

The potential of virtual collaborative spaces for collaborative design

ADITI MAJUMDER

**CHIEF EXECUTIVE OFFICER
SUMMIT TECHNOLOGY LABORATORY (STL)**

**PROFESSOR
DEPARTMENT OF COMPUTER SCIENCE,
UNIVERSITY OF CALIFORNIA, IRVINE**

2 Immersive Collaborative Spaces



- TeamLab
- Art Exhibits

3 How is it done?

- Multiple projectors create imagery all around you
- Sensors detect your body
- Projections change to respond to body

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Can we do this in design?

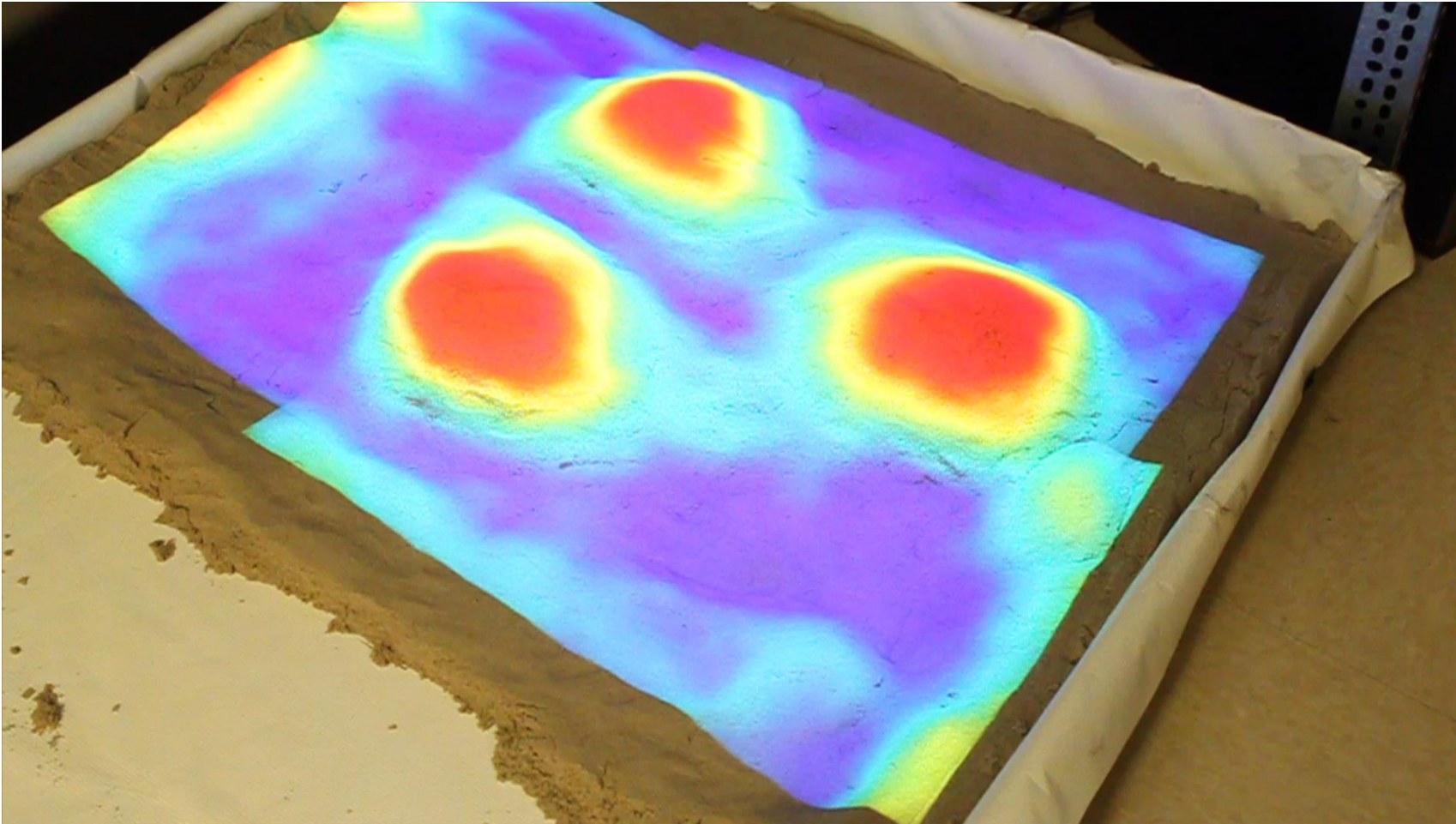
Summit Technology Lab

Surrounding the vase

- 8 projectors
 - Wrap around display
- 8 cameras
 - Detecting hand gestures

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Can we adapt to changing shapes?



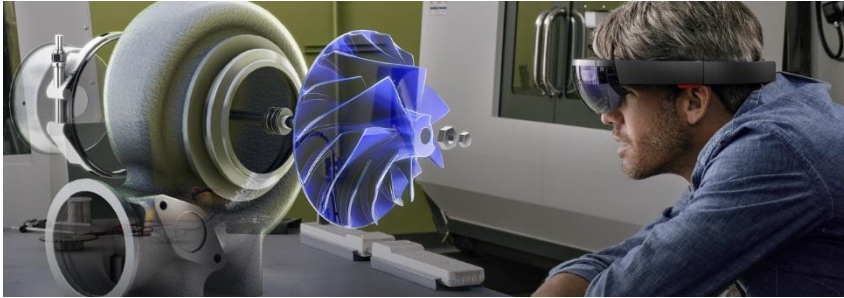
Above the relief

- 6 projectors
 - Creating 6MPixel display
- 4 cameras
 - Detecting change of shape

6 Overview

- Motivation
- Our Technology
- Comparison
- Summary

7 Collaborative 3D Design Today



- + Inexpensive
- + Interactive 3D Experience
- + Portable
- Wearables encumbers users
- Non-shareable single user experiences
- Inhibits natural social interaction
- Sickness and Fatigue

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What is missing?



Multiple people interacting with the same 3D object/space at the same time communicating with each other using natural communication modalities

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Summit Technology Laboratory

- Young Startup Company
- IP - Interactive Graphics and Visualization Laboratory (iGravi)
 - Last 10 years, considered a top VR lab
 - \$1.5M funding from federal agencies, industry and university
 - 8 issued patents
- A technology to revolutionize design

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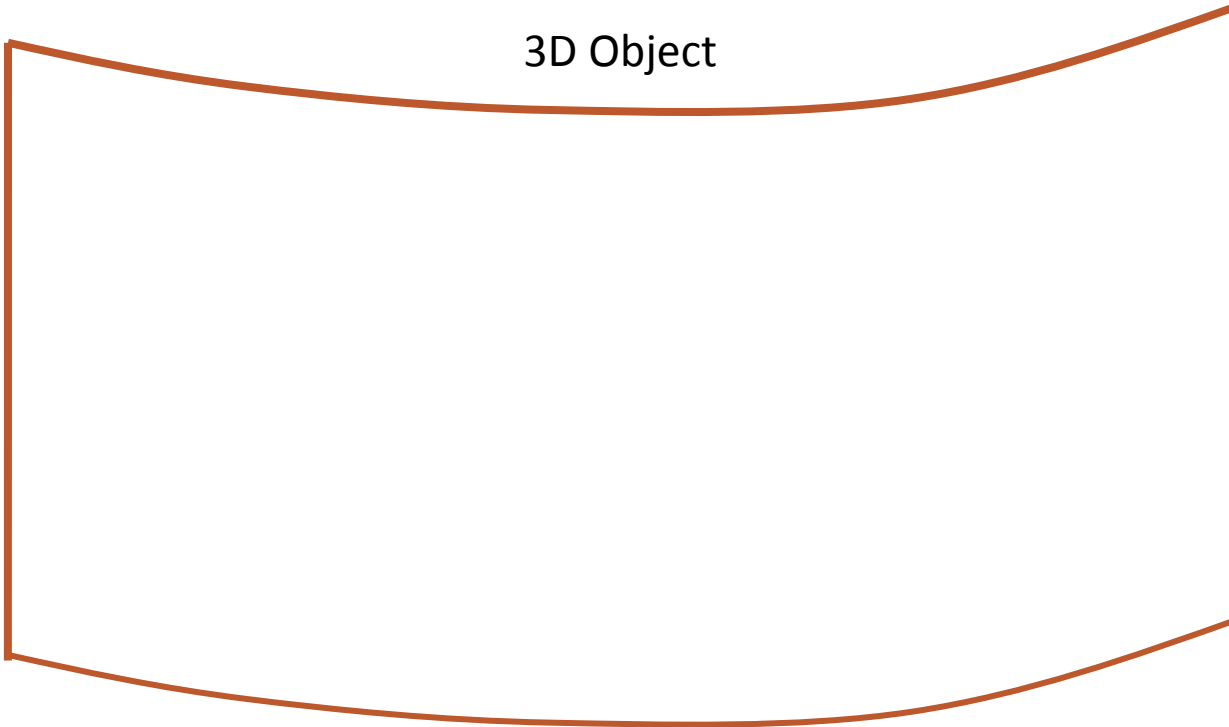
11 Proprietary Software: PRAIS

- **P**Rojector **A**ggregation and **I**nteraction **S**oftware
 - Aggregates images from multiple projectors illuminating object

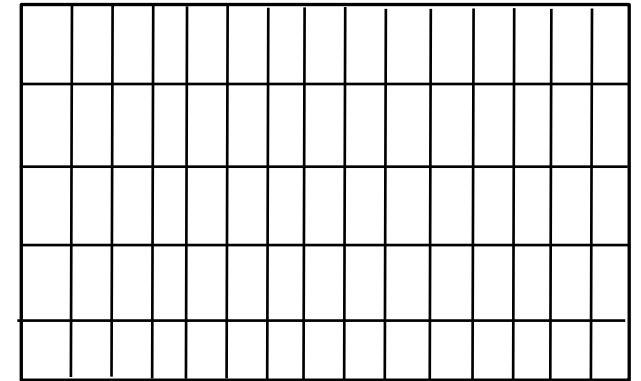
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Challenge in Aggregation

3D Object

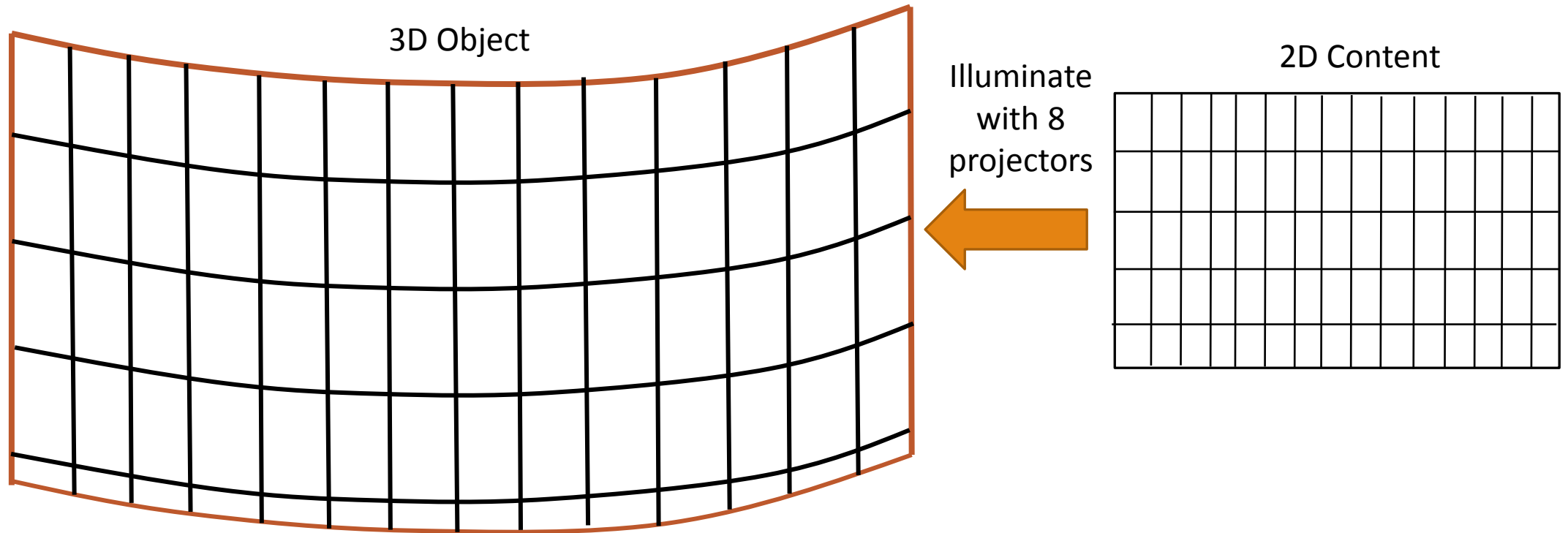


2D Content



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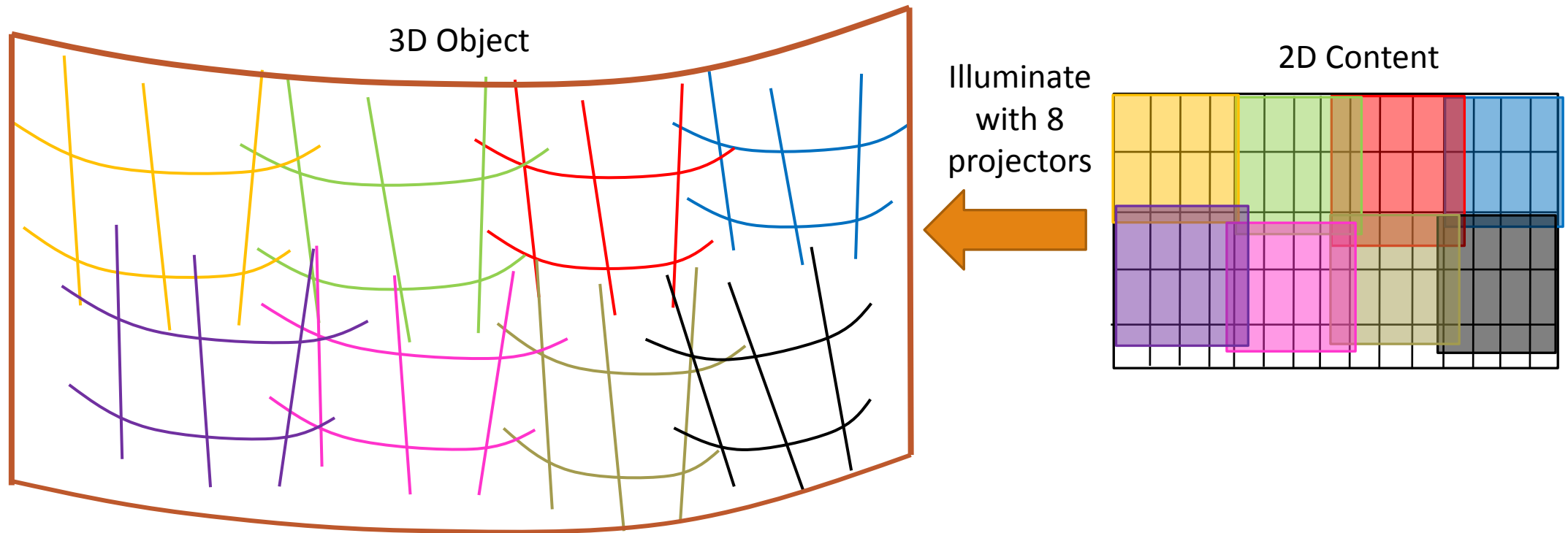
Challenge in Aggregation



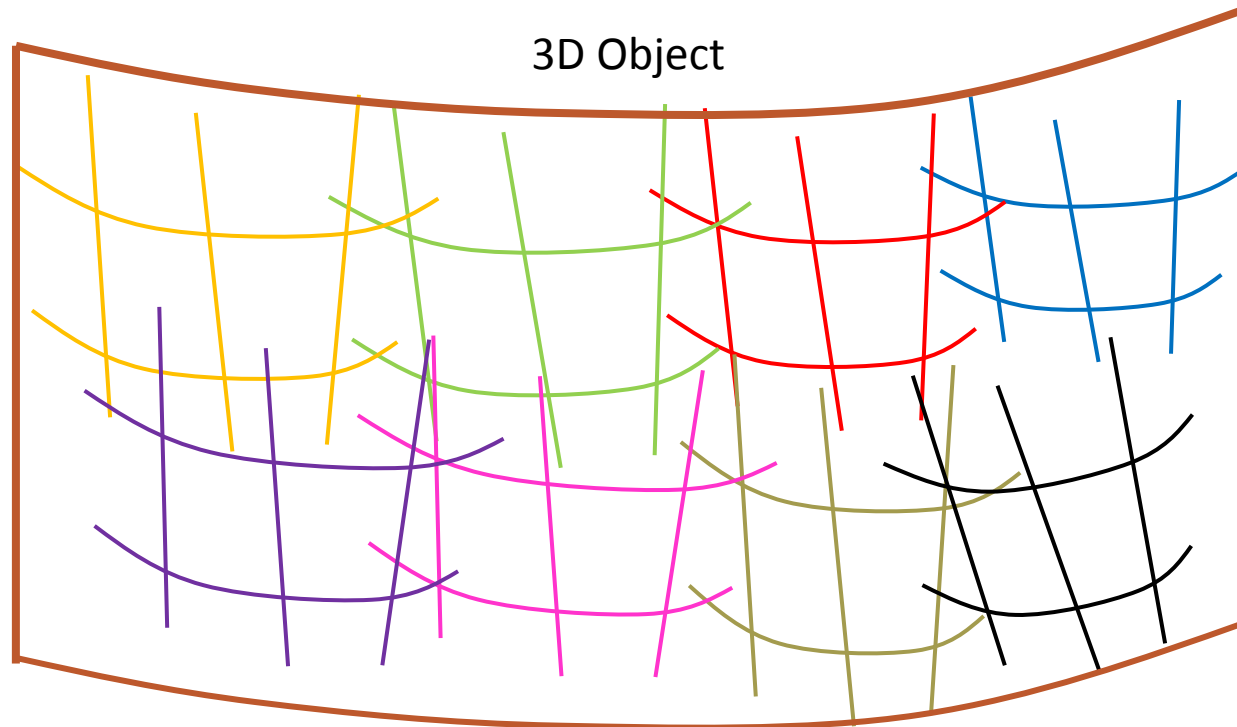
Responds to variations in 3D shape

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Unregistered



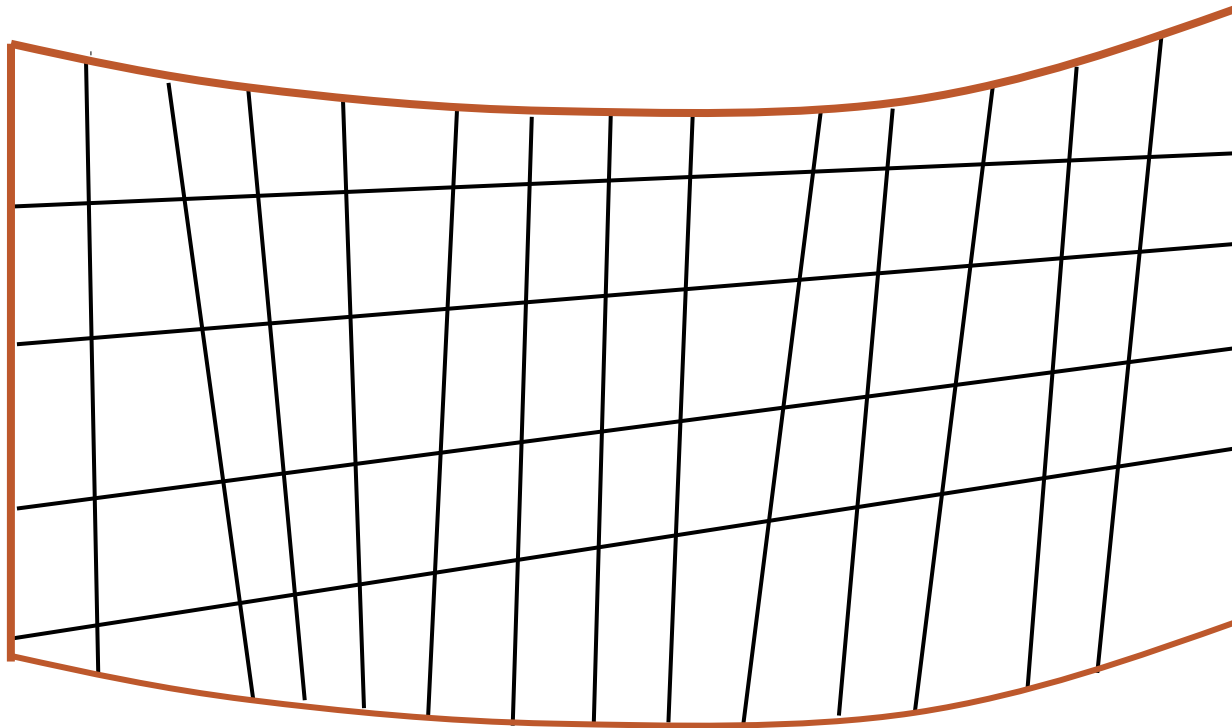
Challenge 1: Registration



- Every surface point is lit by 1 or more projectors
- Should get exactly the same content from all projectors

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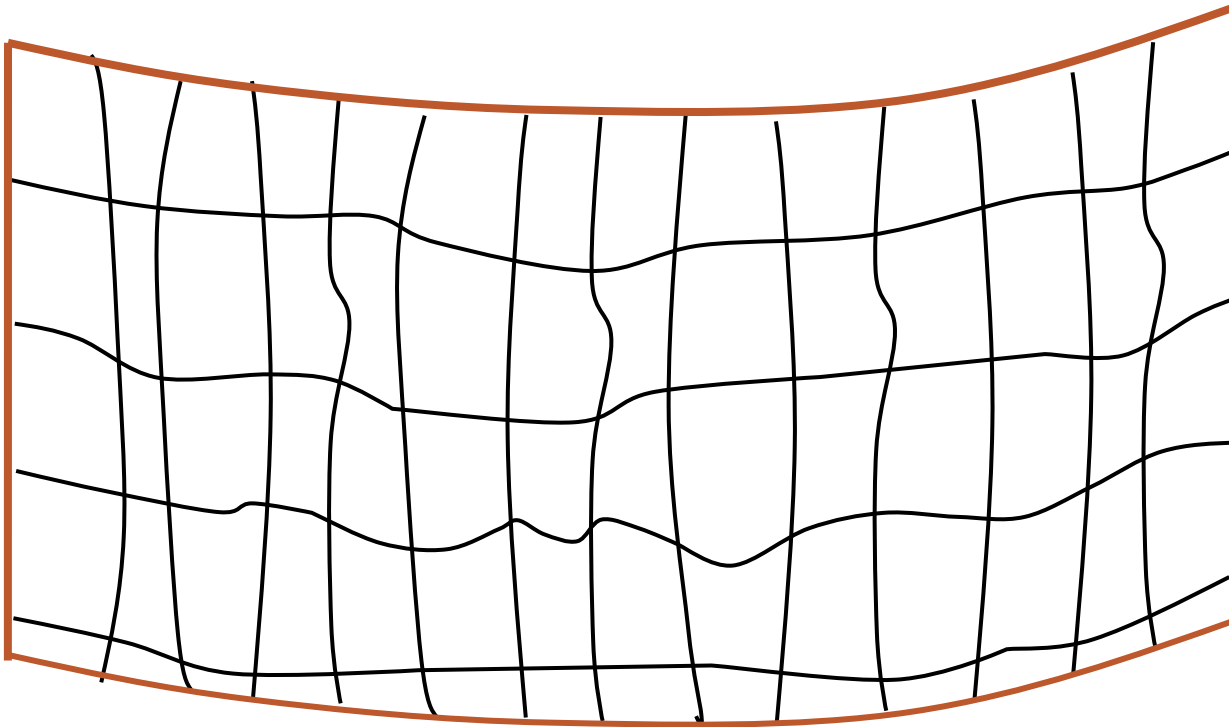
State of the Art: Projection Mapping



- Use **one** camera
- Find pixel correspondences across projectors in camera space

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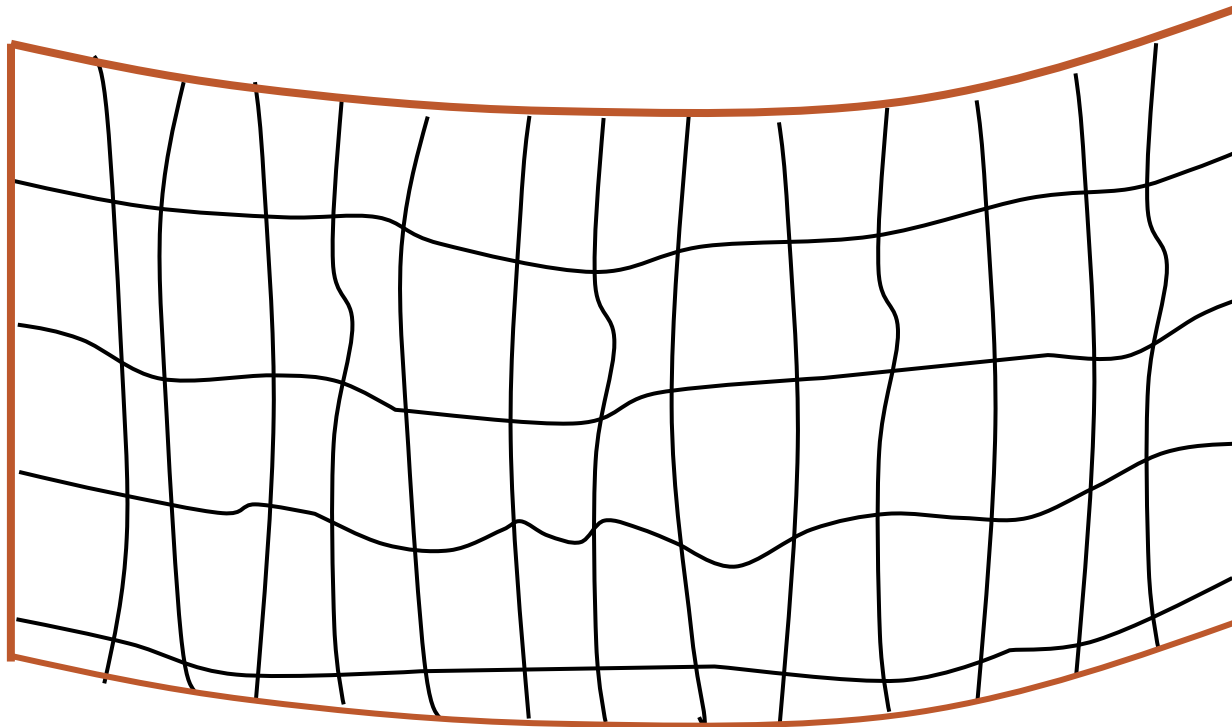
State of the Art: Projection Mapping



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- Find pixel correspondences across projectors in camera space

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State of the Art: Projection Mapping



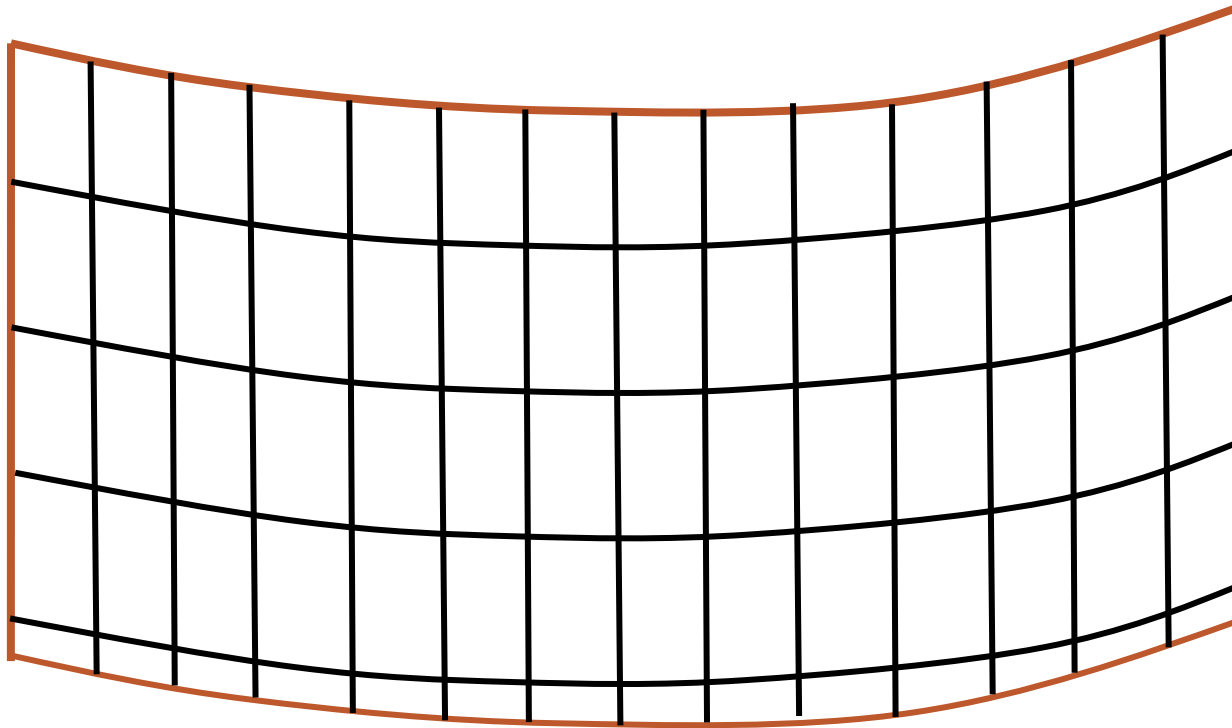
- Registered, But Wrong !
- Shape is not recovered
- Long manual **content warping**



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STL Technology

- Recovers the 3D shape completely automatically
 - Using **one or more** cameras



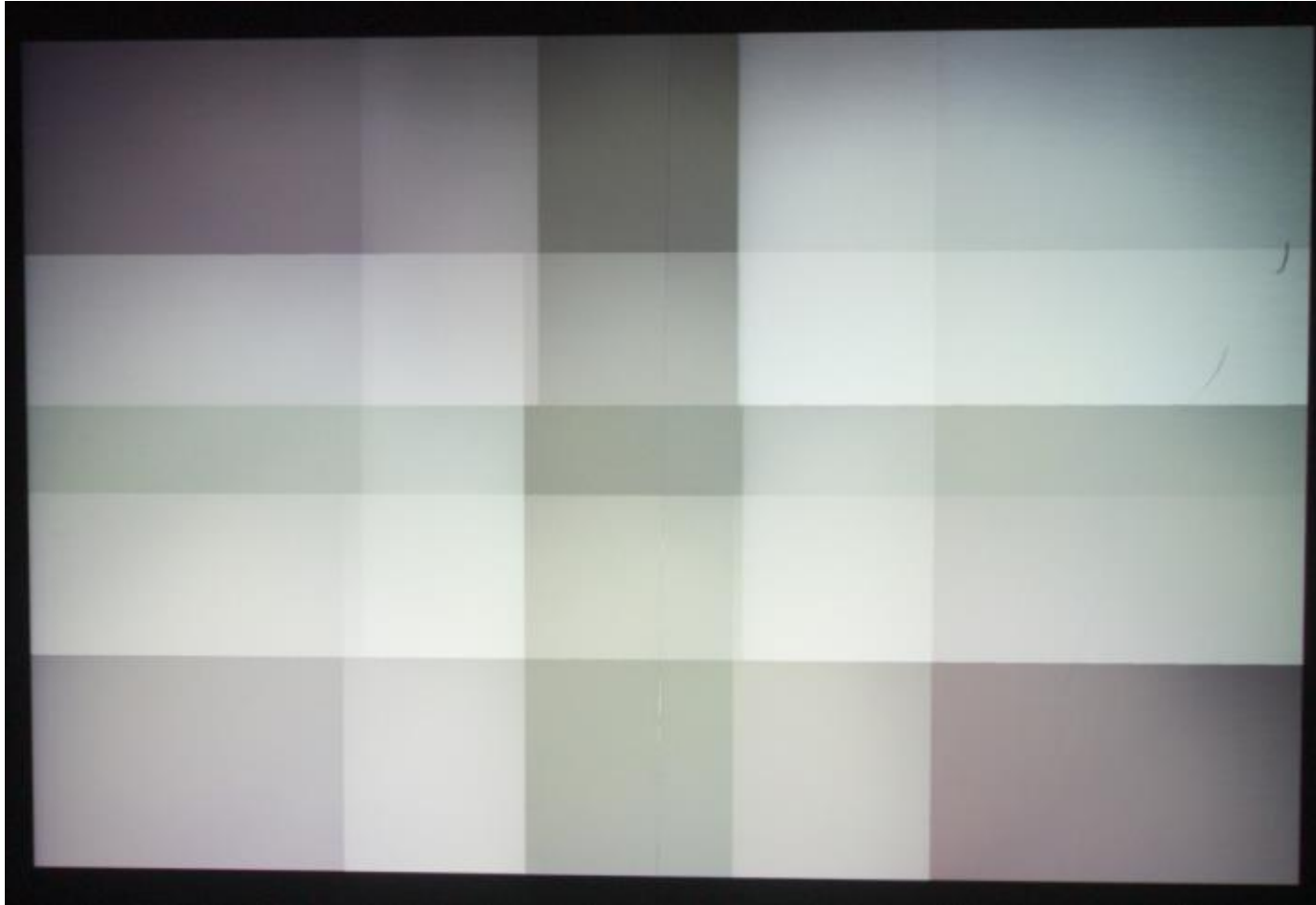
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Proprietary Software: PRAIS

- **P**Rojector **A**ggregation and **I**nteraction **S**oftware
 - Aggregates images from multiple projectors illuminating object
 - First IP: Automated registration **and warping**

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Color Variation



- Desired
 - A flat white
- Significant color variation

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State of the Art: Edge Blending



- Does not work
- Use expensive projectors
 - More than \$15,000
 - Uniform Colors
- Edge Blending suffices

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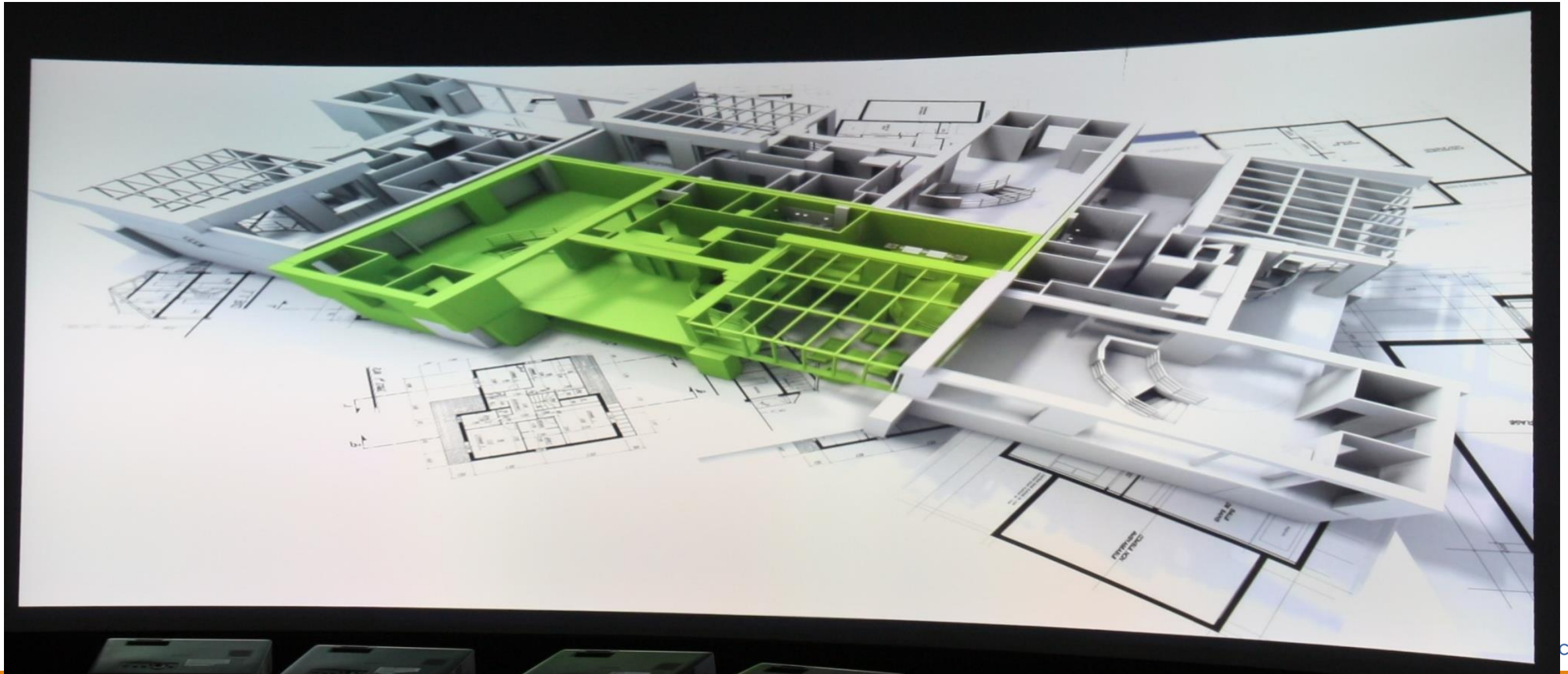
STL Technology: Color Morphing



- Use one or more cameras
- Based on
 - Human perception
 - Size of display
 - Distance of the viewer
- Reduces cost by 30-100x

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Registered and Seamless



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Detection of Input

- From camera space directly to 3D space
 - Enabled by 3D shape recovery
- Triggers change in content
 - Interactive projections

Proprietary Software: PRAIS

- **P**Rojector **A**ggregation and **I**nteraction **S**oftware
 - Aggregates images from multiple projectors illuminating object
 - First IP: Automated registration **and warping**
 - Second IP: Automated color seamlessness
 - Third IP: Automated Interaction Detection and Response
 - Hand gestures, Laser pointers, Tablets

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Prototype: Interactive Veil

- Surface: Drape or a Veil
- Application: A Balloon Popping Game
- Interaction Modality: Laser Pointers
- Display: 4 Megapixels (4K)
- Footprint: 8' x 6' rectangle



28 In Action: Public Event in April 2018



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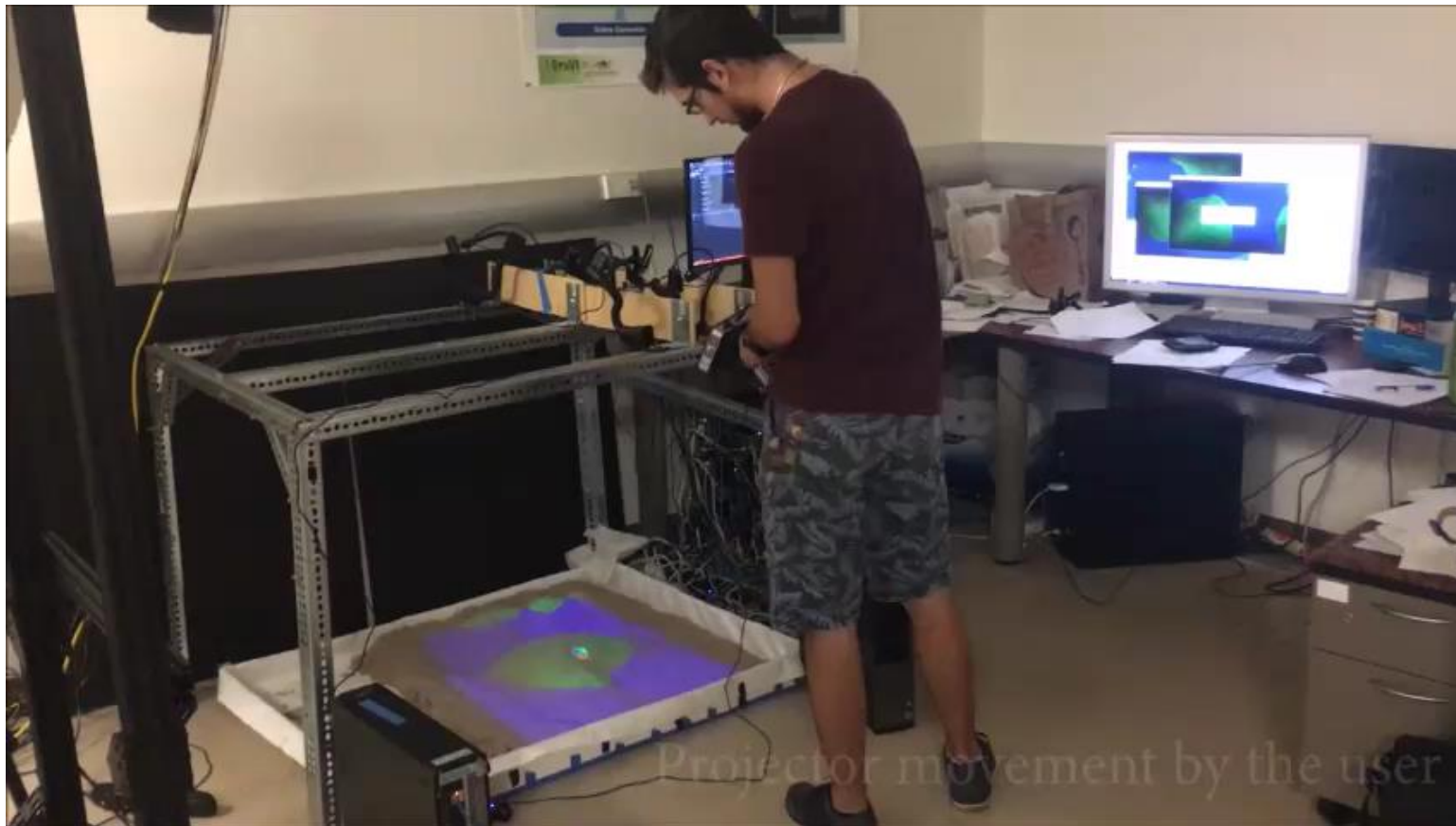
Unique Design Experiences

- On real 3D objects/spaces
- No wearables
- Precision illumination of every inch of the surface
- Controlled by one or more user
- Via multiple interaction modalities

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Projector as Interaction Device

- The interaction device is a handheld projector



- 6 projectors
- 4 cameras
- 12 Megapixel Display
- 4' x 3' footprint

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Cost

Hundreds of Thousands to Millions

Tens of Thousand

Man Months

Minimum 1-2 months

A few hours

Portability

NO

YES

Scalability

NO

YES – Shape, size, number of projector and camera

Interactivity

NO

YES

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Tremendous Possibilities

Natural: Maintain natural interaction with no wearables

Interactive: Multi-modal interaction interfaces with one or more users

Shareable: Creates multi-user collaborative experiences

General: Retrofits to any shapes/structures, operates in ambient light

Portable: Lightweight devices reduces weight by **10-20x**

Accessible: Automated setup speeds up deployment by **50-100x**

Affordable: Consumer devices cut cost by **10-50x**

Scalable: Allows any number of projectors, tiled or superimposed

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Summit is looking for

- Investors
- Partners
- Customers

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Questions?

- Research at University of California, Irvine
 - NSF CAREER, US Army Research Lab
- STL: NSF Funded Company
 - SBIR Phase 1 in 2017

