Oral presentation | Turbulence simulation (DNS,LES,RANS)
Turbulence simulation(DNS,LES,RANS)-V
Fri. Jul 19, 2024 10:45 AM - 12:45 PM Room B

[8-C-02] Space–Time Computational Analysis of Car and Tire Aerodynamics with T-Splines Discretization

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Keywords: Car and tire aerodynamics, Isogeometric Analysis, T-spline, Space–time

Space–Time Computational Analysis of Car and Tire Aerodynamics with T-Splines Discretization

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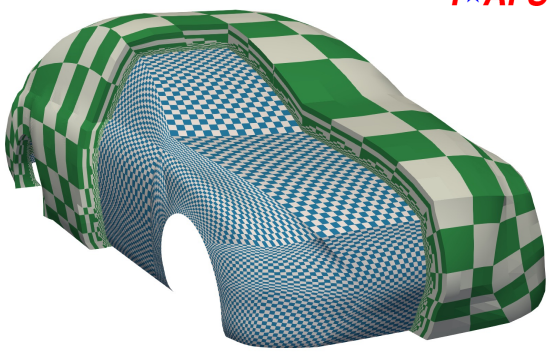
T★AFSM



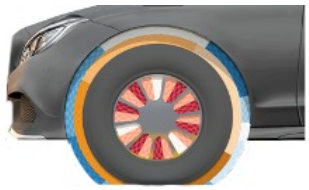
Surface Refinement with T-splines

Abstract

The purpose of the study is to conduct the computational flow analysis of an entire car and its rotating tires, with the ST-SI-TC-IGA and T-splines for local mesh refinement. With the T-splines local refinement, significantly more detailed vortex generation and flow separation behavior will be captured, while keeping the mesh size at a reasonable level.

Isogeometric Analysis

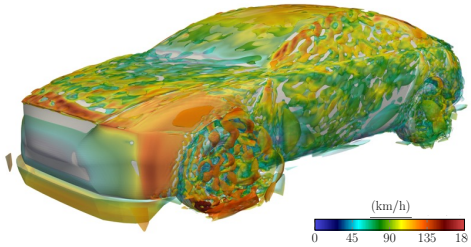
Isogeometric analysis (IGA) is increasing in flow simulations. The IGA uses higher order basis functions, such as nonuniform rational B-splines (NURBS), that give us smooth representation. Using boundary conforming IGA, the exact, or close to exact, representation of the geometry becomes possible. Moreover, it provides straight connection between computational flow analysis and computer-aided design.



ST-SI-TC-IGA

Local Mesh Refinement with T-Splines

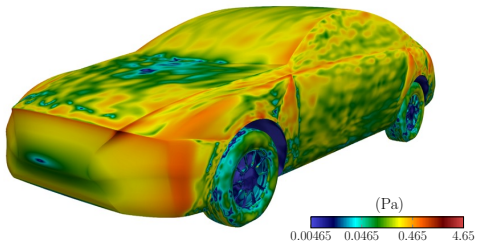
Using NURBS basis functions requires a block-structured mesh(1). Within each block, the knot vector along each parametric direction is unified. With the introduction of the T-splines, that restriction can be removed. In this research, we use T-splines, with techniques similar to those introduced in (2) and (3), to have efficient meshes in the context of IGA. Thus, a closer representation of complex geometries can be achieved without influencing the mesh topology of far field.



Flow Patterns

Space–Time IGA with Slip Interface and Topology Change (ST-SI-TC-IGA)(4)

To simulate the car and tire aerodynamics with tire rotation, road contact, and deformation, the ST-SI-TC-IGA is used. This is a synthesis of the ST-SI(5), ST-TC(6), and ST-IGA(7). ST-SI enables a moving mesh that tracks the geometry of moving structures such as tires and wheels. At the same time, the moving mesh can be flexibly connected to a stationary global mesh, as long as the topology of the meshes at the interface between them (SI) are close to identical. ST-TC allows the mesh to collapse at 0 thickness area while keeping the connection of mesh topology. The ST-SI-TC-IGA enables computational flow analysis with tire rotation, road contact, and deformation.



Wall Shear Stress

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