GEODESIC ATTRIBUTES THINNINGS AND THICKENINGS

Vincent MORARD, Etienne DECENCIERE, Petr DOKLADAL

MINES ParisTech, CMM – Centre de Morphologie Mathématique, Mathématiques et Systèmes
35, rue Saint Honoré 77305 Fontainebleau

Introduction

An **attribute opening** is an idempotent, anti-extensive and increasing operator that removes, in the case of binary images, all the connected components (CC) which do not fulfill a given criterion. When the increasingness property is dropped, more general algebraic **thinnings** are obtained. We propose in this paper, to use criteria based on the **geodesic diameter** to build algebraic thinnings for grayscale images. An application to the extraction of cracks is then given to illustrate the performance of the proposed filters. Finally, we will discuss the advantages of these new operators compared to other methods.

Attribute thinnings [1]

Let $I: D \rightarrow V$ *be a binary image with* $D \subseteq Z^2$ *and* $V = \{0;1\}$
Let $X \subseteq I$ be an object such that $X = \{X \in D \mid I(x) = 1\}$
Let $\{ Xi \}$ be the set of connected components of X
Let C_λ be a given criterion parameterized by λ

$$Att_\lambda(X_i) = \begin{cases} X_i & \text{if } X_i \text{ satisfies } C_\lambda, \\ \emptyset & \text{otherwise.} \end{cases}$$

With this attribute operator, we defined a filter, $\rho^{Att\lambda}(X)$, called an attribute thinning, which is **anti-extensive** and **idempotent :**

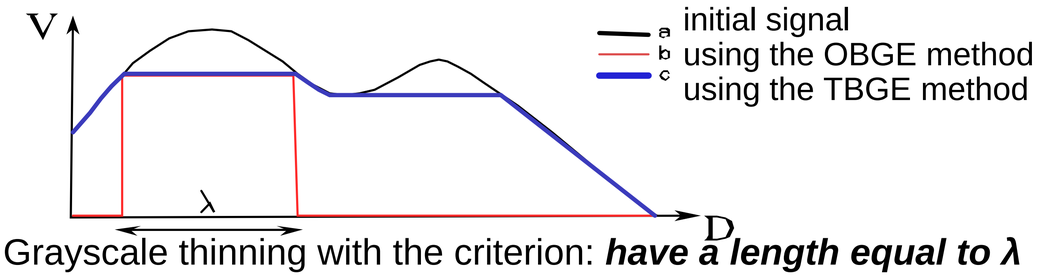
$$\rho^{Att\lambda}(X) = \bigcup \{ Att_\lambda(X_i), i \in I \}$$

➢ Binary to Grayscale Extension, like Opening (OBGE):

Let $f: D \rightarrow V$ *be a grayscale image with* $D \subseteq Z^2$ *and* $V = \{0,\ldots, N\}$
Let $T_h(f)$ be the threshold of f at level h

$$(\rho^{Att\lambda}(f))(x) = \sup \{ h \in \{0, \ldots, N\} \mid x \in \rho^{Att\lambda}(T_h(f)) \}$$

➢ Binary to Grayscale Extension, like Thinning (TBGE):



Grayscale thinning with the criterion: ***have a length equal to λ***

Geodesic attributes

➢ Geodesic diameter [2]:
Let x, y be two points from X and $dX(x,y)$ be the shortest path between x and y. The geodesic diameter is the longest geodesic arc within X:

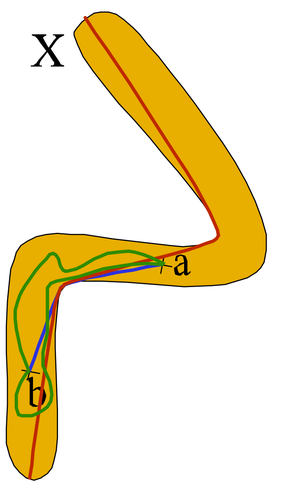
$$L(X) = \sup_{x,y \in X} dX(x, y)$$

➢ Geodesic elongation [2] :

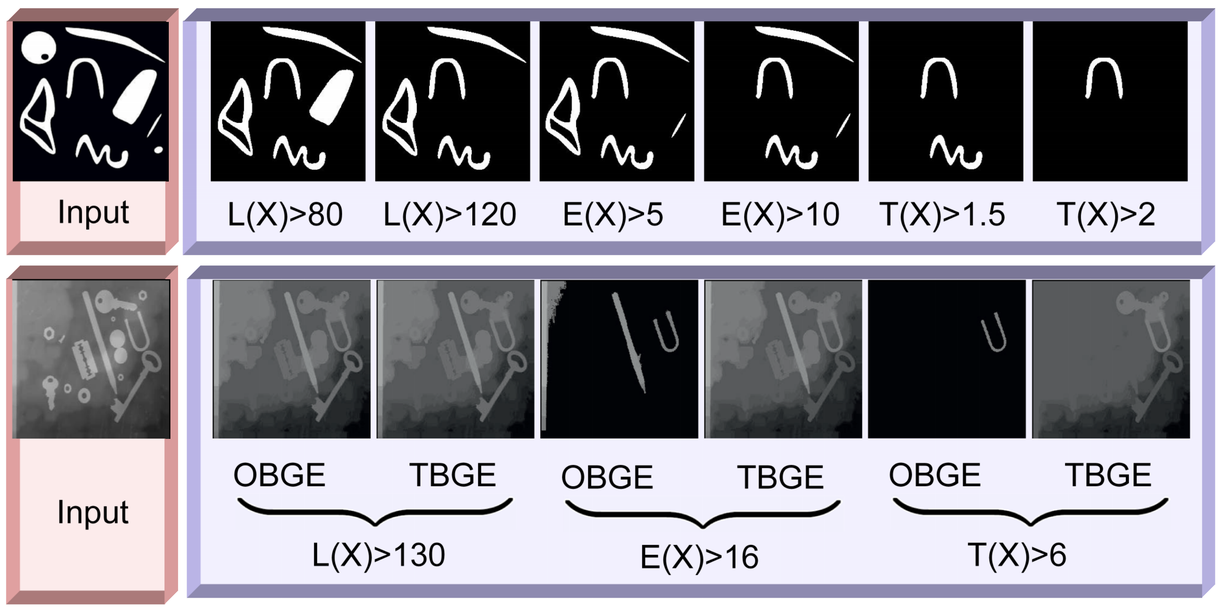
$$E(X) = \frac{\pi L^2(X)}{4S(X)}$$

➢ Geodesic tortuosity:

$$T(X) = \frac{L(X)}{L_{Eucl}(X)}$$

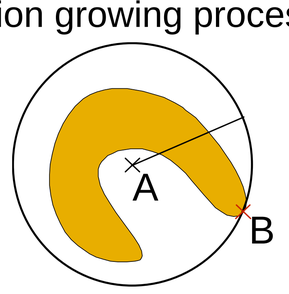


Geodesic attributes thinnings

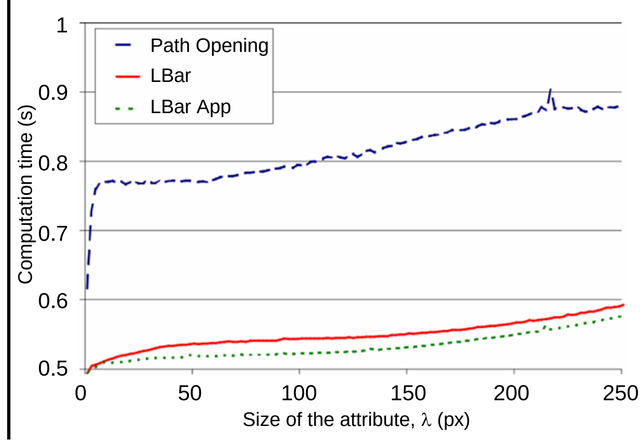


➢ **Barycentric diameter**

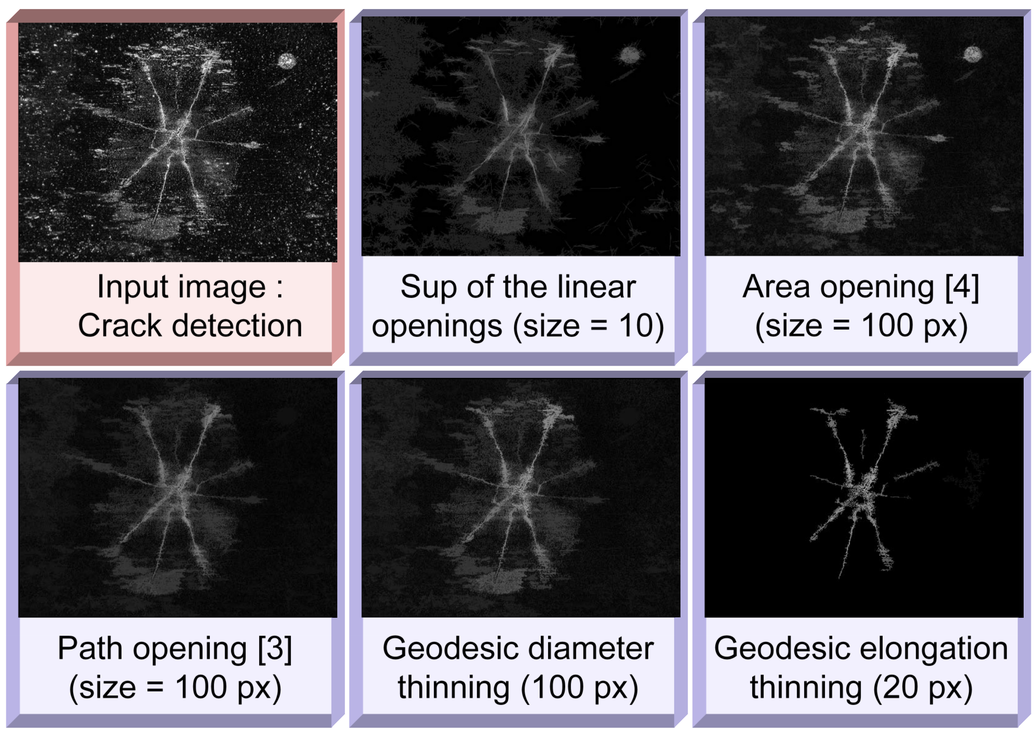
1) Barycentre of *X (point A)*
2) Farthest point from A (point B)
3) Region growing process (LBar App)
4) Region growing process (LBar)



➢ **Benchmark with path openings [3]**



Results : Crack detection



Conclusion & Perspectives

We have presented new attributes thinnings based on **geodesic criteria**. The extraction of long and elongated structures is easy and is made in an efficient way. These filters are **flexible** as we have a representation of the **length**, the **elongation** or the **tortuosity** of the fibres.

Future work will include granulometries and ultimate thinnings with geodesic attributes. The extension to 3D images will be straightforward as we only need to change the connectivity of these filters. Finally, we will work on the **barycentric diameter** theory.

Références

[1] Breen, E.J., Jones, R.: Attribute openings, thinnings, and granulometries, Computer Vision and Image Understanding, 64(3), 377–389 (1996)
[2] Lantuéjoul, C., Maisonneuve, F.: Geodesic methods in quantitative image analysis. Pattern Recognition 17(2), 177–187 (1984)
[3] Appleton, B., Talbot, H.: Efficient path openings and closings. Mathematical Morphology:40 Years On, pp. 33–42 (2005)
[4] Vincent, L.: Grayscale area openings and closings, their efficient implementation and applications. In: First Workshop on Mathematical Morphology and its Applications to Signal Processing, pp. 22–27 (1993)