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## Haptic holography /touching the ethereal

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## Haptic Holography/Touching the Ethereal

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# Haptic Holography/ Touching the Ethereal.

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**Abstract.** Haptic Holography, was perhaps, first proposed by workers at MIT in the 90s. The Media Lab, headed up by Dr. Stephen Benton, with published papers by Wendy Plesiak and Ravi Pappuh. -1

Recent developments in both the technology of digital holography and haptics have made it practical to conduct further investigations. Haptic holography is auto-stereoscopic and provides co-axial viewing for the user.

Haptic holography may find application in medical & surgical training and as a new form of synthetic reality for artists and designers.

At OCAD's PHASE Lab (Prototypes for Holographic Art and Science Explorations) workers are exploring hybrid forms of augmented reality, that combine haptics, interactivity and auto-stereoscopic imagery.

Conventional Haptic environments, while presenting a 3D physics environment, typically provide a 2D visual work/play space. Orienteering in such an environment creates an uncertain spatial relationship for the user.

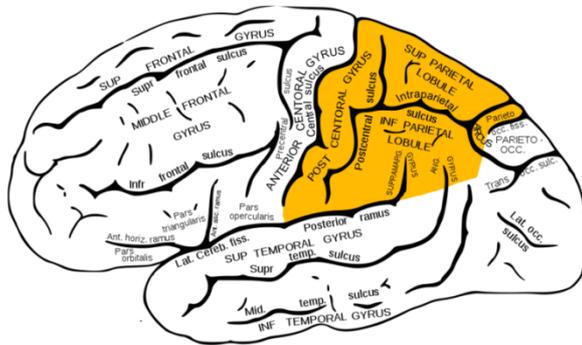
Our group creates 3d models from which we create holographic constructs. The same model is used to create the physics environment. The two models are super-imposed. The result: Holograms you can touch.

## 1. Introduction

As artists and designers our research is focused on human perception and how we might create multi-layered synthetic reality experiences and to successfully blur the lines between illusions to create a hyper state of synthetic reality that is also interactive.

Holography has long been the supreme 3D visioning medium. The public critique of the medium is that it is too static, not interactive. By combining 3D graphics, holography, haptics and audio, we hope to create a more immersive environment for a single user in what we have dubbed the haptic holo workstation.

Haptic derived from the Greek word (haptikos), means pertaining to the sense of touch. Our sense of touch is interpreted through a series of sensors in the brain that can be activated by movement, pressure, chemical and/or temperature changes and vibration. The parietal lob integrates sensory information from various parts of the body (figure 1). -2. Touch is a big part of sensory experience.



**Figure 1** parietal lobe integrates sensory information from various parts of the body

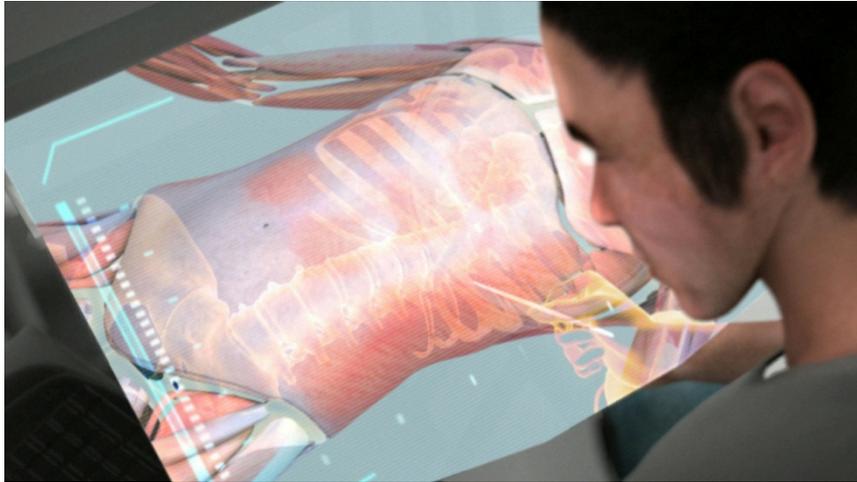
The application of haptics to computer technology typically involves a joystick or stylus equipped with servo motors and encoders that “pay-back to the user and provide tactile sense that responds to a physics-based environment wherein virtual objects are defined in three dimensional space and are given properties such as:

- deformable,
- rigid but movable,
- rigid, not movable, etc.

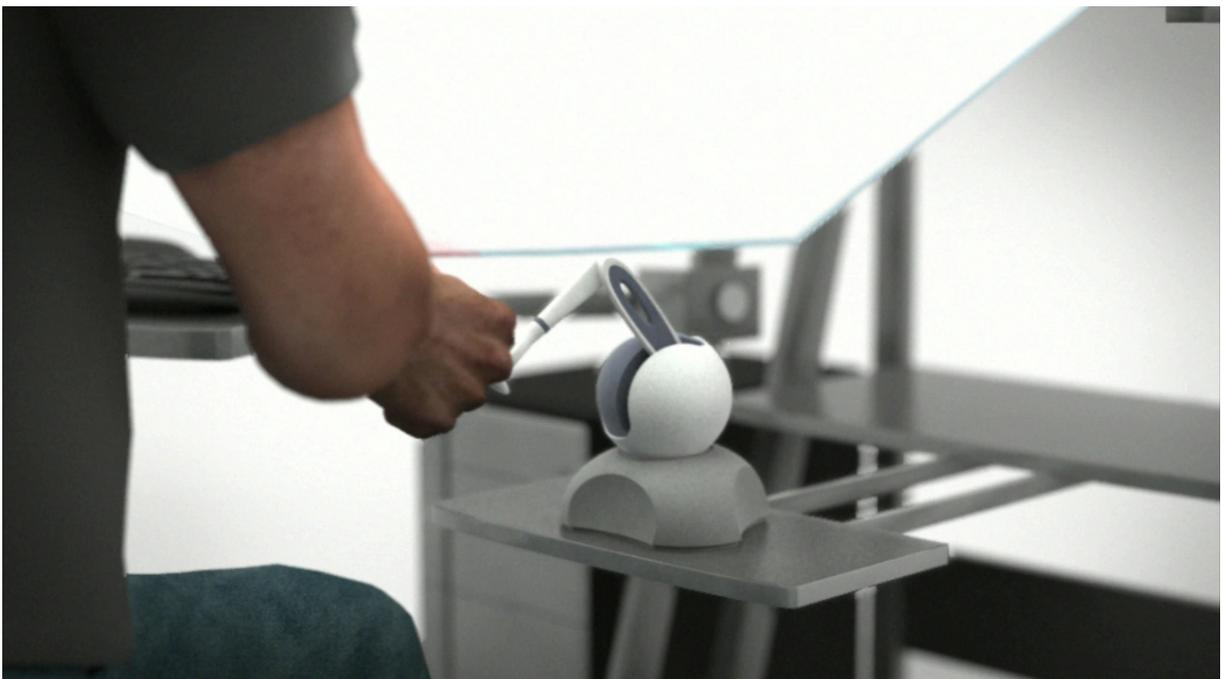
Haptic technology does for the sense of touch what computer graphics does for vision. -3

Our approach to creating prototype simulations is to create a 3D model which is then used to print a digital hologram. The same model is imported into the haptics software to create a 3D physical model of “touchable objects. We then super-impose the two models, add video and sound to create an interactive 3D experience. The haptic/holo workstation has the advantage of requiring a single user interface. Holograms, of course, display full parallax, or in the case of most digital holograms, horizontal parallax. In order to successfully marry 3D animation with holographic projections, head tracking can be used.

The station functions in transmission and reflection mode. In transmission mode the hologram is lit by a low powered laser diode. In reflection mode an array of bright LEDs are used to animate the hologram. This changes the holographic scene for the single viewer to, for example, zoom in on a scene or change scenes completely.



**Figure 2. & 3** Visualization of haptic holo workstation illustrating the co-visual aspect of the workstation





**Figure 4.** The haptic holo workstation and modules.

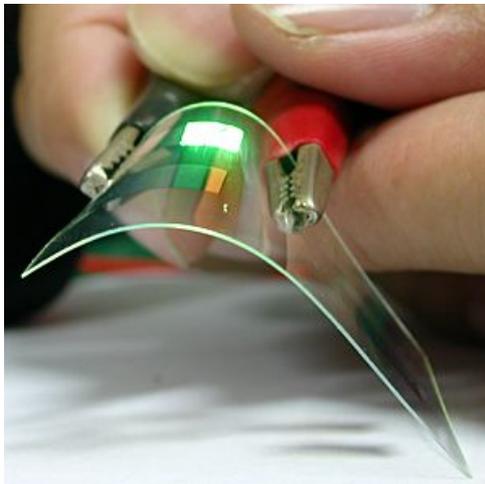
The Haptic Holo Workstation has a number of modules that are responsible for displaying imagery and creating interactivity. (Figure 4)

1. **Hologram and holder.** This device holds the hologram, transmission or reflection in a precise position, aligned with the OLED display.
2. **OLED display.** This display produces very bright and chroma saturated images\* and is viewable at any angle without degradation of the image.
3. **The laser module.** This low power inexpensive laser illuminates the hologram in transmission mode.
4. **The Kinect module.** This device tracks the viewer's head position and instantly modifies the video parallax to conform to that of the hologram.
5. **The Super-bright LED module.** This device, in reflection mode, changes the reconstruction angle of the hologram, which animates the scene. The module is controlled by the computer and will change the holographic scene to accommodate "zooming in" on an image, for example.
6. **The computer** controls all of the input data, real-time processing and output data.

\*This means that the video image will be as saturated as the holographic scene.

**Future modifications include:**

- The use of direct-write reflection holograms.
- The implementation of next generation OLED technology. These brilliant displays, only a few millimetres thick, are transparent where a normal flat screen is black. This will allow the hologram and video display to be sandwiched as one, further compressing the size of the display. (figure 5)
- LED technology continues to evolve into semi-coherent light sources that will sharpen the image in our holograms
- Haptic technology continues to advance into new areas of sensory perception.



**Figure 5** Flexible, thin, transparent OLED screen

**Examples of other haptic research**

MIT has been a world center for research in haptics, including haptics holo video. (Real-time manipulation of holographic video!) -5 The MIT touch lab has been instrumental in bringing about research in hand therapy, intelligent prosthesis design, and the development of autonomous robots that need to perform human-like functions in unstructured environments since 1990. -4

**New areas of research**

Mutual touch over the net. (see figure 6)-6

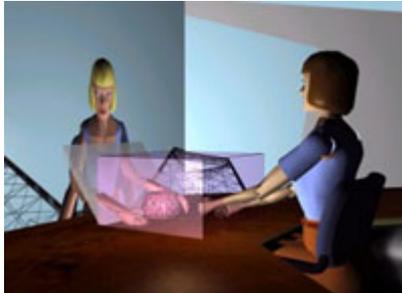


Figure 6 Mutual touch

Disney's Tactile Brush which uses localized piezoelectric devices to create patterns on the back or arms of users that "touch" the user. -7  
Disney's "Touché" haptic device can make your body into an MP3 player.-8

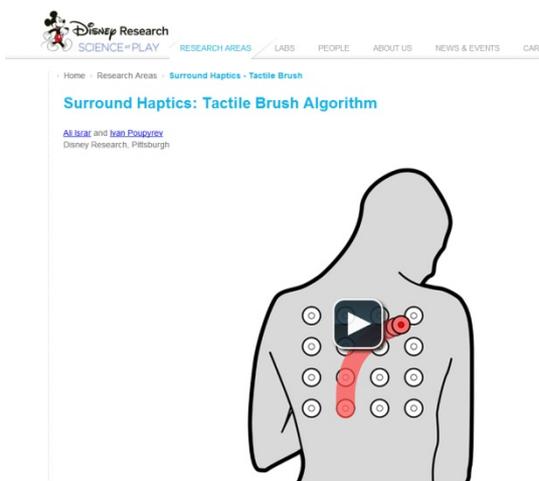


Figure 7. Disney's tactile brush. My computer is tickling me?



**Figure 8** Disney's gaming chair

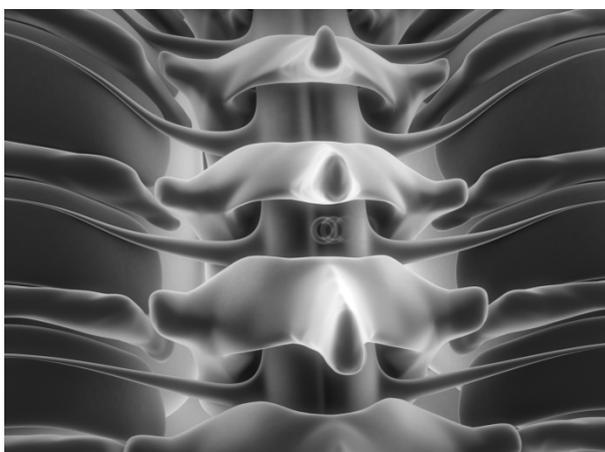
### **Arguments for haptic holography over conventional haptic interfaces.**

The haptic interface we have constructed can be configured to be co-visual. This means that, for example, the user's hand holding the haptic controller would be in the same position as the virtual object, a scalpel or needle.

Unlike other 3D haptic displays that require head gear, goggles or glasses, holograms are auto-stereoscopic.

Haptic interfaces allow the user/medical trainee the option of "zooming in" or making the initial training less critical, then altering the resolution to a more critical state.

Text and other visual or audible communication to the user is also possible (figure 9).



**Figure 9** Image from holographic simulation showing the point of entry of the lumbar puncture as well as a graticule, guiding the angle of entry.

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