PhD thesis proposal (octobre 2013 – septembre 2016)

Title: Stochastic models and geometry of distance maps

Location: LGF, UMR CNRS 5307 - IFRESIS, SFR INSERM 143
Ecole Nationale Supérieure des Mines de Saint-Étienne (ENSM-SE),
158 Cours Fauriel, 42023 Saint-Étienne

Contact: Dr. Yann GAVET (gavet@emse.fr) / ***Mathematical Imaging and Pattern Analysis Group***
Grant: ANR (French Agency for Research) CorImMo 3D project –1650 euros tax free / month
Candidate profile: Student with a master of science in the field of image analysis/processing or applied mathematics, with good skills in programming (C, Matlab).

- **Objective and Subject Matter:**

The goal of the Ph. D. thesis is to model and simulate cells tessellation in the case of non-Euclidean distances obtained by random fields, in order to predict their evolution and analyze their geometric and morphological parameters. The underlying mathematical and computational disciplines are the theory of random fields (e.g., Gaussian and t-student fields) [1], integral geometry [2], the mathematical morphology (e.g., non-linear filtering and watershed operator) [3], and topology (e.g., distance maps and Voronoi diagrams) [4]. This work will allow us to simulate real geometric structures such as cornea mosaics or material grains, as well as model the evolution at short and long term (for living tissues). Our research team is experienced in these fields (3D approach [11]).

- **Targeted application issue:**

The cornea is the transparent front part of the eye that covers the iris, pupil, and anterior chamber. The corneal endothelium is a single layer of cells on the inner surface of the cornea. The number of cells is capital, as well as their sizes and shapes [8]. Our research team has proposed methods to segment images of cornea cells (2D approach, [9-10]) and reconstruct the surface of the grafts (3D approach [11]).

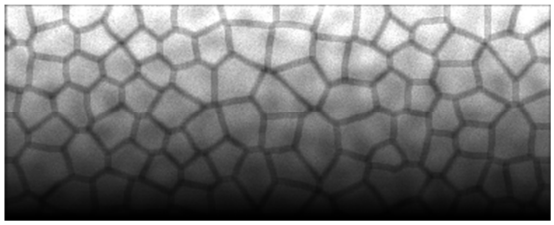

Figure 1: Simulation of an image of the corneal endothelium by specular microscopy.

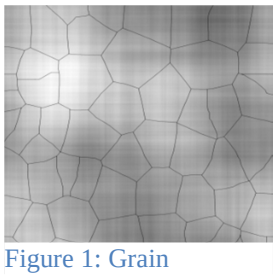

Figure 1: Grain boundaries simulation.

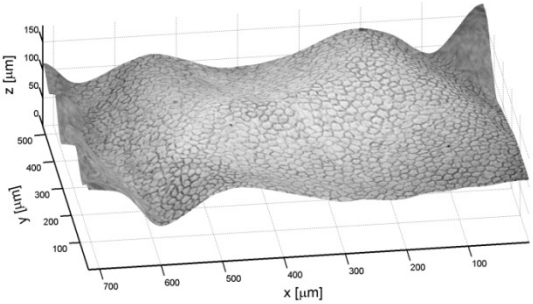

Figure 3: 3D reconstruction of the cornea.

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