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Differential constraints for iteratively generated curves

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Résumé

Roughness is a complex concept, that is multiscale, and based on the study of the local behavior of a curve or a surface in a given neighborhood. A large number of conventional statistical parameters are currently available to attempt to appreciate this concept in the different application areas that make use of it. But it is often difficult, for a given application domain or a special need, to know precisely which parameter(s) connect(s) the topography of a surface to the physical phenomena that it undergoes.
We believe that a geometric characterization should be more suitable.
We suggest to control roughness by exploiting the differential behavior of curves and surfaces. We are interested in the structures generated by the Boundary Controled Iterated Function System (BC-IFS) model. The latter is of interest to encompass Bézier, B-Spline, subdivision and NURBS curves and surfaces.
But in general, the topologies and geometries produced by the BC-IFS are very varied and difficult to master. C0 continuity constraints make it possible to control the topology and thus to construct curves, surfaces or structures of fractal topology (Sierpinsky triangle, Menger carpet, ...). However, the geometry is, most of the time, very chaotic and the shapes often have an unpredictable roughness.
In this work, we propose to extend the C0 continuity constraints to higher orders, to control the degree of differentiability of curves generated by BC-IFS. We show that by applying adequate continuity constraints, we obtain the subdivision matrices of the Bézier and Spline curves.