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P R O J E C T

Development of low-order shock-capturing scheme for discontinuous Galerkin method

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A B S T R A C T

Computational challenges in hypersonic flow simulations are crucial to develop technological application ranging from space vehicle design to mitigation of space debris. Despite a vast range of numerical method used in Computational Fluid Dynamics (CFD), the simulation of hypersonic flows remains a challenge mainly because of the critical phenomena occurring along the shock.

The Discontinuous Galerkin Method (DGM), implemented on the multi-physics CFD platform Argo (developed at Cenaero[1]) is a high-order method that has shown promising results to tackle different kinds of flows. The DGM approximates each cell of the domain by a polynomial of order p which needs to be specified by the user before the computations. Until recently, the software used the interior penalty method (IP) [1] to tackle the diffusive term. The inconsistency of the scheme at low order impose the user to start the computation with a high order ($p \geq 1$). This constraint imposed by the method doesn't allow to capture the thin strong shock region at low order. To remedy this situation, a new method for the diffusive term has recently been implemented. The second scheme of Bassi-Rebay [2] allows computing the flow without any constraint on the order of the DGM method.

The aim of the project is to develop a robust shock-capturing scheme for the DGM by assessing the BR2 in the case of a 2D half-cylinder (perfect gas). The recent tests (Mach 3.25) in p=0 showed that the method is stable in this case. The goal is now to increase the precision of the method and use artificial viscosity to tackle the spurious oscillations around the shock wave. It would also be interesting to compare the IP and the BR2 scheme in high order. Finally, adding the physicochemical phenomena by reproducing the case of Knight [3] is considered.

KEY WORDS: *Computational Fluid Dynamics, Discontinuous Galerkin Method, hypersonic, shock, hybrid solver, Argo Platform, Interior Penalty, second scheme of Bassi-Rebay*

Suggested Evaluation Team

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[1] http://www.cenaero.be/