Solar Car Parametric Design

MSc Project Proposal

1. Introduction

The Bridgestone World Solar Challenge is a biennial solar-powered car race which covers 3,022 km through the Australian Outback from Darwin to Adelaide. The objective of this competition is to promote research on solar-powered cars where teams from universities and enterprises participate. The World Solar Challenge is designed to motivate students into science, engineering, technology, and sustainable energy and teaches them the importance of teamwork.

Solar Team Twente consists of students from the University of Twente and Saxion Hogeschool in Enschede. The team started in 2005 and participated in all subsequent races in the Challenger Class where the goal is to travel the distance as quickly as possible.

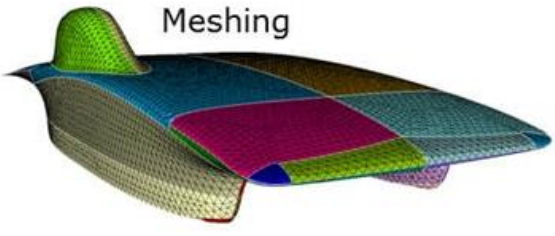
2. Problem Description

For the design of the aerodynamic shape of the solar car a combination of analysis methods is in use by Solar Team Twente. For example, the 2D airfoil analysis & design program XFOIL is used to design the longitudinal cross-sections of the body and the wheel cowlings. These cross-sections are then input in the design of the full 3D geometry. This 3D geometry is discretized and a volume grid around the body is generated. The volume grid is then input for a numerical simulation method that solves the Reynolds-averaged Navier-Stokes equations. This design process for the 3D problem is time-consuming. Especially in the preliminary design phase there is a need for a fast numerical tool chain for accurate 3D aerodynamic analysis and design.

In this project you will develop a set of tools for the parametric description of the solar car external surface. This parametric description is input for the structured grid generator.

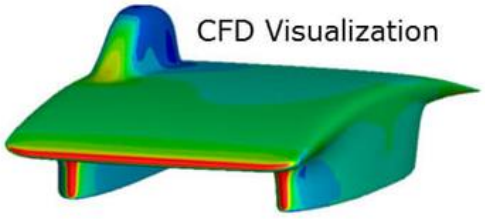
Part of the project are the following elements:

- Literature study
- Mathematical formulation of the parametric surface description
- Mathematical definition of the structured surface grid generator
- Discretization of the equations
- Implementation in Fortran(?)
- Preliminary design(s) for the 2019 solar car
- Numerical flow simulation with a panel method
- Discussion of the numerical results
- Report



3. Your profile

- Basic knowledge of fluid dynamics
- Knowledge of numerical analysis and algorithm development
- Knowledge of a high level programming language



4. Project details

- The work will be carried out at University of Twente.
- The duration will be 8 months

5. Literature

Some links to literature on the panel method and CAD modeling:

- J. Katz, A. Plotkin, “Low-Speed Aerodynamics”, Cambridge University Press, 2001.
- A. van Garrel, “Multilevel Panel Method for Wind Turbine Rotor Flow Simulation”, PhD thesis, University of Twente, 2016.
- L. Piegl, W. Tiller, “The NURBS Book”, Springer, 1997.
- Rhinoceros: create, edit, analyze, document, render, animate, and translate NURBS curves, surfaces, and solids, point clouds, and polygon meshes.
- CGAL: efficient and reliable geometric algorithms in the form of a C++ library.
- OpenVSP: a parametric aircraft geometry tool.
- FreeCAD is a parametric 3D modeler.
- SALOME is an open-source software that provides a generic platform for Pre- and Post-Processing for numerical simulation.
- Axel is an algebraic geometric modeler for the manipulation and computation with curves, surfaces or volumes described by semi-algebraic representations.
- G+Smo is an open-source C++ library of mathematical tools for geometric design and numerical simulation.

6. Contact information

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AvG: ground effect