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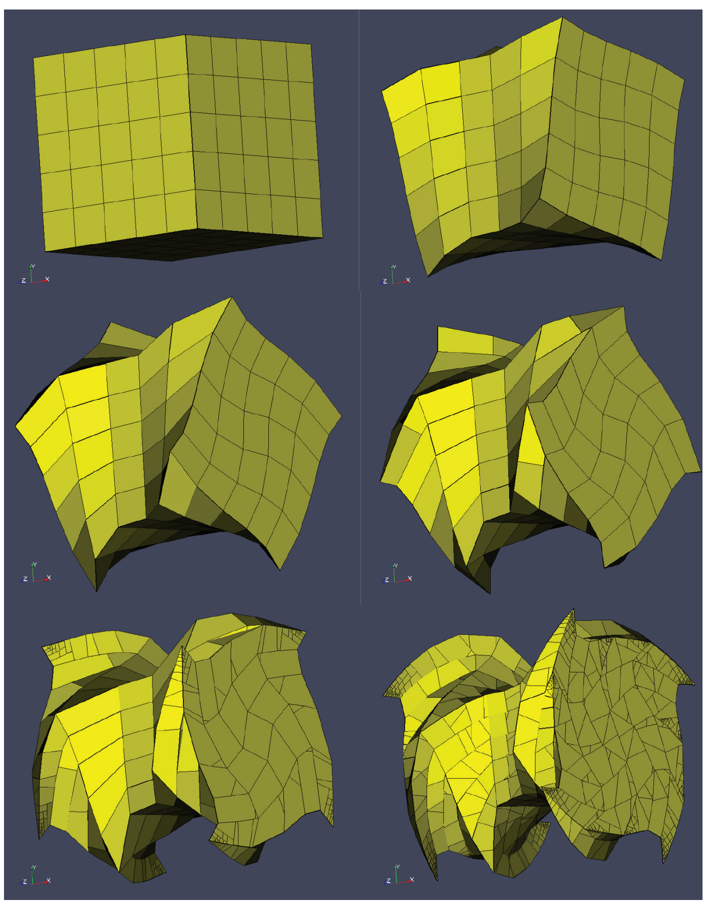
Mesh Refinement and Reconnection in Arbitrary Polyhedral Free-Lagrange Hydrodynamics Simulations

Principal Investigators: Douglas S. Miller (LLNL) and Vera Rasskazova (VNIIEF)

Project Description

The objective of this research is to develop and demonstrate a three-dimensional free-Lagrange hydrodynamics scheme incorporating mesh refinement to track shocks or material interfaces, allowing robust, high-quality hydrodynamic simulations. Mesh refinement allows many advantages: small-scale features in large-scale flows can be resolved, zones that are no longer needed to capture interesting physics can be deleted for efficiency, and dynamic features (such as shock waves) can be captured with many fewer zones than would be needed for equivalent accuracy with a Eulerian scheme.

A mesh refinement and coarsening algorithm was developed in a three-dimensional free-Lagrange code, with a detailed description of the method used to obtain solutions to the hydrodynamic equations and an explanation of the reconnection algorithm. The solution of a test problem defined by a rotating cone of zero viscosity fluid embedded in a stationary cube was used to demonstrate the algorithm and its efficiency.



The cube rotation problem: currently, the number of zones is 3500, compared to 125 zones initially.

Technical Purpose and Benefits

The accurate simulation of hydrodynamic and heat conducting flows requires significant computational resources. While a variety of adaptive mesh technologies exist, each has important drawbacks and inefficiencies. This project developed and demonstrated a three-dimensional free-Lagrange capability with arbitrary reconnection. This approach offers an alternative strategy to arbitrary Lagrangian-Eulerian and adaptive mesh refinement methods for simulating complex flows using the benefits of Lagrangian hydrodynamics extended to three dimensions.

ВНИИ

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Collaboration between Lawrence Livermore National Laboratory (LLNL), Livermore, CA, USA, and the Russian Federal Nuclear Center - All Russian Research Institute of Experimental Physics (RFNC-VNIIEF), Sarov, Russia

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A Publication of the Office of Advanced Simulation & Computing, NNSA Defense Programs. SAND 2007-4400P
Issued by Sandia National Laboratories for NNSA's Office of Advanced Simulation & Computing, NA-114. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.