Torsion of particle trajectories trough pore space and its estimation using information on local pixel configurations

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Introduction

The torsion of trajectories through the pore space is an important quantity for the characterization of porous media (Fig. 1) with respect to filter efficiency and deposition rates of two-phase flow. A typical application is to isolate mammalian cells from body fluids or liquid culture media [1] [2] [3] [4]. The filter efficiency depends on the curvature as well as the torsion of cell trajectories through the pore space [6] [7].

Discrete torsion calculation

Our aim is to present a new algorithmic approach of computing the local torsion from skeletons in 3D images. The local torsion τ is estimated based on the discrete version

$$\tau \approx \frac{(\Delta f_1 \times \Delta f_2) \cdot \Delta f_3}{\|\Delta f_1 \times \Delta f_2\|^2}$$

of the usual differentialgeometric formula for the torsion of a parametric function $f : \mathbb{R} \to \mathbb{R}^3$ where the $\Delta f_k(t)$ are differences of f in typical points of the skeleton,

$$\Delta f_k(t) = f(t + k\Delta t) - f(t + (k-1)\Delta t), \quad k = 1, 2, 3$$

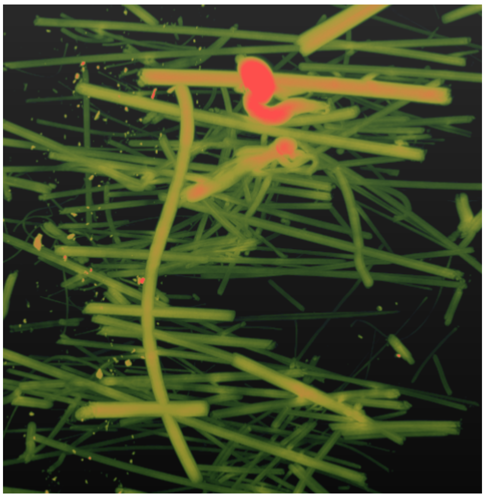

Figure 1. 3D image of a part of a glass fiber filter, produced at European Synchrotron Radiation Facility Grenoble. Resolution 0.65 µm

Results and Discussion

The proposed algorithm is evaluated based on an outer Jordan discretization of a uniformly rotated and shifted theoretical parametric function. It is shown, that the estimation error of the torsion depends strongly on the curvature.

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