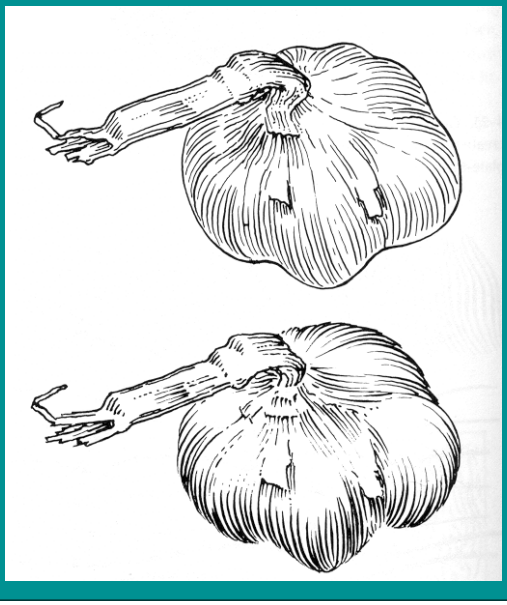
CMSC 491A/691A
Artistic Rendering

Penny Rheingans
UMBC

Announcements

- Lab meeting: Tues 2pm, ITE 352, starting next week
- Proposal due Thurs

Shape Cues: Outlines

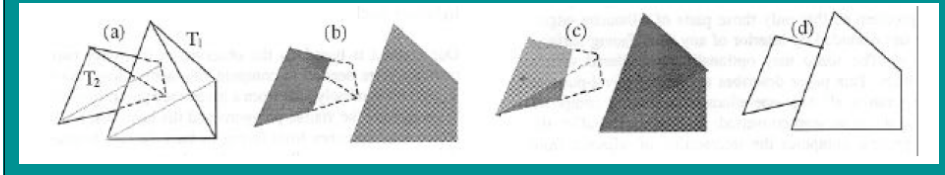


- Outline flat parts
- Outline important boundaries
- Omit outlines if contour is most important

Phyllis Wood, in Wood94, pg 40

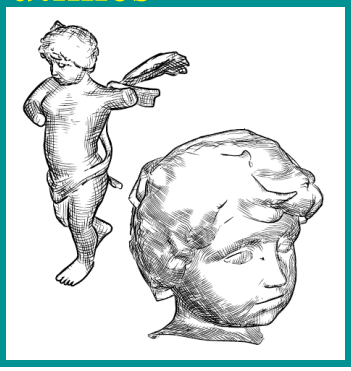
Silhouettes and Outlines

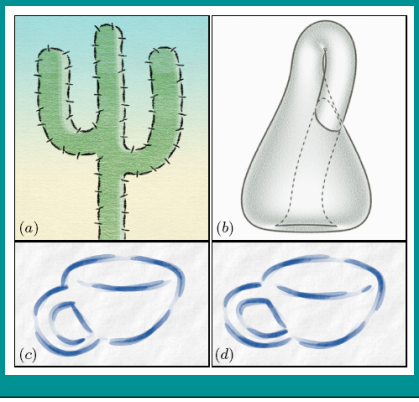
- Draw expressive silhouettes and outlines of objects
- Key issues:
  - Identifying silhouettes
  - Drawing stylized silhouettes



Silhouettes and Outlines

- Papers
  - Raskar99
  - Hertzmann00
  - DeCarlo03
  - Kalnins03





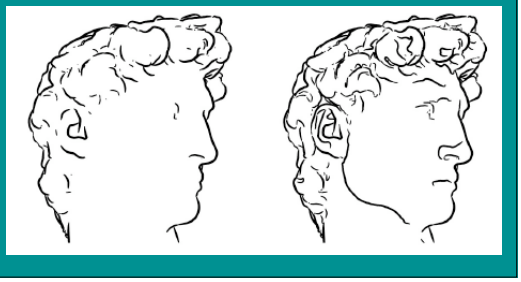


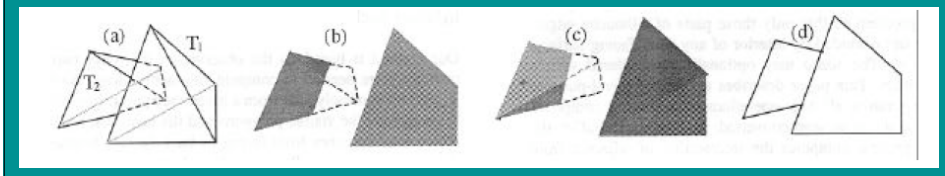
Image Precision Silhouette Edges

Ramesh Raskar and Michael Cohen

I3D 99

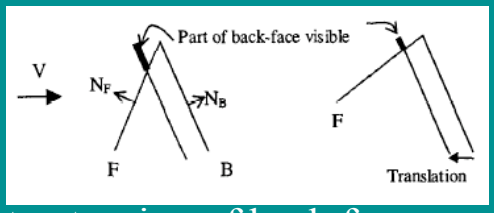
Basic Approach

- Use hardware to draw silhouette edges at image precision
- General method:
  - Identify all front facing visible pgons
  - Identify back facing polygons
  - The intersection of these two is the silhouette

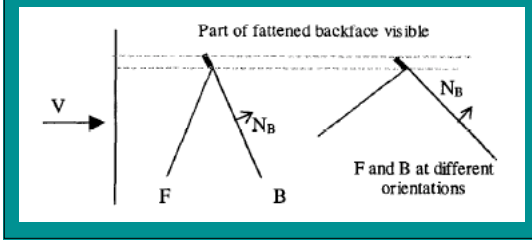


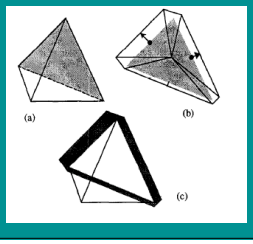
Fattening Lines

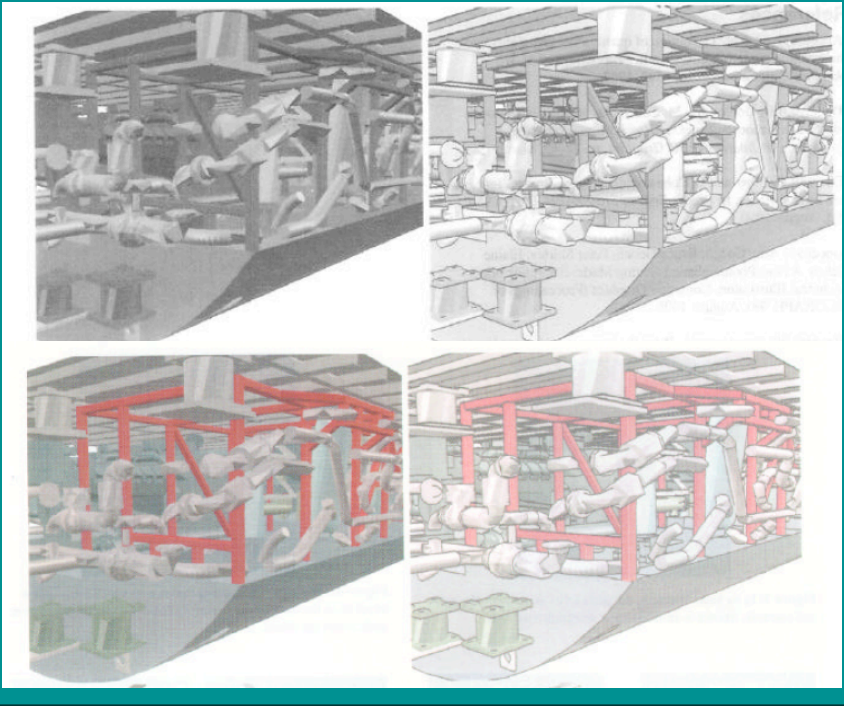
- Render back in wireframe using ≤
- Translate back faces forward



- Use view-dependent extension of back faces

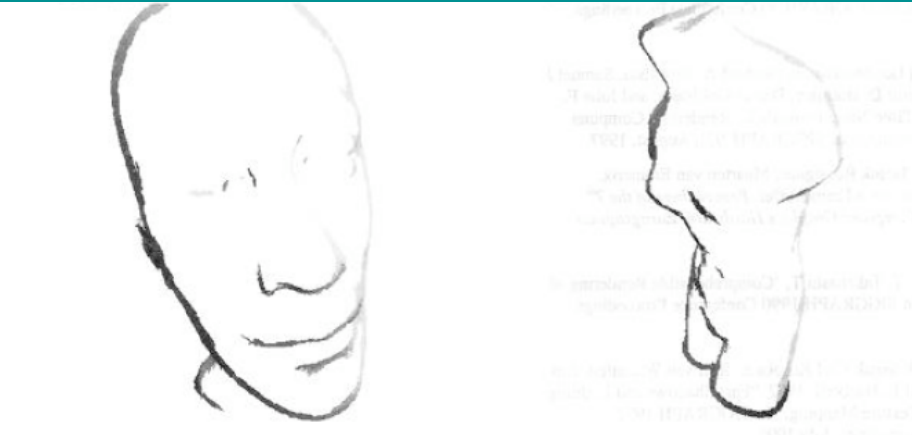






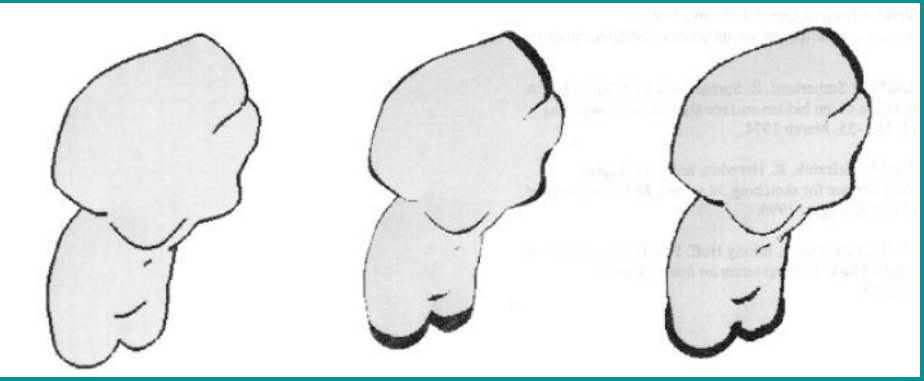
Results

- Fattening to produce a charcoal-like style



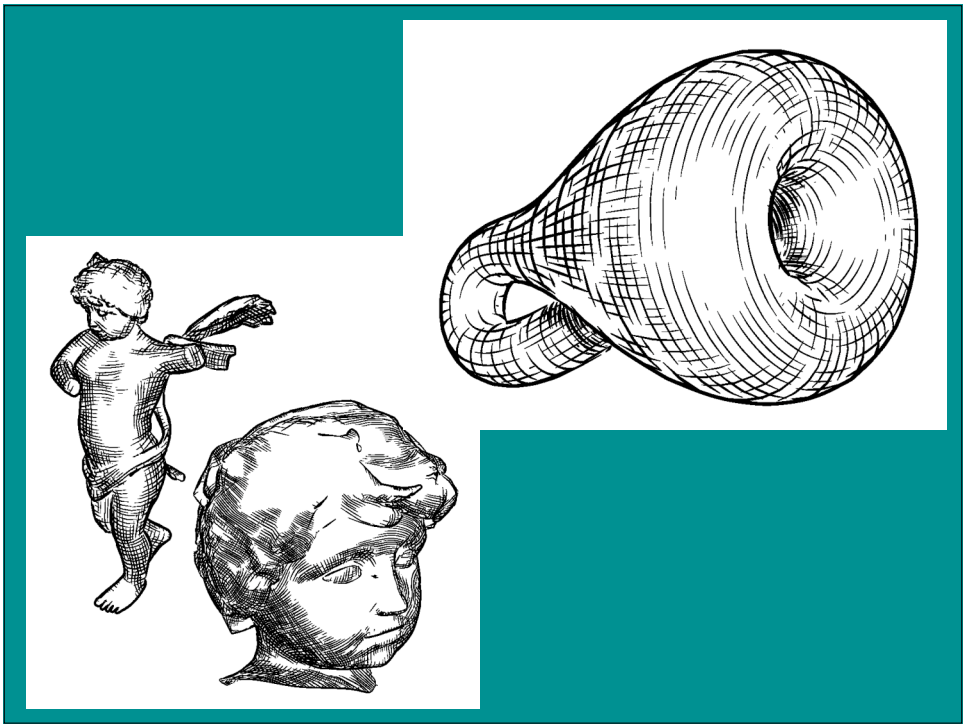
Basic Approach

- Fattening using wirefame, translation, lengthening methods



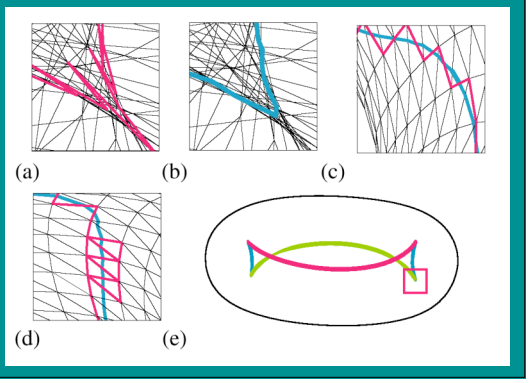
Illustrating Smooth Surfaces

Aaron Hertzmann and Denis Zorin



Overview

- Surface representation
  - polygonal mesh
  - construct piecewise-smooth subdivision
- Strictly polygonal methods create artifacts



Method

- Rendering algorithm
  - determine hatch direction field (view independent)
  - compute silhouette curves (view dependent)
  - generate hatches (view dependent)

Silhouettes

- Include boundaries, creases, silhouette lines, self-intersection lines
- Silhouette set: points p such that

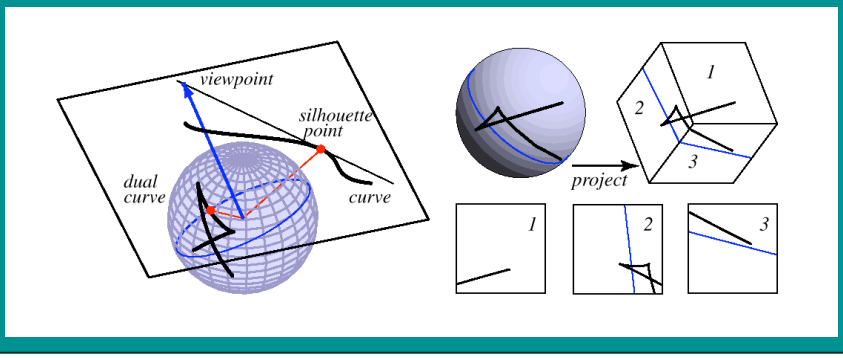
  $g(p) = (n(p)\cdot(p-c)) = 0$
- Curvature
  - principal curvatures: κ_1, κ_2
  - determine coordinate system (r,s,t)
- Smooth silhouette differs from pgon mesh

Silhouette Method

- Approximate silhouette set (zero set of g(p))
  - calculate normal and g(p) at vertices
  - approximate g(p) across pgon by linear interpolation
  - zero set is line segments across pgons

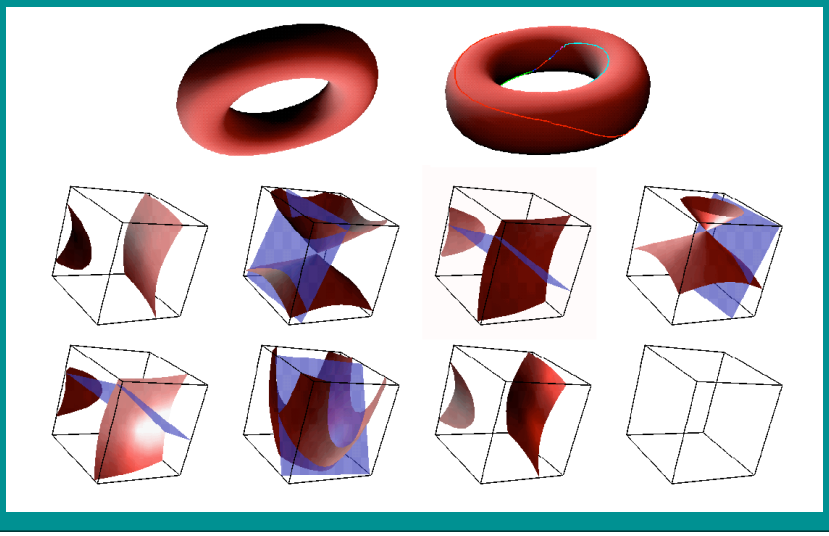
Fast Silhouettes

- Optimize using dual surfaces
  - each point mapped to $N = [n_1, n_2, n_3, -(p \cdot n)]$
  - map viewpoint to C
  - silhouette is all points from which C is in the tangent plane at that point: $(C \cdot N) = (c-p) \cdot n = 0$



Fast Silhouettes (2)

- In dual space, intersect plane with surface

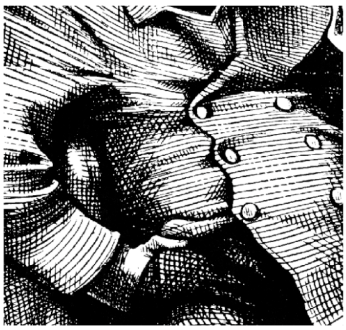


Fast Silhouette Algorithm

- For each vertex p with normal n, compute dual position N
- Normalize each N using l_∞ norm (at least one component becomes 1 or -1; on cube)
- Each tri assigned to list of each face it's on
- Octree constructed for each face
- Each frame, octree used to find intersection of dual plane with dual surface

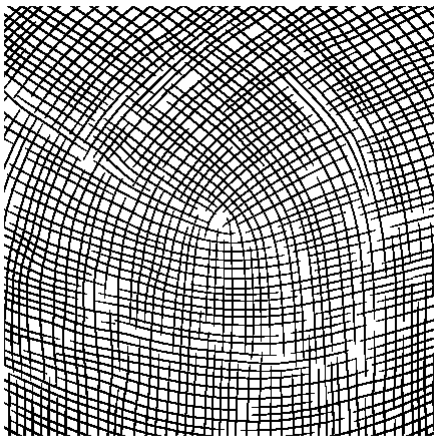
Direction Fields

- Observations from art
  - principal curvature shows geometry on cylinder
  - isometric lines work when parameterization exists
  - artists tend to use straight hatches



Cross Fields

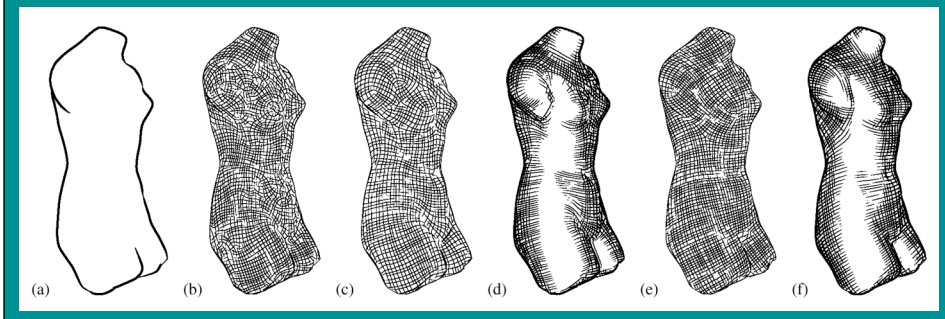
- Defined on nonorientable surfaces
- Some natural cross-hatching patterns cannot be decomposed into two smooth fields



Hatch Field Construction

- Create smooth copy of mesh
- Identify areas where curvature ratio is high and at least one curvature can be computed reliably
- Initialize field over surface from principle curvature directions
- Fix field in reliable regions; optimize rest of field

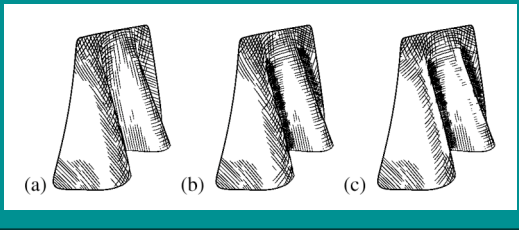
Direction Fields



(a)	(b)	(c)	(d)	(e)	(f)
Just silhouette	raw principal curvature	smooth cross field	hatching smooth field	very smooth field	hatching very smooth field

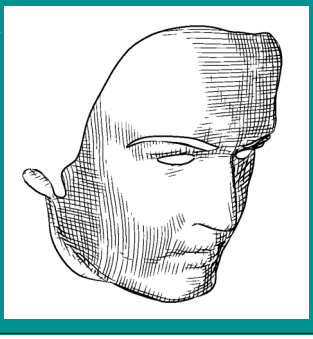
Hatching Levels

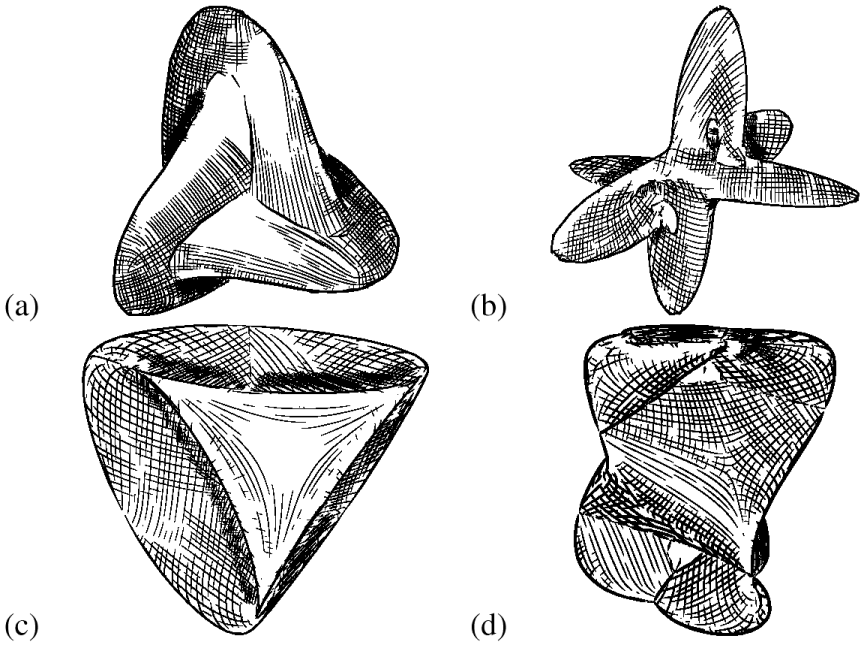
- Four levels of hatching
  - no hatching: highlights and Mach bands
  - single hatching: midtones
  - cross-hatching: shadowed regions
  - dense cross-hatching: undercuts
- Use surface shape to determine level
  - opposite undercut is unhatched Mach band
  - hatches approximately straight
  - hatch thickness proportional to lighting (opt)



Hatch Placement

- Hatching process
  - Identify Mach bands and undercuts
  - Cover single and double regions with cross-hatches; add extra hatches to undercut regions
  - Remove cross-hatches from single regions
  - Hatches clipped to hatch region





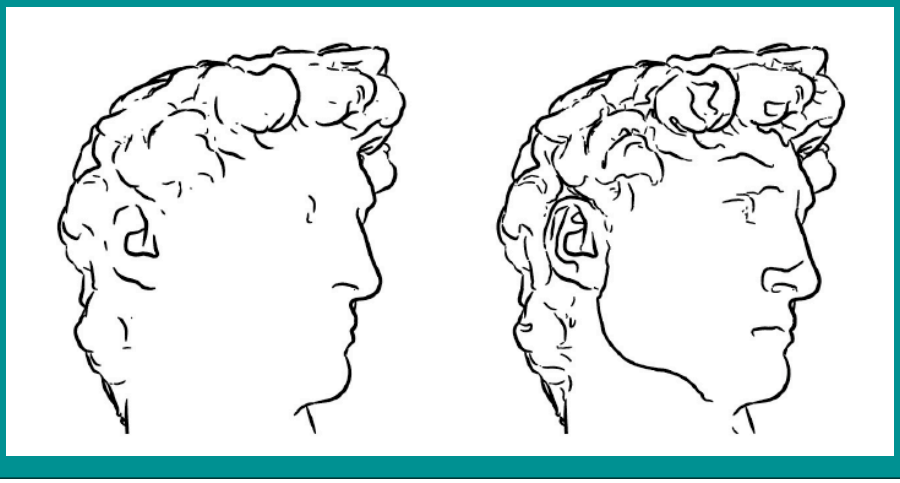
Suggestive Contours for Conveying Shape

Doug DeCarlo, Adam Finkelstein, Szymon Rusinkiewicz, and Anthony Santella

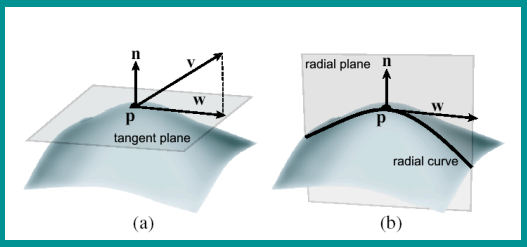
SIGGRAPH03

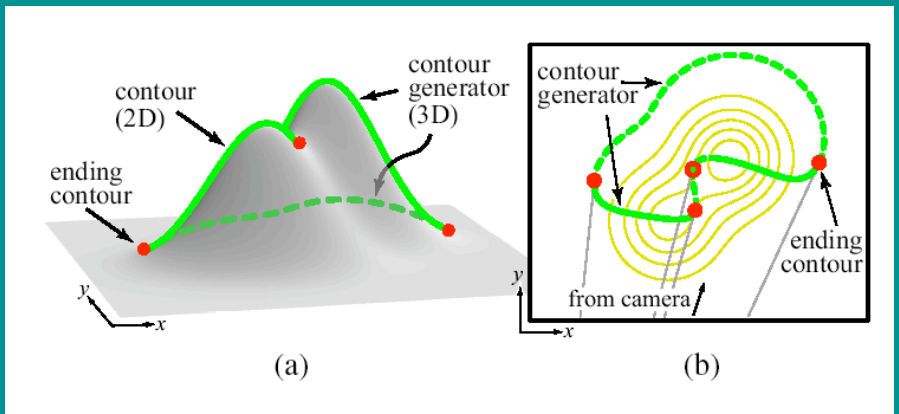
Concept

- Adding contours for nearby viewpoints improves expressiveness

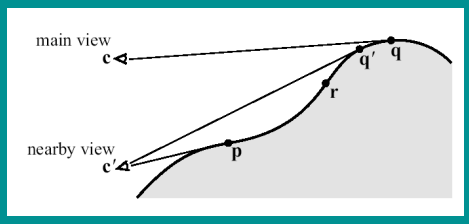


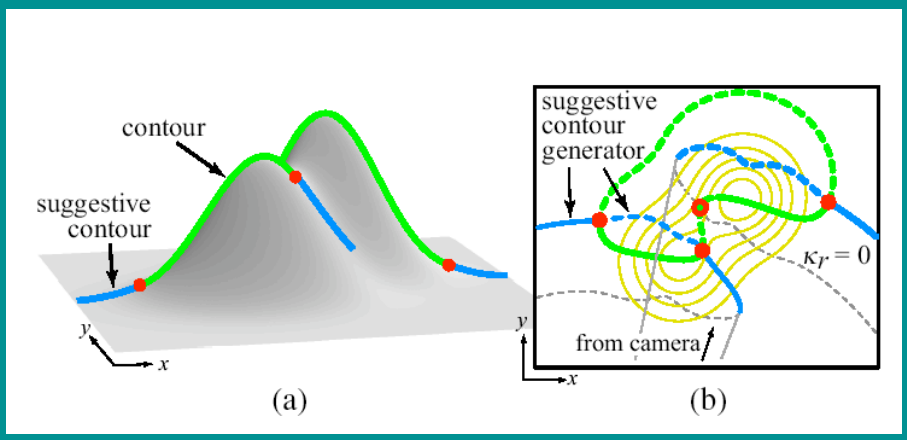
Contour





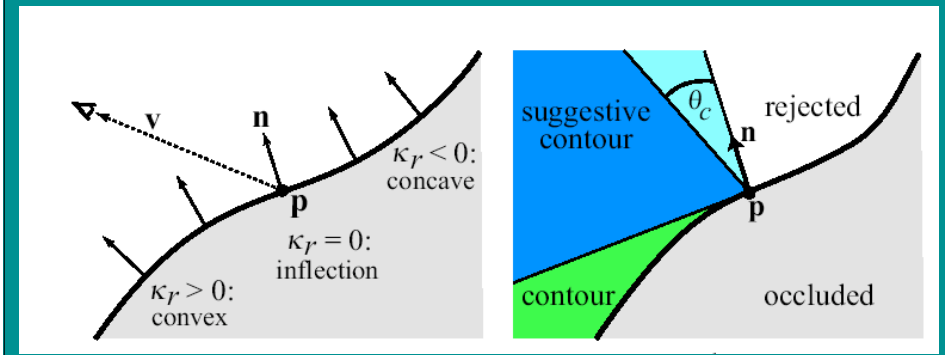
Suggestive Contour



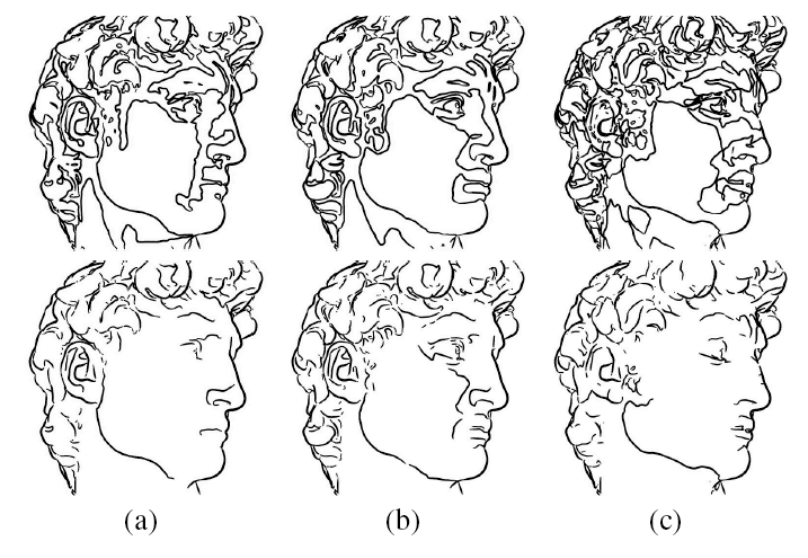


Suggestive Contour Region

- Suggestive contours are inflection points where contours will eventually appear
- Generator where radial curvature is 0 and directional derivative is positive

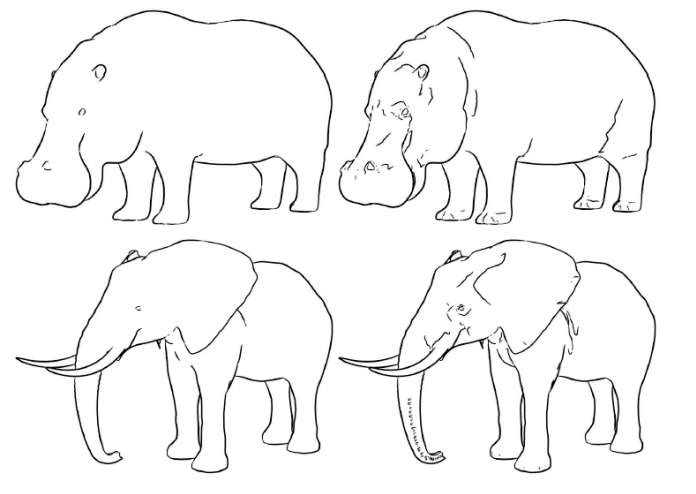


Derivative Test



DeCarlo 03

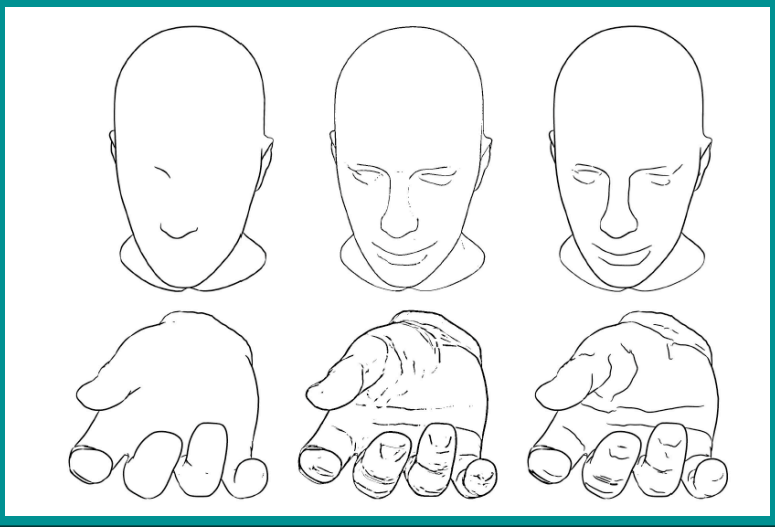
Object Space Algorithm



Contours

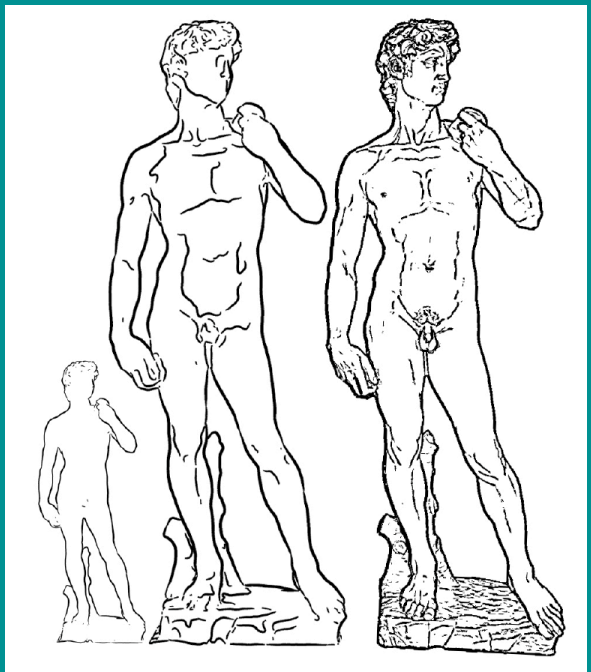
add suggestive contours

Object vs Image Space Algorithm



DeCarlo 03

Object vs Image



DeCarlo 03