



# 3D Scanner

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6.111 Final Project 2016

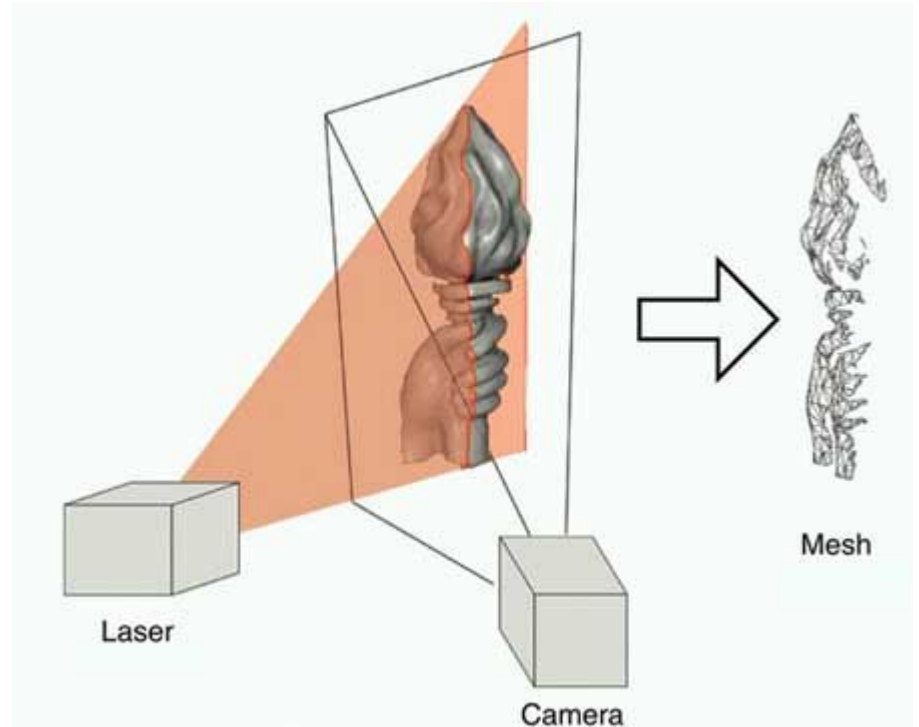


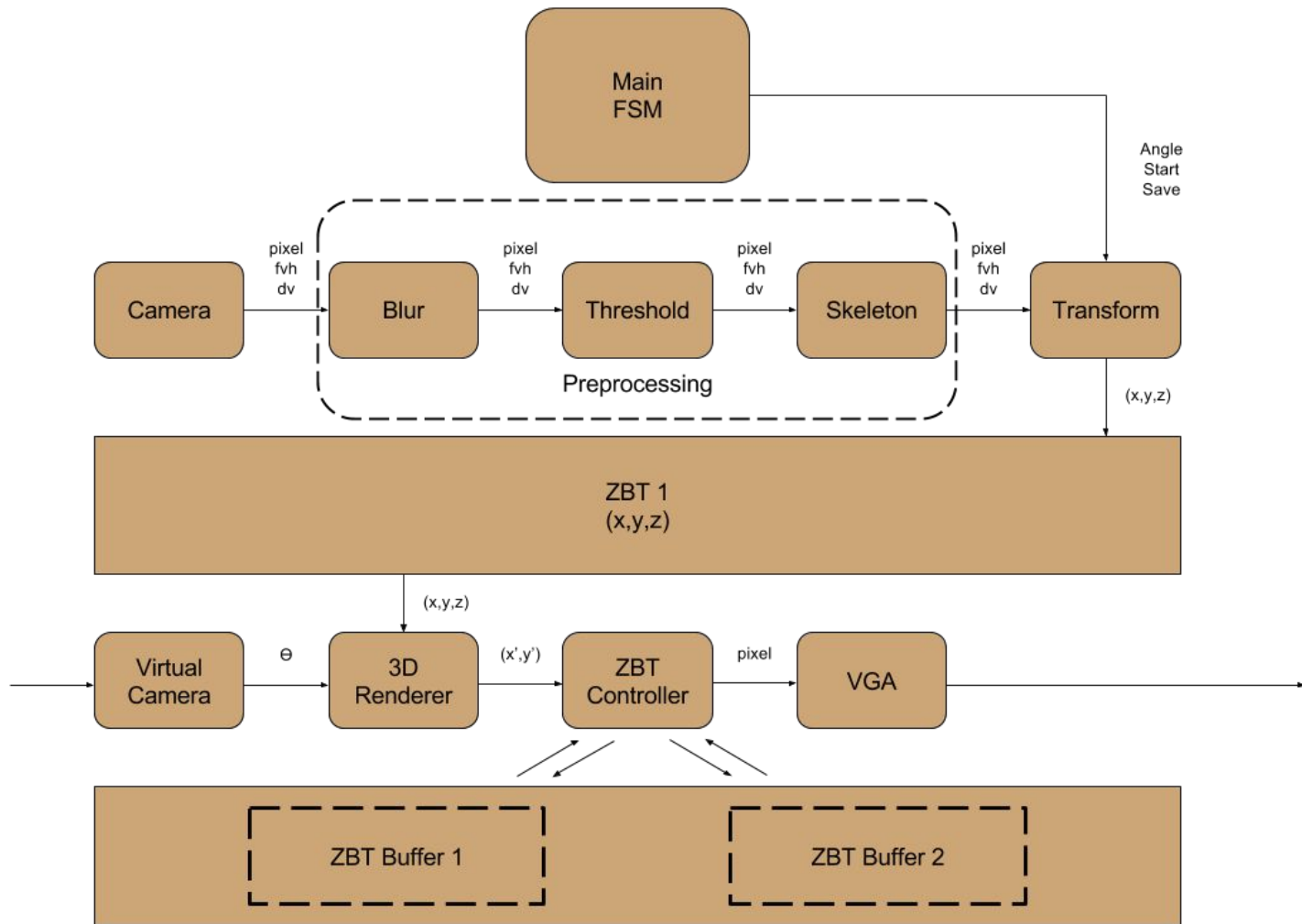


Problem

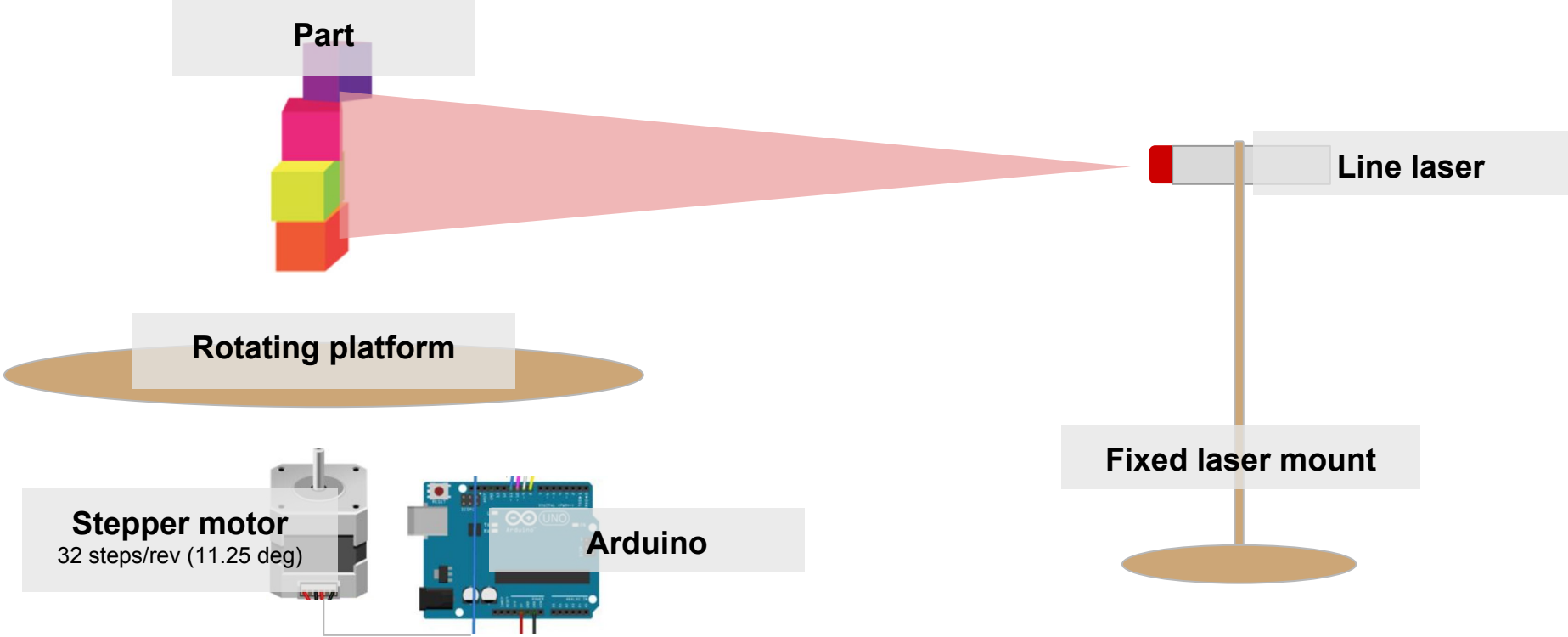
# Overview

- Sweeping laser line scanning
  - Hardware platform
  - Laser line frames
  - Point cloud construction
  - 3D Rendering

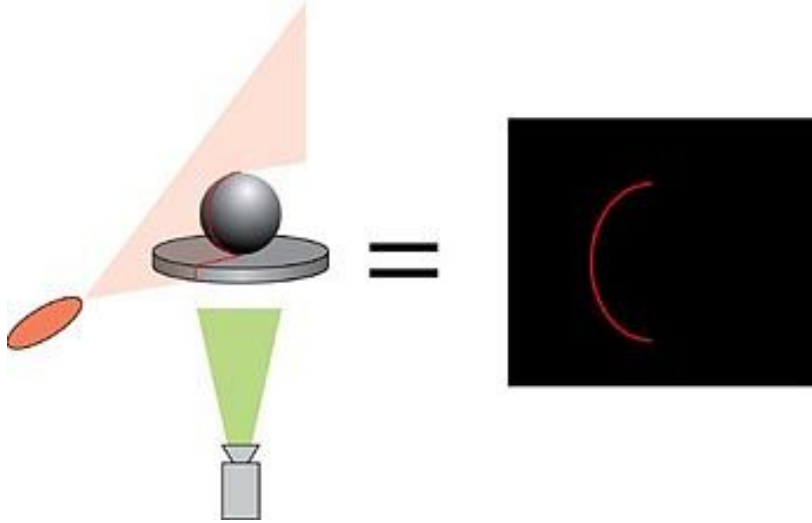




# Hardware



# Camera

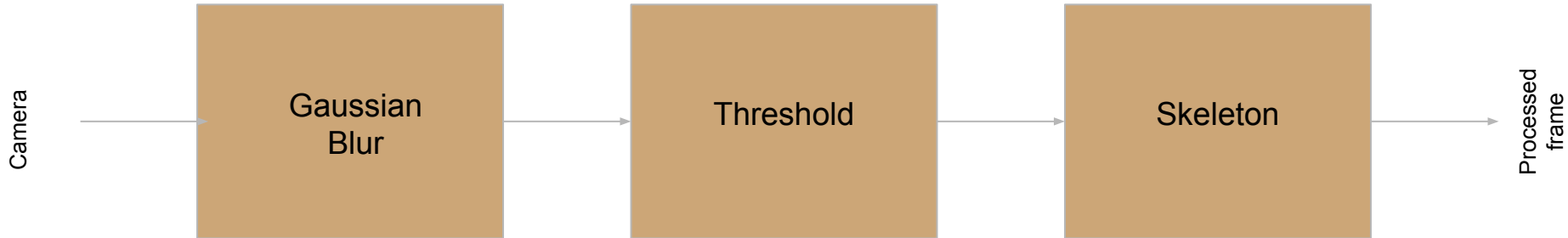
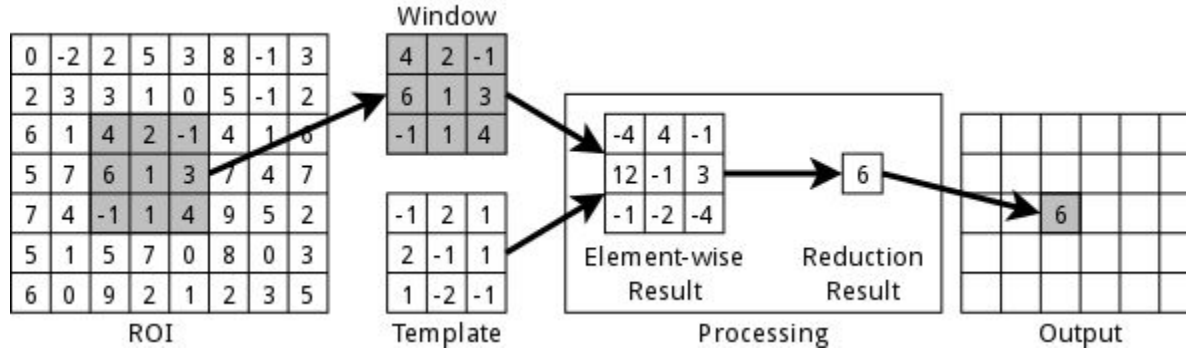


## **NTSC camera:**

use luminance values to extract laser line profile

FSM chooses frames later in processing pipeline

# Preprocessing



# Gaussian Blur

Take weighted average of neighbors  
to reduce noise

$$\frac{1}{16} \begin{pmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{pmatrix}$$

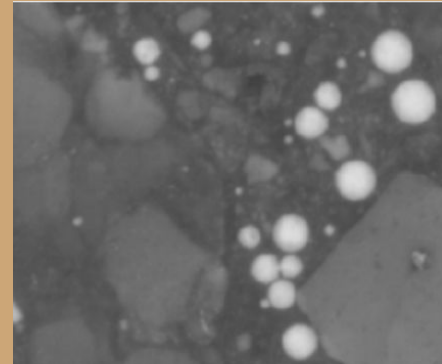
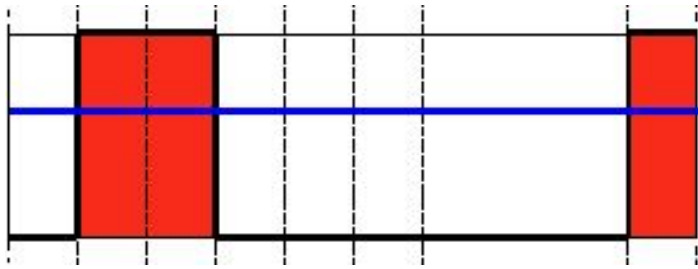




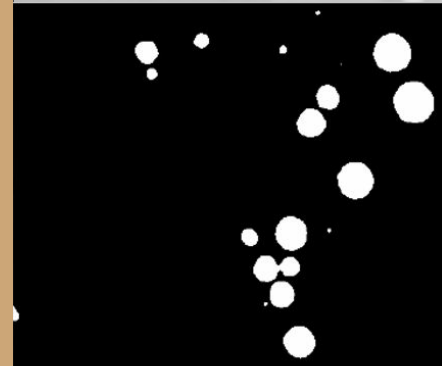
# Threshold

Binary threshold (manual on first pass) to select illuminated pixels

$$\text{dst}(x, y) = \begin{cases} \text{maxVal} & \text{if } \text{src}(x, y) > \text{thresh} \\ 0 & \text{otherwise} \end{cases}$$



Before



Thresholded image

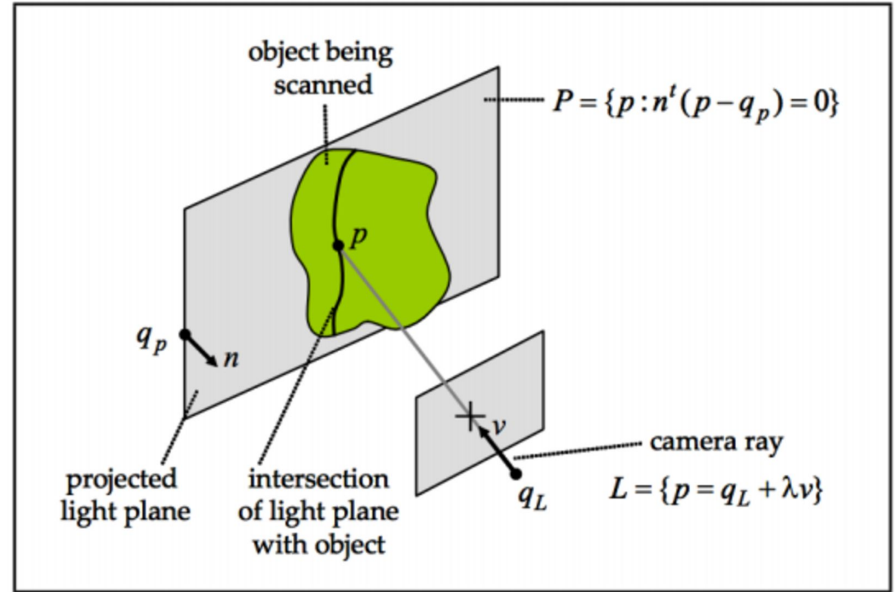
# Skeleton

Thin rough laser outline to line with skeletonization structuring elements

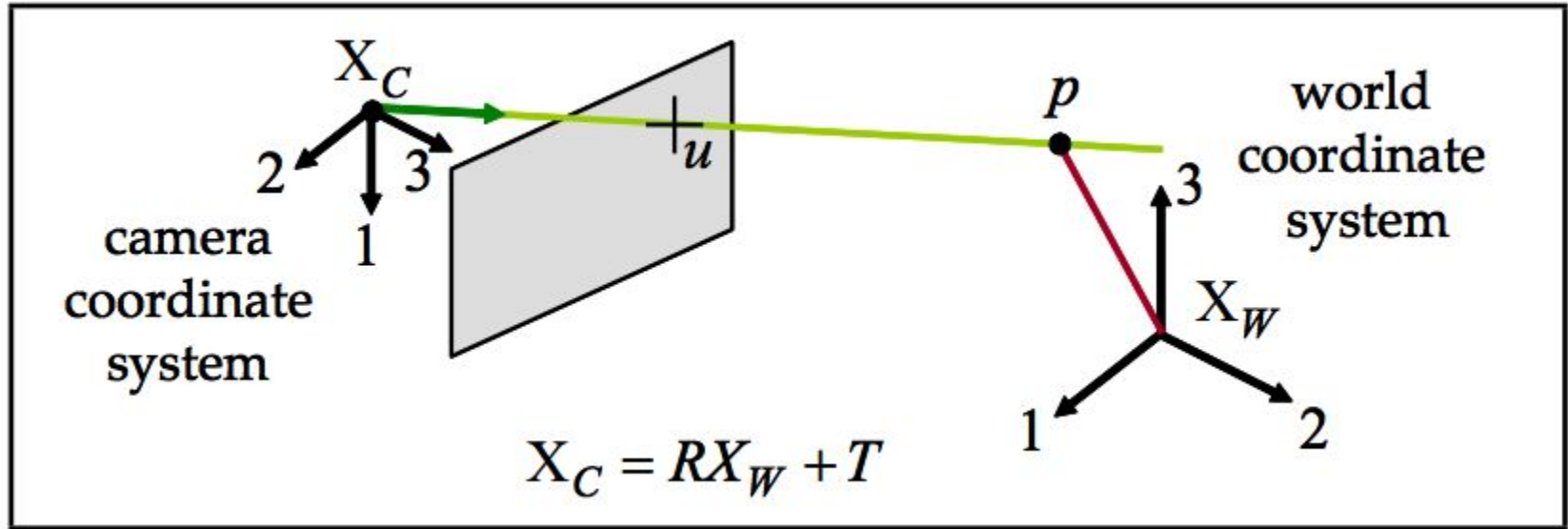


# Depth reconstruction

Calculate intersection  
between plane of laser light  
and camera ray for each  
point

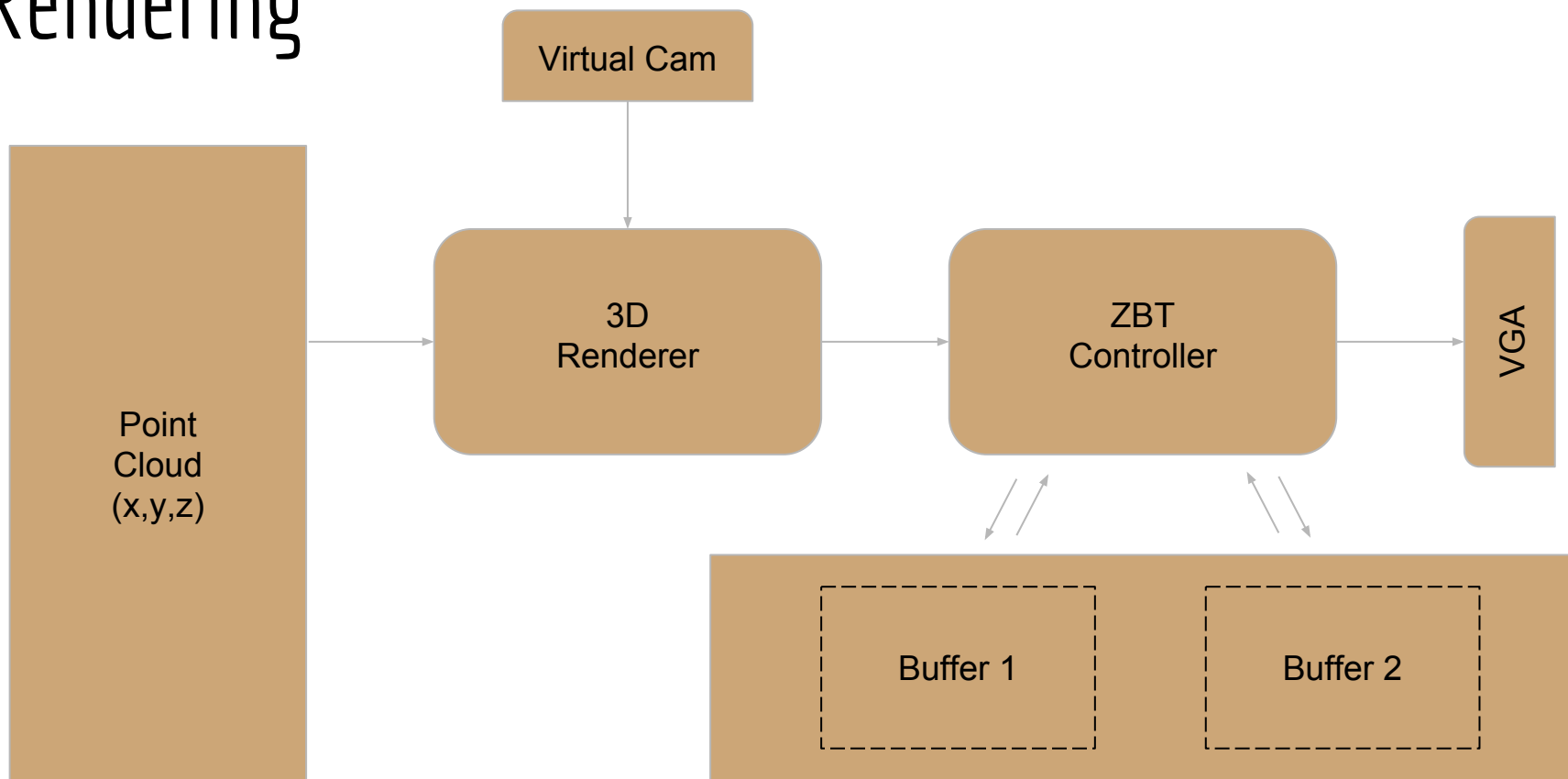


# Depth reconstruction



Transform from camera coordinates to world coordinates

# Rendering



# 3D Renderer

Virtual camera transformations:

- Fixed POV projection
- Rotate around object (fixed z)

$$R_x(\theta) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos \theta & -\sin \theta \\ 0 & \sin \theta & \cos \theta \end{bmatrix}$$

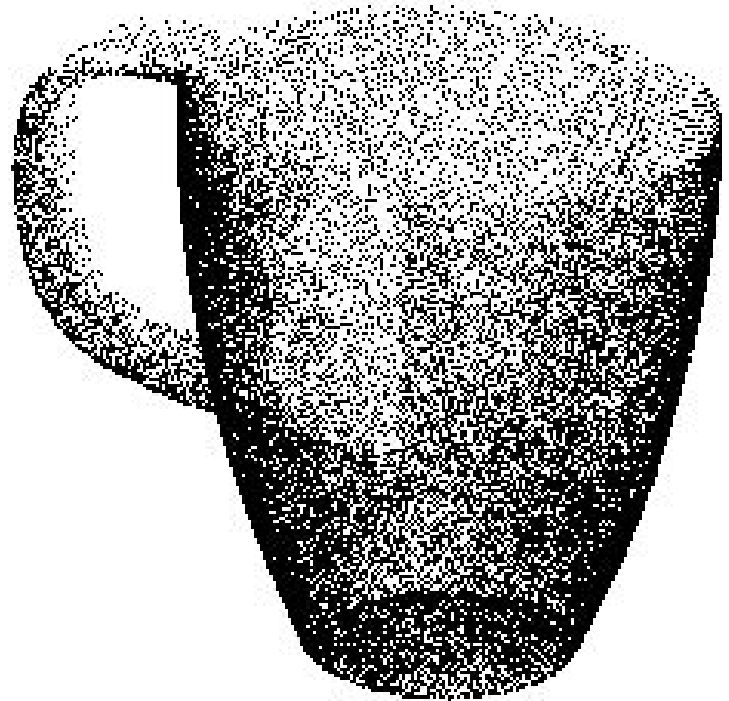
$$R_y(\theta) = \begin{bmatrix} \cos \theta & 0 & \sin \theta \\ 0 & 1 & 0 \\ -\sin \theta & 0 & \cos \theta \end{bmatrix}$$

$$R_z(\theta) = \begin{bmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

# Memory

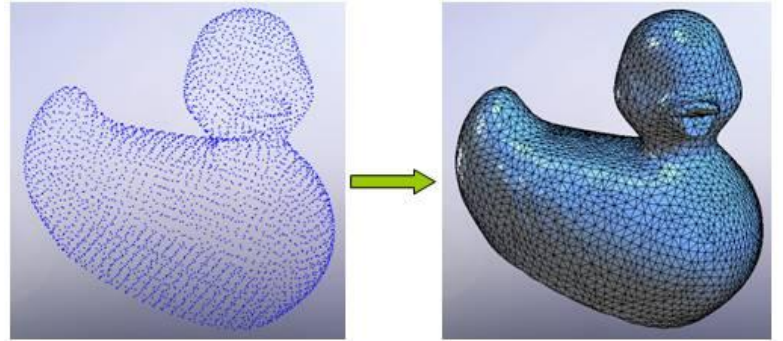
Two Frame Buffer

- Write
- Display



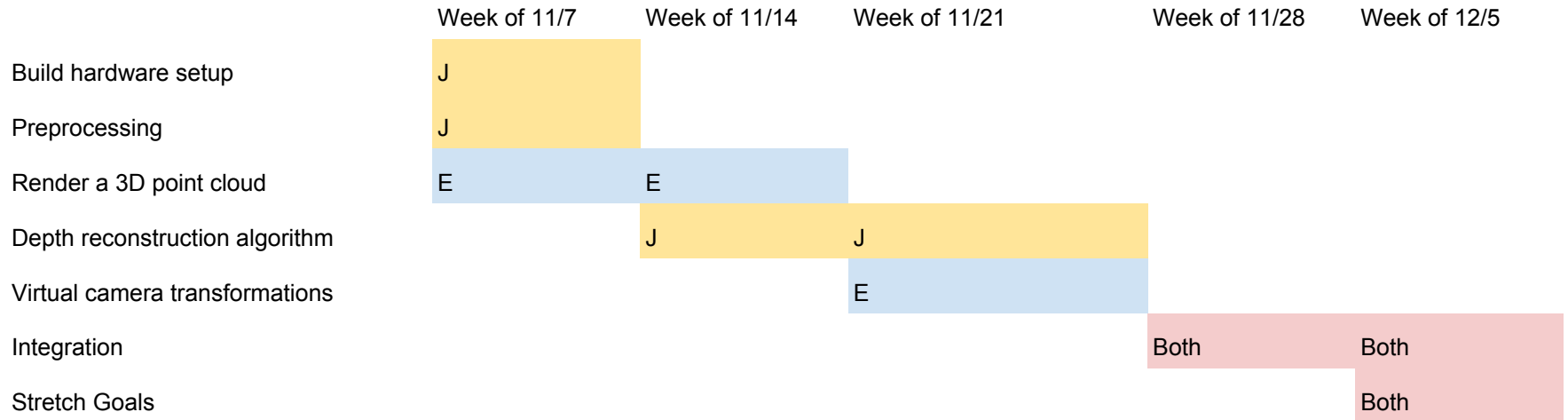
# Stretch Goals

- Additional transformations (zoom)
- Surface mesh (triangulation/shading)
- Gestural interactions with object





# Schedule



Questions?