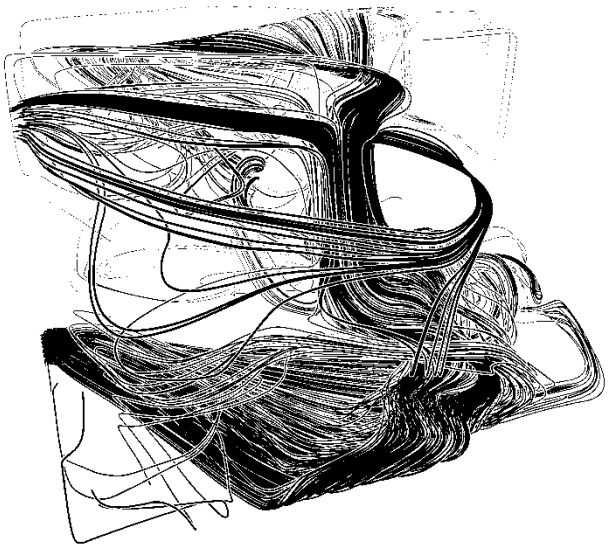
2011 Internship Project Proposal: Illustrative Visualization of Fluid Dynamics Data



Illustrative rendering is a recent development in scientific visualization, incorporating inspirations from traditional illustration into scientific visualization applications. One important application domain within scientific visualization is showing the details of fluid dynamics simulations. For example, one can display the paths that particles are taking when moving through a fluid in a given space. The difficulty is that in order to understand the details of the motion it is often necessary to show many paths at the same time to support, for example, the visualization of vortices and other complex flow patterns. This can be supported using black-and-white illustrative visualization styles because individual lines do not take much space. Illustrative visualization techniques can support this approach to illustrate spatial relations, for example, through halos or line attenuation (see the image at the top-right).

In the context of fluid dynamics visualization it is important to be able to show time-dependent behavior or even to visualize live data. This project will examine this problem: how to use the advantages of fast illustrative rendering for the visualization of time-dependent flow data using GPU techniques. In the beginning, the task is to adapt an existing set of line rendering shaders to the VENISE CAVE environment (EVE) at CNRS-LIMSI. The new application will need to accept fluid dynamics data as it is provided by the experts at LIMSI. Next, the project will focus on realizing the rendering of time-dependent data. This could mean, for example, that shorter but time-dependent streamlines or pathlines are being used instead of the presently used long ones to illustrate the flow. An important aspect will be the optimization of the GPU code to a real-time animation setting so that, at least, pre-computed time-dependent data can be visualized interactively. Once this is successful, the project will continue to explore the use of live data, i.e. explore how the data needs to be processed and evaluated to continuously update the illustrative visualization.

One final aspect is the display of additional data in the illustrative visualization style. Such additional data can include, for example, speed, vorticity, heat, pressure, particle density, etc. For instance, visual variables such as color and patterns may be used for this purpose.

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