Digital Representation of 3D Grain Boundaries using subdivision surfaces

E. Gomes, K. Verbeken and L.A.I Kestens

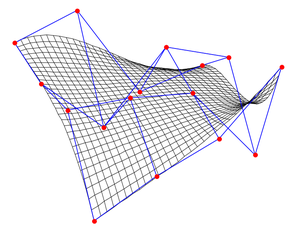
Department of Materials Science and Engineering, Ghent University
Technologiepark 903, B-9052 Gent, Belgium

email: Edgar.Gomes@UGent.be

Introduction

Grain boundaries are important microstructural elements that can be represented by surfaces. Their complexity demands a 3D free-form, watertight and smooth representation.

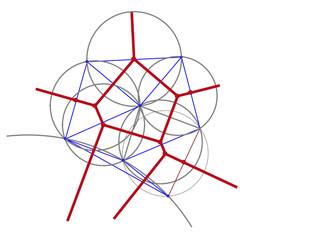
Subdivision surfaces provide significant gains over a NURBS (Non-uniform rational B-spline) representation.



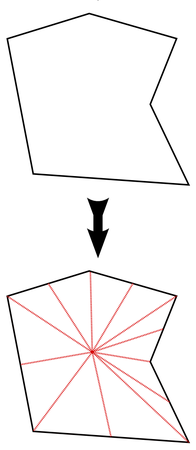
Subdivision surfaces:

- allow creases (sharp edges).
- allow arbitrary topology (not just four-sided domains).
- eliminate many of the problems that can occur at seams when moving.

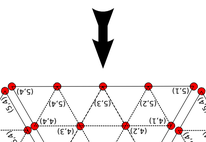
Implementation



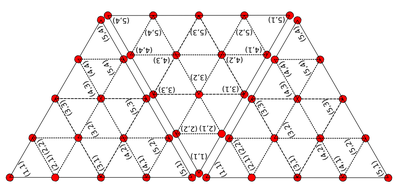
Weighted Voronoi



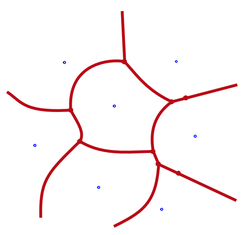
Flat surface



Triangulate

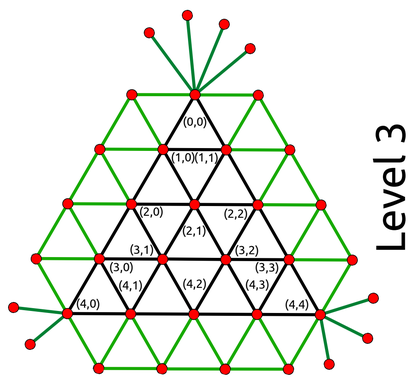


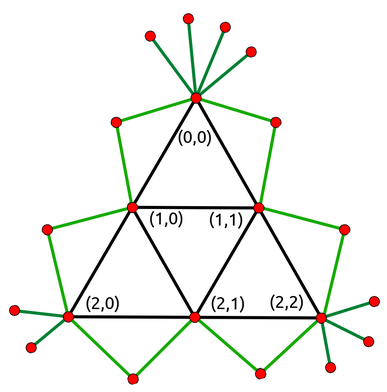
Subdivide

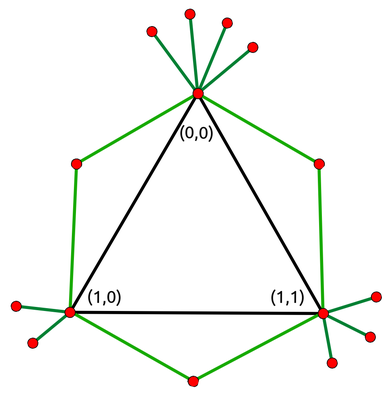


Free-form grains

Subdivision Surfaces



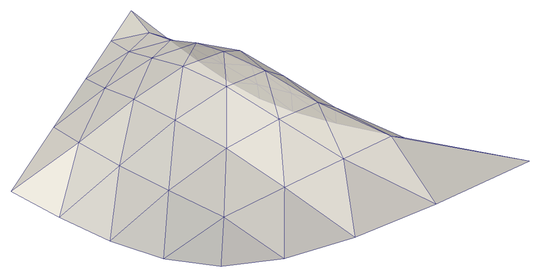


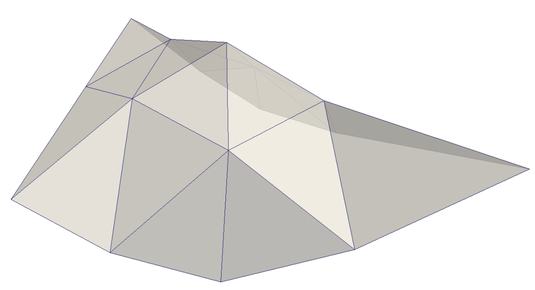


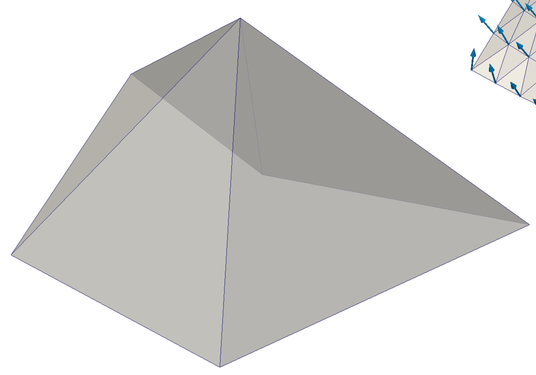
Level 3

Level 1

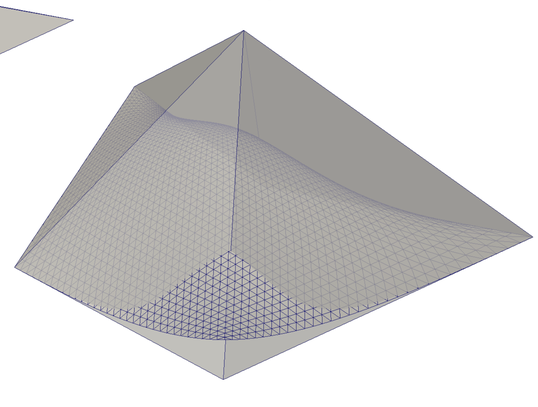
Level 0



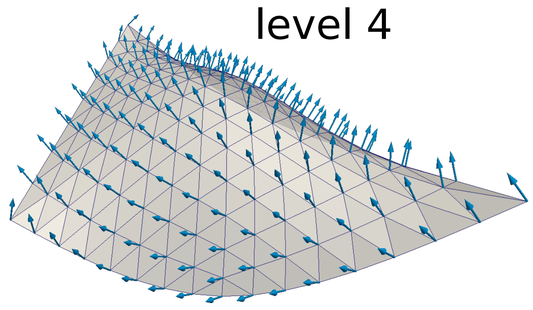




Comparison of levels 0 and 5 (~ limit surface)

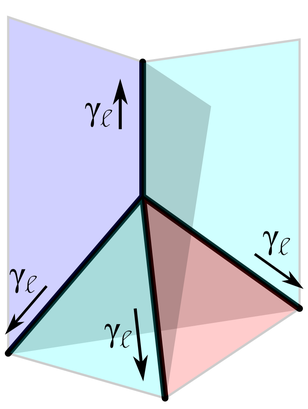


Normals on the limit surface at level 4



Results

Stabilization of quadruple junctions assuming isotropic grain boundary surface tension.



$$\sum_{i=1}^{n} \gamma_i^l = 0$$