Circular Arc Reconstruction of Digital Contours with Chosen Hausdorff Error

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1. Context

Discrete contour representation :

- Many approaches exist for the problem of discrete curve representation with polygonal approximation
  (see for instance the recent work of [Feschet 2010] or [Sivignon 2011]).
- Address the problem of contour approximation by circular arcs.
- More compact representation for numerous shapes.

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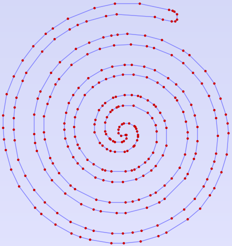
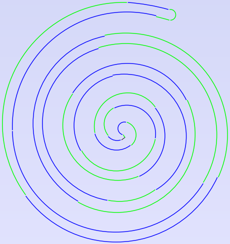
Curvature based polygon



$\delta_H = 2.018$
288 segments

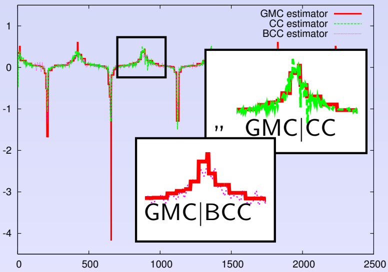
Circular arc representation

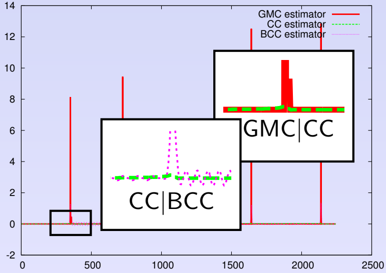


$\delta_H = 2.011$
27 arcs, 1 segment

Reconstruction based on curvature estimators :

- Exploit recent and robust to noise curvature estimators GMC [Kerautret and Lachaud 2009] or BCC [Malgouyres *et al.* 2008].
- Based on a simple split/merged based algorithm.
- Approximation of the Hausdorff distance δ_H between arc/source contour.





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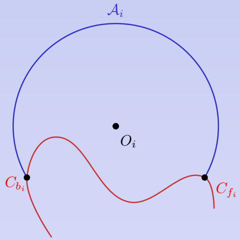

$$\delta_H(\mathcal{A}_i, \mathcal{C}_i) = \max\{\max_{b \in \mathcal{C}_i}\{\min_{a \in \mathcal{A}_i} d(a,b)\}, \max_{a \in \mathcal{A}_i}\{\min_{b \in \mathcal{C}_i} d(a,b)\}\}$$

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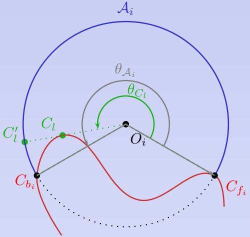

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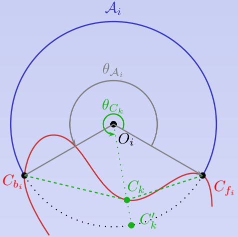

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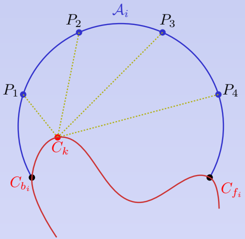

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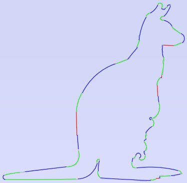
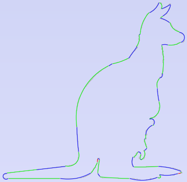
Comparisons by using other curvature estimator BCC [Malgouyres *et al.* 2008], and with recent method NASR [T.P. Nguyen 2010],

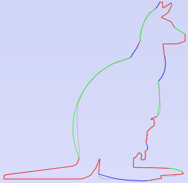
scale=2



GMC : $\overline{A} = 53$, $\overline{S} = 5$
184 ms. $\delta_H = 2.06539$



BCC $\overline{A} = 53$, $\overline{S} = 2$
961 ms. $\delta_H = \mathbf{1.99648}$

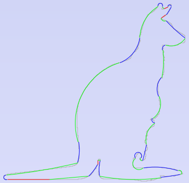


NASR $\overline{A} = 10$, $\overline{S} = 40$
115 ms. $\delta_H = 8.81655$

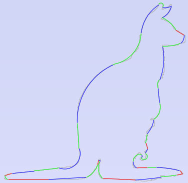
3. Results and comparisons

Comparisons by using other curvature estimator BCC [Malgouyres *et al.* 2008], and with recent method NASR [T.P. Nguyen 2010],

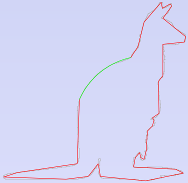
scale=4



GMC : $\overline{A} = 31$, $\overline{S} = 4$
261 ms. $\delta_H = \mathbf{3.94931}$

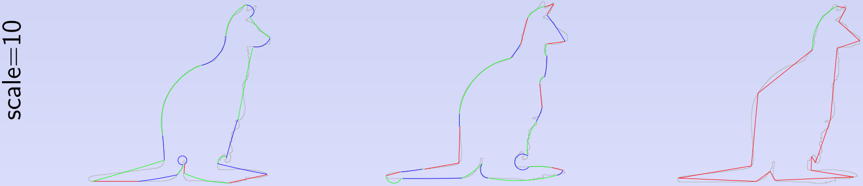


BCC $\overline{A} = 33$, $\overline{S} = 9$
2990 ms. $\delta_H = 6.11619$



NASR $\overline{A} = 1$, $\overline{S} = 34$
138 ms. $\delta_H = 9.84886$

Comparisons by using other curvature estimator BCC [Malgouyres *et al.* 2008], and with recent method NASR [T.P. Nguyen 2010],



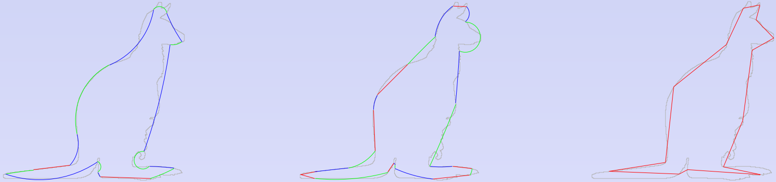
GMC : $\overline{A} = 17$, $\overline{S} = 3$
464 ms. $\delta_H =$ **10.2849**

BCC $\overline{A} = 20$, $\overline{S} = 9$
15596 ms. $\delta_H = 10.5289$

NASR $\overline{A} = 1$, $\overline{S} = 16$
171 ms. $\delta_H = 19.6977$

Comparisons by using other curvature estimator BCC [Malgouyres *et al.* 2008], and with recent method NASR [T.P. Nguyen 2010],

scale=15



GMC : $\overline{A} = 14$, $\overline{S} = 2$
619 ms. $\delta_H =$ **17.2402**

BCC $\overline{A} = 15$, $\overline{S} = 8$
33420 ms. $\delta_H = 17.7125$

NASR $\overline{A} = 0$, $\overline{S} = 14$
190 ms. $\delta_H = 32.8938$

3. More details ...

- Others comparisons with Visual Curvature polygonalisation method [Liu *et al.* 2008].
- More results available on the demonstration session.

[Sivignon 2011] I. Sivignon : A Near-Linear Time Guaranteed Algorithm for Digital Curve Simplification under the Fréchet Distance. In : Proc of DGCI 2011. pp. 333–345 (2011)

[Feschet 2010] Feschet, F. : Multiscale analysis from 1d parametric geometric decomposition of shapes. In : IEEE (ed.) Int. Conf. on Pattern Recognition. pp. 2102–2105 (2010)

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[Liu *et al.*2008] Liu, H., Latecki, L.J., Liu, W. : A unified curvature definition for regular, polygonal, and digital planar curves. Int. J. Comput. Vision 80(1), 104–124 (2008)

[Malgouyres *et al.*2008] Malgouyres, R., Brunet, F., Fourey, S. : Binomial convolutions and derivatives estimation from noisy discretizations. In : Proc. DGCI. pp. 370–379 (2008)

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