Comparing Line Integral Convolution With Other Visualization Techniques

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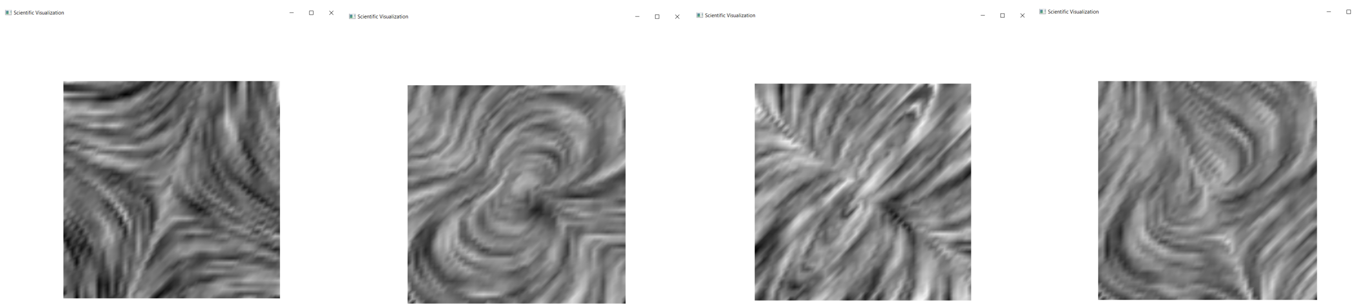

Figure 1: Four different vector fields visualized using LIC.

Abstract

In this paper we found that Line Integral Convolution did well in data sets where Streamlines failed. These data sets our primarily one which have large flat areas where there is not alot of direction in the data, and parts of the data which is to dense to display with streamlines. LIC produced similar and sometimes superior images than the IBFV. However, LIC was far more computationaly expensive and took a long time for the computer to produce the images.

1 Introduction

The objective for this research paper is to gain a better understanding on the implementation of Line Integral Convolution, as well as evaluating the effectiveness of Line Integral Convolution compared to other vector field visualization techniques including Streamlines and IBFV.

Line Integral Convolution is a powerful texture-based technique that uses a low-pass filter to blur input texture along streamlines defined by the vector field. Similar to what happens when a rectangular area of fine sand is blown by a strong wind, applying a vector field onto an input texture will generate an output texture that displays the flow direction of the vector field.

Unlike streamlines visualizations, which fails with high and low density data, Line Integral Convolutions shows flow direction evenly for any vector data set.

2 Previous Work

There has been a lot of work done around Line Integral Convolution since the paper "Imaging Vector Fields Using Line Integral Convolution" by *Brian Cabral and Leith (Casey) Leedom* was published in 1993. In this paper, Brian Cabral and Casey Leedom discuss how this technique can be used to visualize vector fields,as well as provide a method to create appealing animations.

Another paper published on the subject, "Line Integral Convolution to Render Effects on Images" by *Ricardo David Castañeda* , explores how Line Integral Convolution can be used to create special effects.

Both of these works were used to create and inspire the ideas shared in this paper.

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3 Background

Line Integral Convolution is a visualization technique which utilizes distortions to display a vector field. To create these visualizations a vector field and a background image is needed. In the vector data set, streamlines are extracted. This is similar to creating a pure streamline visualization, but to create a Linear Integral Convolution graphic extra steps are needed. A function will utilize these streamlines, and use weighted averages along those streamlines to determine the color of each pixel in the LIC visualization. It is common to use white noise as a background, and this often works well in visualizations. To create a white noise image simply create a matrix of the appropriate size full of random values between two numbers.

4 Evaluating The Effectiveness of LIC

We will evaluate the effectiveness by comparing our line integral convolution with previous methods of visualization in this class. We will take the scalar data we already have access to from previous projects and create streamlines from it. We will then use these streamlines to distort a white noise image displaying the vector data. Using these data sets not only gives us access to consistent well formatted data, but also enables us to easily compare our visualization method to methods used in previous projects. If our visualization displays a comparable amount of information then previously used visualization methods, then we will know that our Line Integral Convolution is effective.

5 Evaluation

Line Integral Convolution worked well for the data sets which were used. On larger data sets Line Integral Convolution might have produced better visualizations. However, for a larger data set the computational cost might become to large. At the current data set size, which is around four-hundred vertex's, the Line Integral Convolution method took about two minutes on our machines. This could be a very effective method with the right data sets and enough computational power. However, the method did not significantly surpass previously used visualization methods in CS 453. Most notably, the LIC was not significantly more visually impressive and produced similar graphic with the IBFV, which was far less computationally expensive.

6 Division of Tasks

Brian Mulch did most of the work for the paper. Ivan Halim did most of the work for writing the actual code. Both members actively consulted each other when working on their individual tasks.

7 Conclusions

Linear Integral Convolution was applied to the data sets and produced appealing and informative visual results. For sparser data sets, streamlines produced the best results. IBFV produced similar results to LIC, but with far less computational power. LIC excelled where streamlines failed.

8 Data Sets

From the the vector data folder we utilized previously used data sets to easily compare against past methods. We will display data sets v1 through v10 excluding v2 and v7.

9 Results

Linear Integral Convolution was successfully applied to the data sets and is shown in the table to the right. Left is LIC, Middle is Streamlines, Right is IBFV. The LIC produced interesting results, and sometimes displayed the data better then the other two methods.

References

B. Cabral and C. Leedom,“Imaging vector fields using line integral convolution“, Computer Graphics Proc. 93 ACM SIGGRAPH, 1993

M. David,“Line Integral Convolution to Render Effects on Images“, Computer Graphics Stu, 99

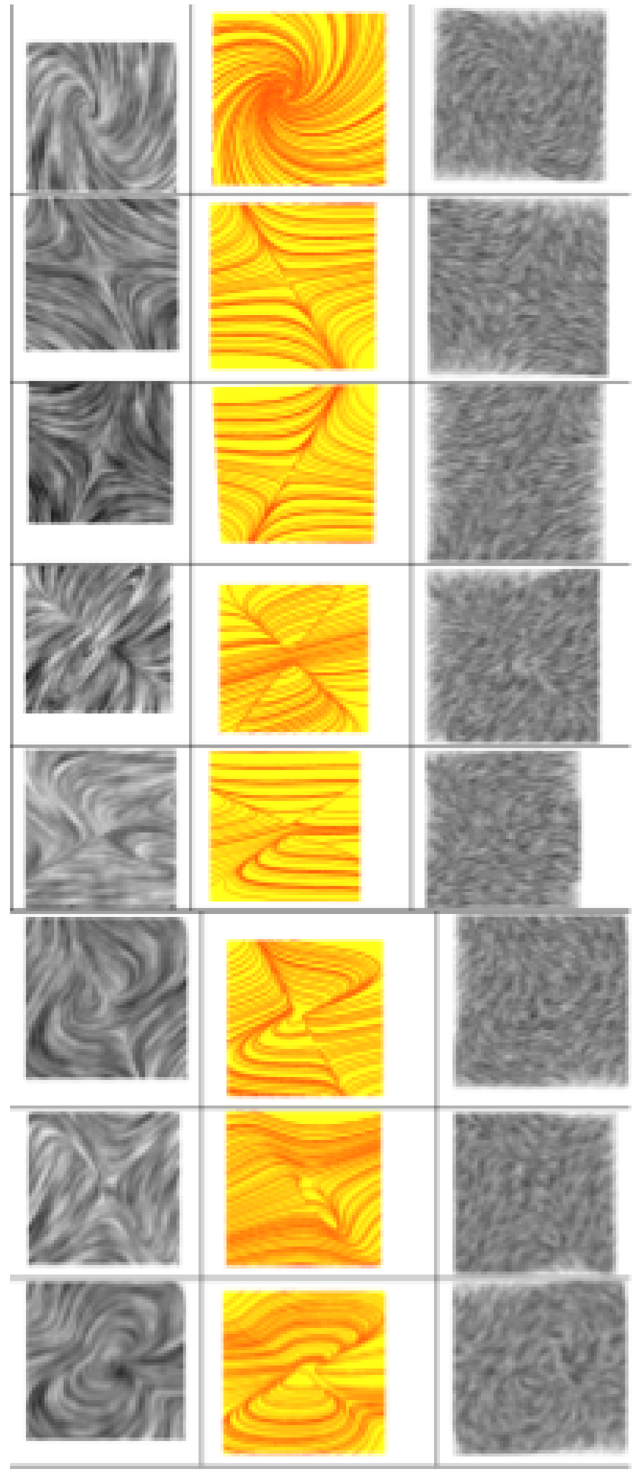

Figure 2: Data Set V1 - v10 excluding v2 and v7 in order. Left is LIC, Middle is Streamlines, Right is IBFV