ETH zürich

Institute of Fluid Dynamics
Institute of Energy and Process Engineering

Colloquium Thermo- and Fluid Dynamics

Experiment Upscaling and Data Assimilation for 3D PIV

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Three-dimensional velocity field measurements with Particle Image Velocimetry are nowadays frequently obtained for the investigation and visualization of complex three-dimensional flows. Most experiments still focus on the study of fundamental, turbulent flow phenomena, but some applications indicate that the technique is reaching the maturity needed to be deployed and advance aerodynamic technologies. The latter have become possible with the realization of seeding devices that produce neutrally buoyant helium filled soap bubbles in the sub-mm range for use in large wind tunnels. Three-dimensional measurements, need to cope with intrinsic limitations of spatial resolution, due to the lower seeding density imposed by the occurrence of ghost particles. On the other hand, time-resolved measurements within a volumetric domain are suited for more advanced data assimilation treatments compared to the traditional signal-processing based (e.g. filtering in space and/or time, proper orthogonal decomposition). 3D and 4D data can embed governing laws in the post-processing algorithm that enforce their physical consistency. The lecture discusses data assimilation techniques that invoke the Lagrangian transport principle to estimate spectra from PIV time series even when the Nyquist criterion is violated. Pouring space into time is demonstrated from advection-based Time Supersampling and later extended and generalized to turbulent shear flows using the vorticity equation (VIC, or vortex-in-cell). The reverse process of estimating data at a higher spatial resolution corresponds to pouring time into space and is referred to as Super-Resolution. Techniques that achieve this goal are explained in their principles and by applications where quantities not measurable otherwise (e.g. 3D turbulent dissipation) can be estimated from experiments.

Fulvio Scarona is Professor at Aerospace Engineering at TU Delft, where he leads the section of Aerodynamics. Research efforts were dedicated to advance Quantitative Flow Visualization Techniques, mostly Particle Image Velocimetry for applications in Aerodynamic flows, turbulence, aeroacoustics and propulsion. He is the recipient of a Marie-Curie grant (1999), Dutch Science Foundation VIDI grant (2005) and European Research Council grants (ERC, 2009, 2015).

Date: Wednesday, 6 November 2024
Time: 16:15 - 17:15 h
Place: ETH Zurich, ML F 36
Host: Prof. Filippo Coletti

Further information: https://ifd.ethz.ch/events/ktf.html

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