Towards Efficient Parallelization of a Z-Model Algorithm for HPC Systems

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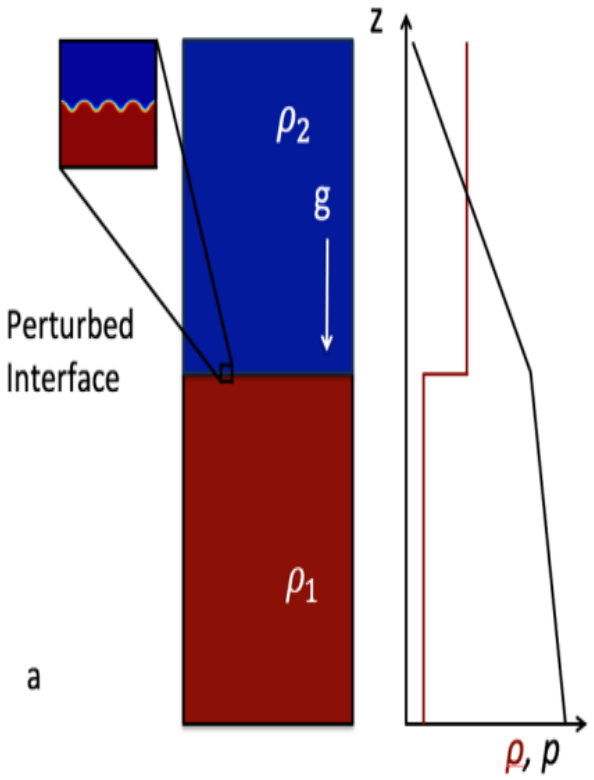
- Goal: A multi-scale modeling proxy application for driving research in communication for multi-physics applications
- Approach:
  1. Develop a parallel implementation of a state-of-the-art interface tracking algorithm for modern HPC platforms
  2. Demonstrate accuracy and scalability of parallel implementation on modern systems
  3. Optimize communication for numerical methods of interface tracking algorithm (intra-application communication)
  4. Examine communication abstractions to interface tracking algorithm implementation with external flow solvers (inter-application communication)

- Numerical Method: Shkoller and Riesner Z-Model
  - Raaghav Ramani, Jon Reisner, and Steve Shkoller. “A space-time smooth artificial viscosity method with wavelet noise indicator and shock collision scheme, Part 1: The 1-D case”. In: Journal of Computational Physics 387 (2019), pp. 80-116.
  - Raaghav Ramani, Jon Reisner, and Steve Shkoller. “A space-time smooth artificial viscosity method with wavelet noise indicator and shock collision scheme, Part 2: The 2-D case”. In: Journal of Computational Physics 387 (2019), pp. 45–80.
  - Raaghav Ramani and Steve Shkoller. “A multiscale model for Rayleigh-Taylor and Richtmyer-Meshkov instabilities”. In: Journal of Computational Physics 405 (2020), p. 109-177.

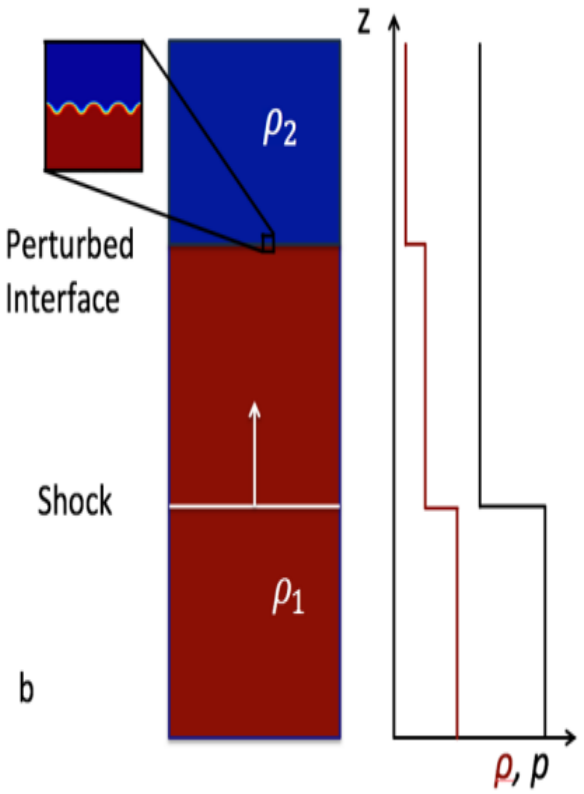
Test Case 1: Rayleigh-Taylor Instability (RTI)

- An interface between two fluids of different densities is assumed to exhibit the Rayleigh–Taylor instability (RTI) if the light fluid is accelerated into the heavier one.
- For RTI, the acceleration is continuous in time.
- The interface model (z-model) is assessed for its evolution of RTI.
- The z-model predicts both bubble and spike growth.



Test Case 2: Richtmyer-Meshkov Instability (RMI)

- Richtmyer-Meshkov instability (RMI) occurs when two different density fluids are impulsively accelerated in the direction normal to their nearly planar interface.
- For RMI, the acceleration is an impulse driven by a shockwave transiting the interface. The RMI acceleration is often represented mathematically as a Dirac delta function.
- It is important to fields ranging from astrophysics to high-speed combustion.
- The interface model (z-model) is assessed for its evolution of MRI. The z-model can allow for interface turnover.



Questions?