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K. Matkovic and G. Santucci (Editors)

Interactive Visual Flow Analysis Research in *SemSeg*

A. Pobitzer[1], A. Lež[2], K. Matković[2], and H. Hauser[1]

[1]University of Bergen, Norway
[2]VRVis Research Center, Austria

1. The *SemSeg* Project and IVA

The project *SemSeg – 4D space-time topology for semantic flow segmentation* (www.SemSeg.eu) is an international research initiative that investigates methods to visualize time-dependent flows that are inspired by *vector field topology* (VFT).
Research directions in the *SemSeg* project are, among others, flow visualization based on *finite-time Lyapunov exponents*, uncertain VFT, and interactive visual analysis for flow visualization.
Interactive visual analysis (IVA) is a theoretical visualization framework based on the idea to depict multiple dimensions in multiple views. These views are dynamically linked and allow for brushing. Brushes in all views can be combined to each other by logical and/or connections. Complex queries can be formulated for the data and interactively refined. For flow visualization, usually a three-dimensional view of the physical domain is included. For time-dependent velocity fields, the analysis can be conducted adopting a Lagrangian, i.e., particle based, perspective on the flow. Computing particle trajectories and both global properties of the trajectory itself, e.g., arc length, and other values along the trajectory, e.g, particle velocity, can yield insight in the dynamic behavior. This attributes are referred to as *pathline attributes*.

2. Pathline Attribute based IVA in SemSeg

Within the scope of SemSeg, we have addressed both performance and interaction aspects of pathline attribute-based interactive visual flow analysis. Notably, pathline integration is computationally expensive and in some cases even prohibitive. We show how a multi-step analysis can be used to speed up path line-based IVA of unsteady velocity fields [LZM*11]. We propose to seed particles on a relatively coarse grid first and identify possibly interesting areas, before starting the full resolution path line analysis in selected regions only. Additionally to the selection of path lines by their attributes, we propose direct path line brushing, using projection views (cf. Fig. 1). Predefined view arrangements for better interaction are also proposed.

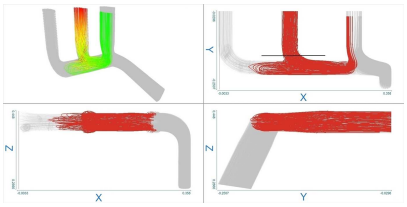

Figure 1: *Linked views of pathlines with direct brushing.*

Another problem in the application of pathline attributes is the selection of the attributes. While the aim of a general analysis is to capture the particle dynamics as good as possible, a high number of attributes can make the analysis challenging. We address this problem by proposing a fixed attribute set that is minimal with respect to the number of attributes contained, while still capturing the essential dynamics of the particles [PLMH12]. This pathline attribute set is derived from the statistical analysis of computational fluid dynamics data sets.

3. Summary and Acknowledgments

We have investigated different ways to cope with the challenges stemming from the analysis of pathline attributes, namely the amount of particle integrations needed, the amount of attributes needed, and user interaction.
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References

[LZM*11] LEŽ A., ZAJIC A., MATKOVIĆ K., POBITZER A., MAYER M., HAUSER H.: Interactive exploration and analysis of pathlines in flow data. In *Proc. of WSCG* (2011), pp. 17–24. 1

[PLMH12] POBITZER A., LEŽ A., MATKOVIĆ K., HAUSER H.: A statistics-based dimension reduction of the space of path line attributes for interactive visual flow analysis. In *Proc. IEEE PacificVis* (2012), pp. 113–120. 1