OpenFOAM in Combustion Research

Heterogeneous-computing based Scalable Solvers for Low and High-speed Turbulent Combustion

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Host: Prof. Wang Han (Beihang University)

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Abstract

In emerging high-speed and low-speed applications, there is a critical need for simulating multiscale problems that span a large range of length and time scales. With the growth in supercomputing technology, such problems have been through handled through domain decomposition or other related techniques. As supercomputers become energy-limited, heterogeneous compute architectures that rely on low-energy processors such as GPUs have become more common. Such new compute systems introduce a multitude of challenges to conventional notion of flow physics computations. In particular, the focus shifts from pure concurrency-driven parallelization to increasing so-called arithmetic intensity, where more calculations per access to memory need to be performed in order to achieve high throughput efficiency.

The focus of this talk is on the fundamental changes to computational methods that are needed to leverage such computing systems. In particular, simulation approaches for turbulent reacting flows of interest to scramjets, detonation engines, and gas turbines will be discussed. An approach for hardware acceleration by recasting chemical source term evaluations as GPU-friendly kernels will be presented. Scalability results for the full solver and results from sample calculations will be discussed.

About the Speaker

Professor Venkat Raman received his PhD from Iowa State University in 2003 in the department of chemical engineering. He was a NASA/Center for Turbulence Research Postdoctoral Fellow at Stanford University from 2003-2004, and a research associate in the Center for Integrated Turbulence Simulations from 2004-2005. From 2005-2014, he was on the faculty of Aerospace Engineering and Engineering Mechanics Department at The University of Texas at Austin, initially as an assistant professor (2005-2011) and later as tenured associate professor (2011-2014). Raman received an NSF CAREER award in 2008, a distinguished paper award at the International Combustion Symposium in 2013, and the George J. Hubener Research Excellence Award from UM in 2022. He held the Eli. H and Ramona Thornton Centennial Fellow in Engineering at UT Austin from 2013-2014. He was elected Fellow of the Combustion Institute in 2022.