The propagated skeleton: a robust detail-preserving approach

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Definition

Skeleton \cite{1}

Definition: Internal medial axis +
Associated radii

- Center of a maximal ball
- Maximal ball
- Internal medial axis
- Boundary of the shape
- Maximal ball: at least two tangencies

Skeleton is useful in shape description, recognition

Problem: Skeletonization

Classic method: Voronoï skeletonization \cite{2} 
Problem with Voronoï on binary shapes: Many spurious branches, coming from rasterization
State of the art: pruning solution (ex: scale-axis-transform \cite{5}) 
Limitation: blue parts of the shape can be forgotten
Ours: Skeletonization by propagation

Idea: Propagation

Estimation of a smoothed distance function from boundary and noise parameter

First circle computation from maximisation of the distance map

Detection of the contact sets

- Green area: fat tangent circle
- Orange area: neighbors for topologic closure
- Light area: non-contact points

Propagation of the circles
Searching for the next center in a given area, such that the intervals intersect

Smoothed distance function

Why?

Due to the noise, the euclidean distance is not a good approximation of the radius.

We propose a \textit{smoothed version of the euclidean distance}, that take into account several points of the boundary.

Contact sets

With a discrete boundary subject to noise, no definition of tangency can be found.

We propose to replace the tangency points by the contact sets, which are the biggest set of neighbors boundary points at a distance less than \( \alpha \) to the circle, such that the extremities of the set are at a distance less than \( \sigma \).

Propagation

Research of the next circle, which is the farthest circle sharing two contact sets with the current one.

We ensure that no part of the boundary is lost, then the details are preserved.

Some results

Propagation: All details are handled, without changing the parameters

- Voronoï alone:
- scale-axis-transform \cite{4}: \( s = 1.7 \)
- \( \lambda \)-medial axis \cite{3}: \( \lambda = 1.7 \)
- \( \theta \)-homotopy medial axis \cite{4}: \( \theta = 90^\circ \)

References

\cite{1} H. Blum, \textit{A Transformation for Extracting New Descriptions of Shape, Models for the Perception of Speech and Visual Form}, 1967

\cite{2} R. Ogniewicz and M. Ilg, \textit{Voronoi skeletons: Theory and applications}, Computer Vision and Pattern Recognition, 1992

\cite{3} F. Chazal and A. Lieutier, \textit{The \( \lambda \)-medial Axis}, Graphical Models, 67(4):304-331, 2005

\cite{4} A. Sud, M. Foskey and D. Manocha, \textit{Homotopy-preserving Medial Axis Simplification}, ACM Symposium on Solid and Physical Modeling, 2005

\cite{5} J. Giesen, B. Miklos, M. Pauly and C. Wormser, \textit{The Scale Axis Transform}, Annual Symposium on Computational Geometry, 2009