

TiGL, an Open Source Computational Geometry Library for Parametric Aircraft Design

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Abstract

The design and optimization of aircraft typically involves several different simulation codes. Many of them require a description of the outer or internal geometry of the aircraft – such as CFD simulations. Here, we present the open source library TiGL, which serves as a central geometry modeler for all those tools involved in the conceptual and preliminary aircraft and helicopter design phase. This library is a joint development from the open source community, foremost the German Aerospace Center, Airbus Defense and Space, and RISC Software GmbH. To create a full 3-dimensional model of the aircraft, it uses the parametric CPACS [1] description as its input, which amongst other things includes geometry cross sections and their relative positioning to each other in a hierarchical manner.

At its core, TiGL has a parametric geometry modelling kernel based on OpenCASCADE, which is used to generate the NURBS based surfaces of the aircraft. It models the external and internal geometry of an aircraft such as wings, flaps, fuselages, engines or structural elements of the wing. The library offers many functions to interact with the generated geometry. These include functions for geometry exports into common file formats (STEP, IGES, STL, VTK), to sample points on the aircraft surface, to project points onto the surface, to compute intersections of planes with the aircraft, or functions to create 3D surface and volumetric meshes of the model. To do so, many different algorithms are involved, which include NURBS interpolation and approximation, surface skinning, computation of intersections and the projection of points onto the surface.

Although TiGL is written in C++, it also ships with bindings to other programming languages, which are currently C, Python, Java, and MATLAB. In addition to the library, the application TiGL Viewer is part of the TiGL package, which is an OpenGL based GUI that displays the 3-dimensional geometries created by TiGL. It allows a convenient access to TiGL functions and to execute small scripts to e.g. convert file formats or create screenshots and animations. We are using an open software development process that allows also external contributors to fix and further extend it via pull request. The TiGL library published under the Apache License 2.0 and can be downloaded from <https://github.com/DLR-SC/tigl>.

References

1. B. NAGEL AND D. BÖHNKE AND V. GOLLNICK AND P. SCHMOLLGRUBER AND A. RIZZI AND G. LA ROCCA AND J.J. ALONSO. Communication in Aircraft Design: Can we establish a Common Language?. 28th International Congress of the Aeronautical Sciences, Brisbane, Australia, 2012.