Multiresolution behavior of estimators of lengths and surfaces in discrete 3D space

Master 2 internship
Theme : computer image

Laboratory and host team

Team MIV (Models, Images and Vision)
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Supervision

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Key words : discrete geometry, estimation of length, area, asymptotic behavior

Duration : 6 months

Place : Illkirch (suburb of Strasbourg)

Intership gratification : 436 euros per month

General frame

To estimate the length of a curve or surface in a discrete space, there are typically two families of estimators :
- local estimators based on the division of the curve in patterns of fixed size.
- global estimators based on patterns whose length is not determined *a priori*, but results from the application of a procedure on the curve studied.

A way to evaluate these estimators is to observe their behavior for curves that are discretized from continuous reference curves. When the resolution tends to zero, the discretized curve "tends" to the reference continuous curve from which it is originated. It is then possible to measure the convergence speed of the length estimator for the reference-curve. However, on the one hand, work carried out in our team [TD03, DTZ09, Zou11] showed that local estimators do not converge to the reference length. On the other hand, global estimators are consistent but their extension to 3D for the areas calculation poses serious difficulties in its implementation (the determination of a general algorithm is a NP-complete problem).

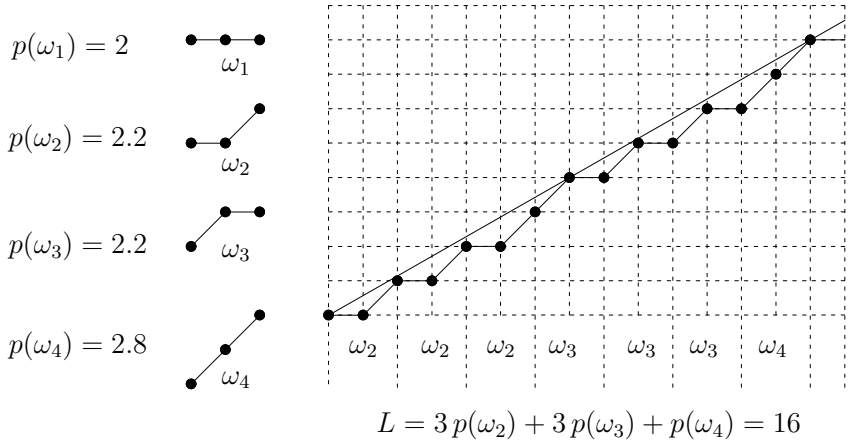

FIGURE 1 – Example of a local estimate of the length of a segment (extract of [Zou11]).

Positioning and scientific objectives

M. Tajine, A. Daurat and M. Zouaoui proposed in 2010 a new class of so-called semi-local estimators. They have the ability to converge towards the reference length. The extension of these semi-local estimators to 3D for the areas calculation is simple since it comes down to build a triangulation on a surface. Along with the theoretical study of the semi-local estimators properties in 2D, computer code was developed by S. Feng during an internship in 2013, allowing the use of these estimators and the validation of their properties.

Regarding the 3D, we started exploring the theoretical properties of semi-local estimators and internship we offer is part of this study. The first objective is to extend to the skew curves the results obtained on planar curves and to develop a program for both the result validation and the practical use of this class of estimators to determine the length of a skew curve. A second objective is to investigate the extension to the area calculation. To do this, we can generate the computer code for, on the one hand, the validation of the results already obtained in the team and, on the other hand, looking for properties for particular classes of surfaces (including convex surfaces). If time permits, we can also study these properties in a more theoretical perspective..

Proposed workplan

- Bibliographic study.
- Extension of 2D results to skew curves.
- Code generation for skew curves.
- Code generation for 3D surfaces.
- Validation and search properties in 3D.
- Report Writing.

Desired skills

- Mathematical bases,
- Knowledge in programming (C/C++ preferred),
- Autonomy and initiative,
- Knowledge in discrete geometry would be appreciated

Contact us for more information.

Références

[DTZ09] Alain Daurat, Mohamed Tajine, and Mahdi Zouaoui. Patterns in discretized parabolas and length estimation. In *DGCI*, pages 373–384, 2009.

[TD03] Mohamed Tajine and Alain Daurat. On local definitions of length of digital curves. In *DGCI*, pages 114–123, 2003.

[Zou11] Mahdi Zouaoui. *Mesures discrète pour l'imagerie*. PhD thesis, Université de Strasbourg, 2011.