Virtual Assembly Verification with Haptic Feedback

Efficiently exploiting space robotic technology for terrestrial applications is a major research topic of the DLR Robotics and Mechatronics Center. Therefore, we started more than a decade ago using our light-weight robot technology for haptic interaction with human operators. One key application for the industry is assembly simulations with haptic feedback.

Aiming at this challenging use case, our technology consists of two key components. On the one side, there are our haptic algorithms that efficiently compute collision data. On the other side, there is the system's robotic component HUG, the *Haptic User Gerät*, which physically provides the user with haptic interaction.

HUG is the bimanual haptic interaction device of the DLR Robotics and Mechatronics Center. Key components are two Light-Weight Robots which enable safe and ergonomic human-robot interaction due to integrated torque sensors and their elaborated mechanical structure.

VPS – The Voxmap-PointShell Algorithm

In contrast to visual rendering, which requires update rates of at least 30Hz for smooth visual feedback, haptic signals must be updated at a challenging rate of 1000Hz to obtain stable and realistic collision feedback. We use an algorithm based on two data structures: voxelized distance fields (voxmaps) and point-sphere hierarchies (pointshells). Our work is inspired by the haptic rendering approach introduced by the Voxmap-PointShell Algorithm which allows for realtime collision feedback even with objects consisting of several millions of triangles.

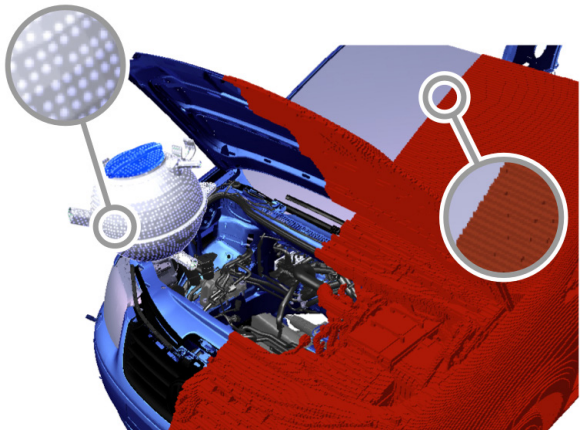
HUG – The DLR Bimanual Haptic Device

Achieving the most realistic force feedback possible for complex unstructured virtual and telepresence scenarios was one of our major goals when developing HUG, the *Haptic User Gerät*. HUG is a bimanual haptic device composed of two Light-Weight Robot arms. The two robots are mounted behind the user maximizing the intersecting workspace of the robots and the human arms. Equipped with thorough safety architecture in hard- and software, HUG assures reliable and robust operation for humans and robots. A head-mounted display and a broad set of various end-effectors increase the level of immersion and extend the range of applications.

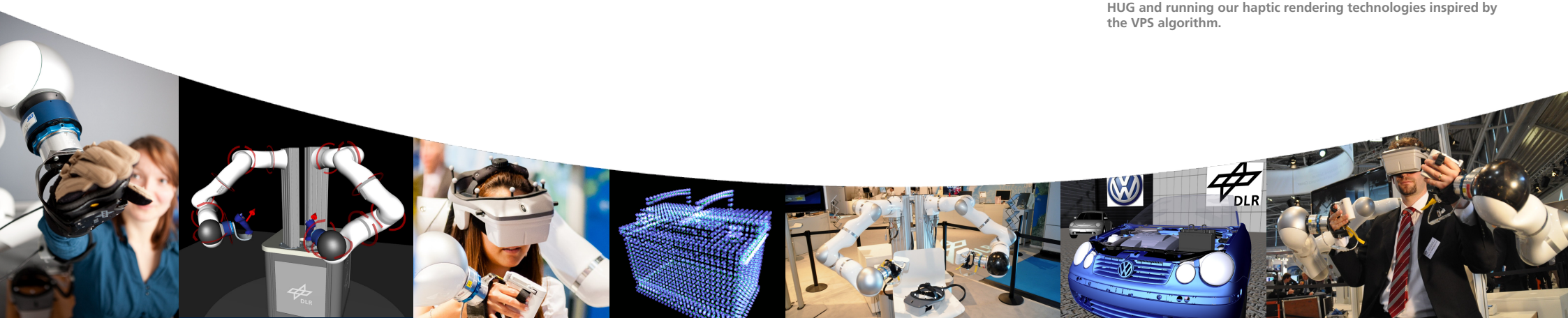
Applications

Using our advanced haptic rendering technologies in virtual reality scenarios, it becomes possible

- to check in early stages of a product design whether different parts can be assembled,
- to integrate the knowledge of manufacturers that build the final product into the product engineering steps,
- to train mechanics in order to prepare them for future complex assembly tasks with fragile objects.



A coolant tank (point-sphere hierarchy) is being assembled into a VW virtual car engine bay (voxelized distance field) using the HUG and running our haptic rendering technologies inspired by the VPS algorithm.



Haptic Assembly Simulations

How can we significantly speed up the development process of new cars? How can we optimally take advantage of the substantiated experience of assembly technicians? How can we beneficially employ novel interaction technologies?

These interesting questions motivate our research on virtual assembly verification with haptic feedback. The main technological outcomes of our research comprise a novel haptic interaction system and sophisticated algorithms for collision detection and force computation.

http://vimeo.com/64882662

Robotics and Mechatronics Center

The Robotics and Mechatronics Center (RMC) is a cluster and DLR's competence center for research and development in the areas of robotics, mechatronics, and optical systems. Mechatronics is the closest integration of mechanics, electronics and information technology for the realization of "intelligent mechanisms" which interact with their environment.

The core competence of RMC is the interdisciplinary (virtual) design, computer-aided optimization and simulation, as well as implementation of complex mechatronic systems and human-machine interfaces. In the robotics community, the center is considered as one of the world leading institutions.

Deutsches Zentrum für Luft- und Raumfahrt

Robotics and Mechatronics Center

Thomas Hulin, Mikel Sagardia
Oberpfaffenhofen
Muenchner Str. 20
82234 Wessling

Telephone: +49 8153 28-1039
Telefax: +49 8153 28-1134

www.DLR.de/rm

Virtual Assembly Verification with Haptic Feedback