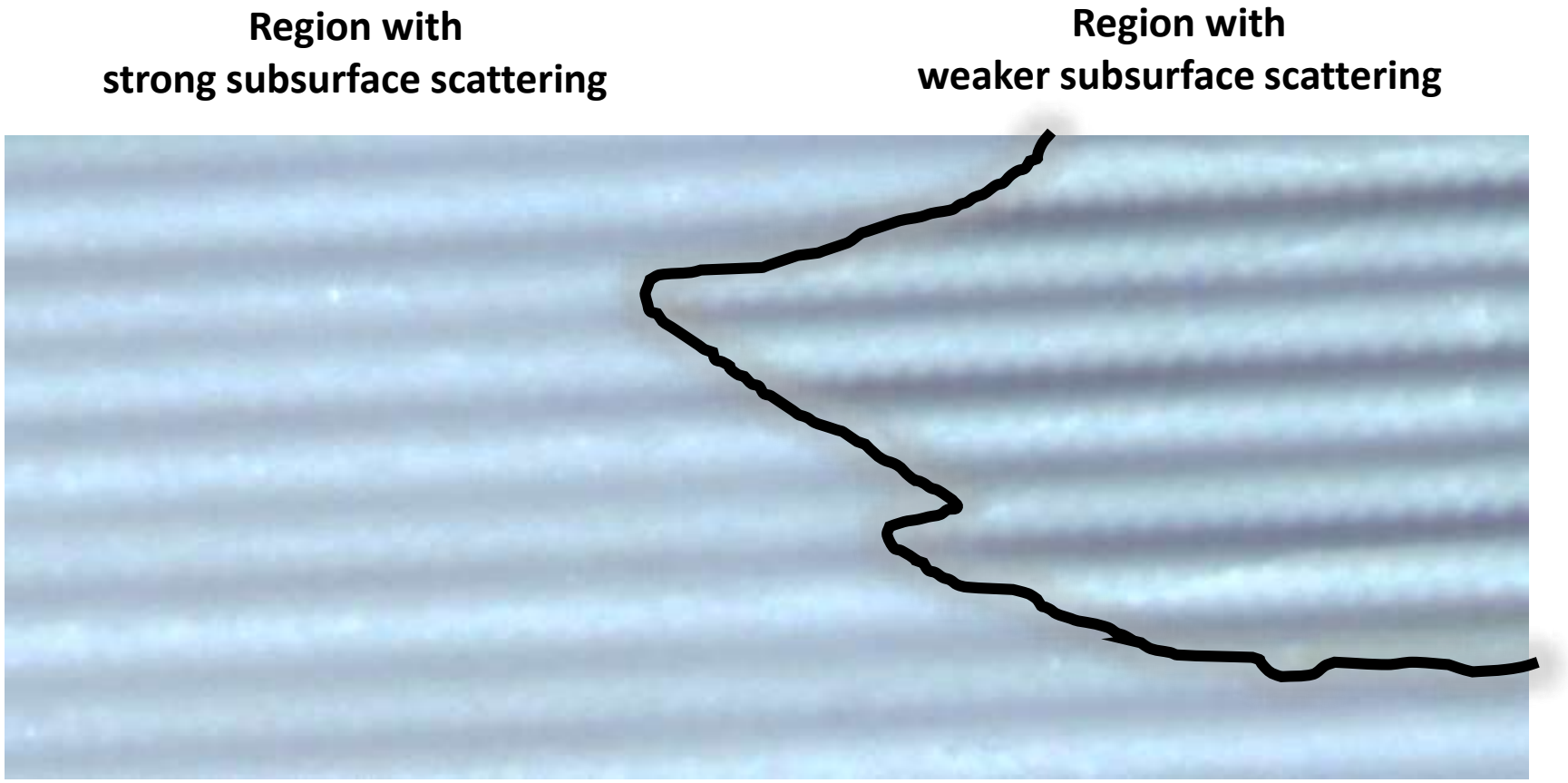
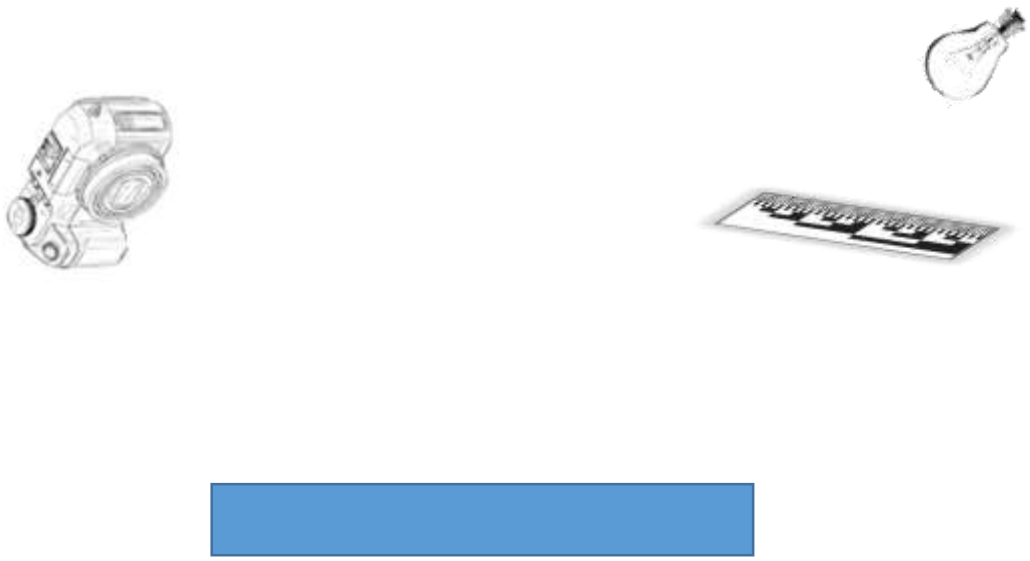


Primary/Secondary Patterns

- We realized that we can treat the initial pattern as a light source, then use Nayar et al's method to decompose that pattern



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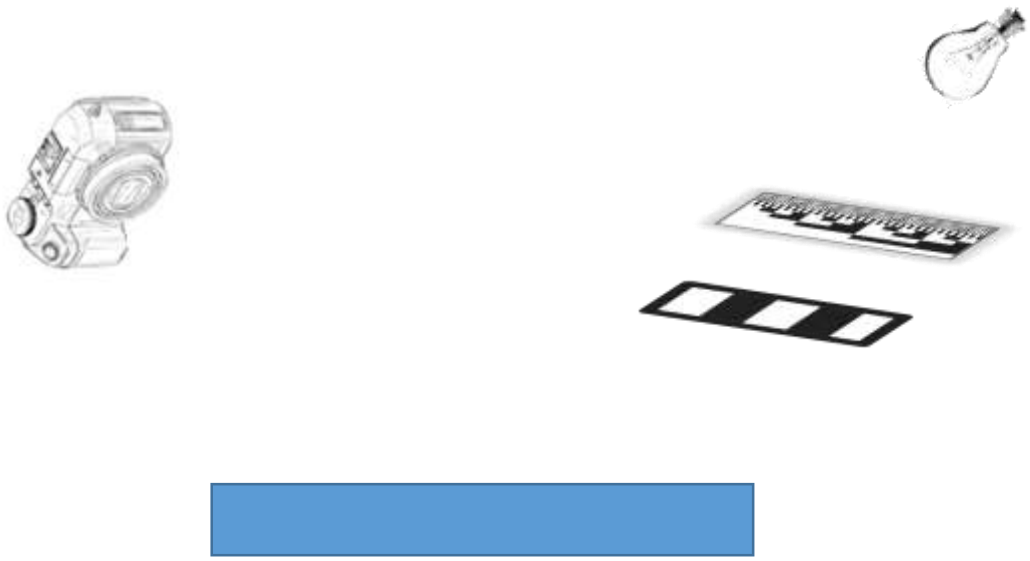
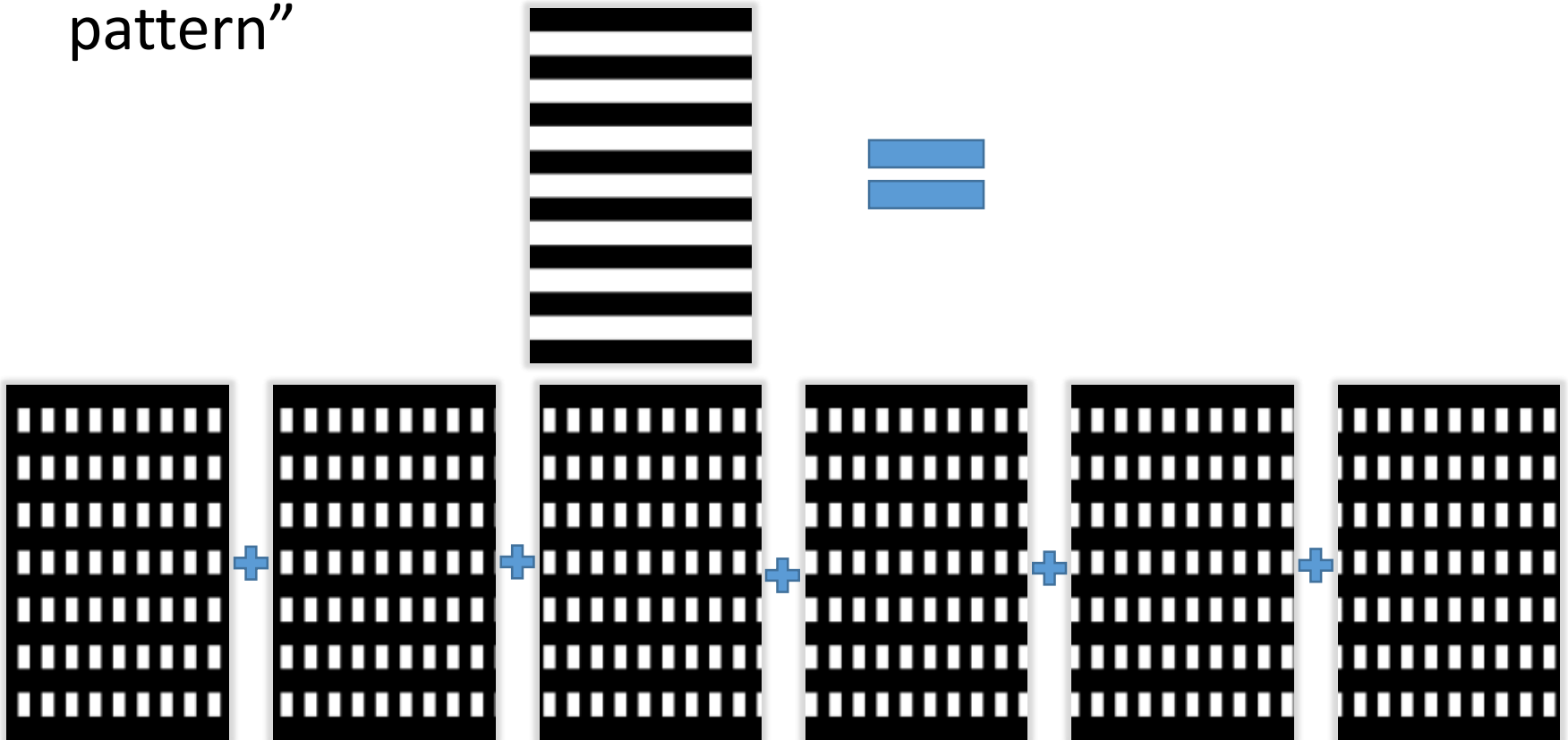


Primary/Secondary Patterns

- This is equivalent to subdividing the initial pattern into a number of new composited patterns.
- For clarity, we call the initial pattern the “primary pattern” and the composed pattern the “secondary pattern”



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Our system

Our system includes:

1. Canon EOS Rebel T5 ($300)
2. AAXA KP-100-02 P2 Jr Pico projector ($200)
3. Raspberry Pi 2 ($45)
4. Tripod/stereo rig/wire management

Our system

- We have three camera/projector pairs.
- That is, we have a total of 6 “view points”.

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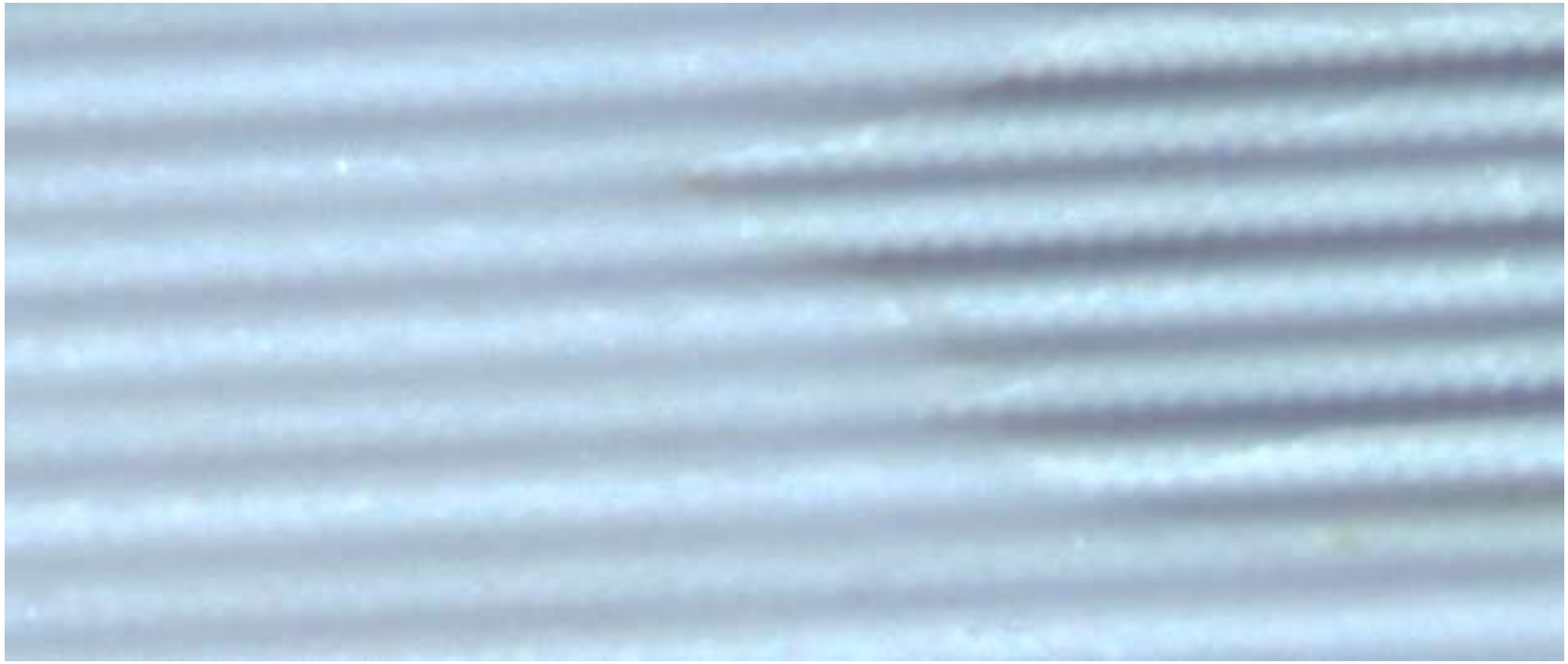
Direct indirect separation

Our separation of patterns

- By separating the direct from the indirect the patterns become more apparent.



Full Image

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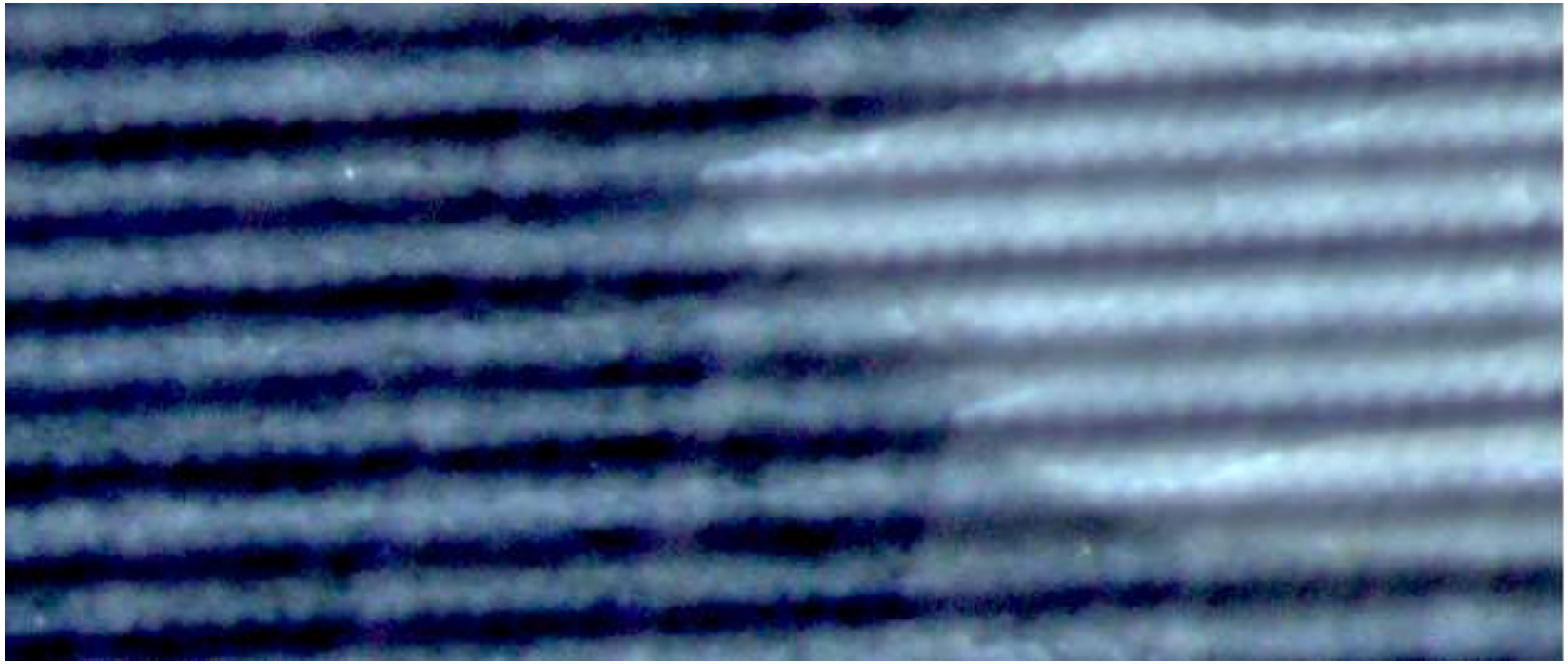

Direct Scattering

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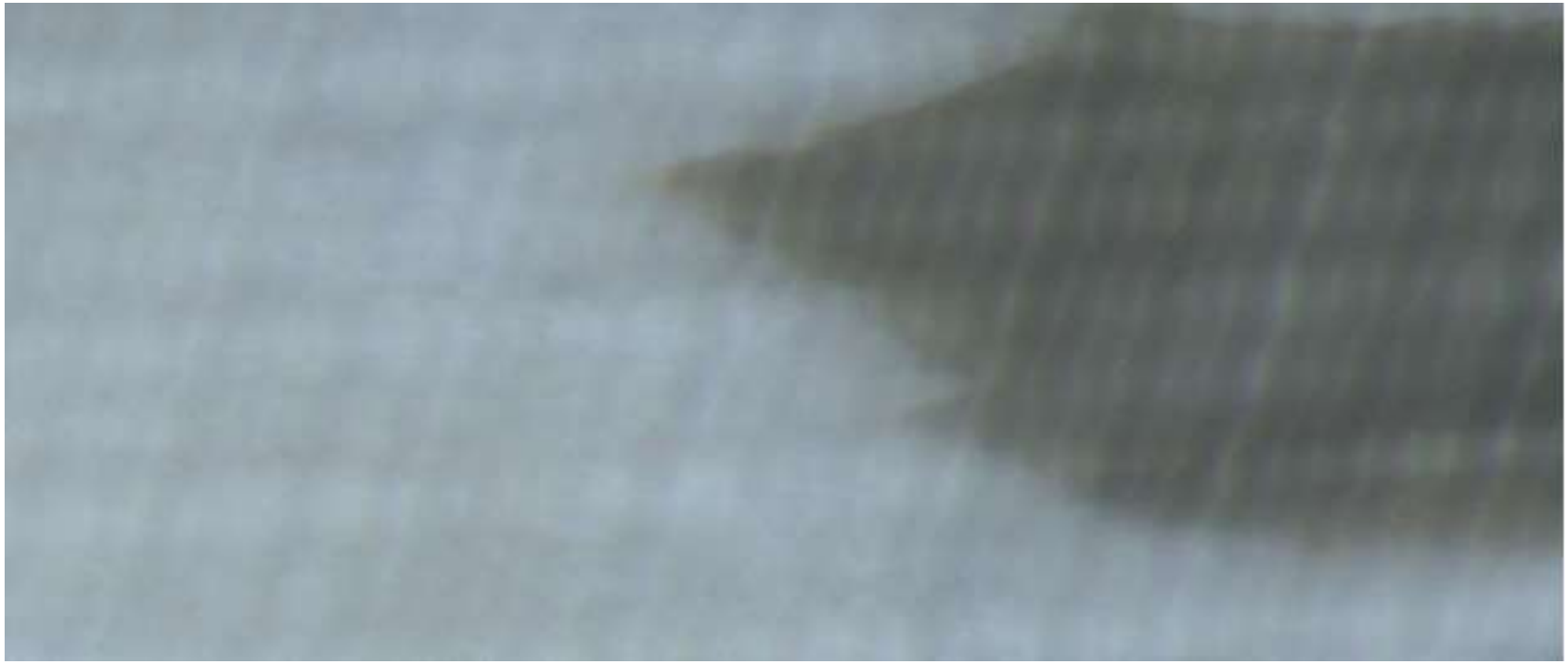
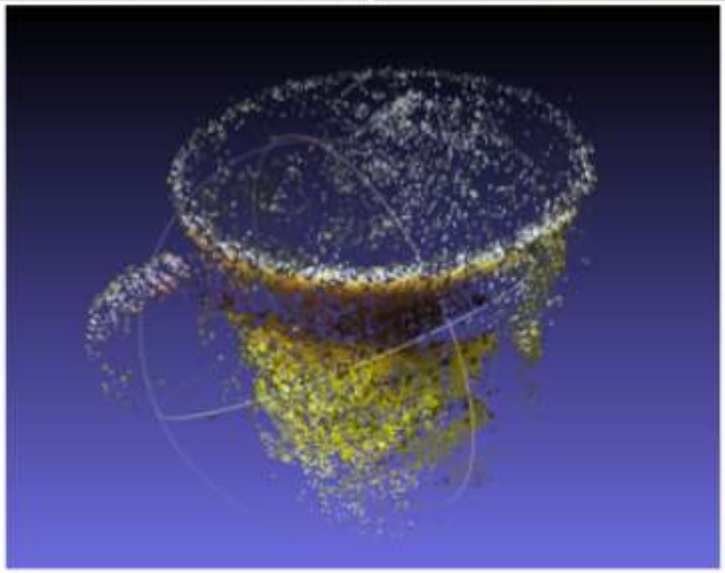


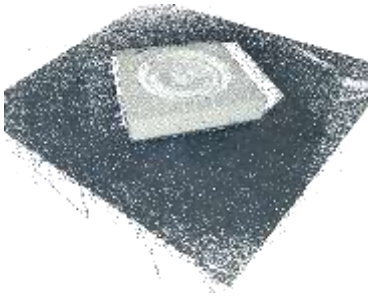
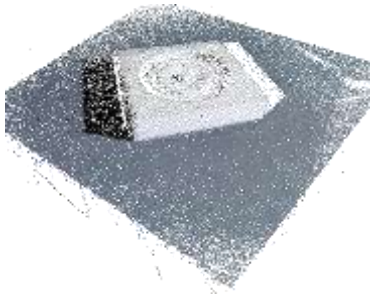
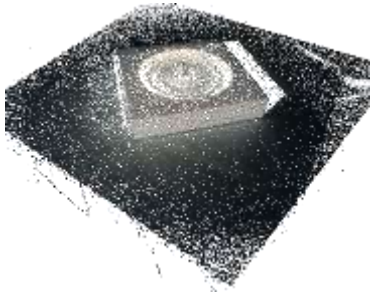
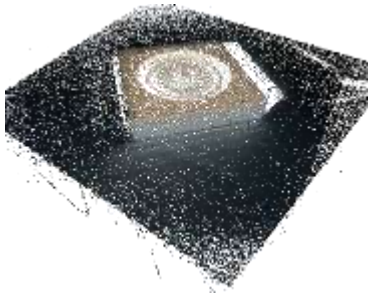
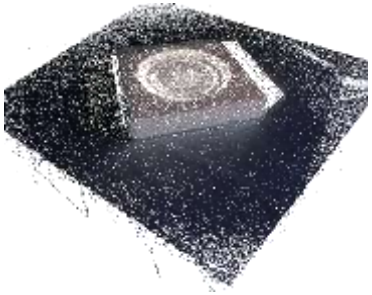
Indirect Scattering

Point Cloud



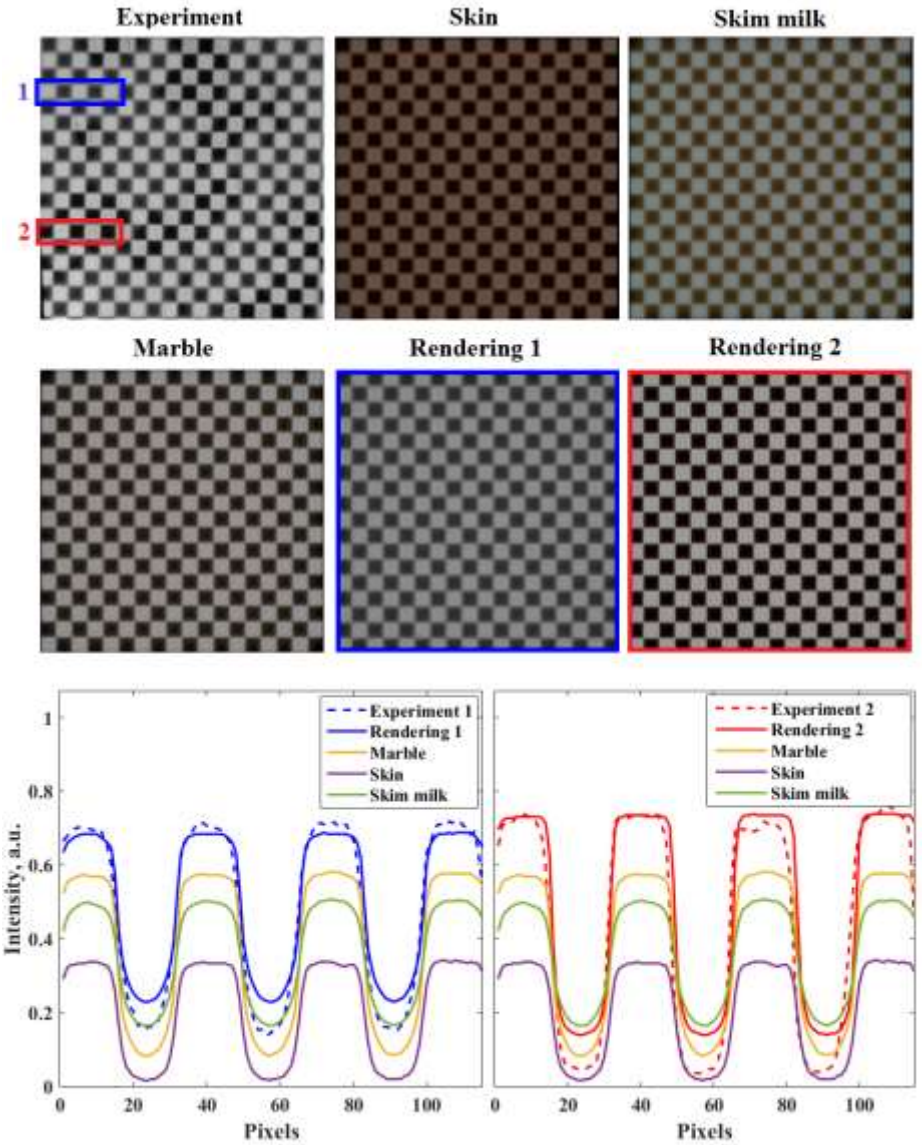
Illuminated Point Cloud

- To the best of our knowledge, this is the only system that can produce point clouds with lighting from multiple illumination directions.
- This illumination can be separated direct and indirect components

	Projector 1	Projector 2	Projector 3
Direct Scattering			
Indirect Scattering			

Comparison of Materials

- We can compare the scattering properties we obtain to rendered materials to estimate parameters.



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To do

- We want to test the level of improvements between our new compared to ordinary binary coding.
- We are looking at methods to directly obtain the BSSRDF from our results.

Acknowledgements

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- The computational resources of the Yale Computer Science Cloud were used in this work.