A Generic High-Quality Meshing Framework

Josef Weinbub[1], Johann Cervenka[2], Karl Rupp[3], Siegfried Selberherr[4]

[1] Graduate Research Assistant and Presenting Author,
Institute for Microelectronics, TU Wien, Vienna, Austria e-mail: weinbub@iue.tuwien.ac.at
[2] Postdoctoral Research Associate, Institute for Microelectronics, TU Wien
[3] Graduate Research Assistant, Institute for Microelectronics and
Institute for Analysis and Scientific Computing, TU Wien
[4] Professor, Institute for Microelectronics, TU Wien

We present the generic mesh generation, adaptation, and classification library ViennaMesh [1], which is capable of handling high-quality meshes based on orthogonal software modules. Currently it supports two- and three-dimensional, unstructured meshes. One of the key aspects is, that the library provides a unified interface to various publicly available mesh generation kernels, such as Netgen and TetGen. Moreover, we have developed a hull mesh adaptation tool which automatically improves the mesh quality [2]. Furthermore, a mesh classification tool is provided for mesh quality evaluations.

The implementation is based on the C++-programming language and facilitates modern programming techniques, namely generic- and meta-programming. As an example, the following code snippet depicts our meta-programming approach to select a specific mesh generation kernel from a set of available kernels during compile time.

```
1 typedef make_map<
2   key::celltype, key::algorithm, key::criteria, key::topoDim, key::geomDim,
3   val::simplex,  val::adv_front, val::delaunay, val::three,   val::three >::type  properties;
4 typedef generate_mesh_kernel<properties>::type                                    mesh_kernel;
```

The associative relations in Line 2 and Line 3 define the properties of the requested meshing kernel. A meta-function evaluates the requested properties and selects a suitable mesh kernel to be further used as basis for the mesh generation task (Line 4). In this case a Delaunay simplex volume mesh generator featuring the Advancing Front algorithm is selected.

Our generic approach emphasizes the extension capabilities, because new associations can be added easily. Moreover, a decoupling of the actual meshing kernel from the application is achieved, as the kernel is selected based on provided features rather than statically relying on a specific module. The focus of the implementation is therefore on extendibility and on exchangeability. Extendibility refers to the ability of adding additional meshing related modules, like mesh adaptation algorithms. Exchangeability denotes the ability to conveniently switch between meshing tools, for instance, switching the volume meshing kernel from Netgen to TetGen.

In conclusion, our approach provides a flexible mesh back-end for applications in the field of scientific computing. This work is supported by the European Research Council through the grant #247056 MOSILSPIN.

References

[1] *ViennaMesh*. http://www.iue.tuwien.ac.at/software/viennamesh/.

[2] Franz Stimpfl et al. A Robust Parallel Delaunay Mesh Generation Approach Suitable for Three-Dimensional TCAD. In *Proc. Sim. of Semic. Proc. and Dev.*, pages 265–268, 2008.