Research Papers on 'Aeronautical'

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Paper 1:

Development and Comparison of Model-Based and Data-Driven Approaches for the Prediction of the Mechanical Properties of Lattice Structures

Date: 2025-01-10

Time: 07:38:24

Authors:

Chiara Pasini, Oscar Ramponi, Stefano Pandini, Luciana Sartore, Giulia Scalet

Summary:

- Lattice structures have great potential for several application fields ranging from medical and tissue engineering to aeronautical one. Their development is further speeded up by the continuing advances in additive manufacturing technologies that allow to overcome issues typical of standard processes and to propose tailored designs. However, the design of lattice structures is still challenging since their properties are considerably affected by numerous factors. The present paper aims to propose, discuss, and compare various modeling approaches to describe, understand, and predict the correlations between the mechanical properties and the void volume fraction of different types of lattice structures fabricated by fused deposition modeling 3D printing. Particularly, four approaches are proposed: (i) a simplified analytical model; (ii) a semi-empirical model combining analytical equations with experimental correction factors; (iii) an artificial neural network trained on experimental data; (iv) numerical simulations by finite element analyses. The comparison among the various approaches, and with experimental data, allows to identify the performances, advantages, and disadvantages of each approach, thus giving important guidelines for choosing the right design methodology based on the needs and available data.

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Paper 2:

Implementation of Immersed Boundaries via Volume Penalization in the Industrial Aeronautical Computational Fluid Dynamics Solver CODA

Date: 2025-01-07

Time: 20:26:46

Authors:

Jonatan Nunez, David Huergo, Diego Lodares, Suyash Shrestha, Juan Guerra, Juan Florenciano, Esteban Ferrer, Eusebio Valero

Summary:

- We present the implementation and validation of an immersed boundary volume penalization method in the computational fluid dynamics solver CODA (from ONERA, DLR, and Airbus). Our goal is to model and simulate turbulent fluid flows in complex 3D aerodynamic configurations through the numerical solution of the Reynolds--averaged Navier--Stokes equations using the Spalart--Allmaras turbulent model. To do that, an immersed boundary method has been implemented in CODA and an efficient preprocessing tool for the construction of unstructured hexahedral meshes with adaptive mesh refinement around immersed geometries has been developed. We report several numerical examples, including subsonic flow past the NACA0012 airfoil, transonic flow past the RAE2822 airfoil, subsonic flow past the MDA30P30N multi-element airfoil, and subsonic flow around the NASA high-lift CRM aircraft. These simulations have been performed in the CODA solver with a second-order finite volume scheme as spatial discretization and an implicit backward Euler scheme based on the matrix-free GMRES block-Jacobi iterative method. The reported numerical simulations are in good agreement with their corresponding experimental data. These encouraging results allow us to conclude that the implemented immersed boundary method is efficient, flexible, and accurate and can therefore be used for aeronautical applications in industry.