Interactive visualization of large-scale numerical simulations with GPU-CPU systems

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We present a method for pipelining results from large-scale fluid dynamical simulations in such as way as to exploit the exponentially increasing computational capacity of the latest generation of multi-core CPUs, many-cores and GP-GPUs. Exploiting this technique, together with an integration with several data post-processing and visualization utilities has enabled numerical experiments in computational fluid dynamics to be performed interactively on a new, dedicated system in our lab at the University of Minnesota. This method provides an immediate, user controlled visualization of the resulting flows on the LCSE PowerWall display as well as through a globally accessible html and java web interface. The code restructuring required to achieve the necessary computational performance boost, as well as the interactive visualization are described. Requirements for these techniques to be applied to other codes are discussed, and our plans for tools that will assist programmers elsewhere to exploit these techniques are briefly described. Examples showing the capability of the new system and software are given for various applications in turbulent hydrodynamics, stellar flows, and mantle convection.