Discrete Voronoi Diagrams and Applications to Surface Offsetting

Keywords: geometry processing, algorithmics, voronoi diagram, surface offsetting

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1 Research Topic

Voronoi diagrams are a fundamental concept in computational geometry, with a wide range of applications [Lévy and Liu, 2010]: anisotropic surface remeshing (Figure 1), feature preserving remeshing, collision detection, path planning, etc. There are many techniques to compute Voronoi diagrams, from diagrams on point clouds, to approximate Voronoi diagrams on general forms [Edwards et al., 2015].

In this internship, we are interested in a particular application of Voronoi diagrams in the context of additive manufacturing (3D printing): the computation of offset surfaces. Offset surfaces have important modeling purposes, as they can be used to quickly generate a mold of an object, and perform morphological operations like closing and opening, which are important to guarantee minimum thickness or minimum hole size in the fabrication process.

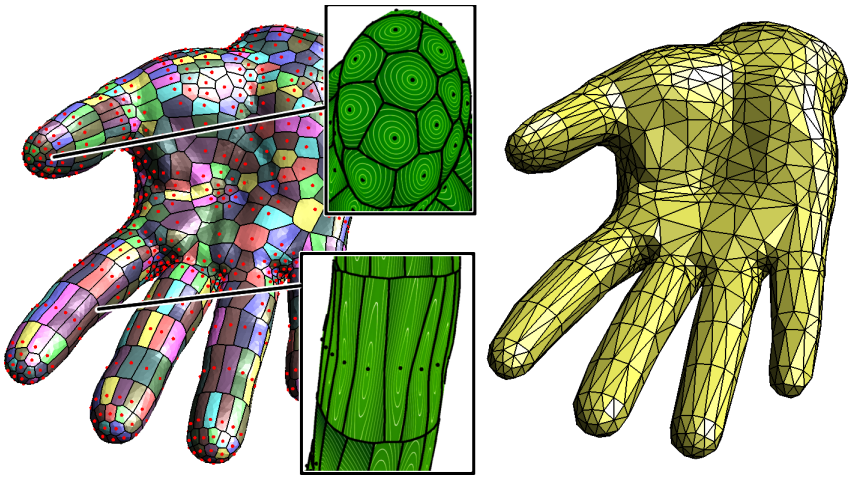

Figure 1: Anisotropic remeshing via Centroidal Voronoi Tesselations [Lévy and Liu, 2010].

Recent papers have been devoted to fast computation of offset surfaces [Wang and Manocha, 2013], or approximation of thereof (see Figure 2, [Martinez et al., 2015]). We propose to explore a new paradigm involving so-called half-space Voronoi diagrams [Fan et al., 2011], in order to compute offset surfaces in a discrete setting (see Figure 3).

The student will first need to understand the 2D sequential offsetting algorithm that we propose. Then, the goal is to devise an extension to 3D that can be computed in parallel on the GPU (using OpenCL). The student will have to analyze the sequential and parallel complexity of his program, and compare it with other existing methods.

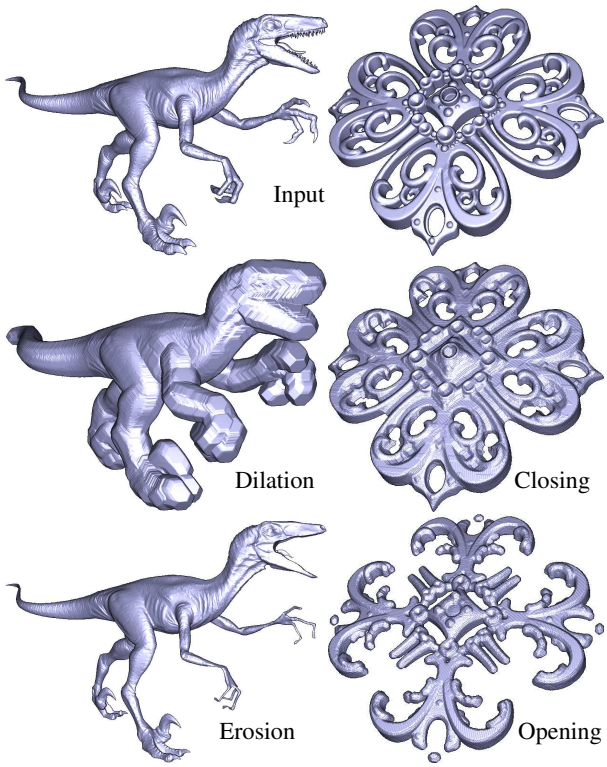

Figure 2: Approximate offset surfaces using [Martinez et al., 2015].

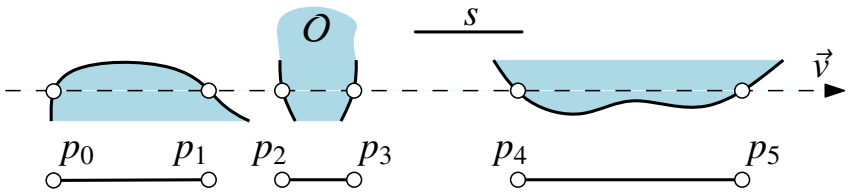

Figure 3: **Discrete morphological operations.** The surface is sampled along rays intesecting the 3D model, which are used to compute dilations and erosions [Martinez et al., 2015].

2 Prerequisites

- Good programming skills in C/C++.
- Not afraid of GPU programming (using OpenCL). Previous knowledge is a plus.
- Not afraid of geometry and algorithmic complexity.

References

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