M. Halûk Aksel

A Cartesian method for the solution of the steady-state three-dimensional Euler equations will be developed for Cartesian grids. This method will be used to overcome the difficulties associated with geometric complexities and adaptation problems encountered in structured and ordinary unstructured methods. In addition, the developed code will be fully automatic to eliminate the user interference between the mesh generation and solution steps.
Instead of simple conventional data structures like two-dimensional arrays, dynamic data structures like quadtree, octree and linked list will be used.
Connectivity information will be obtained from the quadtree or octree data structure via parent-children relationships between the cells. This kind of data structure will enable to handle much more complicated input geometries compared to structured and ordinary unstructured methods.

The finite volume formulation of the three-dimensional Euler equations will be used with cell-centered approach. Flux difference splitting and flux vector splitting methods will be employed for formulation of the flux at cell faces. Primitive variables will be reconstructed using the path integral and least squares methods to achieve second order accuracy in space. In order to ensure accurate and bounded values, limiters will be employed in the reconstruction process.
Multistage time stepping will be used with local time steps to increase the convergence rate. Since Cartesian meshes are highly adaptive, there are significant differences between the length scales of the cells. Hence, the use of local time steps is expected to improve the convergence rate.
Multigrid convergence acceleration technique, specifically nested iteration, will be used in order to increase the convergence rate to the steady-state even more. The problem under consideration will first be solved on a coarse mesh. This solution will then be used for successively finer meshes as the improved initial guess.

Game Theory

Applied Mathematics Employed for Collaboration in the Presence of Challenges, Rapid Changes and Uncertainty

Bülent Karasözen and Gerhard-Wilhelm Weber

Game Theory has a long tradition in economics and operational research. In the last years, real-world challenges in the areas of, e.g., environmental protection, development and new markets asked for a more intensive employment of modern methods from mathematics, such as combinatorics, linear and nonlinear optimization, optimal control, dynamical systems and statistical learning. These areas will support and host our project.

In these years of globalization and rapid changes, common challenges by earth warming, fossile energy resources but also water becoming less, etc., the concerted efforts of collaboration are needed for a future of mankind, appropriate living conditions of future generations, for justice, freedom and peace. The overcoming of antagonisms, conflicts and particular kinds of trade-offs are subjects of cooperative game theory. How can mathematics model "fairness" and "bargaining"? Can answers to these questions be given also in a dynamical and adaptive time sense? And how can the imprecision and uncertainty, in information, technology - even in modern high-tech, in the interrelations between human beings and societies, in the individual and joint decision makings as well, become represented and implemented into such a "game"?

This project wants to find some answers in the context of these questions. We ask for a generalization of the given more classical game theory, for an employing of interval concepts, dynamical, network and matrix models, of control theory and elements of learning theory.

You are cordially welcome!

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