Datastrokes: Extending a Painting Metaphor for Visualizing Flow Fields

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Introduction

Researchers in computational fluid dynamics, biology, and many other fields often work with very large data sets containing multiple variables. These data sets are extremely difficult to visualize, since they contain such a vast amount of information.

A set of techniques which hold promise for improving the visualizations in this area are those based on applying the techniques artists have developed for conveying information intuitively and with minimal clutter. Some work on this has already been done [1]. Our work extends this to more accurately model one visualization creation tool available to the artist: the paintbrush. Our model captures more of the physical characteristics of a paintbrush and hence allows greater flexibility in applying the artistic techniques designed for it.

Methods

Our model was created based on the physical characteristics of brushes in order to maximize the ability of the user to apply techniques from painting. We simulate the physical process of paint flowing off the bristles of the brush at its tip and being replaced by paint from higher up on the brush. In addition, we allow the angle of the brush to vary as the stroke follows a path across the canvas.

The characteristics of each brush stroke are determined from the data. Usually, a stroke's path is determined by tracing it along flow lines or gradients from a point. Other characteristics of the brush are determined by the data at each control point along the path. In the current model, characteristics of the brush stroke which may vary include length, color, rotation, pressure, and area of the brush in contact with the canvas.

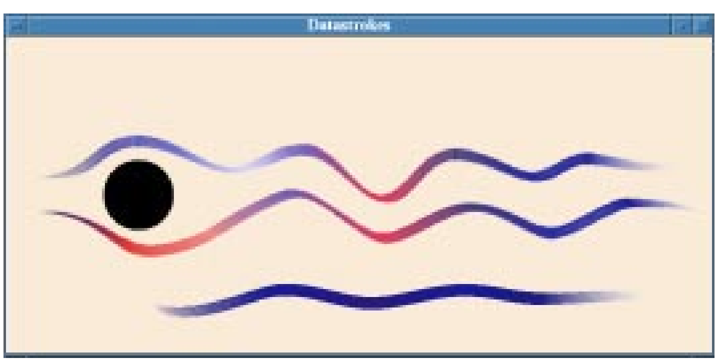

Figure 1: Concise visualization suggesting the essentials of flow and vorticity. The strokes follow the velocity field, thin areas of the strokes show greater speed, and vorticity is represented by bright red (negative) or light blue tendency(positive) on a dark blue stroke. This image was designed as a proof-of-concept for comparison with the visualizations created by Laidlaw et al.

Results

Informal inspection and comparison suggests our method can usefully employ the very complex device of a brush stroke to encode significant amounts of data in a clear and intuitive manner.

In particular, our technique shows promise for:

1. Reducing visual clutter while retaining useful information. Figure 1 shows how a small number of strokes can provide a great deal of information.

2. Presenting information in a more intuitive manner. Note the strong sense of flow in Figure 1.

Future work includes:

1. Compensate for the tendency for our large-scale strokes to obscure small-scale information. Possible methods for doing this include increasing the interaction between various layers of paint using techniques such as blending and simulation of wet-on-wet paint mixing.

2. Include guidance for placing strokes to capture the most important aspects of the data. Our strokes tend to be large relative to the image, meaning care should be taken in placement to capture all the important data features while minimizing visual clutter.

Conclusion

Leveraging artistic techniques for use in scientific visualization allows the centuries of research into image creation by artists to be directly applied to the creation of computer-generated images. Our more realistic brush stroke model gives much greater flexibility in the range of artistic techniques that can be applied, and hence enjoys several benefits over more conventional techniques and even over more constrained painterly visualization methods.

While this technique highlights the importance of considering artistic knowledge and shows significant promise for certain areas of visualization, more work is required to fully explore its capabilities.

References

[1] R. Michael Kirby, H. Marmanis, D. Laidlaw; "Visualizing Multivalued Data from 2D Incompressible Flows Using Concepts from Painting." Visualization '99 Proceedings, October 1999.