KTH Computer Science and Communication

Simulation-Visualization-Interaction

The KTH School of Computer Science and Communication (CSC) in 2009 established a strategic platform in Simulation-Visualization-Interaction (SimVisInt), focused on the high potential in bringing together CSC core competences in simulation technology, visualization and interaction. The main part of the platform takes the form a set of new trans-disciplinary projects across established CSC research groups, within the theme of Computational Human Modeling and Visualization: (i) interactive virtual biomedicine (HEART), (ii) simulation of human motion (MOTION), and (iii) virtual prototyping of human hand prostheses (HAND).

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HEART

Cardiac disease is the major cause of death in western society. The vision of the HEART project is to build a virtual human heart from medical imaging data, together with an interactive interface with visual, haptic and sonic feedback. External collaborators include Umeå University, Linköping University, KTH School of Technology and Health, and the Barcelona Supercomputing Center. The basic idea is to use medical imaging technology to create a virtual model of the heart wall motion, blood flow dynamics, and mechanical stresses. Visual, haptic and sonic interaction with the heart model can be used to get an enhanced understanding of the heart function, and for help in diagnosis as a complement to medical imaging information. In addition, the interactive interface opens for modifications of the virtual heart, simulating cardiac disease or available treatment options, such as choosing between different mechanical heart valves, and thus offering a tool for decision support in planning surgery or other treatment.

Today the model takes the form of a left ventricle blood flow simulator, based on a geometrical model from patient specific ultra sound data, including a visual and haptic interface.

HEART
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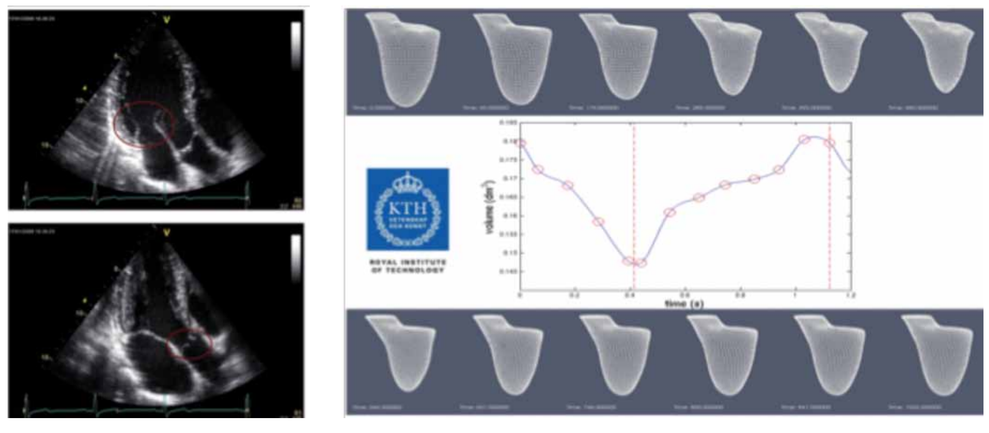

Geometric model of the left ventricle constructed from ultra sound in collaboration with Umeå University (Mats G. Larson, Anders Waldenström, Ulf Gustafsson and Per Vesterlund).

INTERACTIVE HEART DEMONSTRATION

The interactive HEART demonstration is a public showcase designed to aid the perception and understanding of the heart blood flow simulation through natural interaction. The goal is to take advantage of physical movement and gestures instead of traditional interaction techniques requiring additional equipment and tutoring. A 3D camera combined with advanced computer vision software is used to recognize gestures and track the joints of the human body.

By grasping with one hand the user can turn the simulation around to inspect it from different viewpoints. The camera can also be zoomed by grasping with both hands and moving them closer or further apart. The visualization shows the changes in geometry of the left ventricle throughout a heartbeat, a translucent colored cloud illustrates the pressure inside, and arrows indicate the simulated blood flow velocity.

INTERACTIVE HEART DEMONSTRATION
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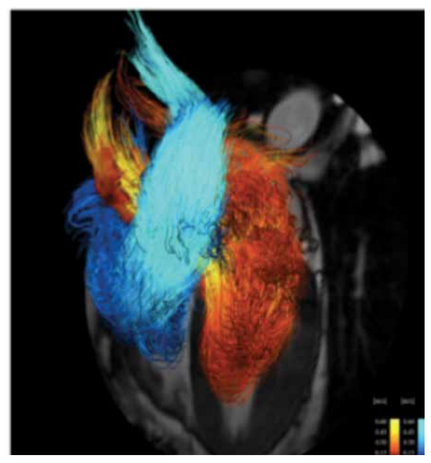
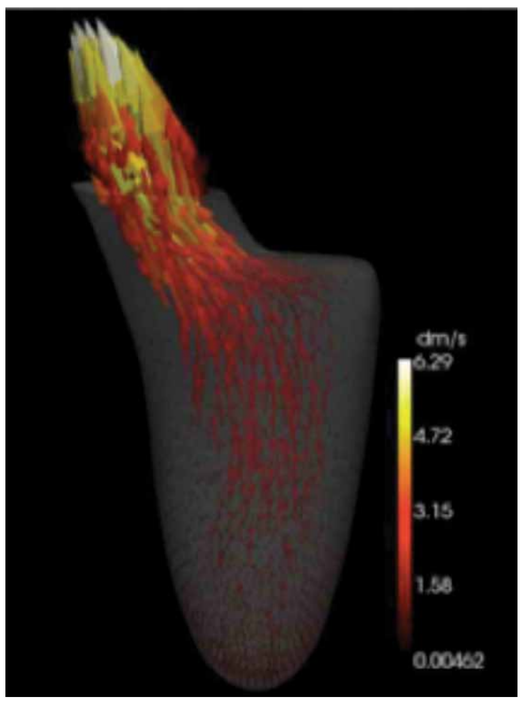
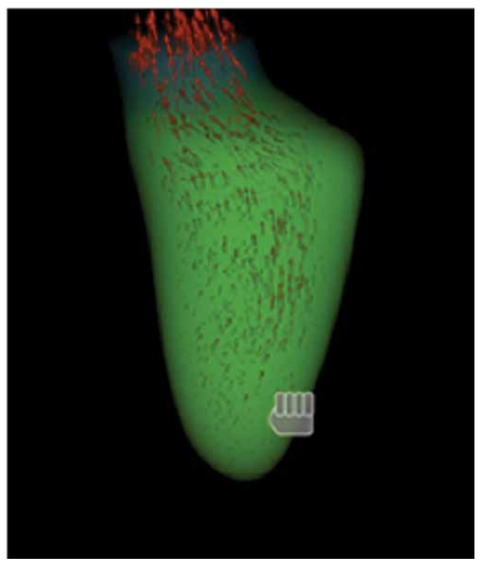
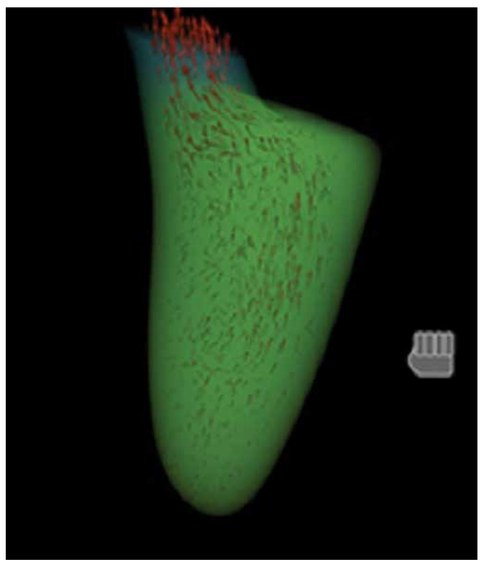


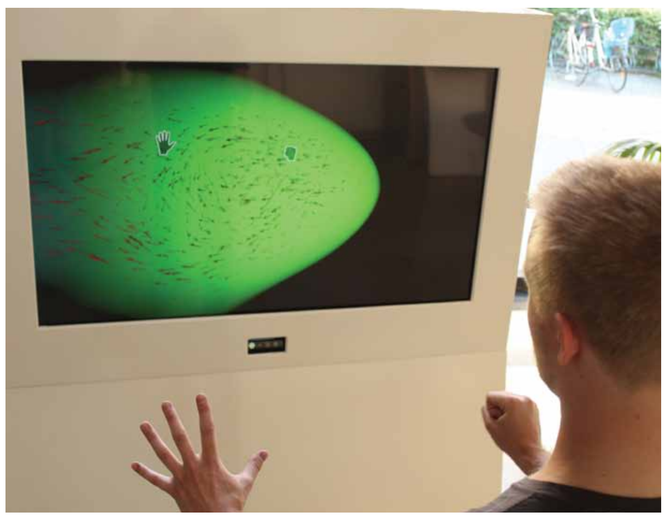


MRI measurement (left) from Linköping University (Tino Ebbers), and computer simulation (right) of the blood flow in the heart in collaboration with KTH-STH (Lars-Åke Brodin and Michael Broomé).

Grasping with one hand rotates the heart simulation model and pauses the heartbeat animation







Grasping with both hands allows zooming in/out by moving them closer or further apart

MOTION

The MOTION project aims at developing a simulation model of a human body to help reconstruct 3D human motion from 2D video capture by data-driven methods. It is expected that a model based on realistic human physiology will narrow down the search space for the statistical methods used, by constraining movement of the virtual body. In addition, with a parameterization of the model sufficiently close to human physiology, from one motion reconstruction the goal is to simulate new motion patterns by the same individual, or to simulate similar motion patterns for a different individual.

MOTION
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HAND

In the HAND project, groups at CSC cooperate with Universitat Jaume I (UJI) in Spain, to integrate physics based simulation with an interactive robotics and animation environment, with the goal of enhancing the realism compared to the heuristic methods used today. As a first step the interactive environment is extended to handle deformable objects from the rigid body dynamics of today, including contact models. This is of key importance for simulating grasping, by a robot or by a human hand. In this interactive environment, various aspects of human body modelling can be studied, such as human hands, robotic hands and interaction of the two. In particular, this environment can support virtual prototyping of human hand prostheses.

HAND
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