High-accurate meshless formulations for non-smooth compressible flows

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Numerical simulation is nowadays a fundamental tool in science and engineering. It is involved in almost every discipline, and it is used in almost every field of research. In particular, computational fluid dynamics (CFD) has become an essential tool in both design and research. The development of numerical methods for the simulation of problems involving highly complex geometries, which are frequent in many engineering problems, remains a very active research field in computational fluid dynamics. However, current CFD methods suffer from a series of drawbacks: The use of CFD in the aerospace design process is severely limited by the inability to accurately and reliably predict turbulent flows with significant regions of separation and; nowadays, the standard numerical techniques in CFD are mainly grid-based methods. Mesh generation and adaptivity continue to be significant bottlenecks in the CFD workflow. In this context, the use of meshless methods may be interesting for problems involving deformable or moving boundaries in the propagation media or multiphase flows. Moreover, these methods do not require a mesh for the discretization, and then they can overcome one of the most important bottlenecks in the design process. In this work, we propose a new high-accurate, stable and low dissipative meshless method based on a Galerkin discretization of a set of conservation equations on an arbitrary Lagrangian Eulerian (ALE) approach, using moving least squares as weight functions for the Galerkin discretization. Differently to most common smooth particle hydrodynamics (SPH) approaches, the proposed method uses Riemann solvers instead of the artificial viscosity approach to prevent oscillations near shocks. The stability of the scheme is achieved by the recent a posteriori multi-dimensional optimal order detection paradigm. Using moving least squares (MLS) functions the partition of unity property is verified even near shocks, which allows the method to obtain very accurate results.

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Biography

Xesus Nogueira has his expertise in Computational Fluid Dynamics. He earned his PhD degree from University of A Coruna, Spain in 2009. He was Visiting Professor during the period 2011-2012 at Arts et Metiers ParisTech, France, and he is currently an Associate Professor in the Civil Engineering School at University of A Coruna. His research interest is focused on computational fluid mechanics, in particular high-order methods for compressible and incompressible flows. He has received the Juan C. Simo Young Investigator Award from SEMNI, the Spanish Society for Numerical Methods in Engineering.

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