Mid-structures of Shapes
- A Brief Review
Blum 67

- “A Transformation For Extracting New Descriptors of Shape”
- Locus of points equidistant from contour
- Medial Axis
- Symmetric Axis
- Skeleton
- Shock Graph
Why do we want mid-structure representation?

- Dimensionality reduction
- Shape understanding

Image source: http://w3.impa.br/~paesleme/MedialAxis/MedialAxis.html
Why do we want mid-structure representation?

• Dimensionality reduction
• Shape understanding
• Shape matching

[Kimia 2003]

[Sebastian 01]

[Liu et al. 2011]
Why do we want mid-structure representation?

- Dimensionality reduction
- Shape understanding
- Shape matching
- Solid modeling

[Xia and Tucker 2011]
Why do we want mid-structure representation?

- Dimensionality reduction
- ...
- Smoothing or sharpening of shape

Image source: http://www.agg.ethz.ch/research/medial_axis
Why do we want mid-structure representation?

- Dimensionality reduction
- ...
- Smoothing or sharpening of shape
- Skeleton-based animation

[Aguiar et al. EG2008]
Different Definitions

- Locus of points equidistant from contour
- Grass-fire, prairie-fire, wave-front collision
- Locus of centers of maximal circles
- Local maxima in distance transform
- Result of topological preserving thinning
- Ridges in envelope of cones (apexes on contour)
- ...

Pictorial Definitions

van Tonder
Medial Axis Transform

- The medial axis of a planar region $S$ consists of all centers of maximum disks in $S$.

- This transformation is invertible!
Distance Transform

Skeleton located at local maxima of the distance field
Exo-Distance/Skeleton
Classes of Points in Skeleton
3D Medial Axis


[Martin and Cohen CG10]

Discrete scale axis [Miklos et al. SIGGRAPH10]
Medial Axis is Sensitive to Noise!

[Liu et al. CAD11]

[Montero and Lang CG12]

Discrete scale axis [Miklos et al. SIGGRAPH10]
Either 1D or 2D structures require manual effort for down-stream applications
Intrinsic to the object (no user interaction except for setting parameters)
Often no consistent topology
Generalized Swept Mid-Structure (GSM)
Generalized Swept Mid-Structure (GSM)

• Consists of
  • 1D segments in tubular regions
  • 2D segments in general regions

• Generated iteratively
  • Allows to track topological changes
  • Sheet-by-sheet topology

• Not intrinsic
  • User has influence
GSM Pipeline
Applications of GSM
Acknowledge

• Part of the materials of this lecture is provided by
  – Diego Nehab
  – Tobias Martin