Persistence of features for robust image matching

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1   Contexte

Image matching is a central problem of image/video processing and computer vision. Classical methods go through two independent steps. First, they extract some geometric features in the image (typically from a corner or blob detection algorithm) and second, they match these features across two images. This approach raises two problems. On one hand, there is no guarantee that the detection algorithm will select the same geometric features in the second image. On the other hand, parts of image 1 can be invisible in image 2 and as a consequence, some features will be incorrectly matched.
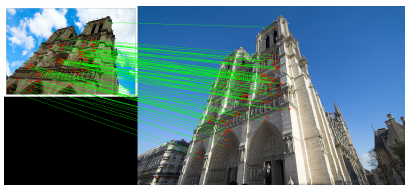

FIGURE 1 – Matching features between images

In order to tackle this stability issue, recent advancements in algebraic topology, and more precisely in persistence topology, have provided a measure on the stability of the topology of a metric space under the perturbation of a filtering function [2]. This measure has already given promising results in clustering [1] and should be extended to the problem of image matching, jointly on the feature detection algorithm and on the matching algorithm. A survey of early applications in computer vision is a good starting point [3].
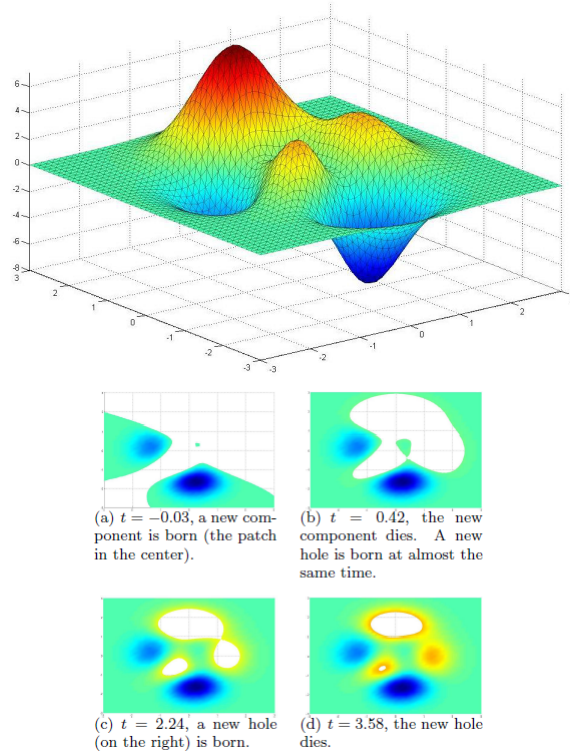
(a) $t = -0.03$, a new component is born (the patch in the center).

(b) $t = 0.42$, the new component dies. A new hole is born at almost the same time.

(c) $t = 2.24$, a new hole (on the right) is born.

(d) $t = 3.58$, the new hole dies.

FIGURE 2 – Persistent of homologies on sublevelsets of the function

2   Cadre

Le stage d'une duré de 2 à 3 mois se déroulera au sein de l'équipe de Géométrie de l'Information du Laboratoire d'Informatique de l'école Polytechnique, sous la direction de Frank Nielsen (`http://www.lix.polytechnique.fr/~nielsen/`) et Sylvain Boltz (`http://www.lix.polytechnique.fr/~boltz/`).

Références

[1] F. Chazal, L. J. Guibas, S. Y. Oudot, and P. Skraba. Persistence-based clustering in riemannian manifolds. Research Report 6968, INRIA, June 2009.

[2] H. Edelsbrunner, D. Letscher, and A. Zomorodian. Topological persistence and simplification. *Discrete & Computational Geometry*,

28(4) :511–533, 2002.

[3] D. Freedman and C. Chen. Algebraic topology for computer vision. Technical Report HPL–2009–375, HP Laboratories, 2009.