Exploring unsteady flows by parallel extraction of property-enhanced pathlines and interactive post-filtering

Michael Vetter, Sebastian Manten, and Stephan Olbrich
Chair for IT-Management, Heinrich-Heine-Universität Düsseldorf, Germany

MOTIVATION

- Huge data sets
  - 3D grid: ~10^9 data points
  - Non-stationary: ~10^4 time steps
  - Data volume: ~100 Terabyte
- Volume/Flow visualization
  - Online viewing and batch processing support
  - High degree of interaction even in video-on-demand scenarios

SOLUTION

- Visualization middleware DSVR
  - Framework for „Virtual Science Labs“
  - Distributed, parallel, portable, modular approach
- High-throughput dataflow
  - Generation of 3D scenes
  - 3D streaming, remote viewing
- Browser-embedded controls
- Direct and parallel extraction of 3D geometries during the simulations instead of classical graphical post-processing
- Reduction of data volume (O(n^3) -> O(n)) by storing extracted 3D geometries instead of raw data
- Preserving the degree of interaction by post filtering of homogenously seeded pathlines via “queries over streams” (query function \( \sigma \))

TECHNOLOGIES

- Parallel data extraction (MPI)
- Delivery over Gbit/s WAN (TCP/IP)
- Real-time streaming (RTSP)
- Replay of animations (OpenGL)
- Perceptual encoding, compression
- Support for C/C++/Fortran applications (software library libDVRP)
- For major operating systems

APPLICATIONS

- E-Science
  - Computational Fluid Dynamics
- E-Learning
  - Exploration / Presentation
  - Collaborative Scenarios

PROCESS CHAIN OF THE DSVR-FRAMEWORK

- Scalability on massively-parallel computers
  - Hybrid Parallelization Concepts (MPI/OpenMP)
  - Parallel Streaming
  - Efficient encoding and load balancing
- Performance over 10 Gbit/s network

CONTACT

Email: m.vetter@uni-duesseldorf.de
olbrich@uni-duesseldorf.de
Web: http://www.itm.uni-duesseldorf.de/

FIRST EVALUATION: FLOW VISUALIZATION OF A TORNADO-LIKE SIMULATED SWIRL

(a) unfiltered: approx. 30000 pathlines
(b) filtered using a threshold of 0.185: approx. 4500 pathlines