

# VU Augmented Reality on Mobile Devices

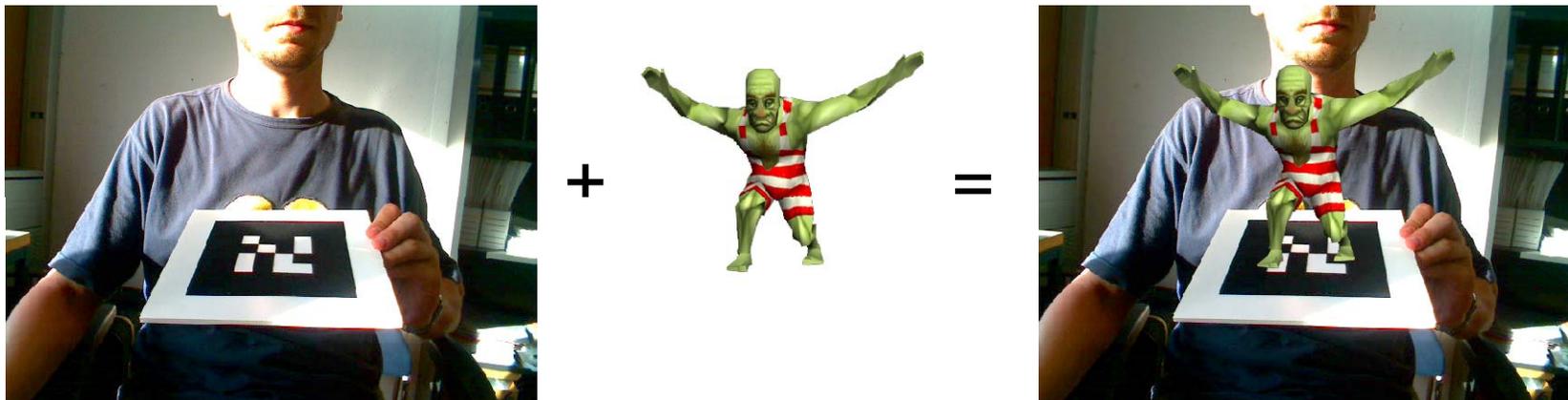
- Introduction – What is AR
- Interaction Techniques
- Navigation, Collaboration
- Visualization Techniques
- Visual Coherence
- Tracking
- ...



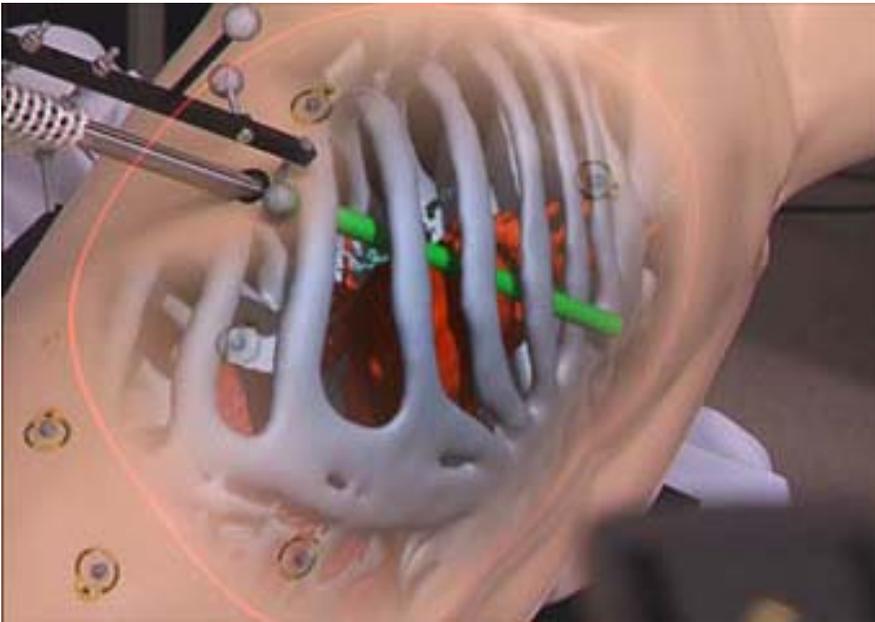
Based on material from Denis Kalkofen, TU Graz

# Visual Augmentation

- Combine real and virtual imagery
- Tracking & Registration data is used to align virtual objects within real imagery



# Augmented Graphics



- Information
  - Visualization
  - Understanding



- Virtual Objects
  - Graphics
  - Realism

# Spatial Arrangements

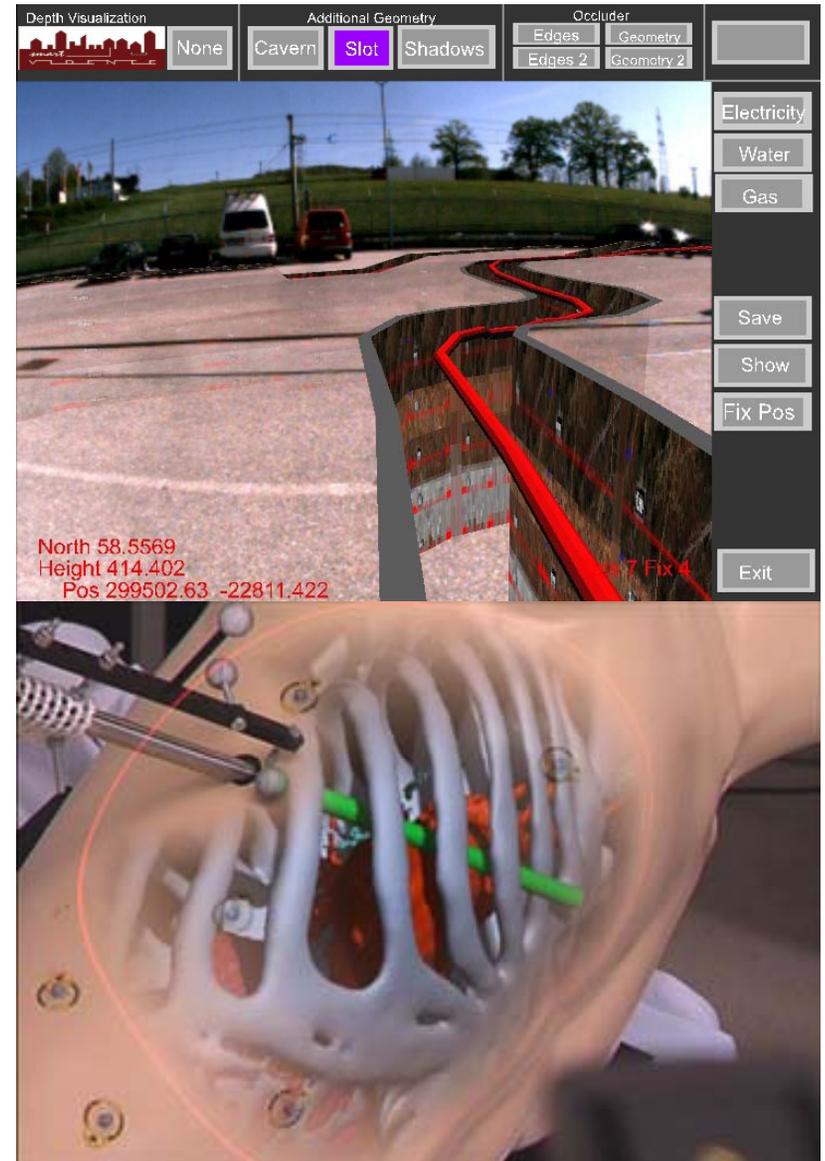


- Left, Right
- In Front / Behind

How do we perceive spatial arrangements?

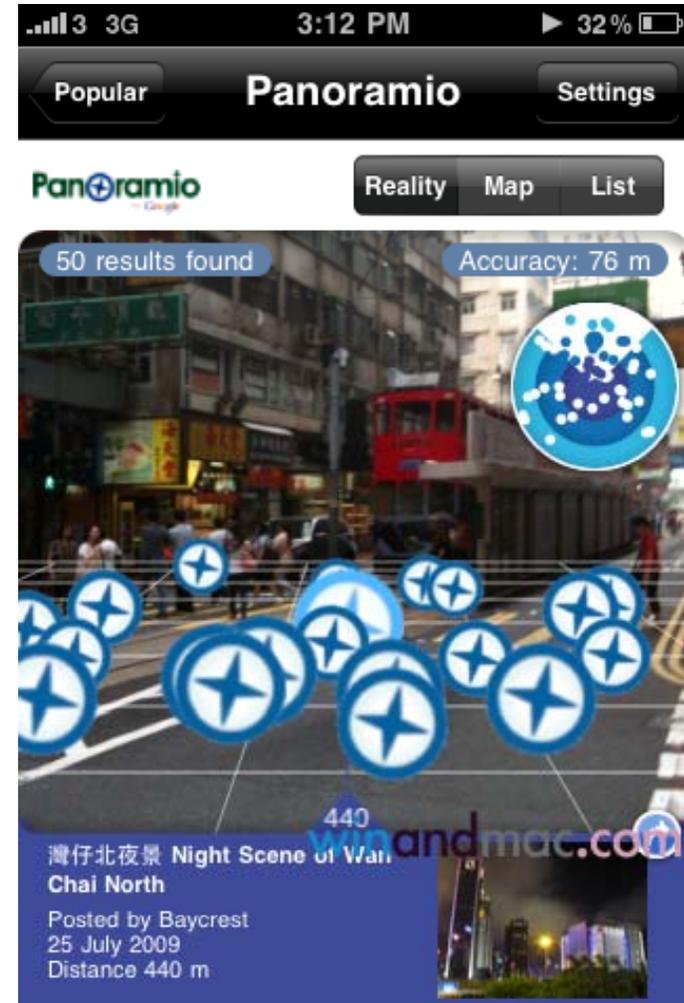
# Making the Invisible visible

- Hidden structures & information
- Superman's Xray Vision
- Spatial arrangement?



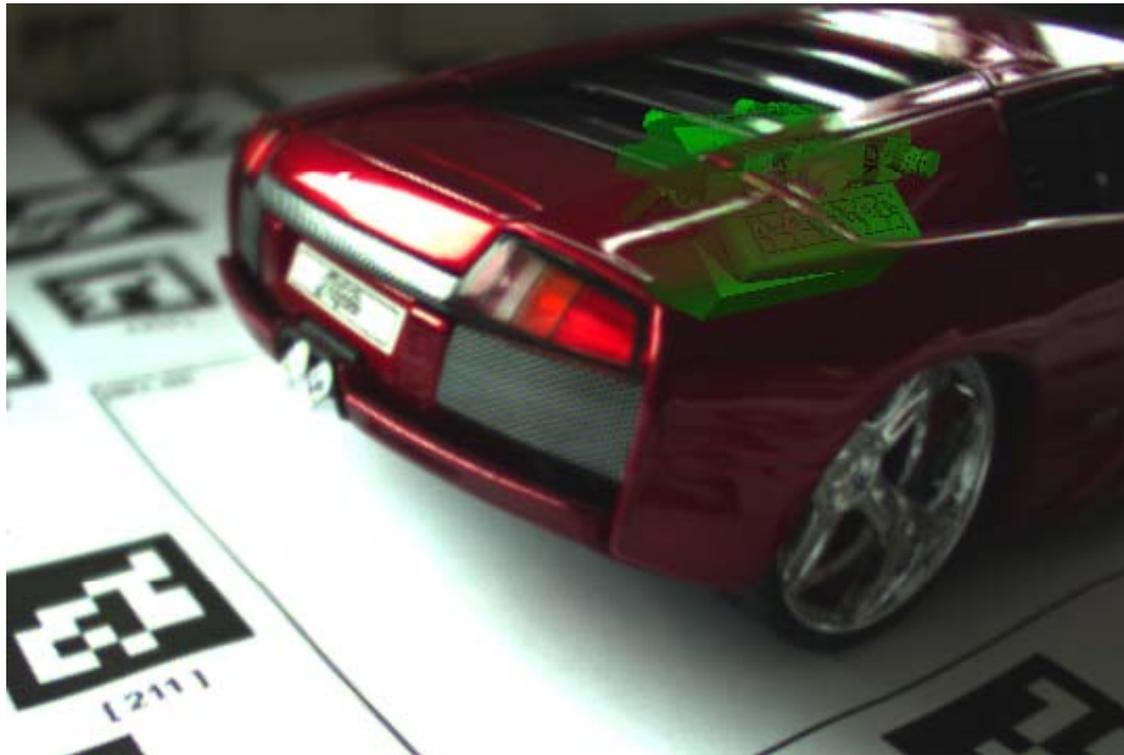
# Information display management

- Selection
- Placement
- Clutter
- Context
  - Task
  - Environment



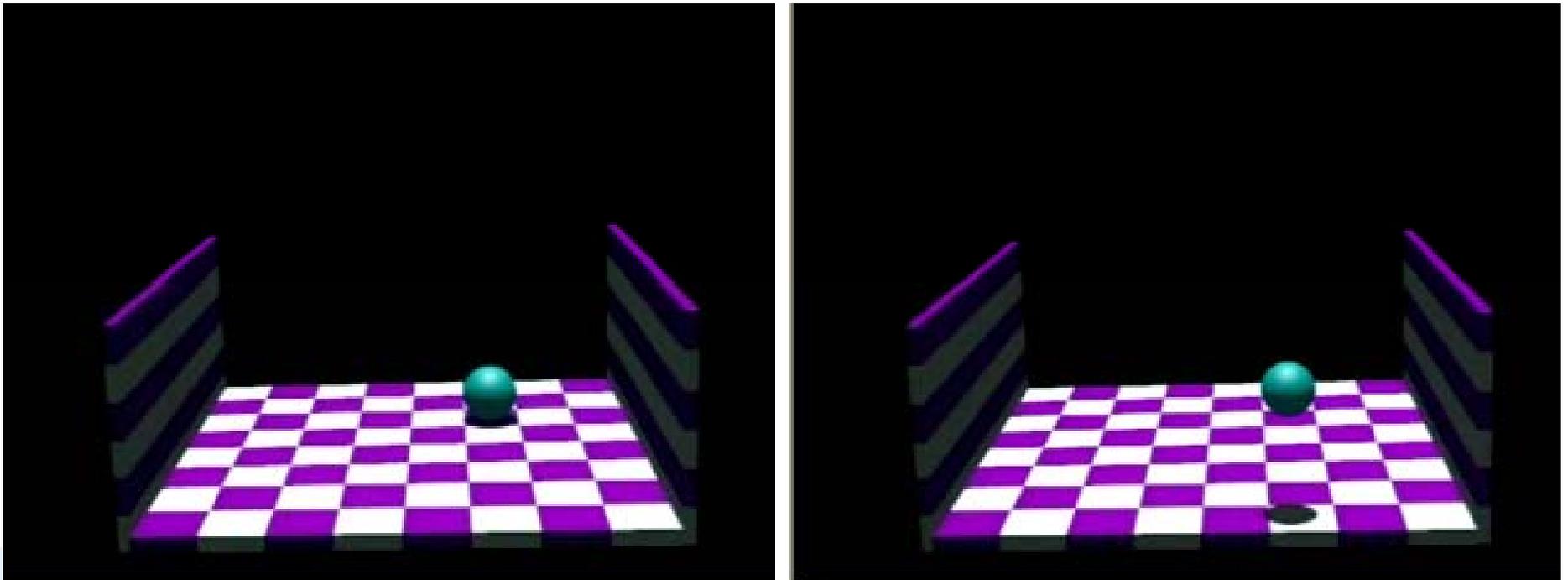
# XRay Vision

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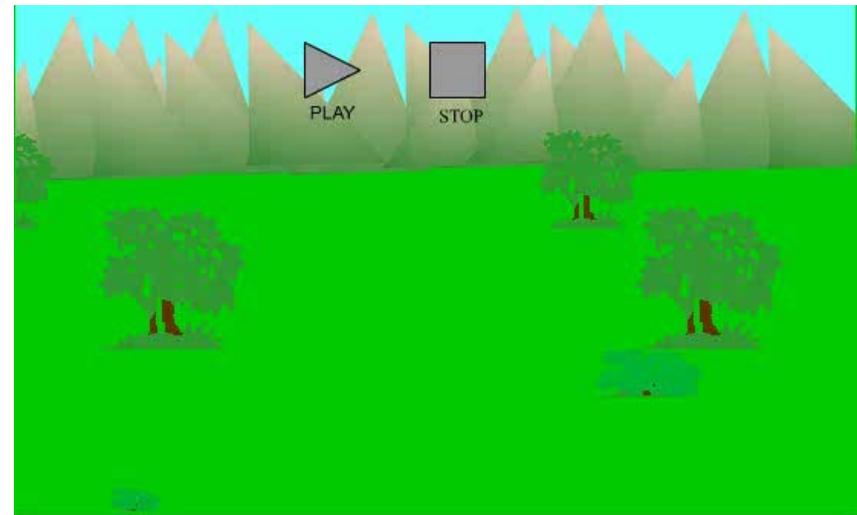
# The Depth Problem

- Where is the ball in 3D?
- Same position in 2D
- Depth cues indicate position in 3D



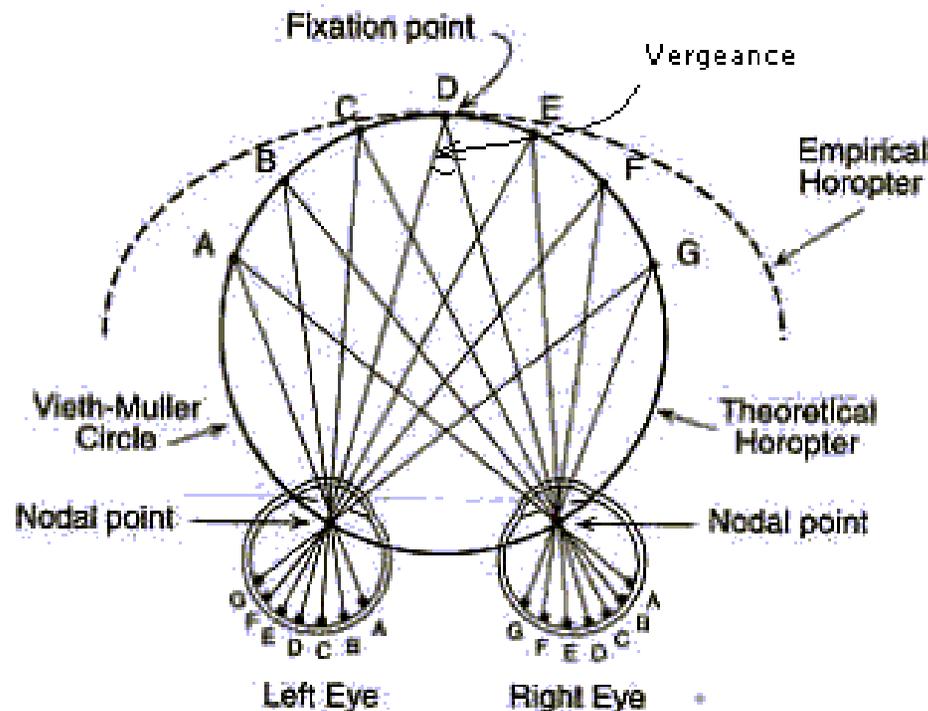
# [Depth]: Dynamic Cues

- Motion Parallax
- Obtained by
  - Movement of the scene
  - Movement of the camera (head)
- Speed as a function of distance
- Far distant objects appear to move slower than near objects



## [Depth]: Disparity

- The difference in distance of the projected position of the same point on the retina
- Used in stereo displays



## [Depth]: Static Cues

- Occlusion
- Relative height
- Relative size
- Perspective
- Brightness
- Shadows
- Texture Details



# Transparent Occluder

- Blend foreground pixel where object is hidden
  - Via pixel blending & stencil masking



# Transparent Phantoms

- Entire occluder is transparent  
-> Need scene knowledge
- Via pixel blending & stencil test

## Algorithm:

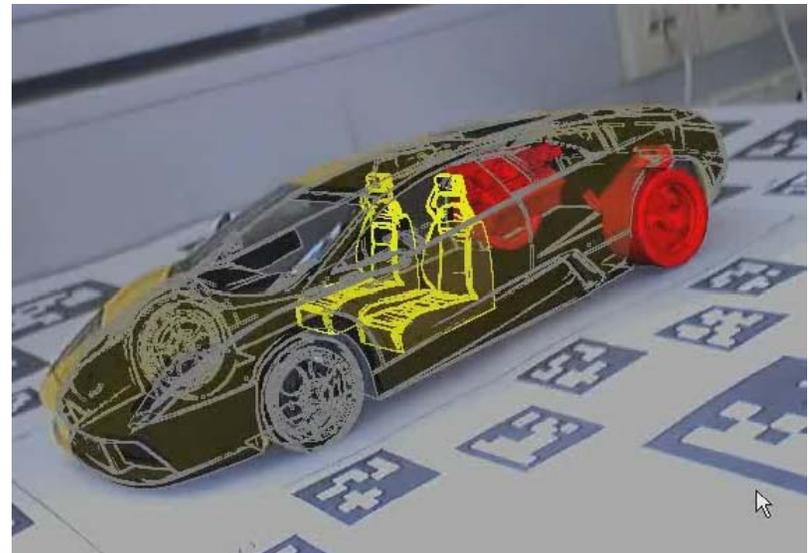
1. Render Phantom to stencil buffer
2. Draw video outside the mask
3. Clear depth buffer
4. Render virtual objects
5. Setup glBlendFunc
6. Blend video inside mask

# Transparent Phantoms

## Problem:

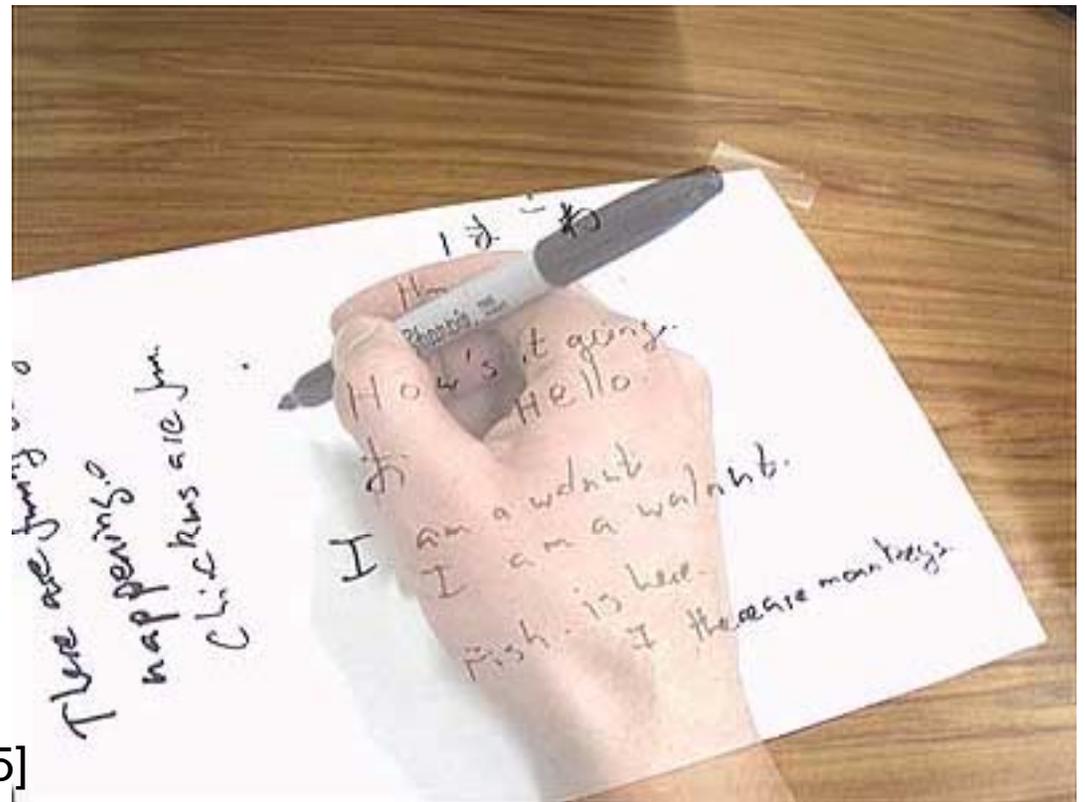
Blends with black if no virtual object is hidden

Sometimes hard to 'understand' the object's spatial relationship, especially in case of multiple occluding objects



# Transparent Phantoms

- Better blend with video's history
  - Static viewpoint
  - Static hidden background



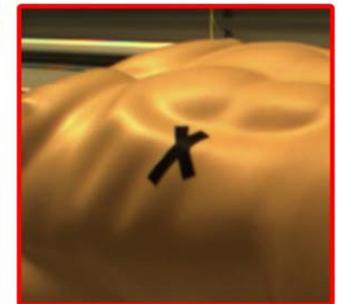
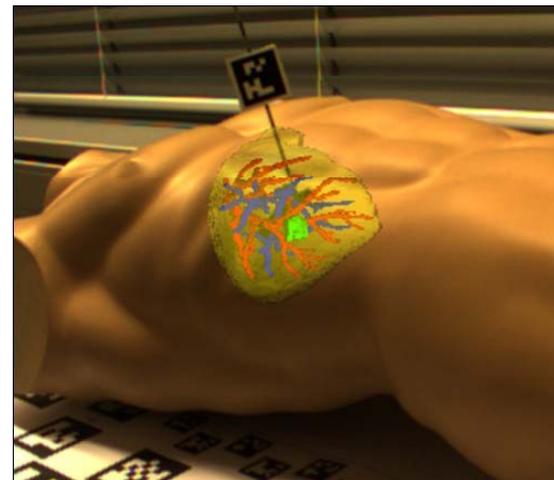
[Buchmann05]

# Problems with Simple Blending

- If occluder's transparency is very high, scene may be hard to 'understand'
  - Object's spatial relationship, especially in case of multiple occluding objects
  - Important depth cues and landmarks are lost



! Missing Occlusion Cues !



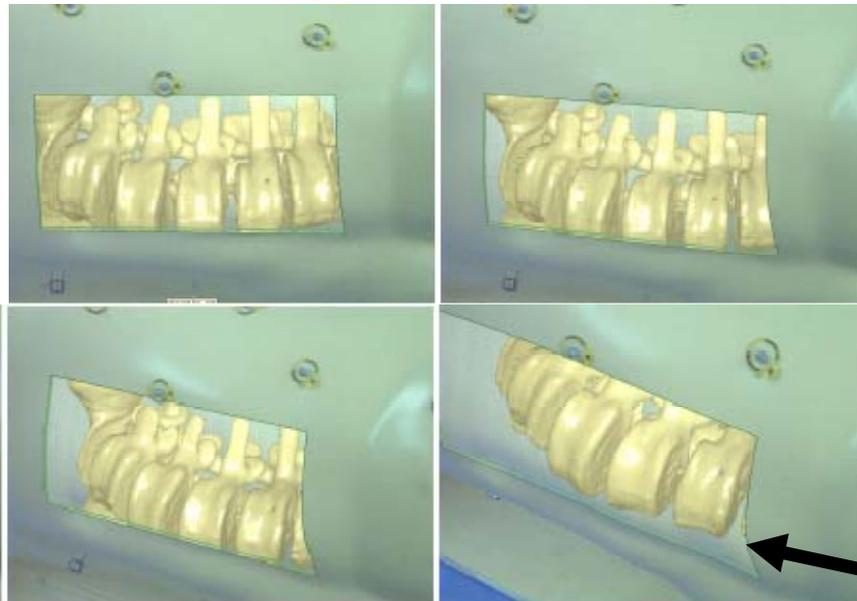
# Cut Aways

- Display Fully opaque hidden objects
- Additional occlusion cues provided via cut-out

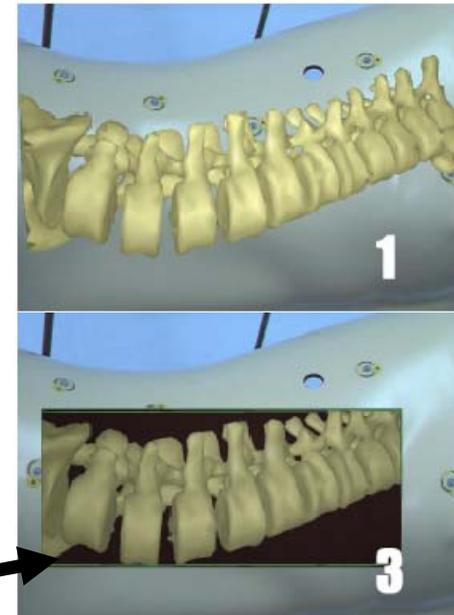
[Sielhorst06]



# Cut Aways



[Bichlmeier06]



[Sielhorst06]

- Video vs. Black background
  - Left: Only hidden objects are cut
  - Right: Video is removed in cutting

# Cut Away Shapes

- 2-1/2D Window
  - Screen aligned
  - Cut-away follows occluder's geometry
  - -> Need 3D Representation



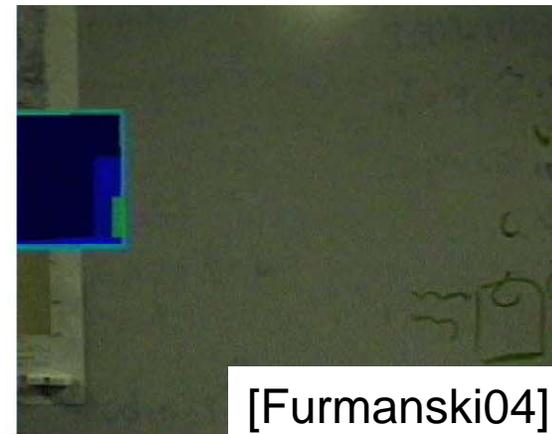
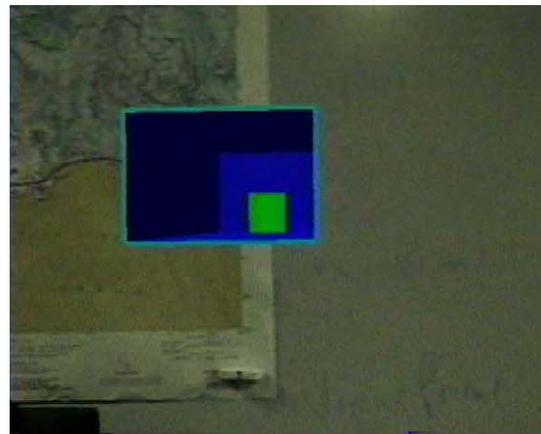
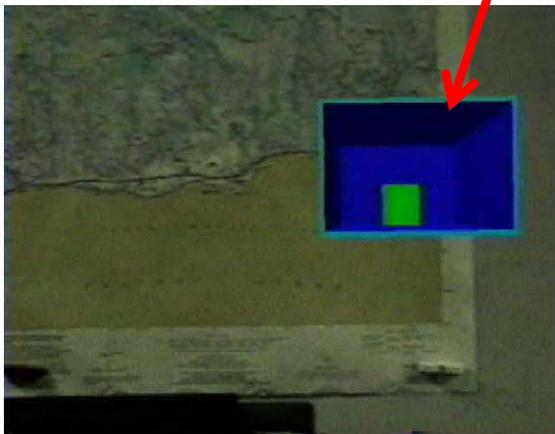
[Bichlmeier06]



[Furmanski04]

# Cut Away Types

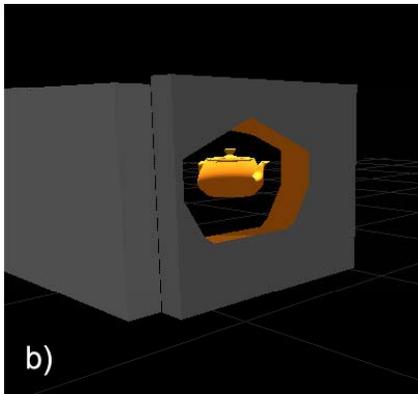
- 2-1/2D Window
- Additional Box Rendering
  - Additional perspective cue



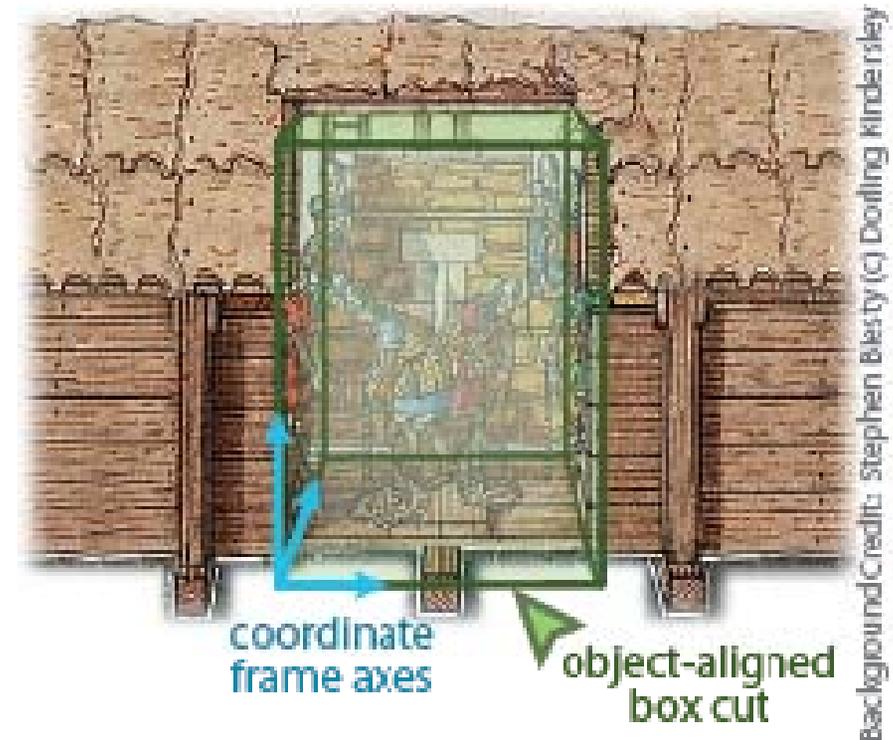


# Cut Away Types

- 2-1/2D Window Cuts
- Additional Box
- Box Cuts
  - Use a cubic geometry to cut away occluder
  - Need 3D occluder



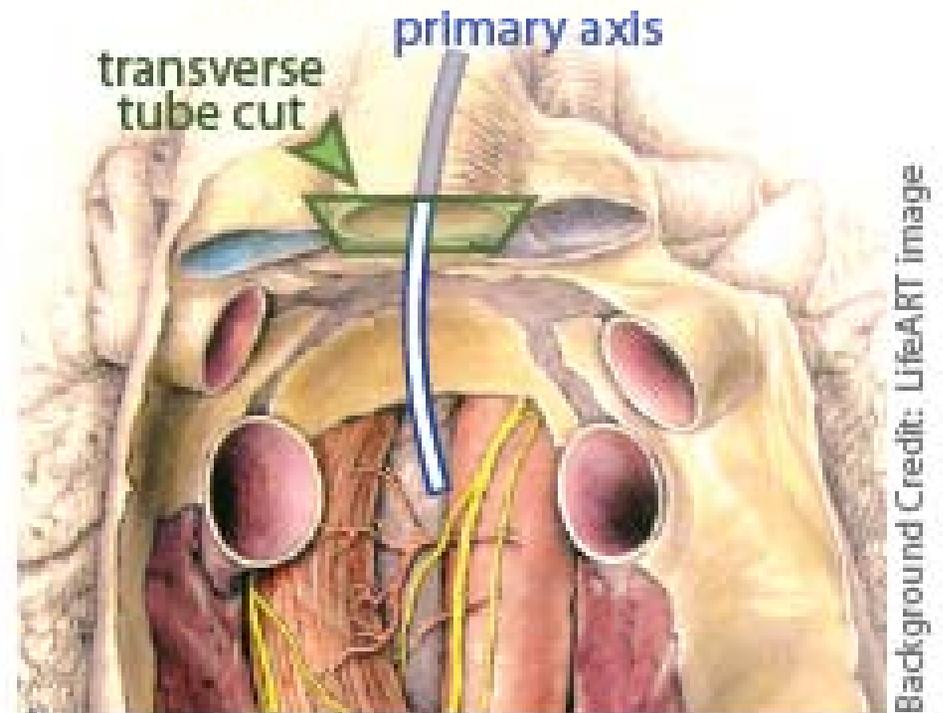
[Coffin02]



[Li07]

# Cut Away Types

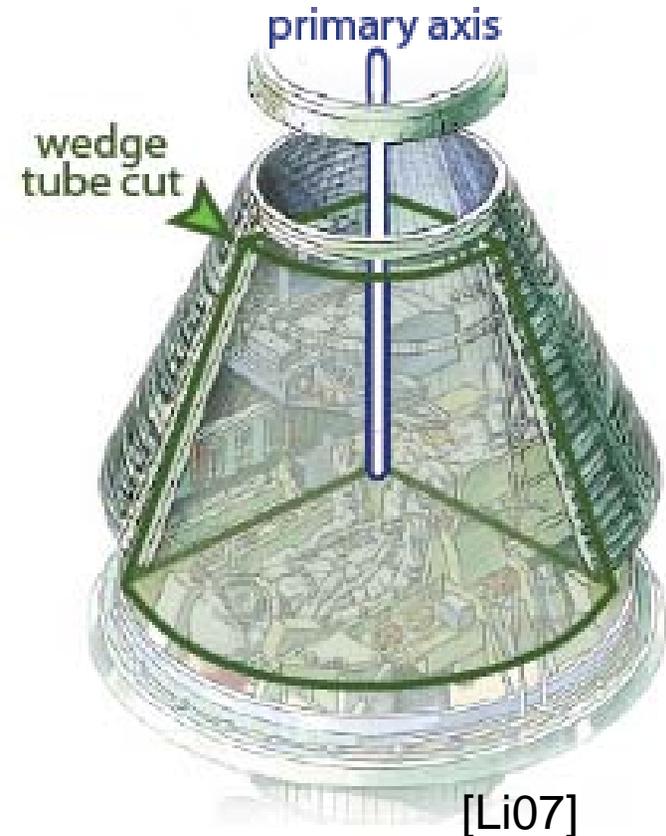
- 2-1/2D Window
- Additional Box
- Box Cuts
- Tube Cuts
  - Perpendicular to primary axis



[Li07]

# Cut Away Types

- 2-1/2D Window Cuts
- Additional Box
- Box Cuts
- Tube Cuts
- Wedge Cuts
  - Similar to Box Cuts
  - Use wedge instead of box



Combined Wedge  
and Tube Cut

Background Credits: Nick Lipscombe, Garry Biggin (c) Dorling Kindersley

# Cut Away Types

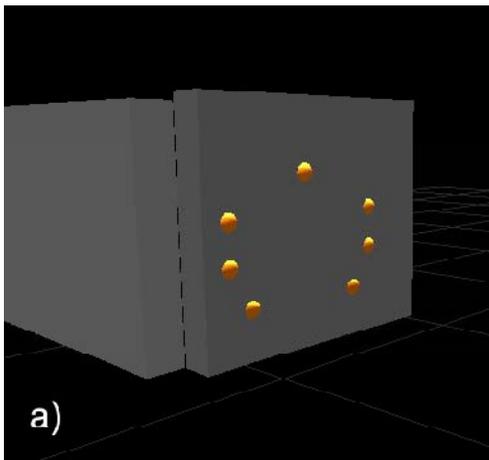
- 2-1/2D Window Cuts
- Additional Box
- Box Cuts
- Tube Cuts
- Wedge Cuts
- Inset Cuts
  - Multi-Object Occlusions



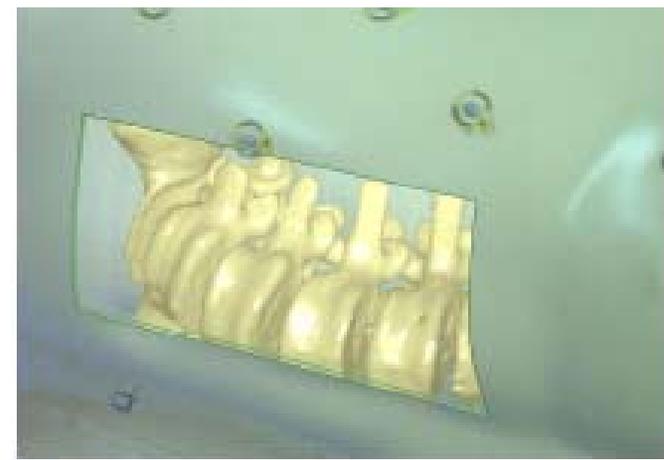
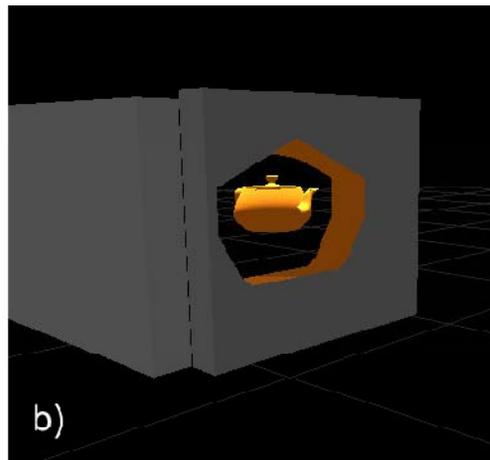
[Li07]

# Interactive Cut Away Creation

- Interactive 'window' placement
  - Define window corner



[Coffin02]



[Bichlmeier06]

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# Interactive Cut Away Creation

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- Li 2007
  - Interactive object classification
  - Based on classification, the system chooses the cutting type



# Cut-Away Problems

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- Big cuts
  - 'Hole' can become as big as occluder
  - -> No occluder and no occlusion cue will remain
  - Mentally 'uncutting' becomes difficult for big cuts

**=> Use Ghosting in such cases <=**

Ghosting = Sparse representation of occluding objects

# Ghosting

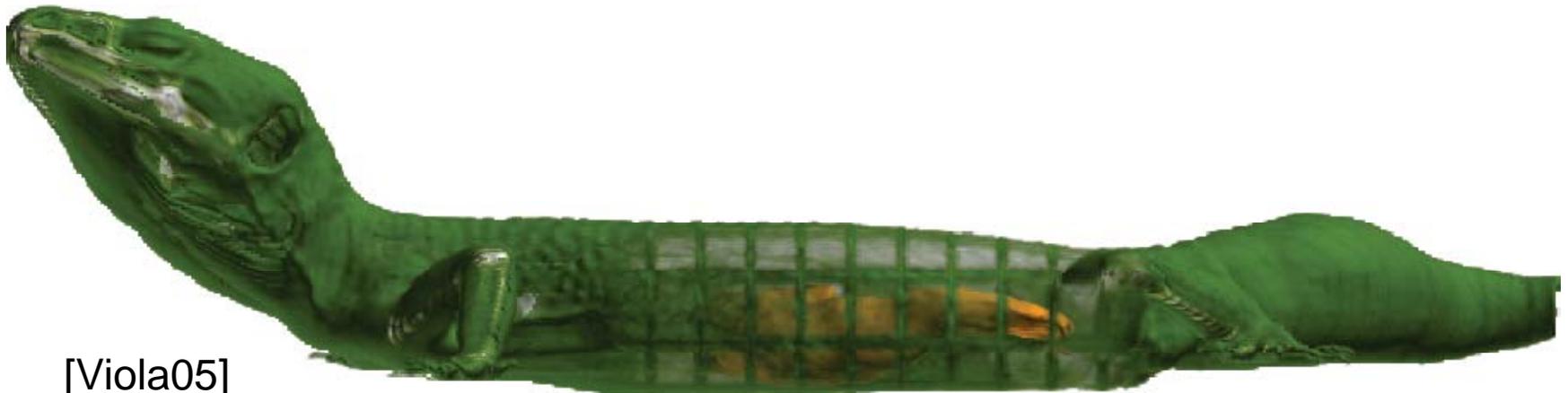
- Illustrators technique
- Occluder's most important features are kept visible to preserve its shape, texture or landmarks.



# Types of Preservings

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- Screen door
  - Easy to compute
  - Easy scalable between sparse and dense representations
  - Introduces pattern

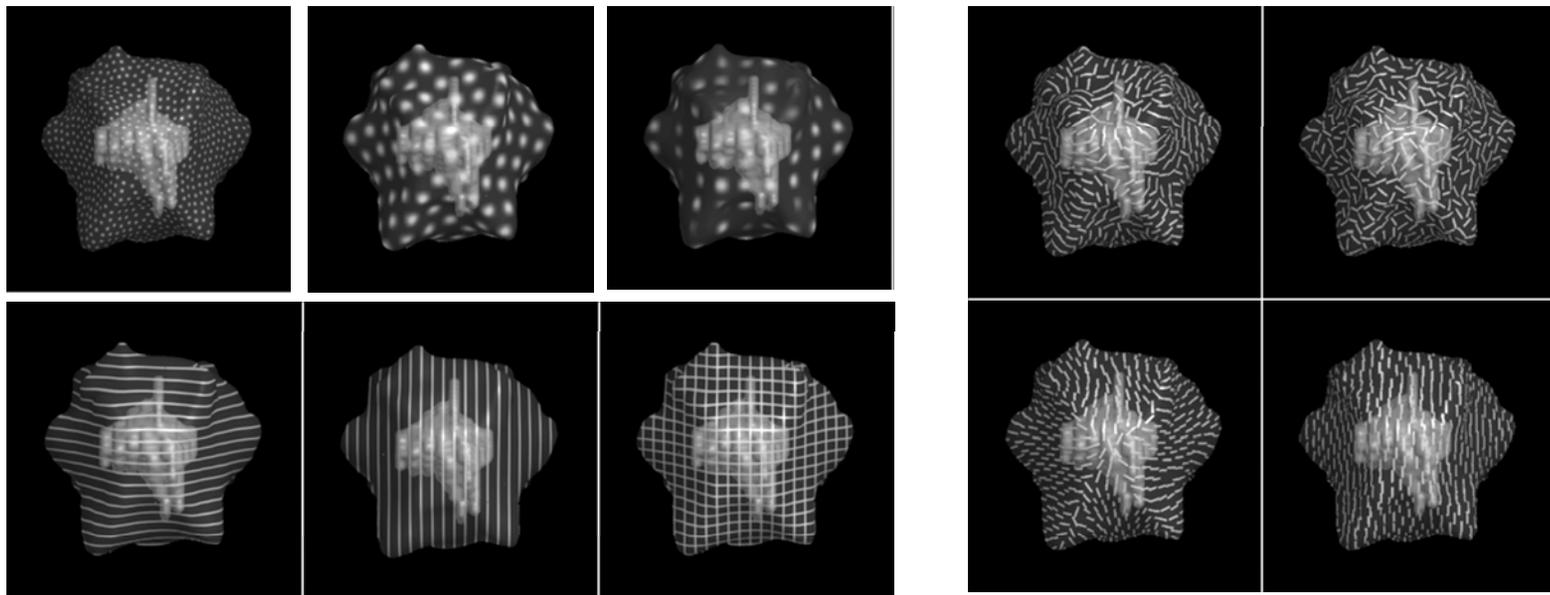


[Viola05]

# Types of Preservings

- Perceptual driven preserving
- Interrante: Experiments with different types of occlusion pattern

[Interrante95]



# Procedural Masks

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- Static and dynamic masks

**Some More Augmented Reality Importance Masks**  
Enhancing the Perception of Depth

Erick Mendez  
Graz University of Technology

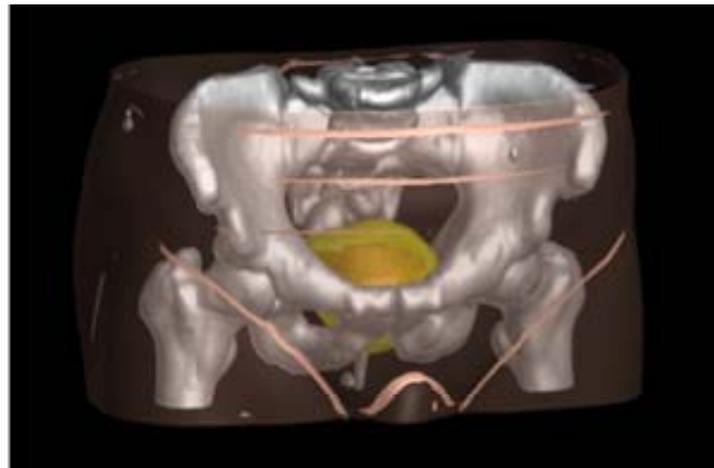
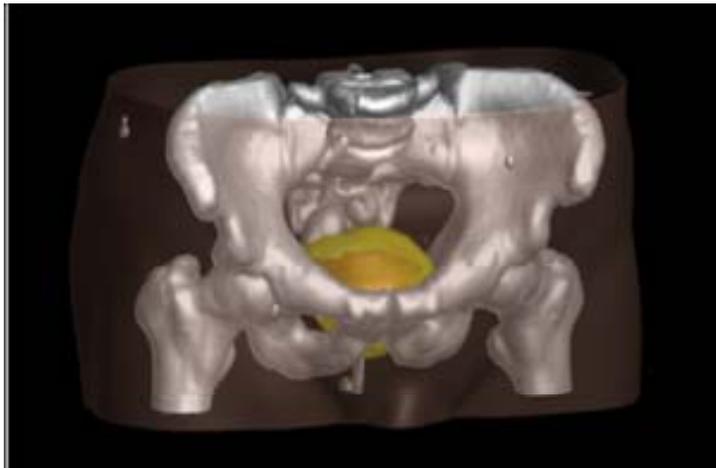


**Procedurally Generated Masks  
for Augmented Reality**

Erick Mendez  
Graz University of Technology

# Types of Preservings: Discrete Preserving

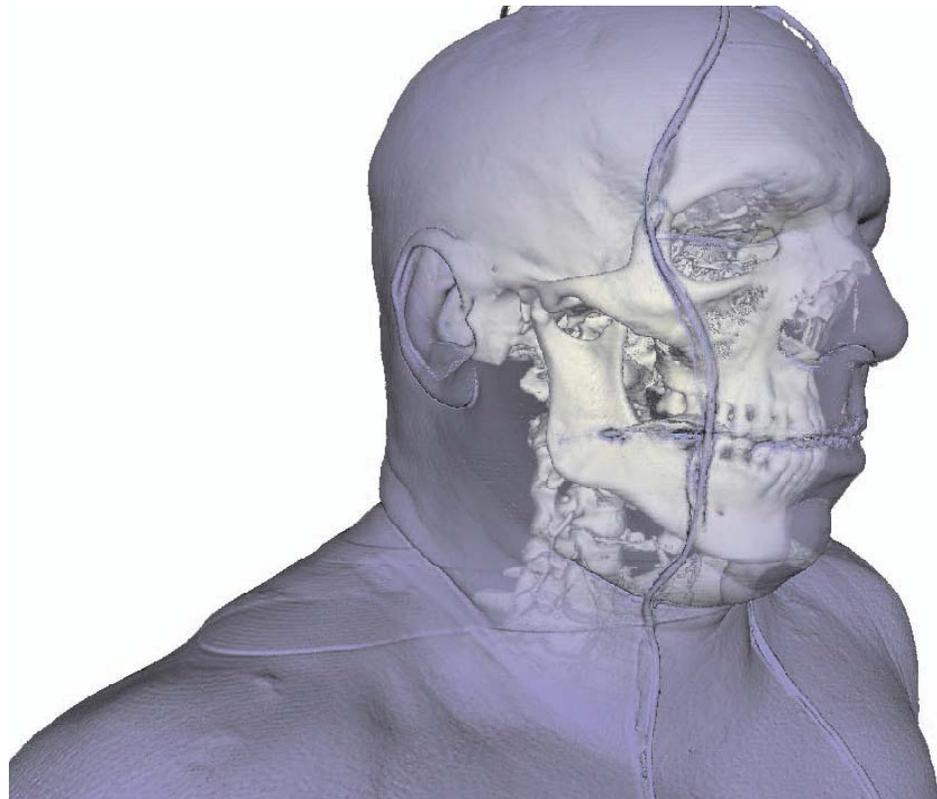
- Interrante: Curvature = Import shape indicator
- Preserve Ridge and Valley Lines



[Interrante95]

# Types of Preservings: Continuous Preserving

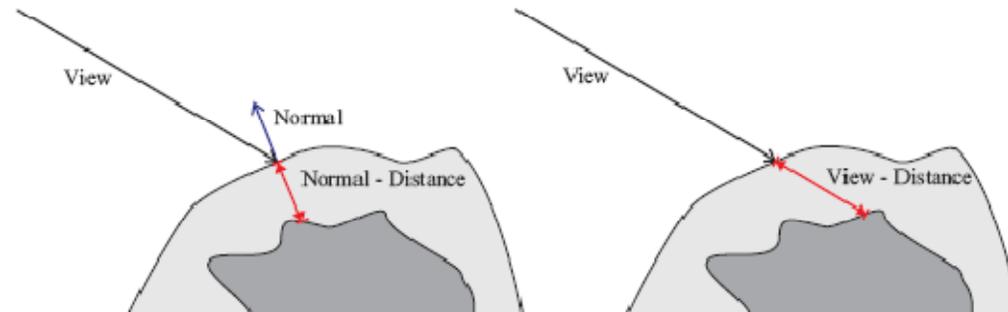
- Non-uniform transparency modulation as continuous function of occluders attributes
  - $\text{transp} = f(\text{curvature})$
  - ...



[Krueger06]

# Types of Preservings

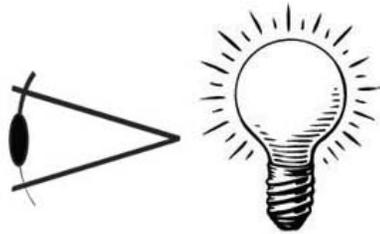
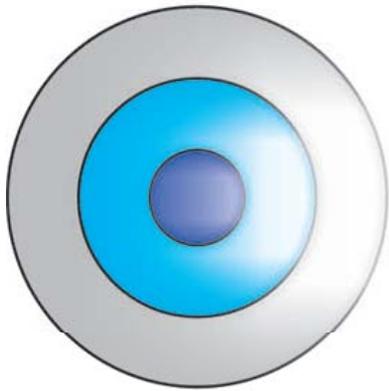
- transparency =  $f(\text{distance\_to\_hiddenobject})$



[Krueger06]

# Types of Preservings

- transparency =  $f(\text{ShadingIntensity})$



[Bruckner06]



# Types of Preservings

- transparency = combination of parameters



Curvature



Angle(normal,viewDir)  
similar to f(ShadingIntensity)

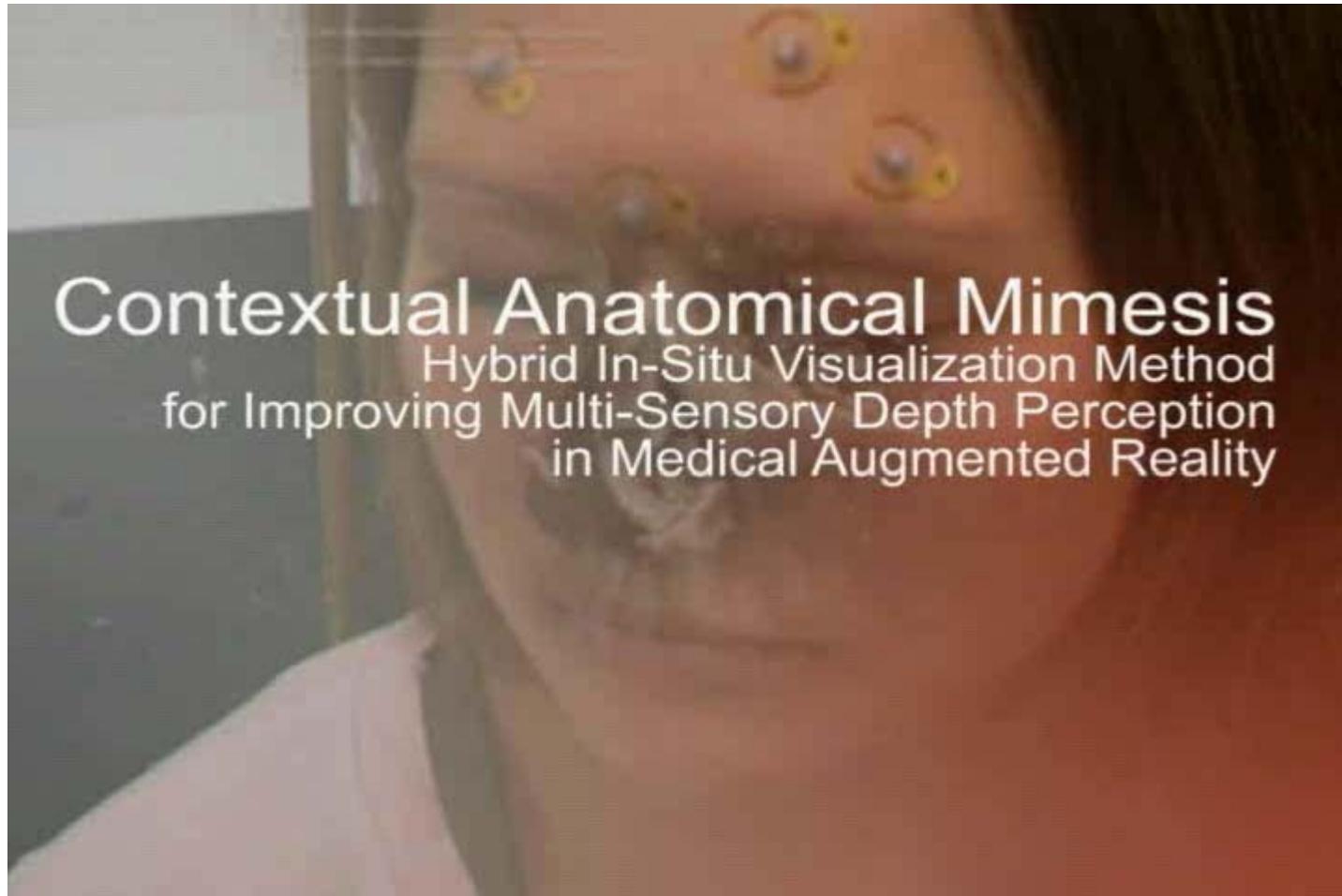


Dist(maskCenter)



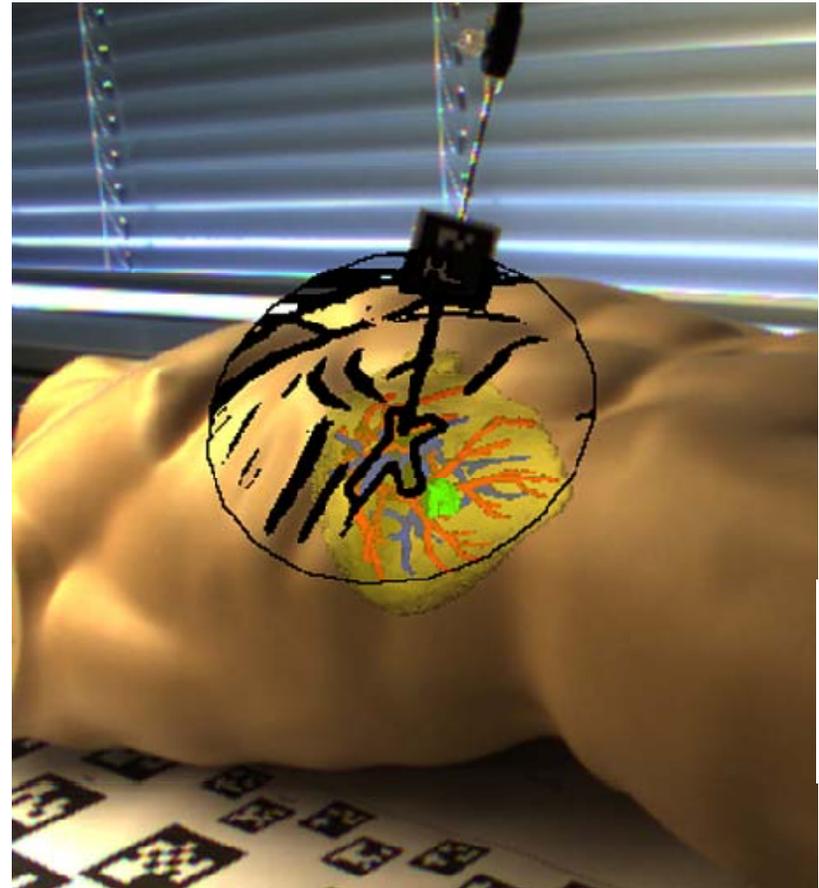
[Bichlmeier07]

# Ghosting in AR



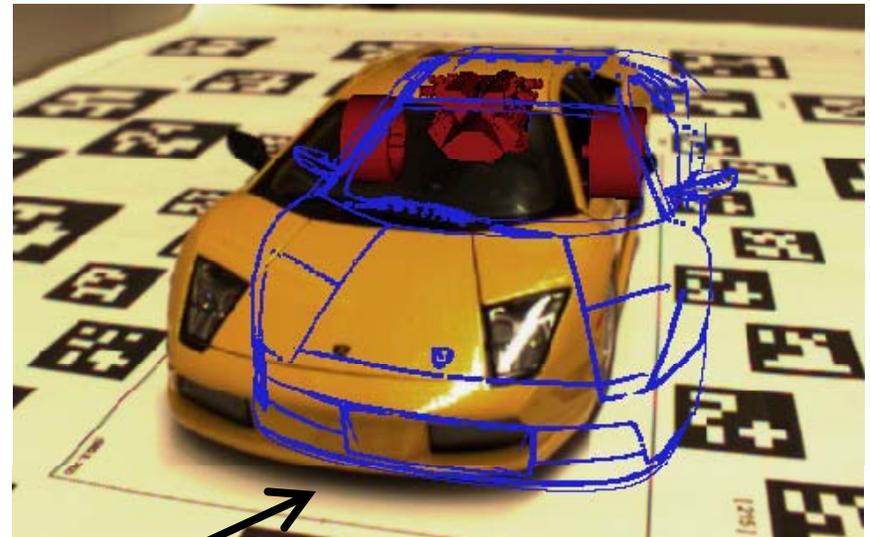
# Features from Real World Imagery

- Use image based filter operation, e.g. any type of edge detector



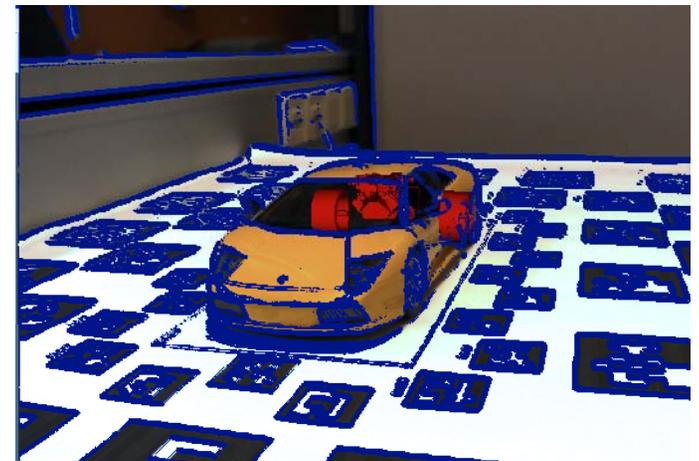
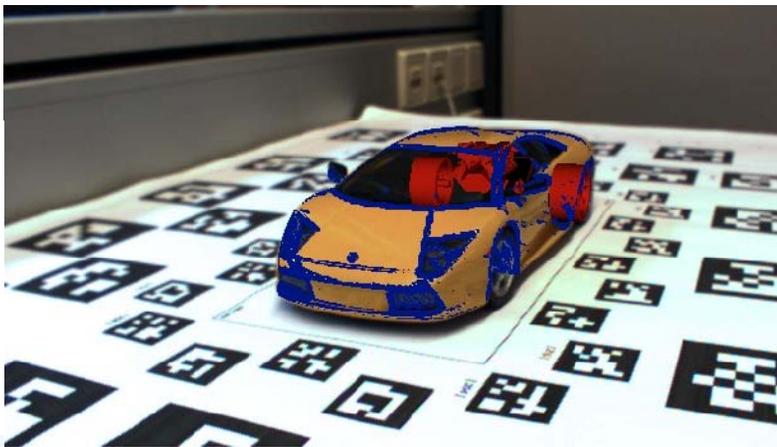
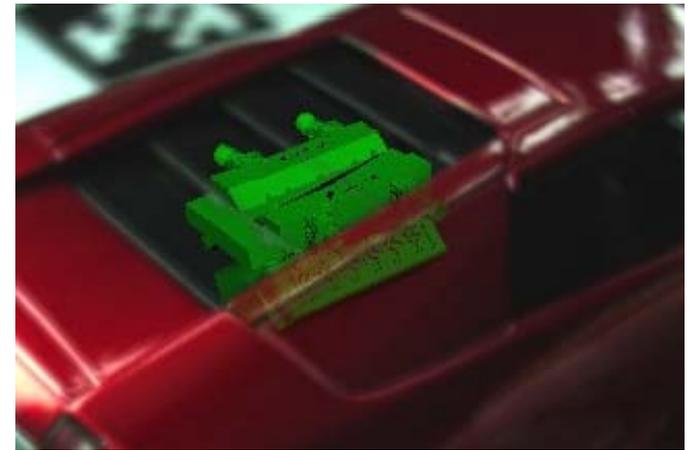
## Features from Tracked Model

- Object-based feature detectors are independent from scene conditions like lighting, texture  
->gives us usually better results
- May suffer from poor tracking / registration



# Sources of Features in AR

- Feature from video feed
  - Easily over- or underpreserving
- Reduce overpreserving with hybrid approach
  - detect features only inside tracked mask



# Discrete vs. Continuous Preservings

- Continuous

- Can be difficult to understand
- Less number of fully opaque pixel



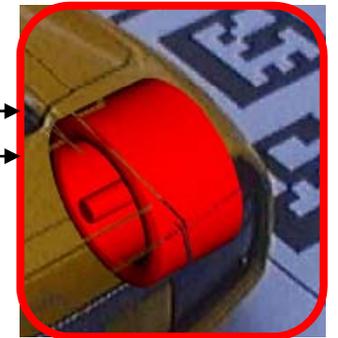
- Discrete

- Difficult to interpolate between level of sparseness



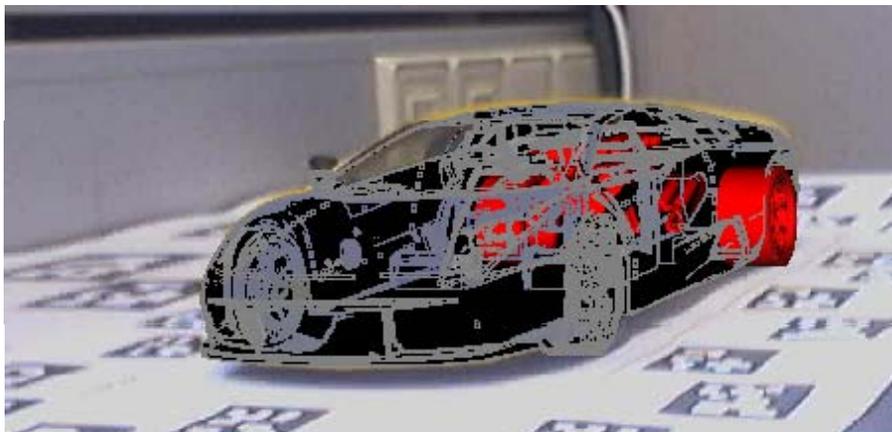
# Enhanced vs. Non-Enhanced (Video) Preserving in AR

- Discrete, non-enhanced preservings are difficult to identify in video imagery
- To 'understand' the occluder, we need to perceive its ghosting as one object
- Enhance preserving to perceive ghosting or use continuous preserving



# Problems with Context Preserving

- Multiple object occlusions
  - which object to preserve?
- Amount of preserving
  - Under preserved
  - Over preserved



## Need:

- Better feature detectors
- Information Filter

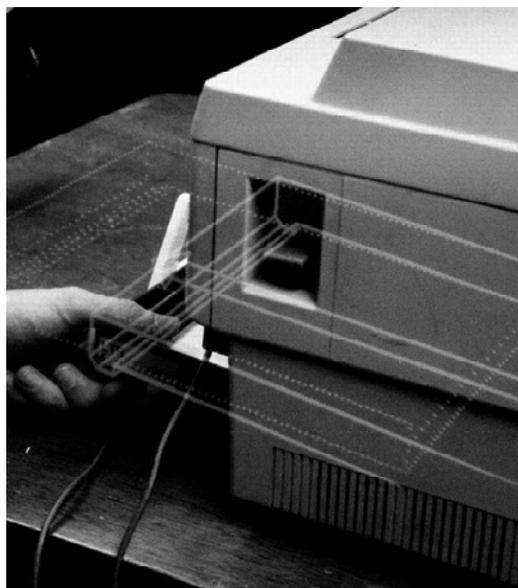
# Information Filter

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- Online and Interactively control
  - Amount    What ?
  - Location    Where ?
  - Style    How ?

# Knowledge base Filter

- Select current set of augmentation
  - Based on current applications state
  - From data base using rule engine



Printer maintenance

- Step 1 open printer
- Step 2 take out drawer

[Feiner93]

# Spatial Filtering: Magic Lenses

2D

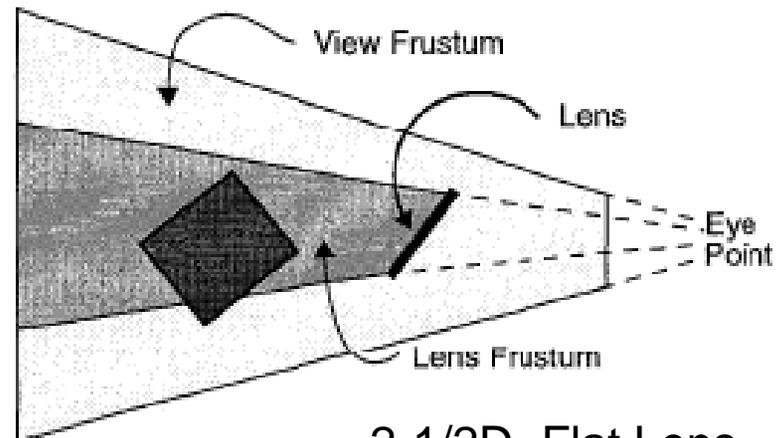


[Bier93] Bier Eric, Stone Maureen, Pier Ken, Buxton William, DeRose Tony, "Toolglass and Magic Lenses: the see-through interface," In proceedings SIGGRAPH 1993, pp. 73-80



3D

[Viega96] Viega John, Conway Matthew, Williams George, Pausch Randy, "3D Magic Lenses," In proceedings ACM Symposium on User Interface Software and Technology, 1996, pp. 51-58



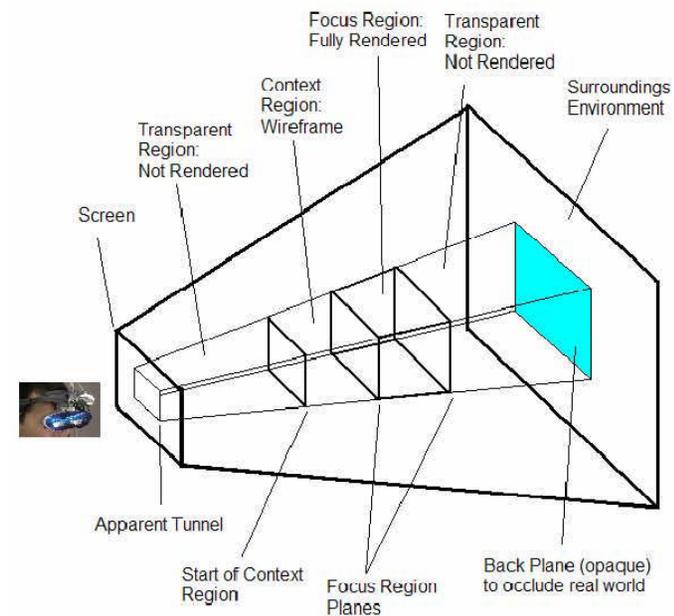
2-1/2D=Flat Lens

# Spatial Filter: XRay Tunnel

- Filter information using classification of frustum
- Similar to multi-3D lenses



[Bane04]



# Hybrid Filter

- Simon Julier 2002:
  1. Select area using Focus / Nimbus
  2. Request augmentation from data base using selected area and task (e.g. find room\_x, displayed in green)



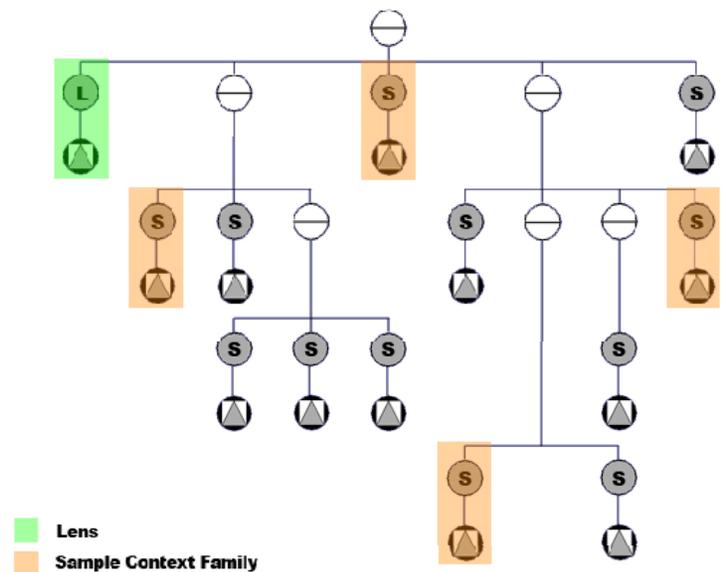
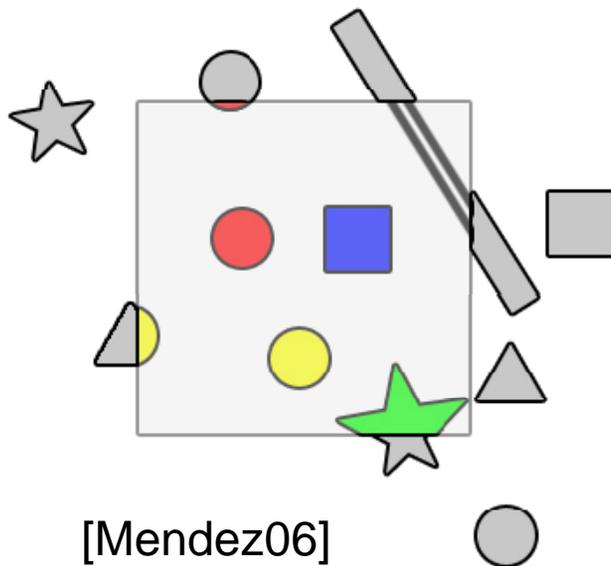
Query with two different distances, results in two different sets of augmentation

[Julier02]

# Hybrid Filter

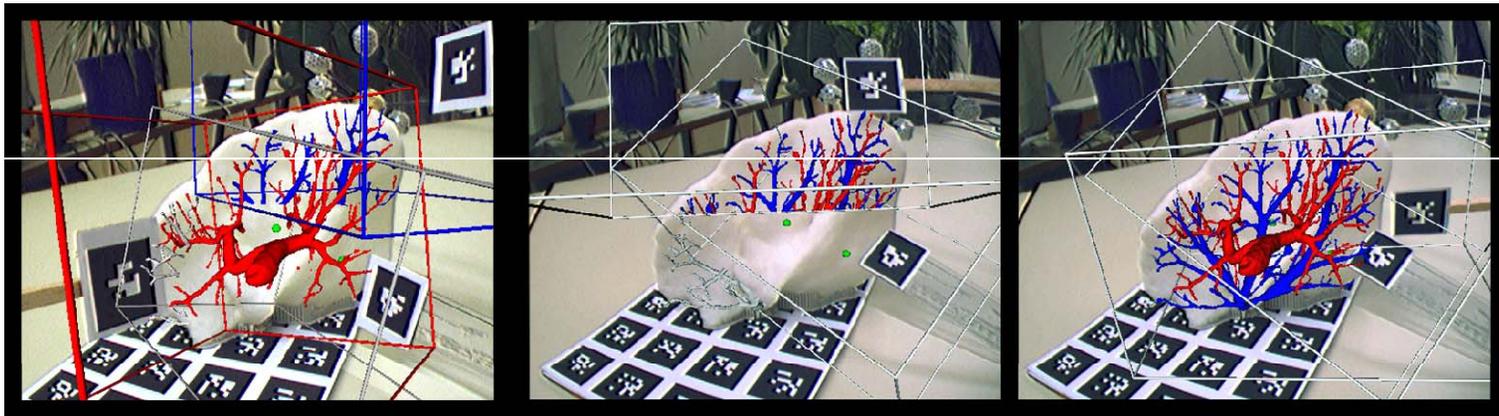
- Mendez: "Context driven rendering"

1. Select area using a 3D magic lens (a)
2. Request object's appearance from data base (scene graph) using lens / object combination



# Context Driven Filtering

- Traditional Lenses define single style per lens
- CSML: Style per lens, object/group pair
- Selectively render/filter objects inside lens, e.g. red lens intersects two objects (vessel trees), but renders only one (red tree)



[Mendez06]

# Context Driven Filtering

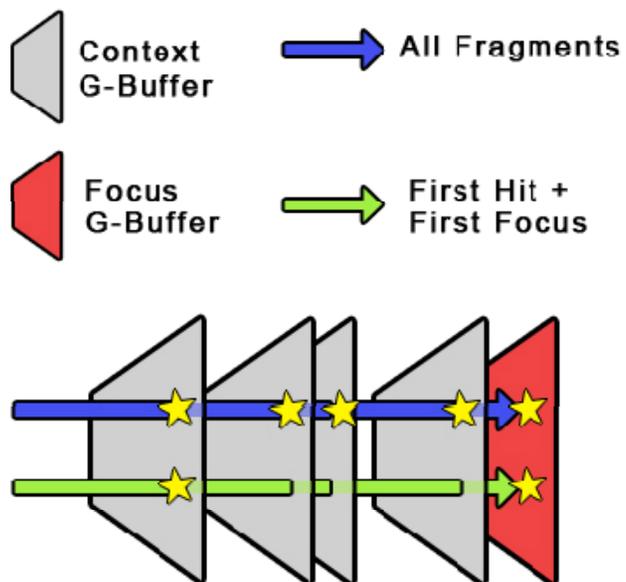
- First Lens:
  1. Color tumors in green
  2. Turn vessel trees transparent
- Second Lens:
  - Stylize only hepatic tree
- Third Lens
  - Stylize only portal tree



[Mendez06]

# Fragment Reduction

- Spatial based filter - during Scene Compositing



# Fragment Reduction

## - During Scene Compositing -

- Pro:
  - No knowledge needed
  - Easily applicable per region
- Con:
  - Last step of rendering



# Flat G-Buffer Lens on Video Source

