Reconstructions of Noisy Digital Contours with Maximal Primitives Based on Multi-Scale/Irregular Geometric Representation and Generalized Linear Programming

Antoine Vacavant [1] Bertrand Kerautret [2] Tristan Roussillon [3] Fabien Feschet [1]

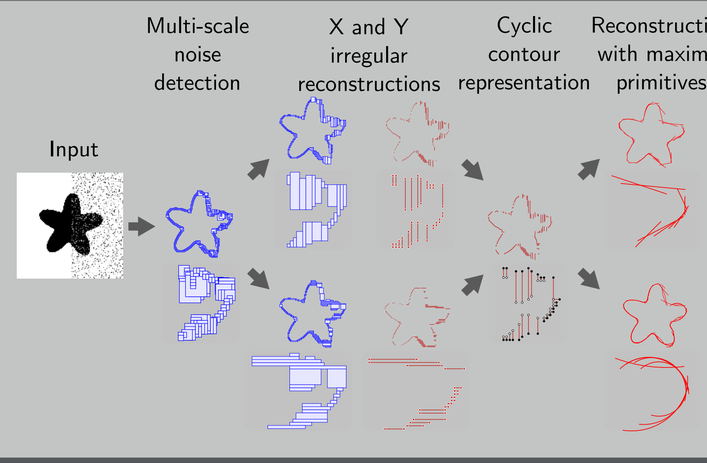
[1]Institut Pascal, UMR6602 CNRS / Université Clermont Auvergne, France

[2]LORIA, UMR7503 CNRS / Université de Lorraine, France

[3]LIRIS, UMR5205 CNRS / INSA-LYON, France

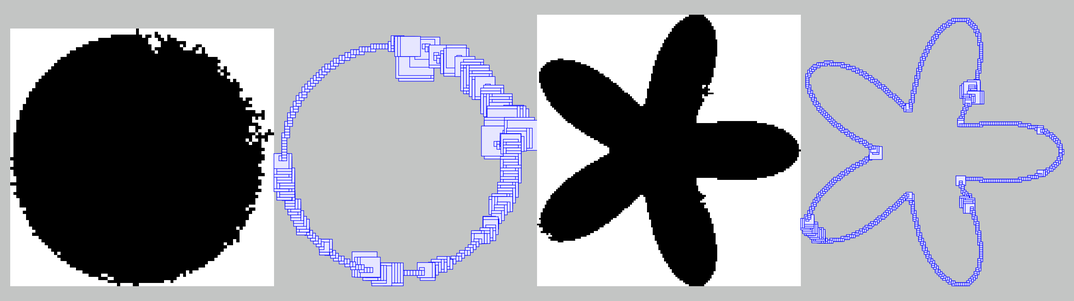
Overview

- Our contribution: **novel approach dedicated to noisy contour representations**
- An extension of [1] enabling calculation of maximal primitives
  - Straight line segments
  - Circular arcs
- Strenghts and originalities:
  - Unsupervised method, without any parameter
  - 1-D intervals represent the contour, from multi-scale and irregular-grid-based analyses
  - Generalized linear programming (GLP) calculates maximal primitives from intervals
- Tested with synthetic and real images



Multi-scale noise detection

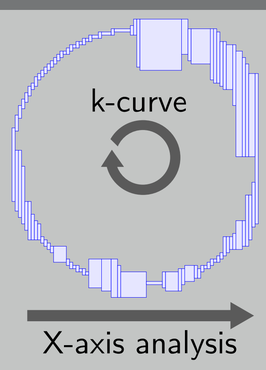
- Detects automatically the local amount of contour noise [2]
- Based on multi-scale profile / asymptotic properties of maximal segments
- Multi-scale output: Large boxes represent large uncertainties

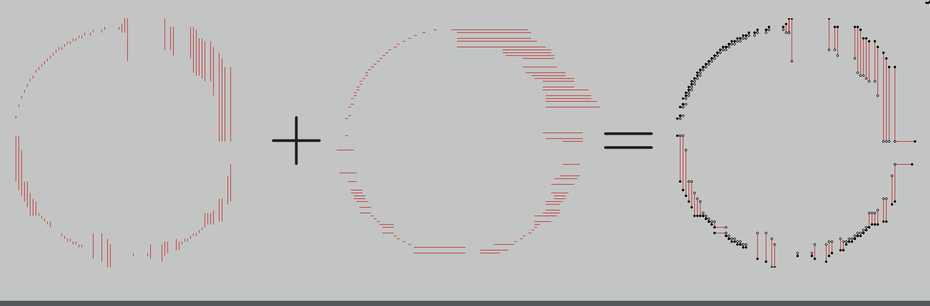


- **Meaningful boxes** cannot be used directly to reconstruct primitives

Irregular isothetic cyclic representation

- We use irregular isothetic objects
- Composed of **cells**: adjacent axes-aligned boxes
- Meaningful boxes analyzed along X and Y axes
- Reconstructs 2 k-curves (cyclic set of cells)
- Each k-curve converted into 1-D intervals
- 2 sets of segments aligned along X- and Y-axes
- Merged to obtain a single list of 1-D intervals



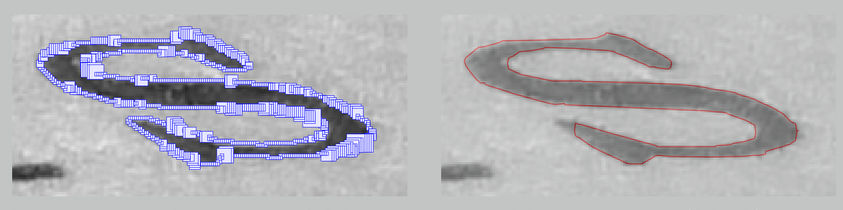


Recognition of Straight Segments and Circular Arcs

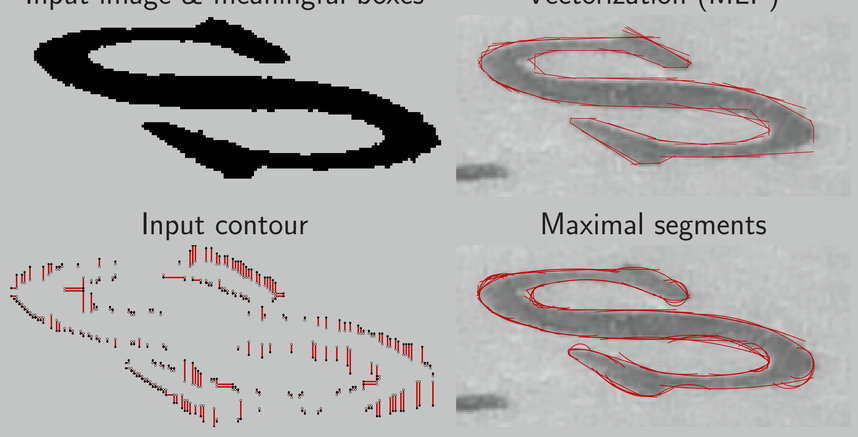
- 1-D intervals analyzed by GLP
- Interval endpoints:
  - • black (external) points
  - ○ white (internal) points
- **Solving GLP** = finding primitives enclosing ○ and not •
- Easy-to-implement, fast and incremental algorithm [3]

Experimental results

- I. Maximal segments and arcs with a complex synthetic contour
- II. Complete pipeline with a scanned character
- Compared with vectorization by MLP (Minimum Length Polyline)



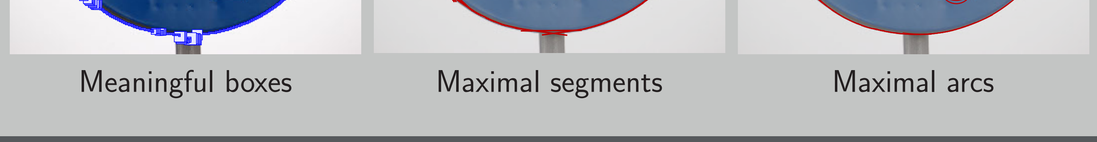
Input image & meaningful boxes — Vectorization (MLP)



Input contour — Maximal segments

1-D intervals — Maximal arcs

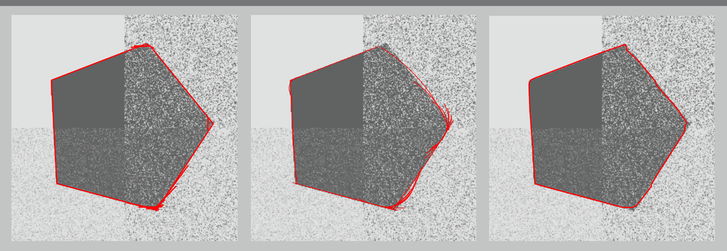
- III. Final results with a large image with 2 contours
  - External contour: 1,364 boxes
  - Internal contour: 1,234 boxes



Meaningful boxes — Maximal segments — Maximal arcs

Future works

- Our next step: exploit tangential cover to compute minimal number of primitives [4]
- Enables the calculation of a single contour representation based on maximal arcs and segments
- Compare our contribution to other approaches from state-of-the-art
- Evaluate their robustness with datasets of binary shapes (e.g. KIMIA)
- How to reconstruct shapes with other geometrical primitives (B-splines, etc.)?



Maximal segments — Maximal arcs — MLP

References

[1] A. Vacavant et al. A Combined Multi-Scale/Irregular Algorithm for the Vectorization of Noisy Digital Contours. Comp. Vision and Image Und., 117(4):438-450, 2013

[2] B. Kerautret and J.O. Lachaud. Meaningful Scales Detection along Digital Contours for Unsupervised Local Noise Estimation. IEEE Transactions on Pattern Anal. and Machine Intel., 34(12):2379–2392, 2012

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[4] F. Feschet and L. Tougne. On the Min DSS Problem of Closed Discrete Curves. Disc. App. Math., 151(1-3):138–153, 2005

antoine.vacavant@uca.fr