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Creative freedom for computational mesh generation in deal.II

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Many modern 3D modelling tools offer the possibility of creating complex geometries in a very straightforward way (what is usually called creative freedom). Such softwares are extensively used in computer graphics (video-gaming, animation studios) and they are able to produce smooth surfaces exploiting the subdivision surface modelling which was derived by Edwin Catmull and Jim Clark in 1978 as a generalisation of bi-cubic uniform B-spline surfaces to arbitrary topology. We believe that a bridge between such computer graphics techniques and scientific Finite Element computations can open new perspectives for the deal.II users community.

We present the possibility to use such tools to generate a complex geometry to be integrated as a computational mesh inside the deal.II library.

To demonstrate the possibilities of our approach we use Blender, an Open Source python based software which has emerged as one of the most successful 3D modelling tool. We believe that its success is due both to its outstanding possibilities and spreading, in particular we stress that Blender

- is Open Source software,
- allows for straightforward geometry creation using Graphic User Interface,
- is highly scriptable using a Python 3 based Text User Interface,
- has a large user community (tutorials, manuals, youtube channel, wikipedia).

We use the Open Asset Import Library (ASSIMP) to convert the standard Blender format into a deal.II geometry through the interface that is already inside the library. These passages allow deal.II users to generate complex three dimensional surfaces in a very controllable way.

We prove the capabilities of our approach in different framework varying from Boundary Element Method for Stokes flows, to the discretisation of surface operators on non trivial geometries.

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