The propagated skeleton: a robust detail-preserving approach

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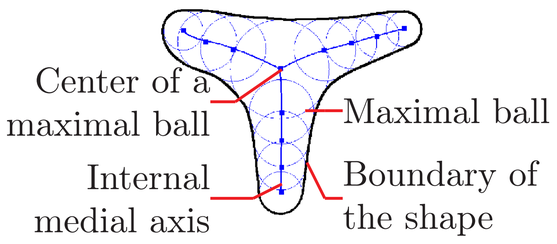
Definition

Skeleton [1]
Definition: Internal medial axis + Associated radii

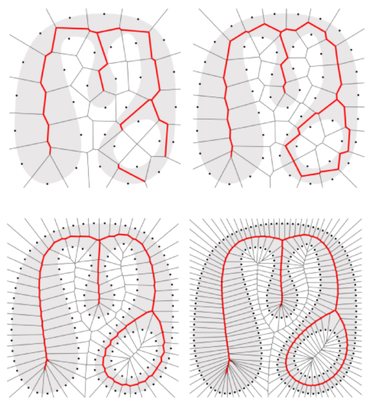


Maximal ball: at least two tangencies

Skeleton is useful in shape description, recognition

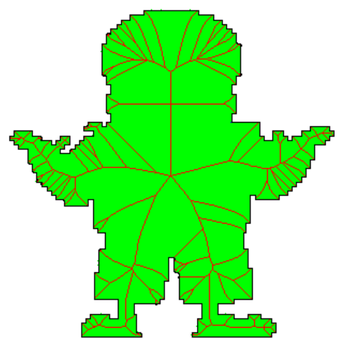
Problem: Skeletonization

Classic method: Voronoï skeletonization [2]



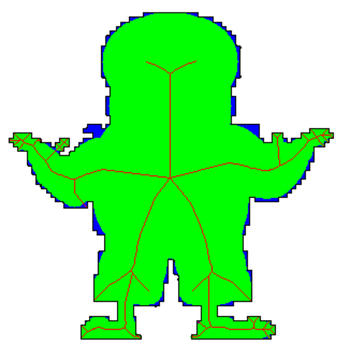
The precision comes from the discretization of the boundary

Problem with Voronoï on binary shapes: Many spurious branches, coming from rasterization



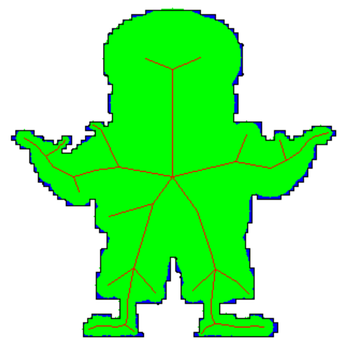
Noisy skeleton

State of the art: pruning solution (ex: scale-axis-transform [5])



Limitation: blue parts of the shape can be forgotten

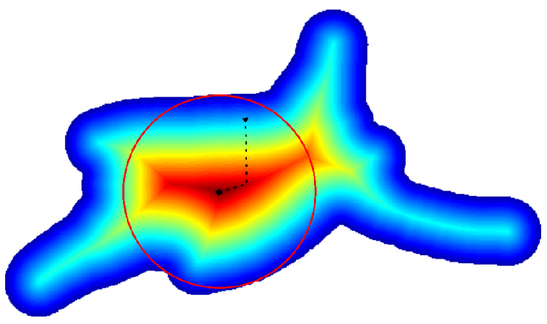
Ours: Skeletonization by propagation



Idea: Propagate a circle inside the shape, tangent to the boundary, up to a noise

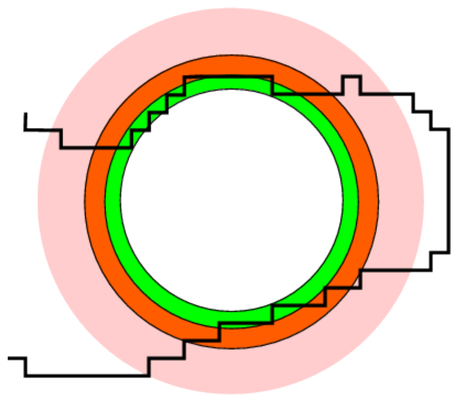
Idea: Propagation

Estimation of a smoothed distance function
from boundary and noise parameter



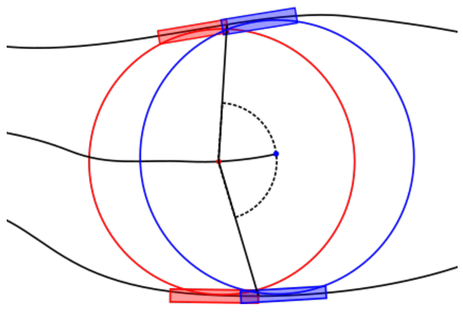
First circle computation from maximisation of the distance map

Detection of the contact sets



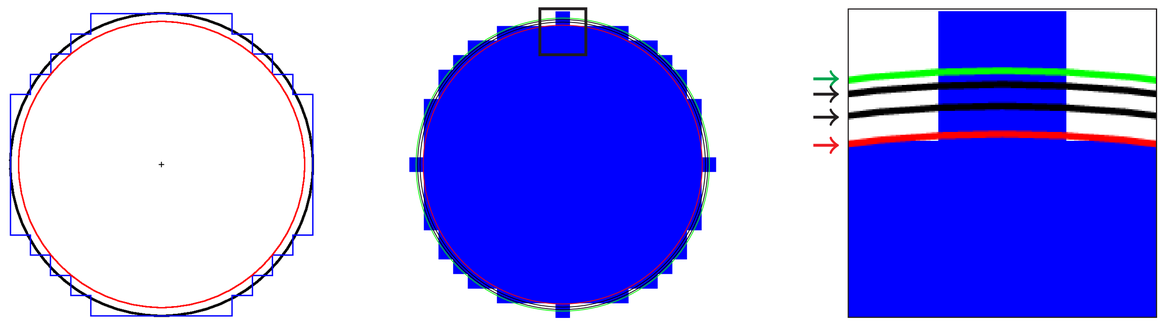
- Green area: fat tangent circle
- Orange area: neighbors for topologic closure
- Light area: non-contact points

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



Smoothed distance function

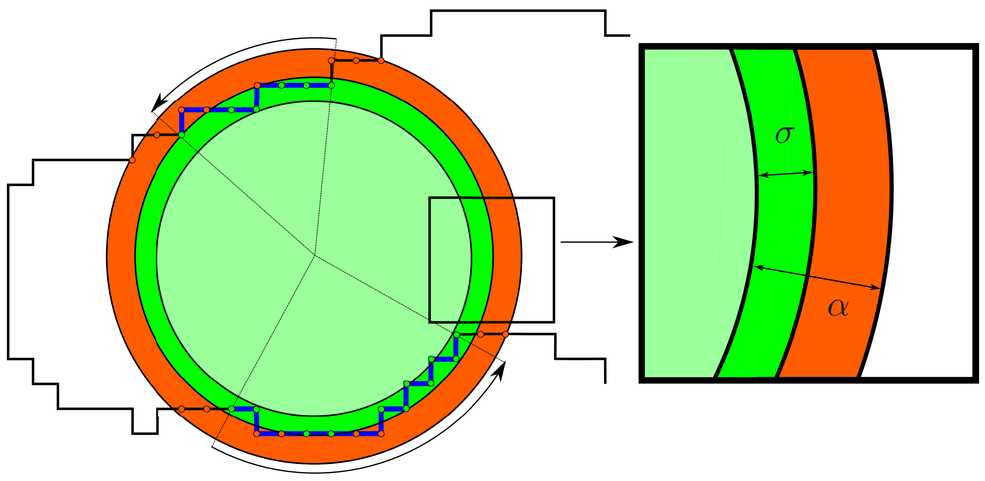
Why?



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

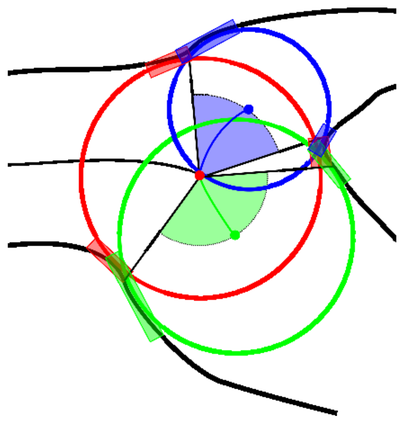
We propose a **smoothed version of the euclidean distance**,
that take into account several points of the boundary.

Contact sets



With a discrete boundary subjet 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 α to the circle,
such that the extremities of the set are at a distance less than σ.

Propagation

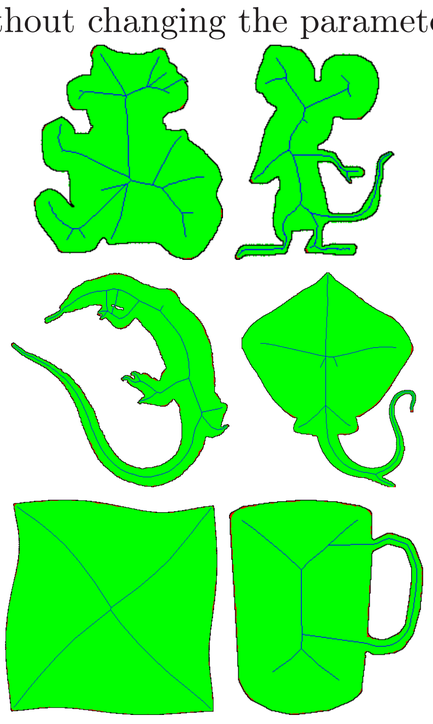


Research of the next circle,
which is the farthest circle
sharing two contact sets
with the current one.

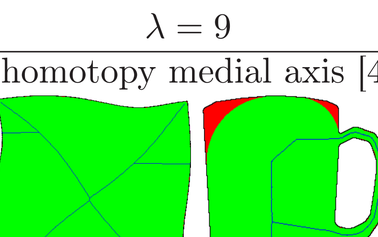
We ensure that no part of the boundary is lost,
then the details are preserved.

Some results

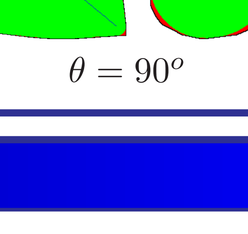
Propagation:
All details are handled,
without changing the parameters



Voronoï alone:

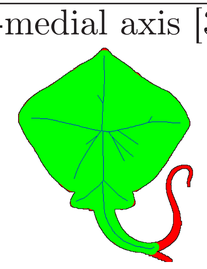


scale-axis-transform [5]:



$s = 1.7$

λ-medial axis [3]:



$\lambda = 9$

θ-homotopy medial axis [4]:

$\theta = 90^o$

References

[1] H. Blum, *A Transformation for Extracting New Descriptors of Shape*, Models for the Perception of Speech and Visual Form, 1967

[2] R. Ogniewicz and M. Ilg, *Voronoi skeletons: Theory and applications*, Computer Vision and Pattern Recognition, 1992

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[4] A. Sud, M. Foskey and D. Manocha, *Homotopy-preserving Medial Axis Simplification*, ACM Symposium on Solid and Physical Modeling, 2005

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