



Tutorial 7: Feature Oriented Methods in Flow Visualization

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Helwig Hauser, Raghu Machiraju,
Ronald Peikert, Xavier Tricoche

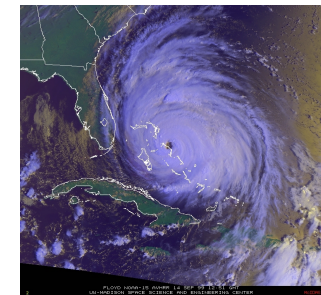
Features

- Features are parts of a dataset that get special attention by the user.
- Application dependence!
- User dependence!
- Definition complicated and often unclear!

Flow Features

- Flow features are areas of fluid flow datasets that are of special importance for fluid dynamics!
- Main examples:
Vortices (regions of swirling motion),
vortex cores,
Vortex burst,
shock waves,
stagnation points/critical points,
attachment/separation lines

Examples for Vortices I

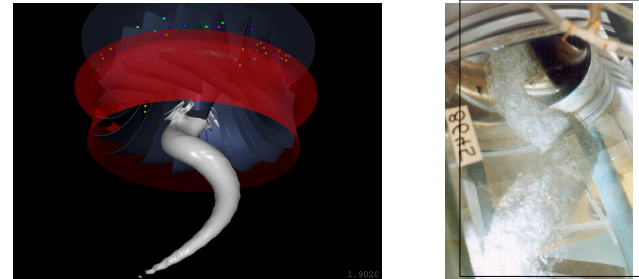


Collection by Raghu Machiraju

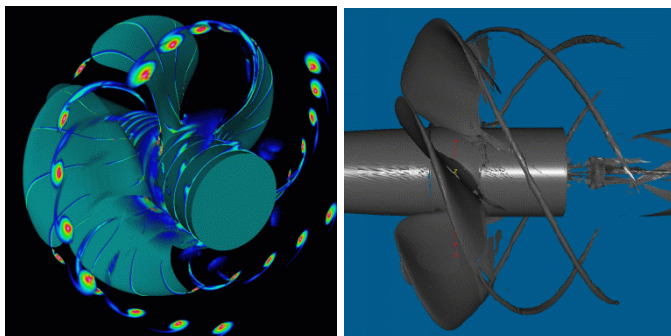
Vortices II



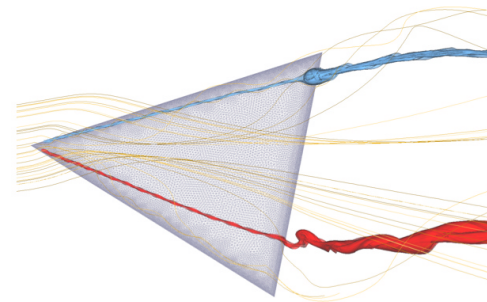
Vortex with Strong Core



Vortex Core



Vortex Burst

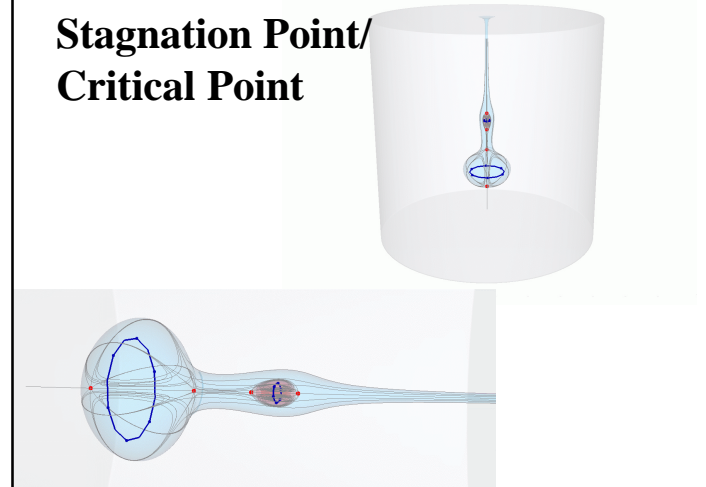


Shock Wave

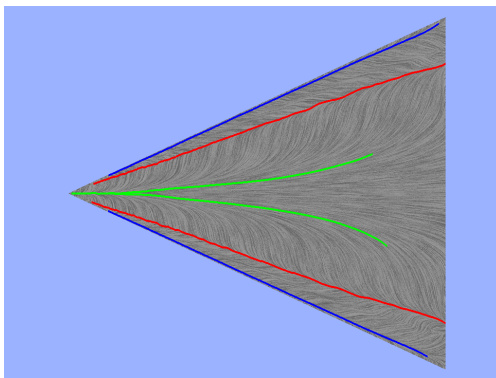


Figures by Hans-Georg Pagendam

Stagnation Point/ Critical Point



Attachment and Separation Lines



Types of Features

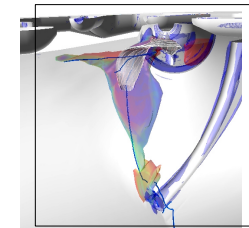
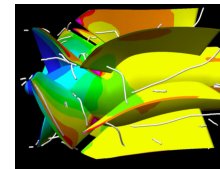
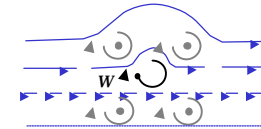
- A good classification of features is based on their geometric shape!
- **Point Features:** Critical points/stagnation points
- **Line Features:** Vortex cores, attachment and separation lines
- **Surface Features:** Shock fronts
- **Volume or Region Features:** Vortex region, region of swirling motion

Tutorial Overview

- I. Introduction
(Gerik Scheuermann, University of Leipzig, Germany)
- II. Automatic Feature Detection
(Ronald Peikert, ETH Zürich, Switzerland)
- III. Evaluation of Features
(Raghu Machiraju, Ohio State University, USA)
- IV. Clifford Convolution
(Julia Ebling, University of Leipzig, Germany)
- V. Topological Methods
(Xavier Tricoche, University of Utah, USA)
- VI. Interactive Feature Definition and Detection
(Helwig Hauser, VRVis, Vienna, Austria)

II. Automatic Feature Detection

- Basics from Fluid Dynamics
- Vortex Definitions
- Vortex Detection
- Real World Applications
- Pros and Cons



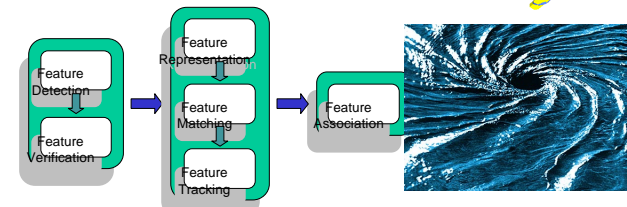
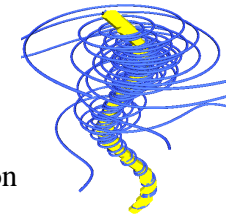
Ronald Peikert

- Senior Researcher at Institute of Computational Science at ETH Zürich, Switzerland, since 1999
- PhD in mathematics, ETH Zürich, 1985
- 1988-1995 Visualization at ETH's Interdisciplinary Project Center for Supercomputing
- 1996-1998 Leader of Scientific Visualization Group of the Swiss Center for Scientific Computing
- Special Interests: Flow Visualization, Feature Extraction Techniques, Industrial Applications of Visualization, Visualization in Virtual Environments



III. Evaluation of Features

- Vortex Definitions
- Detection
- Verification
- Application - characterization



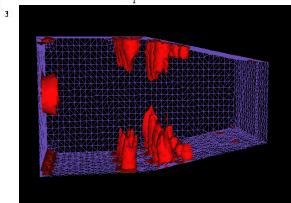
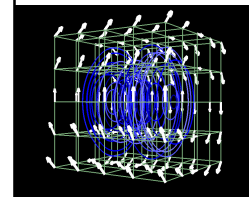
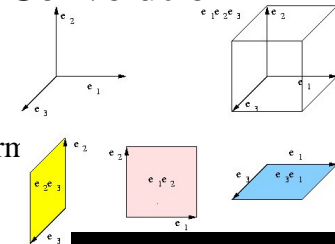
Raghu Machiraju



- Associate Professor at The Ohio State University since 1999
- PhD in Computer Science, Ohio State University, 1996
- Assistant Professor at NSF Engineering Research Center for Computation Field Simulation, Mississippi State University, 1996-1999
- Special Interests: Feature Detection, Large Data Visualization, Signal Processing

IV. Clifford Convolution

- Clifford Algebra
- Clifford Convolution
- Clifford Fourier Transform
- Gabor Filter



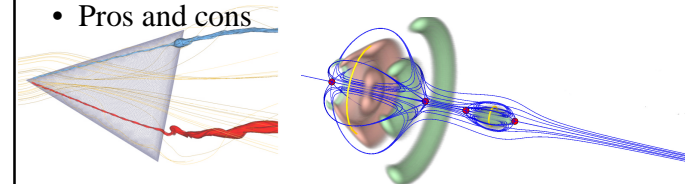
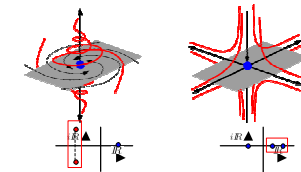
Julia Ebling



- Research assistant at University of Leipzig since 2004
- Research assistant at University of Kaiserslautern, 2002-2004
- Special interests: flow visualization, image processing, clifford algebra

V. Topological Methods

- Motivation
- Theory basics
- Implementation
- Applications
- Pros and cons



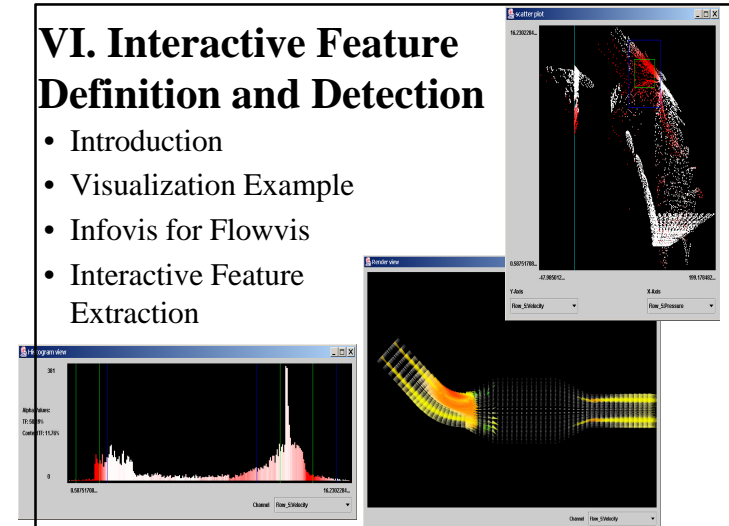
Xavier Tricoche

- Postdoc at SCI, University of Utah, since 2003
- PhD in Computer Science, University of Kaiserslautern, 2002
- Special Interests: Topological visualization, vector and tensor visualization, time-dependent data, direct volume rendering



VI. Interactive Feature Definition and Detection

- Introduction
- Visualization Example
- Infovis for Flowvis
- Interactive Feature Extraction



Helwig Hauser

- Scientific director of VRVis Research Center, Vienna, since 2000
- PhD in computer science, TU Wien, 1998
- Assistant professor at TU Wien, 1998-2000
- Research interests: volume visualization, flow visualization, information visualization, combination of these visualization fields



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