# Portfolio of Haptic projects

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Master's thesis "Simulator for Surgical Extraction of Wisdom Teeth"

(Fall 2007) Following a User-Centered design approach involving contextual inquiry, prototype design and co-operative evaluation, a prototype simulator for training final year dental students in surgical extraction of wisdom teeth was developed. Field studies involved interviews, operation observations, in-class participation and prototype testing. A volume sampling based haptic algorithm (Agus, 2004) was implemented in C++ with H3D API. The contextual inquiry suggested that it was of great importance to visually constrain the work space since the mimicked environment context was a patient's mouth. A polygon mesh of a standard head from MakeHuman, was modified by me to suit the particular surgical task. In the model's mouth, a carvable jaw part was placed that contain a partially impacted wisdom tooth and proximity bone and teeth. The jaw model was derived from CT scans and binary classified for the haptic algorithm but visually direct volume rendered. Presented at the Swedish chapter of Eurographics 2008 (Forsslund, 2008).
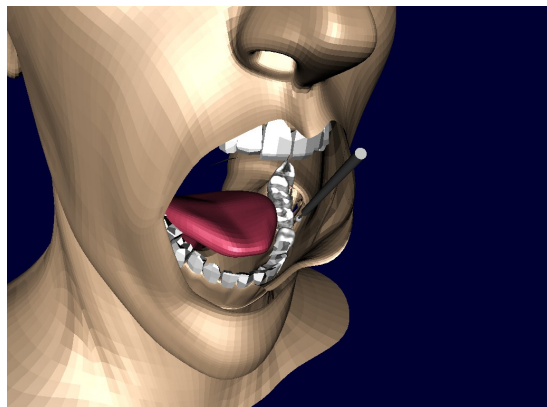

Oral Surgery Simulator

(2008-2010) Based on the positive feedback provided by the oral surgery teachers at Karolinska Institutet, I founded a spin-off company (Forsslund Systems AB) and led the development of the co-located system (embedded a Linux-based PC in a custom designed enclosure with 120Hz mirrored monitor), a networked database server system (that provided patient cases and stored results) and graphics improvements as well as a GUI in Qt.

I designed a segmentation system allowing different properties of the voxel model such as hardness, and where the student should and should not carve on a per-voxel basis. Implementation was aided by a team of developers from a consulting company and an additional Master's thesis project under my lead. Also the graphics has been improved by professional 3D artists. The core system has been released as open source under the name forssim and demonstrated at World Haptics 2009 (Forsslund, Sallnäs & Palmerius, 2009) and Association for Dental Education Europe's annual meeting 2009 (Forsslund, Flodin, Sallnäs, Lund & Rosén, 2009).
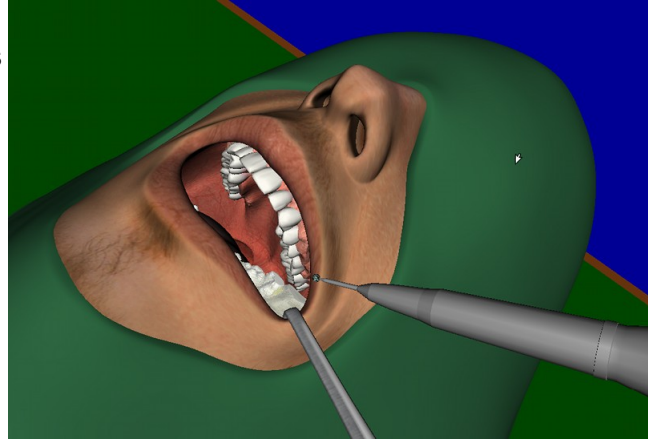

Liver Surgery Planning tool

(2009-2010) In the research project Funkis, the objective is to explore multimodal technologies for enhancing communication in medical multidisciplinary team meetings concerning patient specific liver surgery planning. To support discussions between radiologists and surgeons, I implemented a combined visualization of 2D slices of an Computed Tomography volume, with an stereography visually

and haptically rendered iso-surface of the same volume. The radiologist has before hand segmented the tumors which the users are now able to feel the size and shape of, and distance to contrast-enhanced tissues. Pointing with mouse in one perspective showed the corresponding position in the 3D view and vice verse.
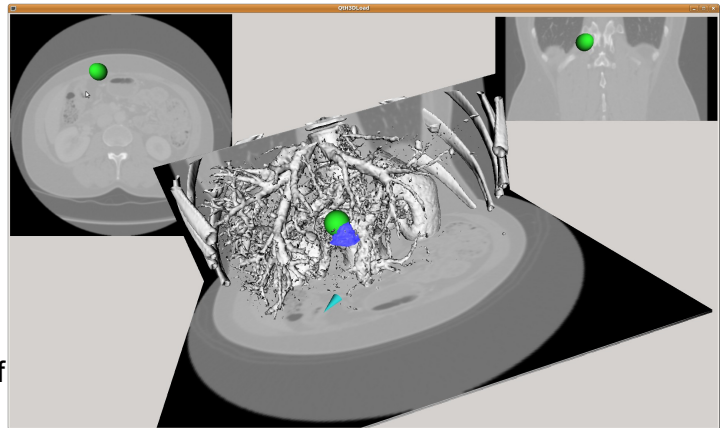
To support several haptic feedback devices, a custom network haptic device proxy was implemented, where each haptic device is controlled by a dedicated computer sending position and receiving calculated force over a local network (UDP) with a measured ~800Hz update rate.

Heart Simulation

(July 2010) In the recent started project Interactive Virtual Biomedicine, I am responsible for implement perceptualizations for a pre-calculated FEM simulation of a human heart, where parameters will have been set by medical professionals investigating a particular patient. The model is implemented by the department of Numerical Analysis and executed on their parallel data center. So far a proof of concept has been implemented in Chai3D where it is possible to feel the pumping half heart and adjust the speed giving quite interesting perception of the simulation. Further work in the project will include investigation of physicians current work, implementation of more visual and haptical exploration features as well as research of communicative and collaborative aspects.
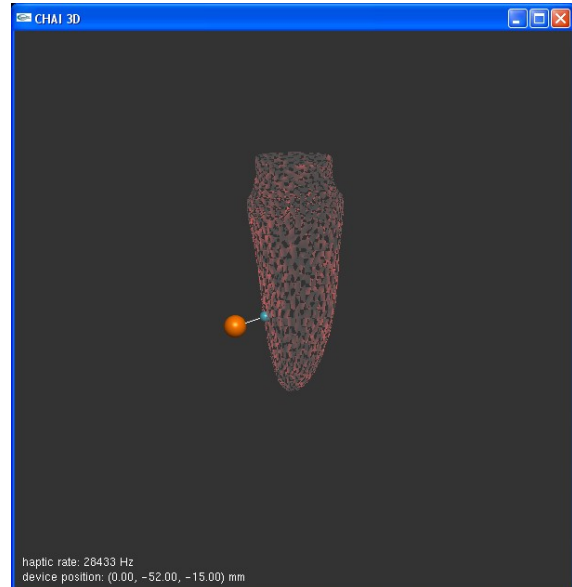
SnowHard

(2009) I participated in a student game developer team for the Swedish Game Award competition 2009, where I implemented the haptic interface and effects. As this game is about throwing snow balls, you could do that using a Novint Falcon device and feel from which direction you were hit etc.

References

Agus, Marco (2004). Haptic and Visual Simulation of Bone Dissection. PhD thesis, Dept. of Mechanical Engineering, University of Cagliari, Italy.

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