

Introduction and overview

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P. Picasso's line drawing [1]

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Lortet Caves

Paleolithic drawings from the Iberian Peninsula



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A. Durer : line drawing of a rhino [1]

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Lines in line-drawingsWhere to put the lines?

Overview of view-dependent featurelines

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View-dependent featurelines





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Lines we focus on:

- Contours
- Suggestive contours
- Highlight lines
- Apparent ridges
- Abstract shading

Contours

➤ What are contours?

- Contour lines describe a form from the outside by its edge
- (e.g.if we leane some object in front of the blackboard and just draw the line with chalk we get contour line of that object)
- ➤ Where do we use contours?



Figure showing usage of contour lines in topography

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Contours

Geometry of contour formation
n(p) - surface normal at p
v(p) - view vector

Contour generator
 Radial curvature - kr(p)
 Ending contour





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Suggestive contours (SC)

• Lines drawn on clearly visible parts of surface, where a true contour would first appear with minimal change in viewpoint.





Michelangelo's David with example of C and SC

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➢ Explanation



Figure showing both contours (**q**) and suggestive contours (**p**), as seen by the main viewpoint **c**. As the viewpoint moves to **c**', a contour suddenly appears at **p**, while the contour at **q**' slides along the surface from **q**. [2]

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Definition I:

 The suggestive contour generator is the set of points on the surface at which its radial curvature kr is 0, and the directional derivative of kr in the direction of w is positive:

Dwkr > 0

➤ Definition II:

 The suggestive contour generator is the set of minima of n * v in the direction of w.

➤Definition III:

 The suggestive contour generator is the set of points on the contour generator of a nearby viewpoint (of radial distance less than 90 degrees) that are not in radial correspondence with points on the contour generators of any (radially) closer viewpoint.

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Figure: A portion of a surface around the point **p**, as seen in the radial plane.
(a) A suggestive contour appears at the inflection point on the radial curve.
(b) If the location of the camera is in the dark blue region, the surface will have a suggestive contour at **p**.

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Viewpoint dependence and stability Smoothness properties

- Anticipation
- Extension



Figure: Anticipation and extension of SC [2]

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Computing SC

- Object-space algorithm (OS)
- Image-space algorithm (IS)



Figure: Comparison of image- and object-space algorithms for computing suggestive contours.[2]

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➢OS algorithm

- Detect contours on the mesh
- Render all the lines (filtering)

► IS algorithm

 Determine suggestive contours directly from a rendered image



Lines with light colors over dark backgrounds.



Figure: David's head with different types of highlight lines (and a toon shader) [3]

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Mathematical approach
 Intensity of ridges
 and valleys

Figure: Different types of lines given by the viewing direction v



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Suggestive highlights (SH)

complementary to suggestive contours
positive maxima (or negative minima) of product of normal vector n and view direction v in the curvature direction w

Principle highlights (PH)

Strong positive maxima (or negative minima) of normal vector n and view direction v in the curvature direction w
Ridges have positive k1, and valleys have negative k1
These correspond to the PH+ and PH–

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Rendering styles a) Grey Background



Figure: A rendering with suggestive contours and both suggestive and principal highlights conveys details across the entire shape (left), unlike toon shading (right)

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Rendering styles b) Shading in Black and White

Christopher J. Priest's comic hero Black Panther



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Rendering stylesc) Off-center Light



Figure: A rendering with off-center light

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Apparent ridges

SC capture some, but not all, of the desirable curves that comprise a line drawing

For example, they ignore the dihedrals that define a cube, and will entirely miss the ridge-like features



Figure: Depiction of a cube with traditional computer graphics shading and with line drawing (using our apparent ridges).

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Apparent ridges

Apparent ridges:

 loci of points at which the maximum view-dependent curvature assumes a local maximum in the principal view-dependent curvature direction



Figure: Comparison of curvature and view-dependent curvature

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Apparent ridges

Examples



Figure: Brain model



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GPU-based algorithm for rendering 3D models
 Rendering of highlight lines along thin bright areas and tone boundaries

Figure: Drawings by Karen Winters



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Figure: Shading used for presenting configuration of terrain

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- Rendering lines in 2 passes:
 - I. render the tone image
 - II. detect ridges and valleys in the tone image

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Level of abstraction

Figure: Varying levels of abstraction based on edge length

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Summary

Types of view-dependent featurelines
 Description and properties
 Motives based on real art

Importance for NPR usage
 View-dependent featurelines do make a difference in conveying shape of objects

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Questions and answers...

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