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Interactive Blood Damage Analysis in Ventricular Assist Devices

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Abstract — Ventricular Assist Devices (VADs) support the heart in its vital task of maintaining circulation in the human body when the heart alone is not able to maintain a sufficient flow rate due to illness or degenerative diseases. Advanced modeling methods and computer simulations enable engineers to investigate the fluid flow inside such devices. In particular, these methods allow experts to assess blood damage a priori. However, models for blood damage prediction may lead to complex output fields which are non-trivial to analyze with standard visualization methods.

In this talk we will discuss the development of a set of visualization methods which have specifically been designed to support the analysis of a tensor-based blood damage prediction model. This model is based on the tracing of particles through the VAD, for each of which the cumulative blood damage can be computed. The model's tensor output approximates a single blood cell's deformation in the flow field. The tensor and derived scalar data are subsequently visualized using techniques based on icons (cf. Fig. 1), particle visualization, and function plotting. All these techniques are accessible through a Virtual Reality-based user interface, which features not only stereoscopic rendering but also natural interaction with the complex three-dimensional data. To illustrate the effectiveness of these visualization methods, we present the results of an analysis session that was performed by domain experts for a specific data set for the MicroMed DeBakey VAD.

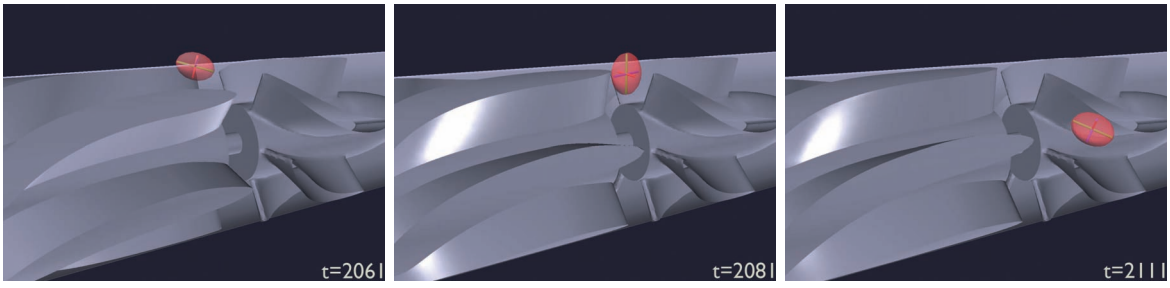

Figure 1: A close-up view of icons for several time steps t in the impeller-diffuser region, where considerable deformation is evident.