

# Computational Photography

- \* Study the basics of computation and its impact on the entire workflow of photography, from capturing, manipulating and collaborating on, and sharing photographs.



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# Projector Camera Systems

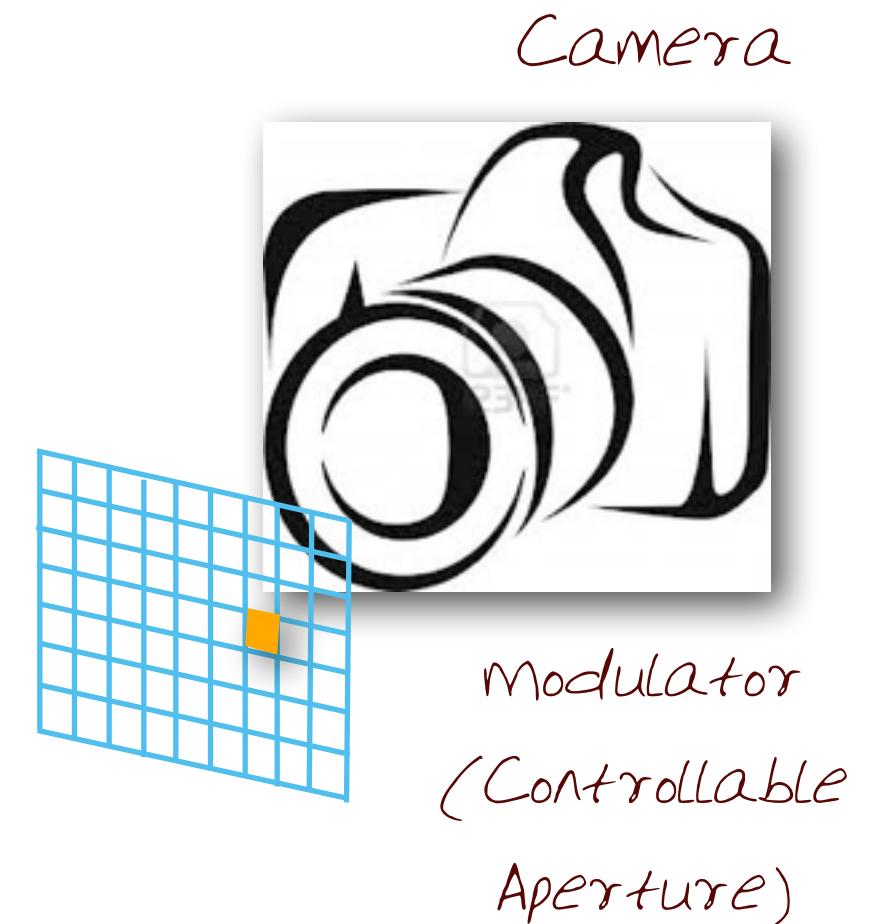
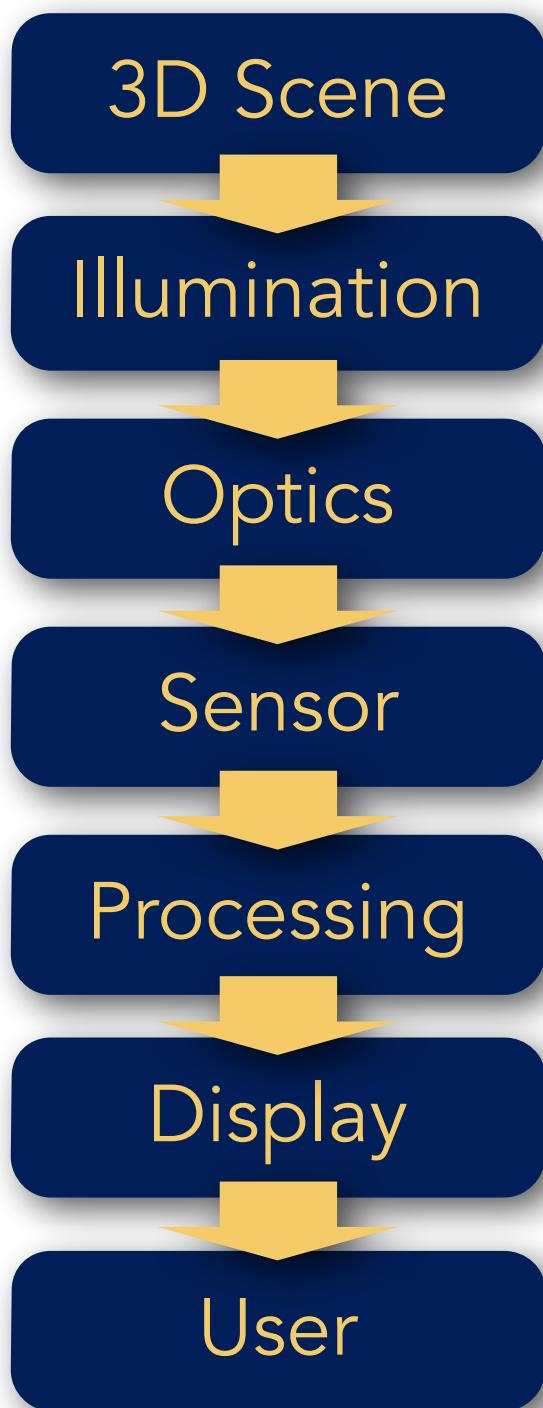
- \* Combining a Controllable Camera and a Light Source



## Lesson Objectives

1. Basics of Controlled Illumination
2. Use of a Projector as a controlled Light Source
3. Projector-Camera System
4. Projector Calibration
5. Examples of PROCAMs

# Recall: Computational Photography



# Controlled Illumination



Projector  
(Controllable  
Light Source)

Modulator  
(Controllable  
Aperture)



Lightstage,  
USC/ICT



Trimensional  
Schindler

# Lightstage

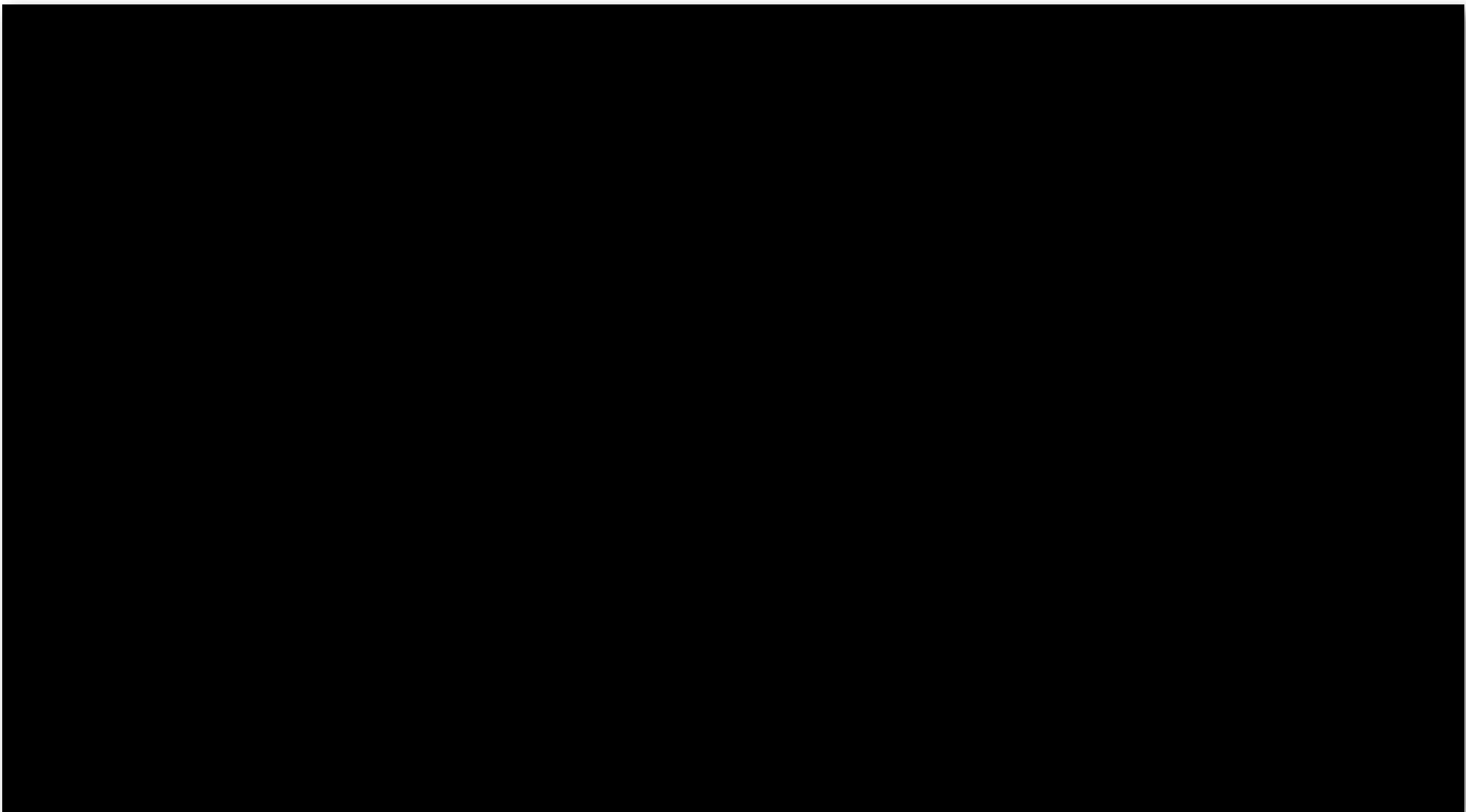


<http://gl.ict.usc.edu/LightStages/>

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Debevec (2012)

# Lightstage



# 3D Scanning on Mobile Phone



Trimensional iPhone App

# Controlled Illumination

- \* Given a controlled light source, we can:
  - \* Scan
  - \* Relight
- \* How can we computer control light?
- \* Projectors are computer controlled light sources!



# Projector Calibration

How do we automatically get a perfectly rectangular image on the display of the exact aspect ratio of the original image?

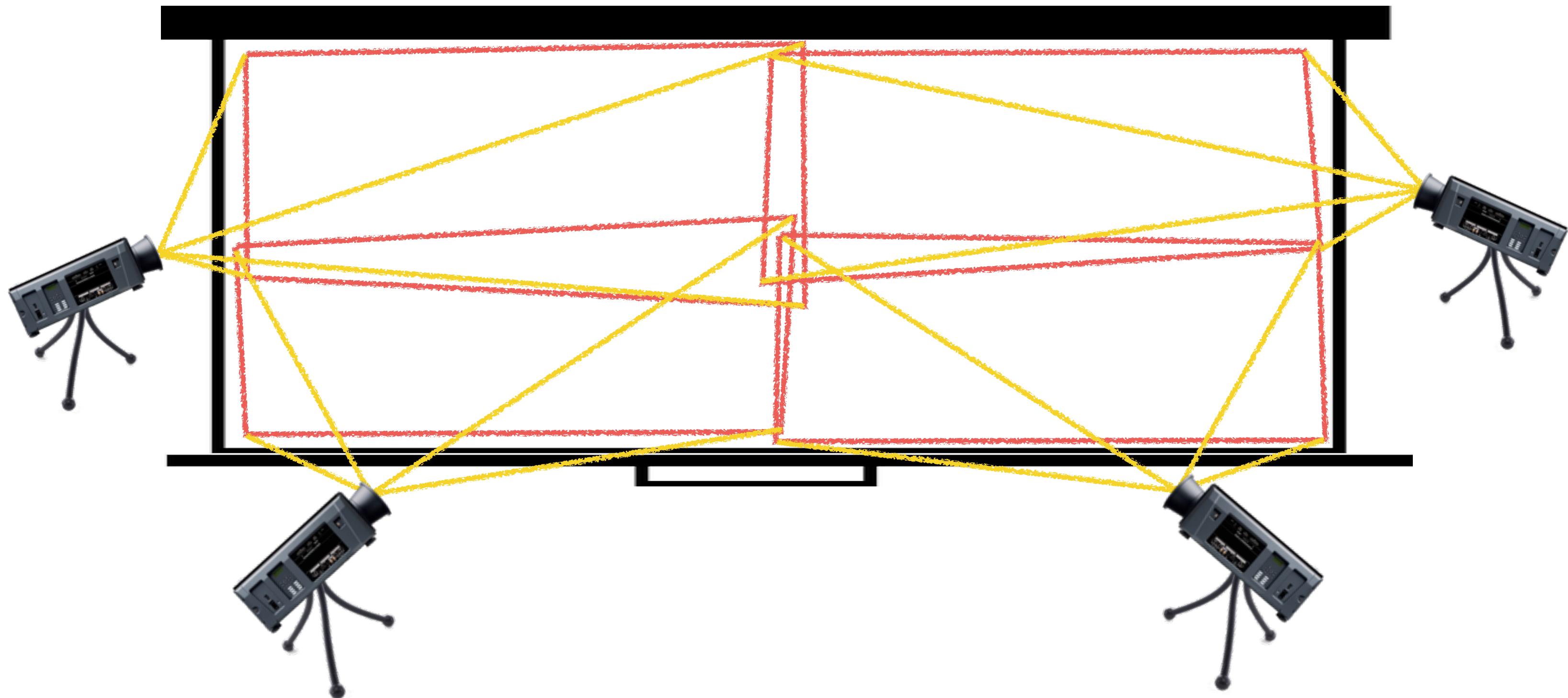
- Move the screen
- Move the projector
- Use a Camera to "see" the displayed image and transform the image on the projector



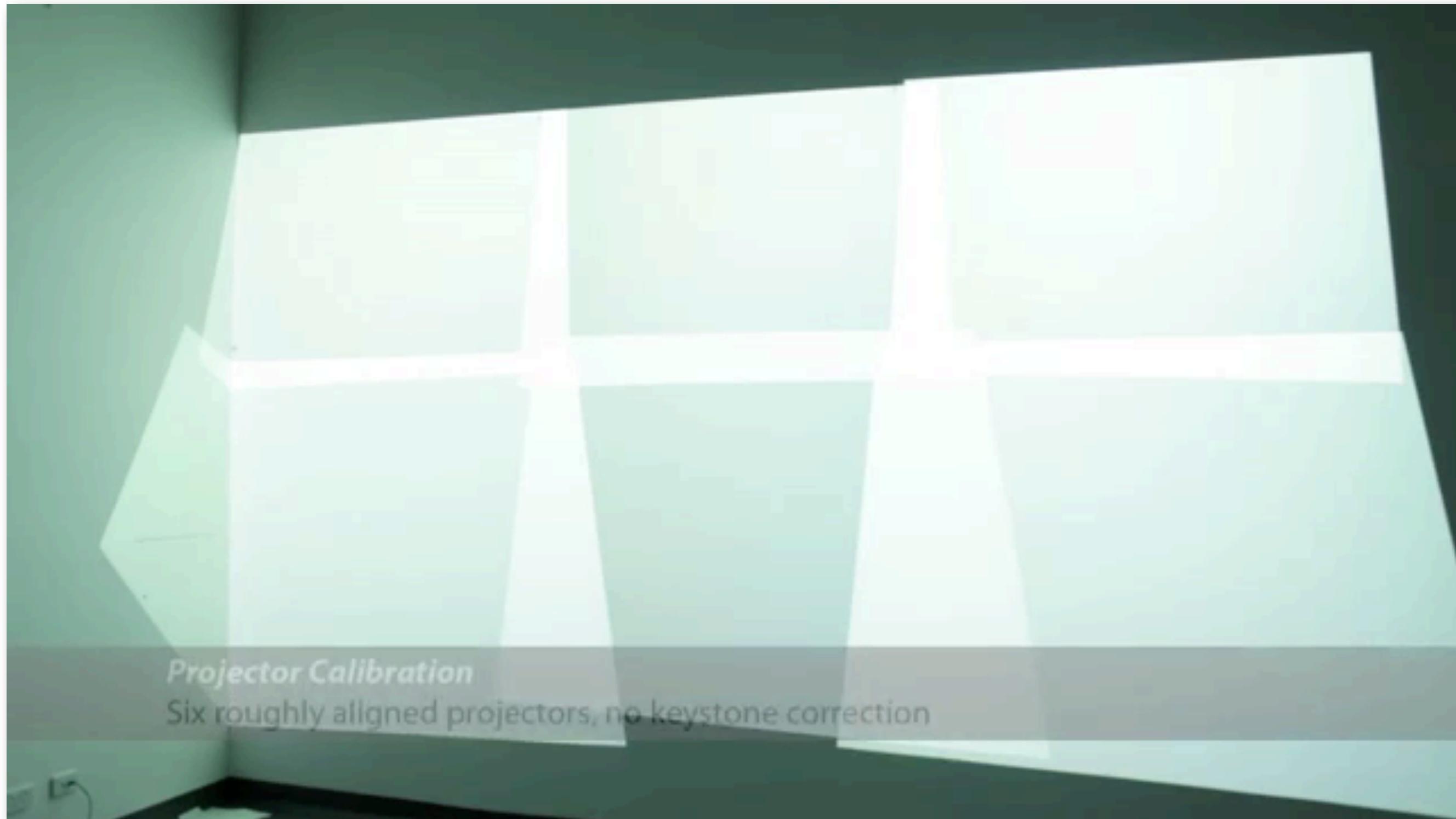
# Projector Calibration



# Projector Calibration

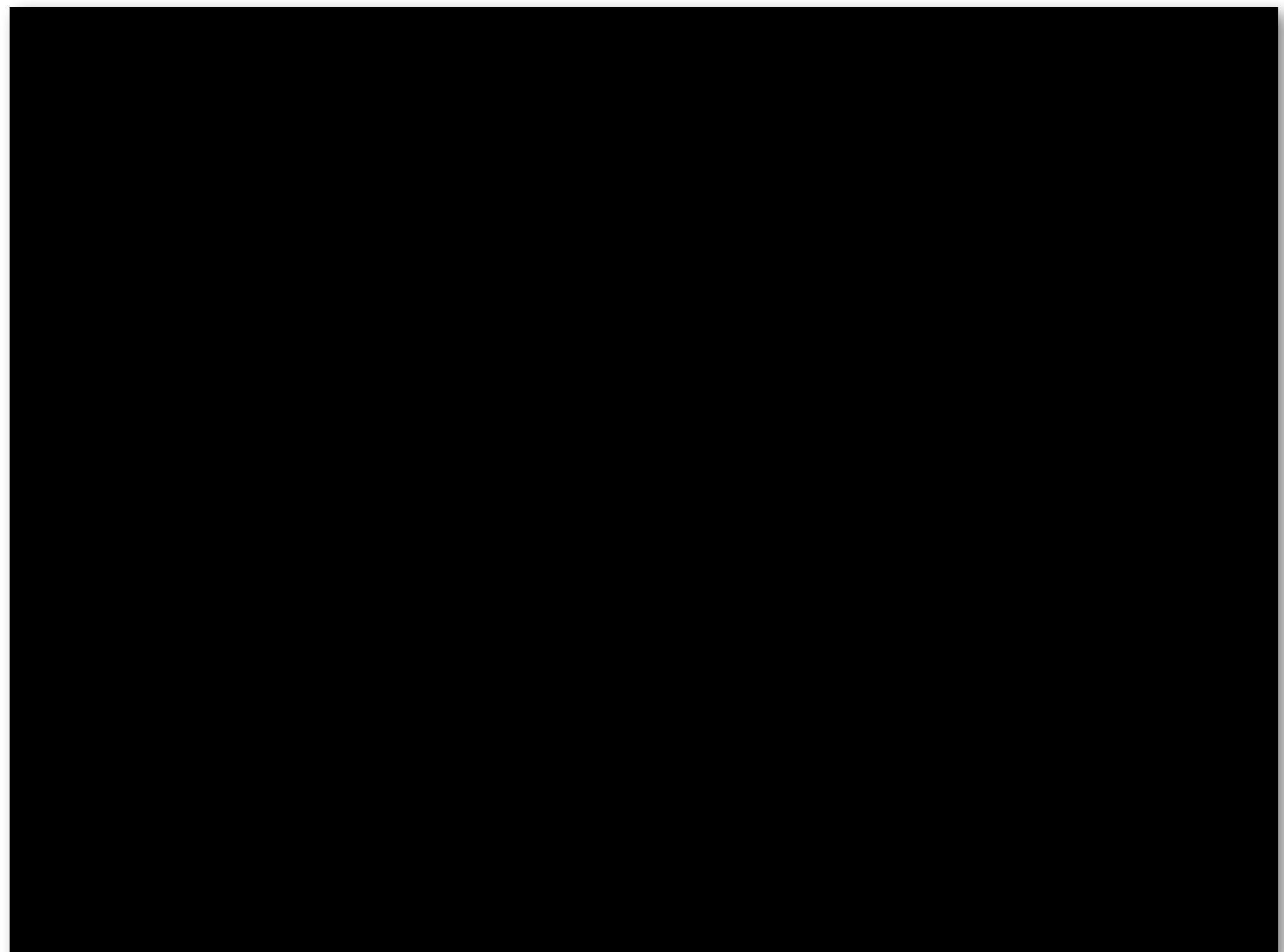


# Projector Calibration



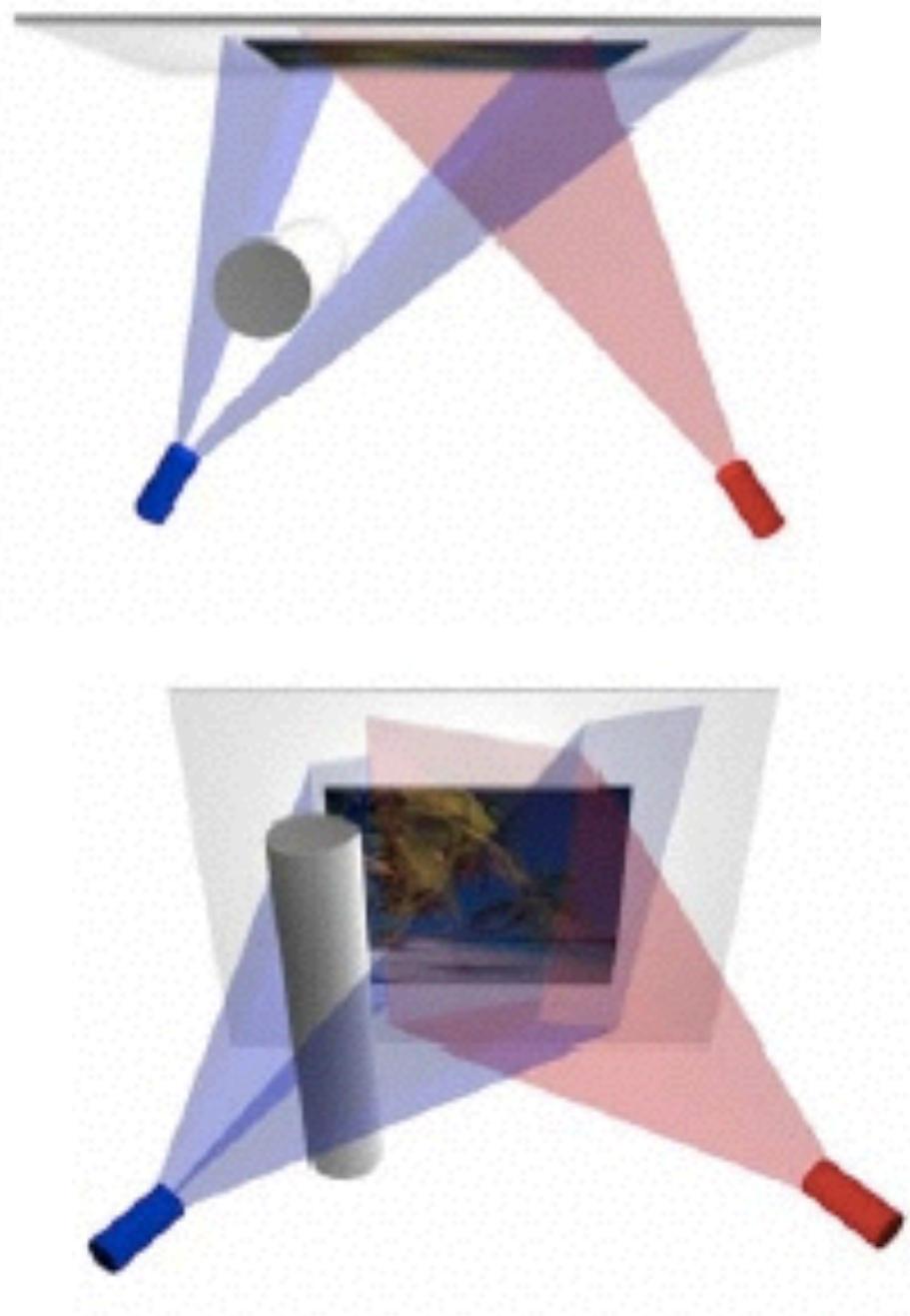
# Projector Calibration with 1 Pixel Sensor

- \* Low resolution cameras can be used with structured light
- \* A single "pixel"



Lee, Dietz, Aminzade, and Hudson, (2004)

# Light that is Aware of Obstructions



Summet, Flagg, et al. (2007)

# Programable Headlights



# Room Alive



## RoomAlive: Magical Experiences Enabled by Scalable, Adaptive Projector-Camera Units

Brett Jones<sup>1</sup>, Rajinder Sodhi<sup>1</sup>, Michael Murdock<sup>2</sup>, Ravish Mehra<sup>3</sup>, Hrvoje Benko,  
Andrew D. Wilson, Eyal Ofek, Blair MacIntyre<sup>4</sup>, Nikunj Rathi<sup>1</sup>, Lior Shapira

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ACM UIST 2014

All clips in this video were captured live in real-time  
without any post production or compositing

# Summary

- \* Introduced systems where a controlled light source is coupled with a camera
- \* PROCAMS



# Further Reading



- \* Debevec (2012), "The Light Stages and Their Applications to Photoreal Digital Actors" , SIGGRAPH Asia 2012 Technical Briefs [\[PDF\]](#)
- \* Marner, Smith, Walsh, Thomas (2014), "Spatial User Interfaces for Large Scale Projector-Based Augmented Reality" , in IEEE CGA 2014 [\[PDF\]](#)
- \* Summet, Flagg, Cham, Rehg and Sukthankar (2007) "Shadow Elimination and Blinding Light Suppression for Interactive Projected Displays" IEEE TVCG 2007 [\[PDF\]](#)

# Further Reading



- \* Lee, Dietz, Aminzade, and Hudson, (2004) "Automatic Projector Calibration using Embedded Light Sensors" , ACM UIST 2004 [[PDF](#)]
- \* Tamburo, Nurvitadhi, Chugh, Chen, Rowe, Kanade and Narasimhan (2014) "Programmable Automotive Headlights" ECCV 2014 [[PDF](#)]
- \* Jones, Sodhi, Murdock, Mehra, Benko, Wilson, Ofek,, macIntyre, Shapira, (2014) "RoomAlive: magical Experiences Enabled by Scalable, Adaptive Projector-Camera Units" ACM UIST, 2014 [[PDF](#)]

# Credits

- \* [https://www.youtube.com/watch?v=x\\_gUW/RN8QNM](https://www.youtube.com/watch?v=x_gUW/RN8QNM)
- \* <https://www.youtube.com/watch?v=IW4tZGXAGVQ>
- \* [https://www.youtube.com/watch?v=XgrGjJUBF\\_I](https://www.youtube.com/watch?v=XgrGjJUBF_I)
- \* <https://www.youtube.com/watch?v=d0ljhDkwDss>
- \* <http://www.cs.cmu.edu/smartheadlight/>
- \* <http://projection-mapping.org/roomalive-list/>
- \* Thanks to Jay Summet for slides



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