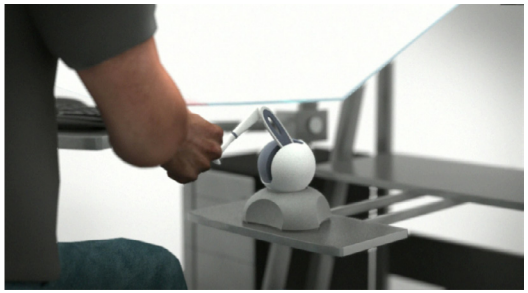
FedDev Ontario's ARC Initiatives OCAD University

Project # 1 – Haptic Holography

Through innovative haptic and holography application, Haptic Holography focused on developing a more realistic and accurate three-dimensional (3D) 'synthetic reality' for purposes of pre-commercialization to enhance current medical training.



The Haptic Holography team collaborated with Entact Robotics Inc. to investigate merging holographic images and sensory perception (haptics) with various mediums for application in medical and surgical training.

Entact Robotics Inc. is a leading innovator of haptic (sense of touch) devices in Canada and was the colaborating partner for the Haptic Holography project contributing to OCAD University's extended history of over 30 years experience of innovation in holography.

Entact Robotics Inc. focuses on the development of tele-operation (machine operation at a distance) robotic systems with haptic feedback, engineering design and the ability to work with clients in real-time to prototype, test and integrate their haptic/robotic systems.

In addition to the development of proprietary devices, **Entact Robotics Inc.** consults with research institutes and industry regarding custom applications.

Technological developments in digital holography and haptics made further investigations for this collaboration possible.

The research methodology for the Haptic Holography project resulted in the following work plan:

1. Survey of existing publications, technology, co-axial viewing
2. Full literature review on sensory feedback to holographic projection
3. Identify real-time interactive Graphics Processing Unit (GPU)
4. Development of Graphic User Interface (GUI) to control the device
5. Identify a process for mapping haptic data ('touch' in 3D space)
6. Production of digital hologram prototypes
7. System design for controlling super bright LEDs
8. Completion of a prototype workstation
9. Creation of multiple 'synthetic' experiences
10. Analysis of field tests in medical education and design industries
11. Final report

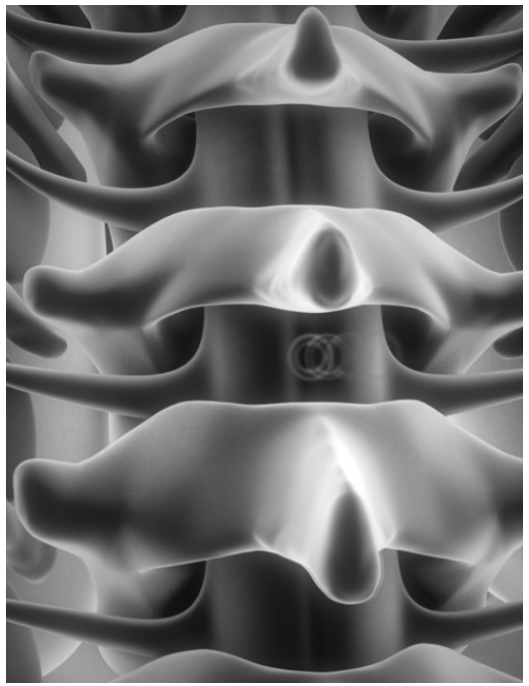


Image from holographic simulation showing the point of entry of the lumbar puncture and 3D graticule guiding the angle of entry.

The fields of science and medicine were early adopters of ‘haptics’, sense of touch, and ‘holography’ - Greek for ‘holos’ meaning ‘whole’ and ‘grafe’ meaning ‘writing or drawing’.

Haptic Virtual View

The initial prototype for the Haptic Holography workstation began with the creation of a holographic ‘species’ and a haptic ‘scalpel’ to understand the application in medical training simulations.

A literature review and survey of current technology and existing medical training devices in the field were done by researching a centralized base of those engaged in the development of haptics, holography and H3D software (an open source program for haptics), used in haptic physics environments at universities and in research labs around the world.

Although current 3D imaging systems in the medical field exist, they primarily employ the use of latex models to simulate medical training procedures. The built internal structures of these dummies replicate the actual tissue, ligaments, vertebrates and bones of patients, in physical form. However, current models do not allow practitioners to see beneath the surface and are not paired with instant feedback systems.

Haptic Holography’s research found that existing training tools and equipment could vastly be improved upon, by integrating visual awareness through holographic overlay and sensory touch with haptics.

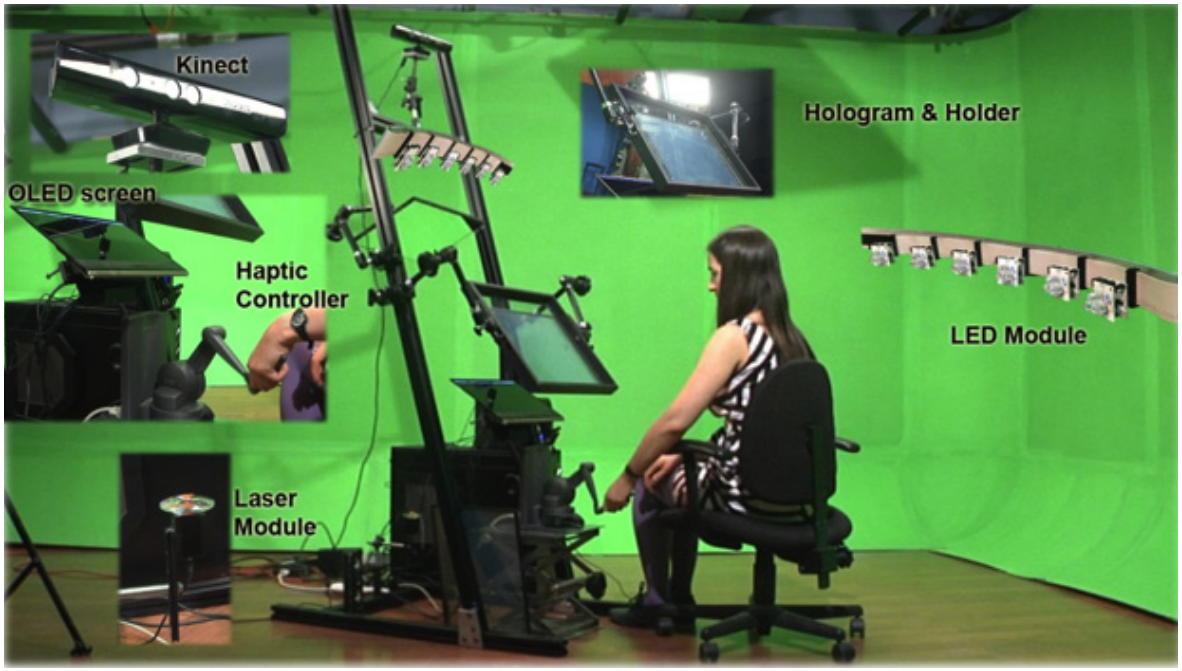
Based on the research conducted, a holographic scene that was useful for training medical professionals in critical medical procedures was created.

The model produced by the Haptic Holography project, incorporating holographic scene and haptic workstation, greatly improves the visual simulation training currently available in the medical field.

Digital and analogue holograms were used to create multiple prototype simulations that proved convincing to observers.

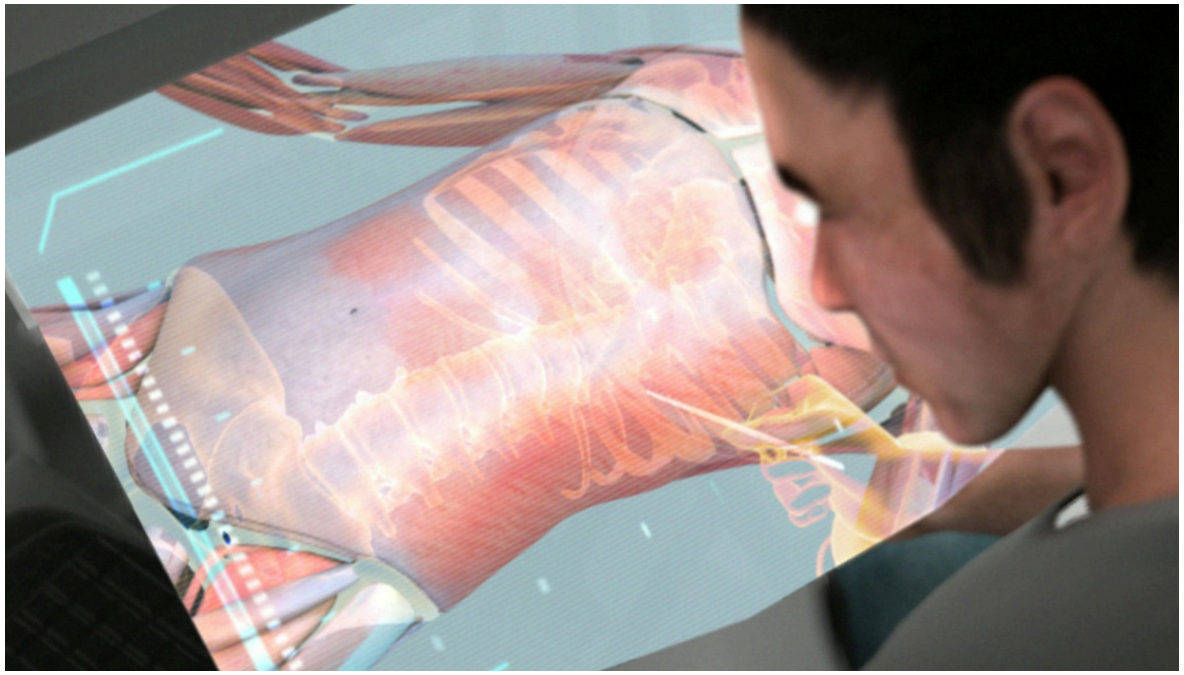
Observers repeatedly failed to notice the partition between 3D animation, video and holography media, making the differentiation between simulation and actual, virtually unrecognizable.

In medical procedures such as lumbar puncture or spinal tap, extreme precision is required to safely and accurately carry out the procedure. The **Haptic Holography** workstation supports training by facilitating learning and building expertise



The Haptic Holography workstation is auto-stereoscopic, providing co-axial viewing so that the holographic illusion can be viewed from all angles in a 3D capacity. It also eliminates the need for cumbersome head-gear, goggles or glasses, creating a more 'realistic' experience.

The Haptic Holography project resulted in a rapid-responsive, customized, interactive workstation fully suitable for the task of inputting haptic data, head tracking data, processing, outputting to video, audio and creating LED control in real-time.



Full immersion with the 3D display screen is simulated, by providing the user with the freedom to use the controller to move, angle, adjust and "feel", the structures necessary to the medical procedure, thus, which results in a superior-responsive training tool.

The workstation produces a holographic 'reality' designed to train medical workers with a sophisticated integration of haptics and holography to simulate lumbar puncture or spinal tap operations.

The workstation's haptic controller is in the same position as the virtual object, which may be a scalpel or a needle.

The simulation provides haptic feedback, giving the user the sense of shape and feel through the controller. As well, the simulation provides audible cues and text speaking to the degree of penetration.

The Haptic Holography Workstation has a number of modules responsible for displaying imagery and creating interactivity:

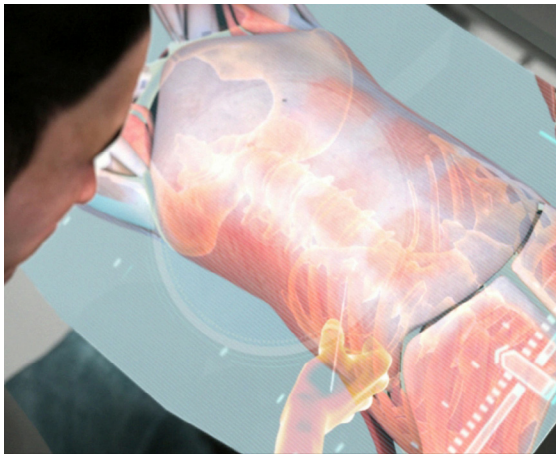
Hologram and holder - This device holds the hologram, in transmission or reflection mode in a precise postion, aligned with the OLED display.

OLED display - This display produces very bright and chroma saturated images; so that the video image will be as saturated as the holographic scene. The computer controls all the input data, real-time processing and output data. The display is viewable at any angle without degradation of the image.

The laser module - This low-power, inexpensive laser illuminates the hologram in transmission mode.

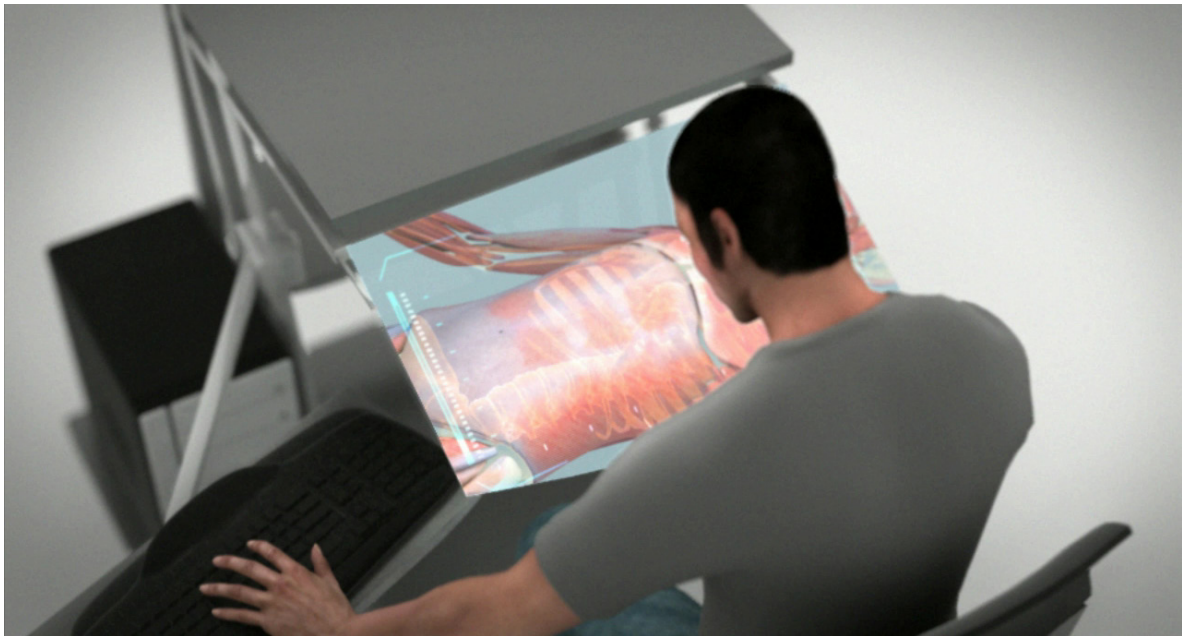
The Kinect module - This device tracks the viewer's head position and instantly modifies the video parallax to conform with that of the hologram.

The Super-bright LED module - In reflection mode, this device changes the reconstruction angle of the hologram, which animates the scene. The module is controlled by the computer and changes the holographic scene to accommodate the "zoom" of the image.



The Haptic Holography workstation provides flexibility in resizing so the user can rehearse the procedure at an image of 1:3 of human scale, with less critical precision, to 1:2 with more precision and then to an 'actual' 1:1 size to train for accuracy and extreme precision.

Users of the Haptic Holography technology can find application in medical and surgical training procedures as well as providing a new form of 'synthetic reality' for artists and designers.



Haptic Holography Principle Investigator and OCAD University Assistant Professor Michael Page, presented this research at The 9th International Symposium on Display Holography (ISDH 2012) at MIT Media Lab, in Cambridge, Massachusetts where the next generation haptic holography workstation was installed.

The **Haptic Holography** workstation was first demonstrated at Canada 3.0 in 2012, at the OCAD U booth. The technology of the workstation received positive feedback from medical professionals in 3D imaging field.

In late 2012, the project work was presented at The Subtle Technologies Conference and tentative plans include an exhibit to show the technology at an international conference on haptics in Finland.

Entact Robotics Inc., has plans to develop the **Haptic Holography** workstation for market commercialization.

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Credits:
Sang Hoon Hwang, renderings pgs 1, 3, 5-7
Finlay Paterson, image pg 2
Michael Page, photo pg 4

Source:
H3D http://www.h3dapi.org/

Software donation in support of Phase Lab provided by Autodesk.