CONSERVATIVE AND ADAPTIVE FRONT TRACKING METHOD FOR FLUID INTERFACE INSTABILITIES

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We present in this paper an enhanced front tracking code, the *FronTier* and its interoperability with other software packages such as the *Overture* code developed by the Lawrence Livermore National Laboratory. We have improved the front tracking code by enforcing the conservation across the tracked front. We have developed a new, fully conservative Front Tracking algorithm, with one order of accuracy improvement resulting from this algorithm. On this basis we believe that it will offer a very fundamental advantage. The new tracking scheme is based on the Rankine-Hugoniot condition along the boundary of a time-space region. Let $W = \{u, f(u)\}$ be the vector in time-space dimensions, and $\nabla = \{\frac{\partial}{\partial t}, \frac{\partial}{\partial x}\}$ be the time-space differential operator, the conservation law can then be written as $\nabla \cdot W = 0$. If $\mathbf{n}$ is the normal vector of a time-space region boundary, then $\mathbf{n} \cdot [W] = 0$ regardless whether W is continuous or not across the boundary. The conservative tracking method divides the time-space region between t^n and t^{n+1} into time-space cells and applies $\mathbf{n} \cdot [W] = 0$ at each boundary side of the cells.
Another important advancement is to add the adaptivity to the front tracking code. We have accomplished this by using the existing code *Overture* by LLNL. A interface between the two codes is created to communicate the data structures for the adaptive patches between the operations in *FronTier* and in *Overture*. The merger of the two codes represents two significant progresses. First, it has demonstrated interoperability between different hydro codes by using a commonly accepted data model. Second it has enhanced the resolution of the *FronTier* computation in the off-front region without re-writing a new code. We have applied the new *FronTier* code to the study of the fluid interface instabilities including the Rayleigh-Taylor and the Richtmyer-Meshkov instabilities and the study of the fuel-injection jet problem.

References

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