



Spring 2010 - CS63500

Capturing, Modeling, and Rendering 3D Structures

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- Topic:
 - Covers fundamental problems and challenges encountered when capturing, modeling, and rendering 3D structures and objects.
 - Covers material in computer graphics, computer vision, and visualization
- Goal:
 - To bring students up to speed in latest methods (research)
 - To enable students to develop new and improved approaches

Syllabus



- Geometry-based Acquisition
- Image-based Acquisition
- Photogeometric/Light-Transport based Methods
- Calibration and other Fundamentals

Workload

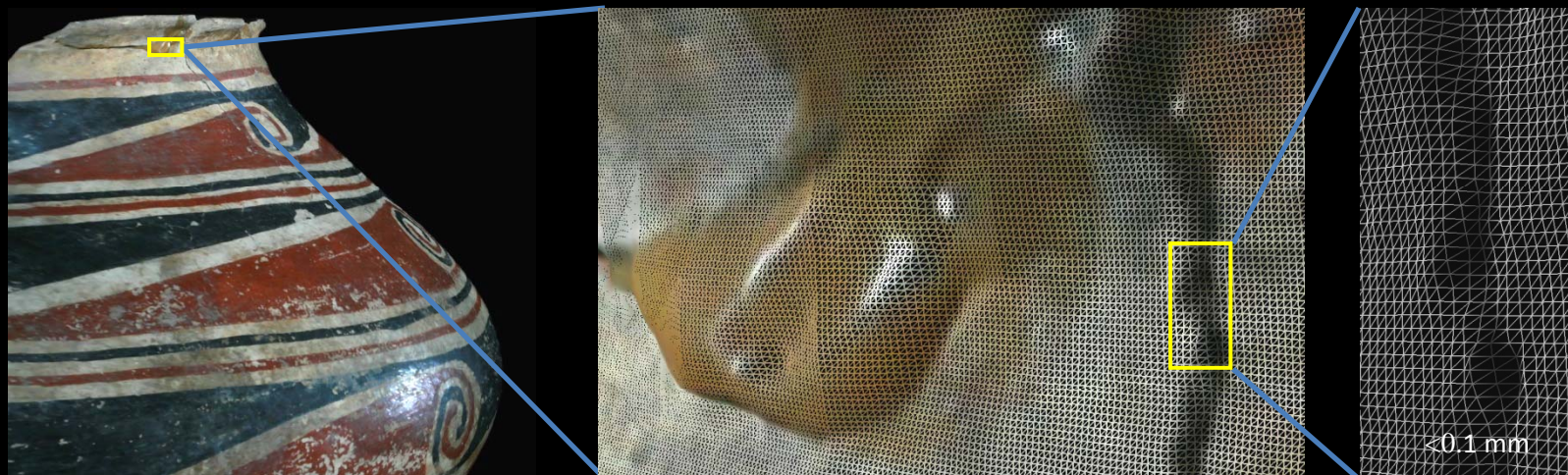


- 2-3 “short warm-up” assignments
- In-class presentation
- **Final project**
 - Suitable for conference or journal submission...

Example Challenge



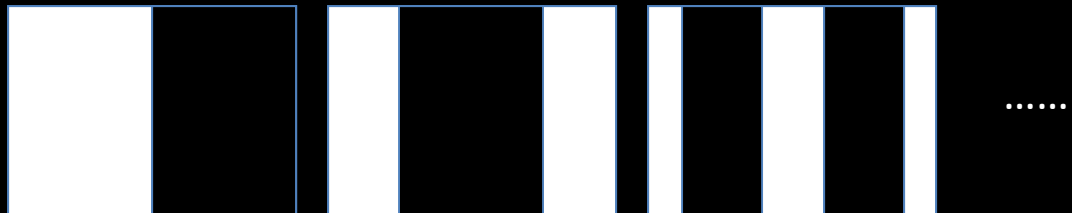
To provide an easy-to-use and high-resolution acquisition platform for deployment



Geometry-based Method



- Structured Light
 - Project binary-stripe patterns onto the object to encode projector-camera pixel correspondences

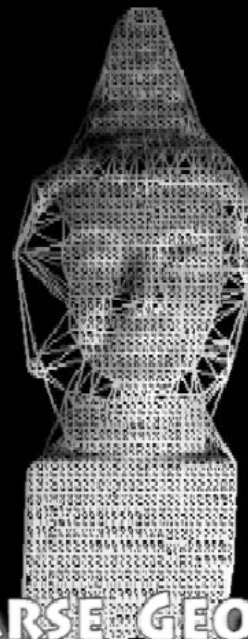


ALL WHITE PATTERNS

Geometry-based Method



- ...results in a robust reconstruction
 - but of limited resolution



COARSE GEOMETRY

Photometry-based Method



- Use diffuse illumination model
 - $a(n \cdot l) = c$
- Simultaneously solve for n and l -- possible as a linear system of equations given ≥ 3 lights and ≥ 6 pixels



Photometry-based Method



- Next, can use n to integrate a surface $z(x,y)$...
 - but it suffers from global deformations and fundamental ambiguities



side



front



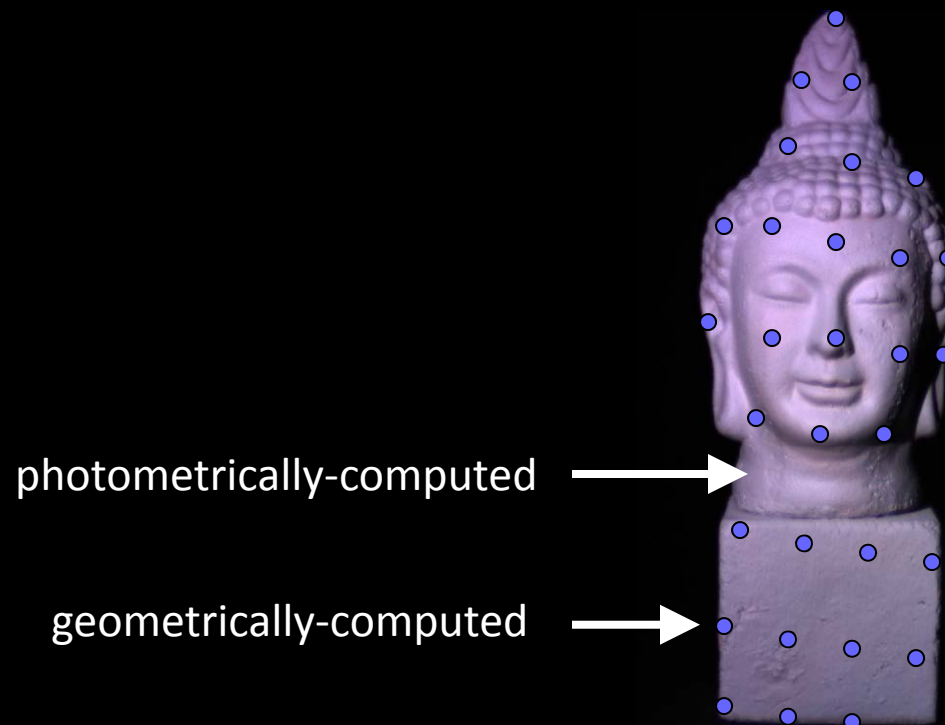
several integrations



Photogeometric Methods



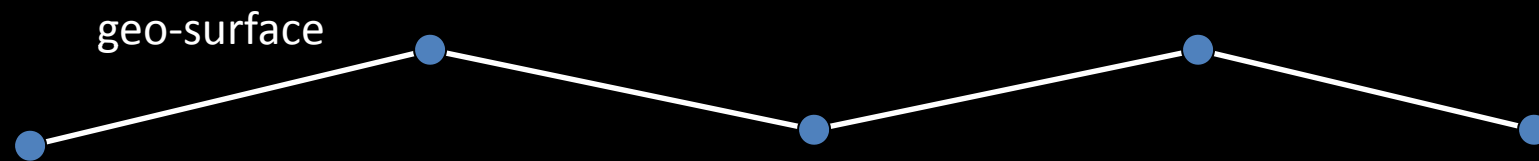
- Combine photometrically-computed points with geometrically-computed points



Photogeometric Methods



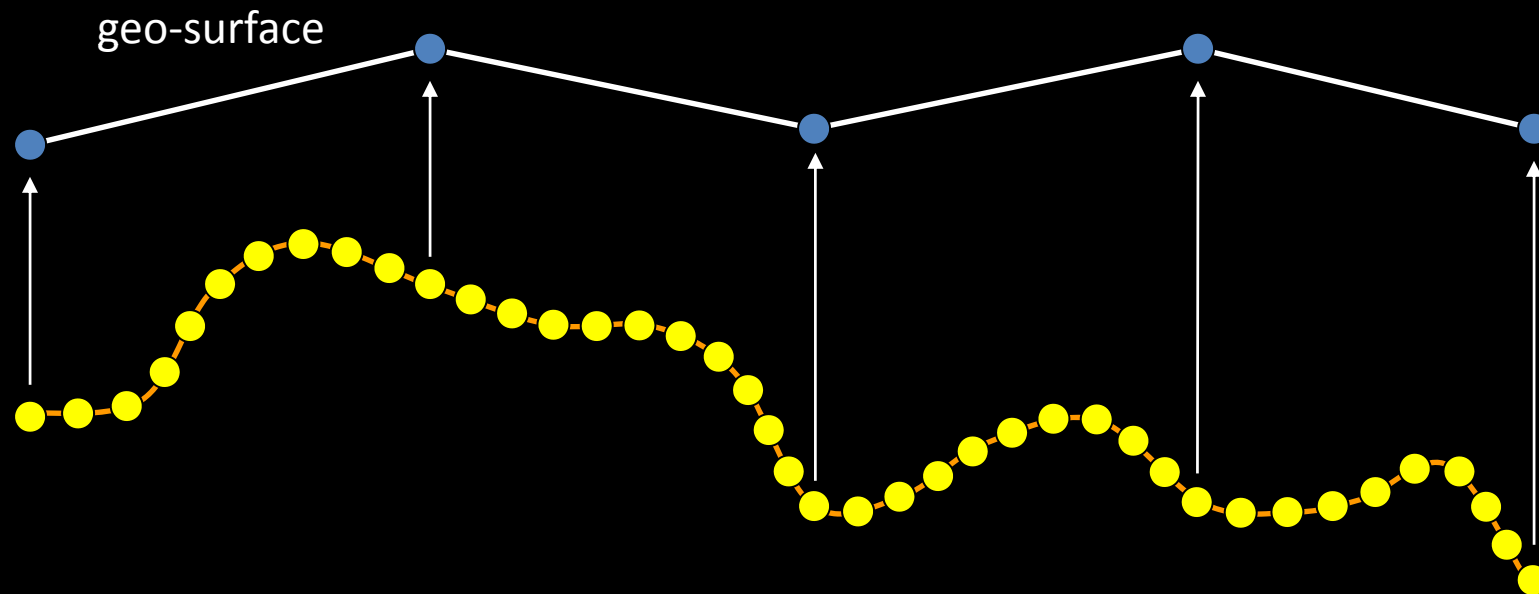
1. Compute sparse geometric model



Photogeometric Methods



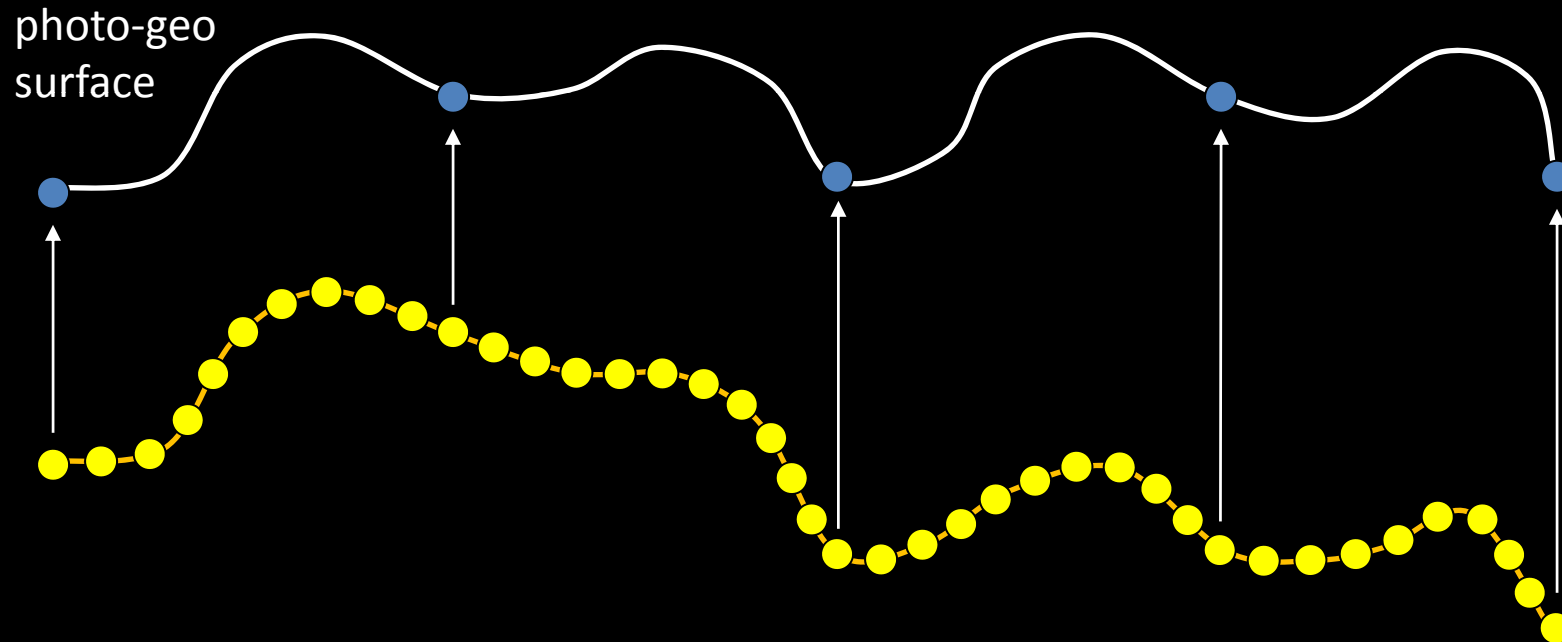
2. Warp photometric surface to geometric surface



Photogeometric Methods



2. Warp photometric surface to geometric surface



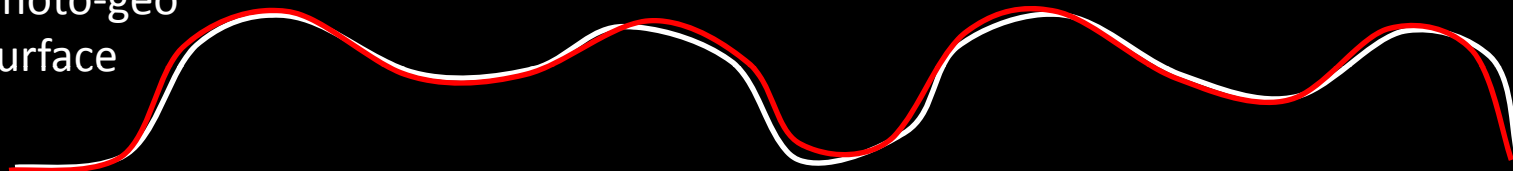
Photogeometric Methods



3. Triangulate a single high-resolution model

photo-geo
surface

true surface



Photogeometric Methods



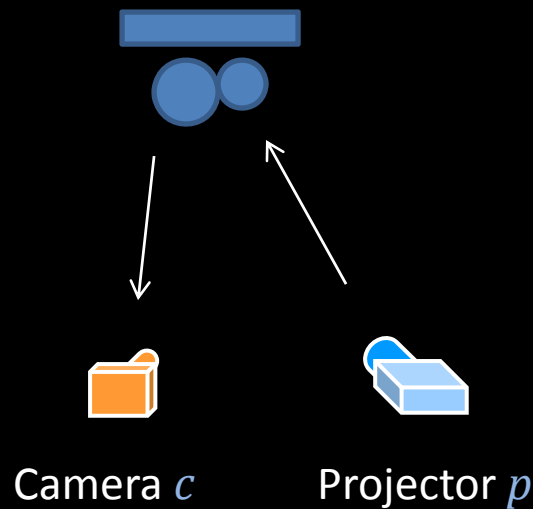
photographs

reconstruction

Light Transport Based Methods

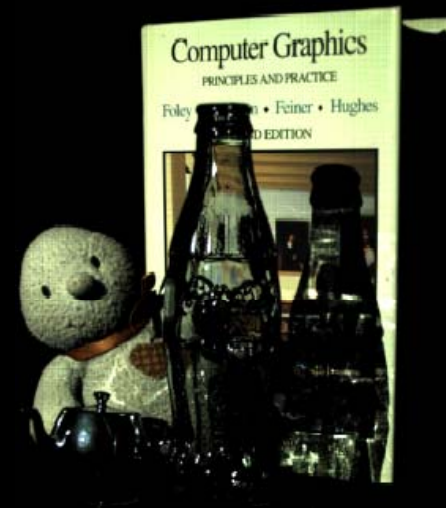


- Can encode light (or projector) to camera “transport” in a large matrix T



$$\begin{bmatrix} c \end{bmatrix} = \begin{bmatrix} T \end{bmatrix} \begin{bmatrix} p \end{bmatrix}$$

As seen from camera...



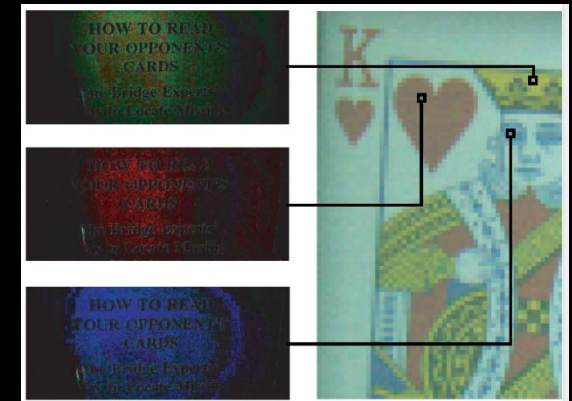
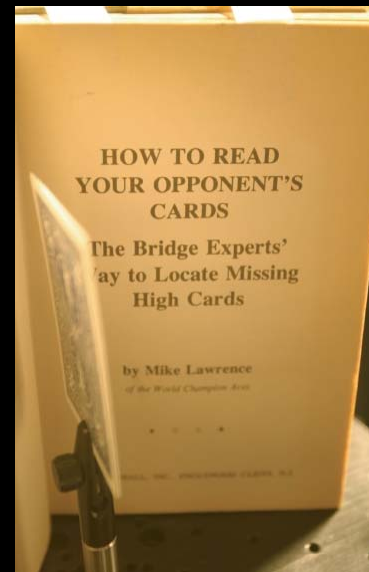
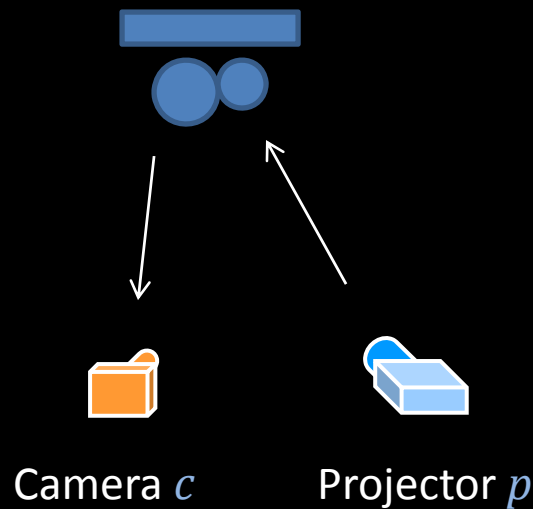
$$\begin{bmatrix} p \end{bmatrix} = \begin{bmatrix} T^t \end{bmatrix} \begin{bmatrix} c \end{bmatrix}$$

As seen from projector!!!

Light Transport Based Methods



- Can encode light (or projector) to camera “transport” in a large matrix T



$$\begin{bmatrix} c \end{bmatrix} = \begin{bmatrix} T \end{bmatrix} \begin{bmatrix} p \end{bmatrix}$$

$$\begin{bmatrix} p \end{bmatrix} = \begin{bmatrix} T^t \end{bmatrix} \begin{bmatrix} c \end{bmatrix}$$

As seen from camera...

As seen from projector!!!



Questions?



Come to CS635 in the Spring!

or email aliaga@purdue.edu...