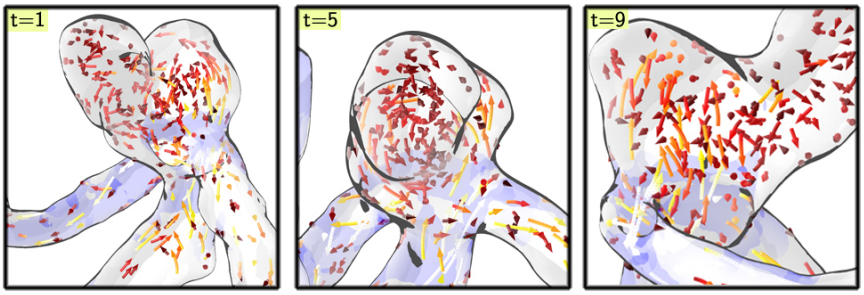
# Open Project:

## "Automated comic strip visualization of 4D MRI blood-flow velocity data"




Mockup of comic strip from 4D MRI blood flow data

**Introduction:**
Measurements from a wide variety of modalities are used to diagnose cardiovascular diseases. Magnetic Resonance Imaging (MRI) enables such measurements, especially for more complex conditions. Current procedures in clinical practice are based on anatomic MRI scans, while more advanced MRI acquisition protocols exist that provide quantitative blood-flow information.

Clinical research takes a large interest in finding correlations between blood flow and the progression of vascular diseases. Until recently computational fluid dynamics (CFD) simulations delivered the main source of information. Nowadays also quantitative flow MRI data can be acquired; providing an in-vivo measurement of the blood flow.

The flow measurements provide large data sets, which are hard to interpret on a slice-by-slice basis. Visualization of the time-resolved volumetric velocity fields is moreover impeded by visual clutter and occlusion. Therefore, visual analysis of the blood-flow mostly relies on simplified representations of the blood-flow data, and interactive exploration. This exploration includes interaction with the virtual camera, as well as exploration of the data through time. Although the field is readily simplified, the exploration process remains tedious and time consuming.

**Problem Statement:**
In the previous, we have introduced the challenging and time-consuming visual exploration of 4D MRI blood-flow velocity data. Given a simplified representation of the blood-flow velocity data, as presented by Van Pelt et al. [1], the camera interaction and exploration in the temporal domain still take up a significant amount of time, which is scarce in clinical practice.

In the past, techniques have been proposed to automatically select a suitable camera viewing direction, based on the information content of the visual representation. An suitable initial selection of the camera viewing direction re-

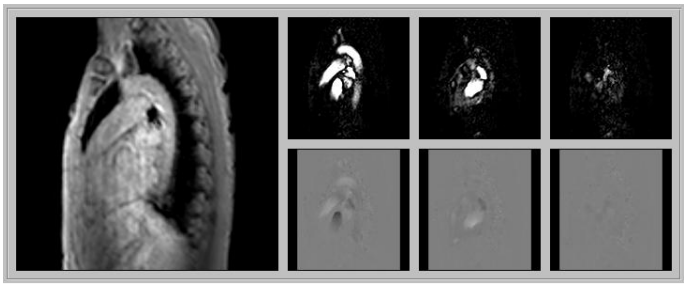


Figure 1: Sagittal view of an anatomy, phase and magnitude data slice

duces the amount of interaction. This viewing direction should rely on both the blood-flow characteristics, as well as the cardiovascular anatomy.

Moreover, current visual analysis requires exploration of the data through time. However, only a few time points of the cardiac cycle convey interesting blood-flow patterns. The interesting hemodynamic behavior is in many cases concentrated around peak systole and peak diastole. Based on the information content in the blood-flow data, the key time points can be selected automatically, further reducing the exploration time.

**Goal:**
The goal of this project is to investigate automated selection of camera viewing directions, as well as an automated selection of the key time points throughout the cardiac cycle. Therefore, the view- and time point should be determined, based on blood-flow characteristics and the cardiovascular anatomy. This selection may also be used for the assessment of pathology. Using existing simplified representations of the blood-flow velocity field, the selection effectively leads to a comic representation of the blood-flow velocity data, sequentially presenting an optimal view for each key time point.

**Execution:**
Execution of the project comprises the following aspects:

- Literature Study
  Investigate literature on viewpoint selection and information theory ([2],[3],[4]).
- Design of an algorithm
  Devise a methodology to obtain an optimal camera viewing direction for the 4D MRI blood-flow data, and select the key time point of the cardiac cycle, based on information theory.
- Implementation
  Implementation should be executed in either the C++ programming language.
- Visualization
  Using existing simplified representations, visualize the blood-flow veloc-

ity data as a comic strip, based on the automatically selected viewing directions and key time points.

**References:**

[1] *"Visualization of 4D blood-flow fields by spatiotemporal hierarchical clustering."*, R.F.P. van Pelt, S.S.A.M. Jacobs, B.M. ter Haar Romeny, and A. Vilanova in Computer Graphics Forum (2012)

[2] *"Representative Views and Paths for Volume Models."*, P.Vzquez, E. Moncls, I. Navazo in SmartGraphics (2008)

[3] *"Efficient Selection of Representative Views and Navigation Paths for Volume Data Exploration."*, E. Moncls, P.-P. Vzquez, and I. Navazo in Visualization in Medicine and Life Sciences (2011)

[4] *"LiveSync: Deformed Viewing Spheres for Knowledge-Based Navigation"*, Peter Kohlmann, Stefan Bruckner, Armin Kanitsar and M. Eduard Groller in IEEE TVCG (2007)