Haptics and Extensible 3D in Web-Based Environments for e-Learning and Simulation

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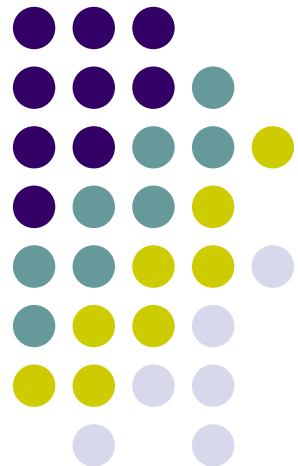
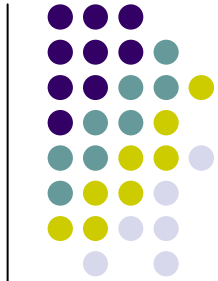


International Conference on Web Information Systems and Technologies (WEBIST), May 4-7, Funchal, Madeira, Portugal

Outline



- Our Goals
- Background and Related Work
- User Interaction
  - X3D-based GUI
  - HTML/JavaScript-based GUI
  - Haptic-based GUI (Multimodal)
- Case Studies
  - 3DRTT (Medical Procedure e-Learning)
  - HaptEK16 (Physics Concept e-Learning)
- Conclusion

Goals

- Exploring Web3D and haptics for novel e-Learning systems
- Development of collaborative spaces for e-Learning and simulation using multi-modal environments
- Haptic Environments for Education (HaptEK-16)
- 3D Environments for Medical Education (3DRTT)

Background

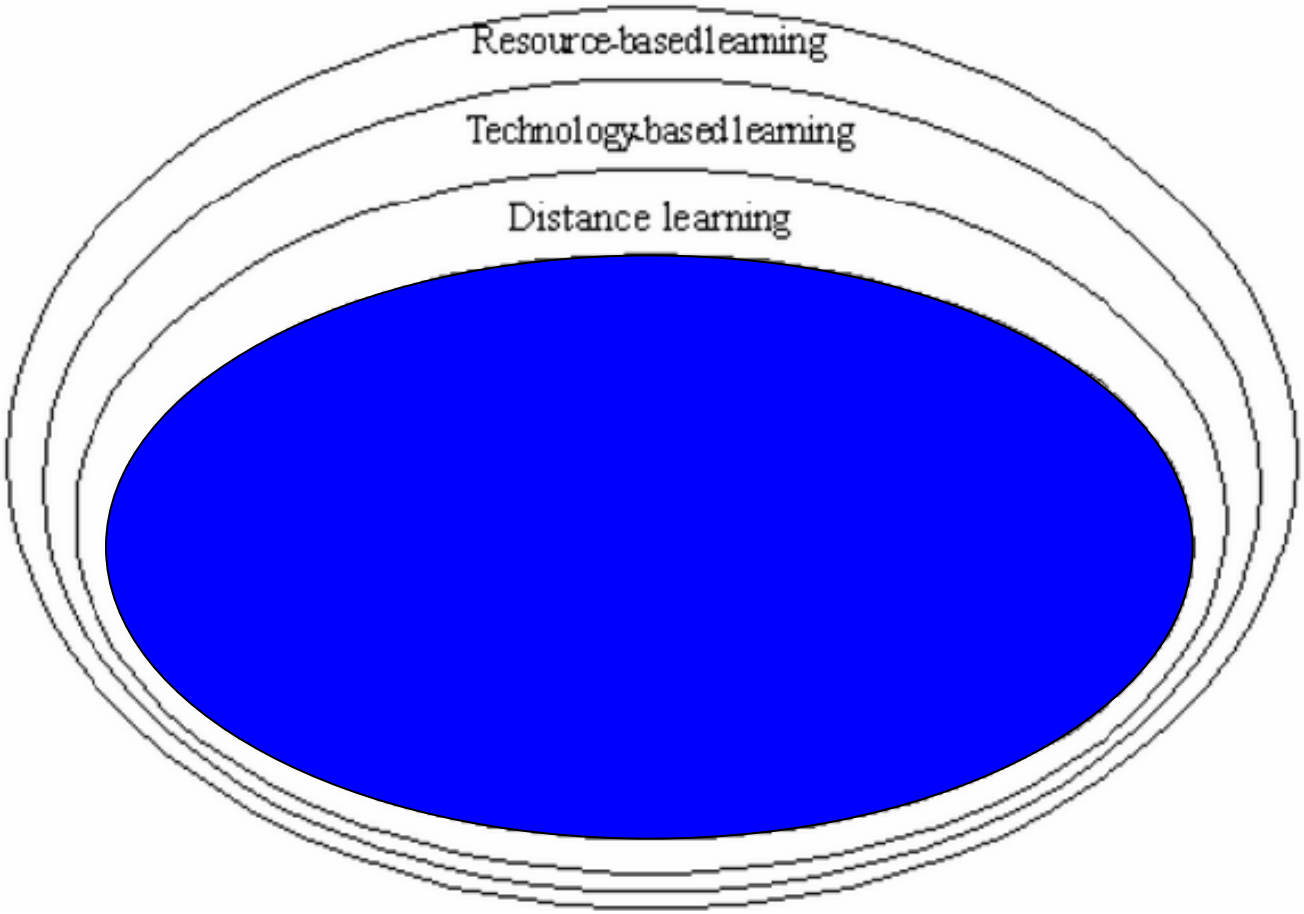
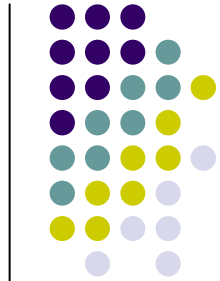


Figure 1: Subsets relationships among the group of terms (Anohina, 2005)

Background – X3D



- EXtensible 3D (X3D) is an ISO standard for real-time 3D computer graphics on the Web.

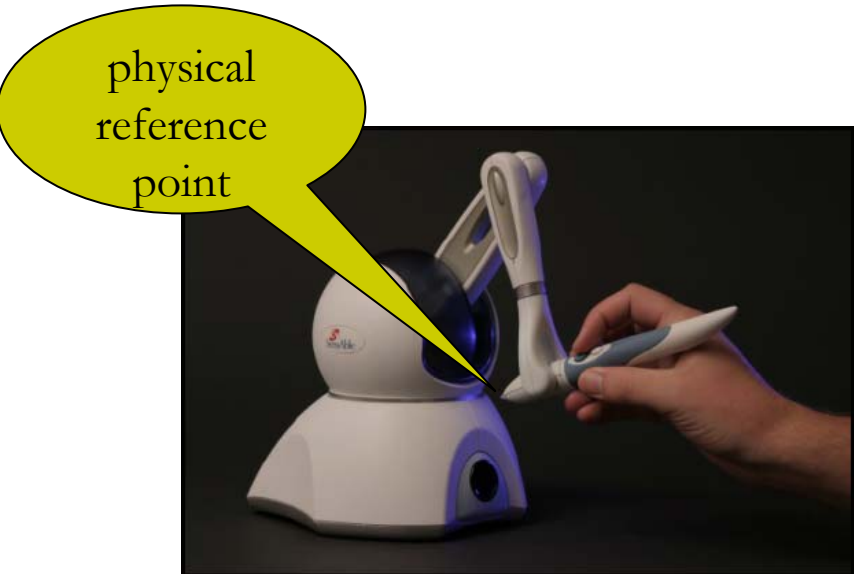
www.web3d.org

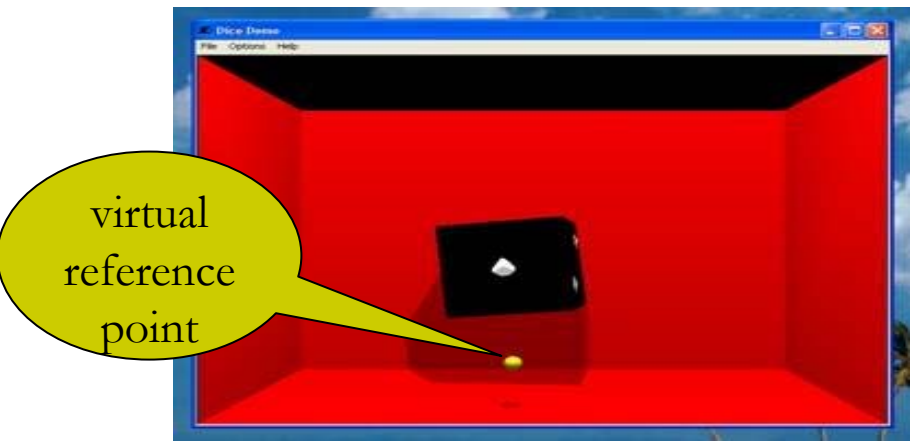
Background – Haptics

- **Derived from the Greek word "*haptikos*" ("able to touch")**
- **Working with the sense of touch.**
- **5 senses:** sight, smell, taste, touch, an hearing
- **Haptic interfaces**

Courtesy of SensAble Technologies

Background – Haptics





- Robotic arm that tracks position and orientation of user's hand.
- Updates position and orientation information every ms (1KHz)
- Visual representation of physical reference point within virtual application.

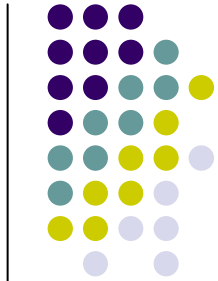
Related Work

- In Interactive Molecular Dynamics (Stone, Gullingsrud, and Schulten, 2001)
  - the users manipulate molecules with real-time force feedback and a 3D graphical display.

- Pilot demonstrations with biology students using graphical models with haptic feedback
  - provides an intuitive and natural way of understanding difficult concepts and phenomena (Sankaranarayanan et al, 2003).

- University of Patras (Greece), is designing simulations to aid children in understanding several subject areas of science such as Newtonian Laws, Space Phenomena, and Mechanics Assembly (Pentelios, Christodoulou, and Papatheodorou, 2004).

Outline



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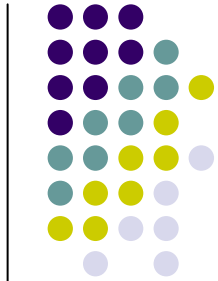
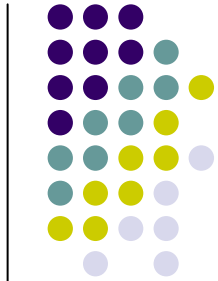
X3D-based GUI



- In X3D-based GUI the entire functionality is embedded in the X3D.
- To change the scene the code has to be altered and the page has to be manually refreshed.
- Many components can be controlled by simply clicking, dragging, rotating, or activating specifically designated sensors.
- The scripting capabilities of X3D enrich the GUI interactivity and enable developers to create efficient custom control panels.

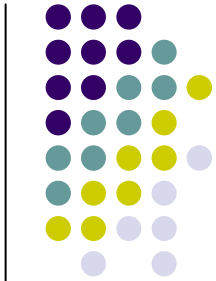
HTML/JavaScript-based GUI



- HTML and JavaScript can effectively communicate with the 3D scene.
- JavaScript implements most of the features, and HTML serves as its operating environment.
- With JavaScript it is difficult to encode unconventional GUI components because of limited browser support.
- Powerful and flexible task-oriented GUI components require the usage of the traditional HTML powered by extensive JavaScript.

Haptic-based GUI

- Haptic feedback improves the interface usability and interactivity.
- Tactile sense incorporates pressure, heat, texture, hardness, weight, and the form of objects.
- Lederman, Klatzky, and Metzger (1985) summarized basic procedures for haptic exploration:
  - *Lateral motion* (stroking) – information about the surface texture of the object.
  - *Pressure* – information about how firm the material is.
  - *Contour following* – information on the form of the object.
  - *Enclosure* – the volume of the object.



Case Studies

Medical Procedure Simulators – 3DRTT

www.3drtt.org

- Radiation therapy treatments processes are preplanned in advance of the operation.
- 3D Radiation Therapy Training (3DRTT) is a web-based 3D graphical simulator for radiation therapy.
- 3DRTT simulates linear accelerators (linacs) used to deliver radiation doses to an internal tumor.
- The focus is improving the efficiency and reliability of the treatment planning and delivery by providing accurate visualization of the linacs hardware interaction.

3DRTT with X3D GUI

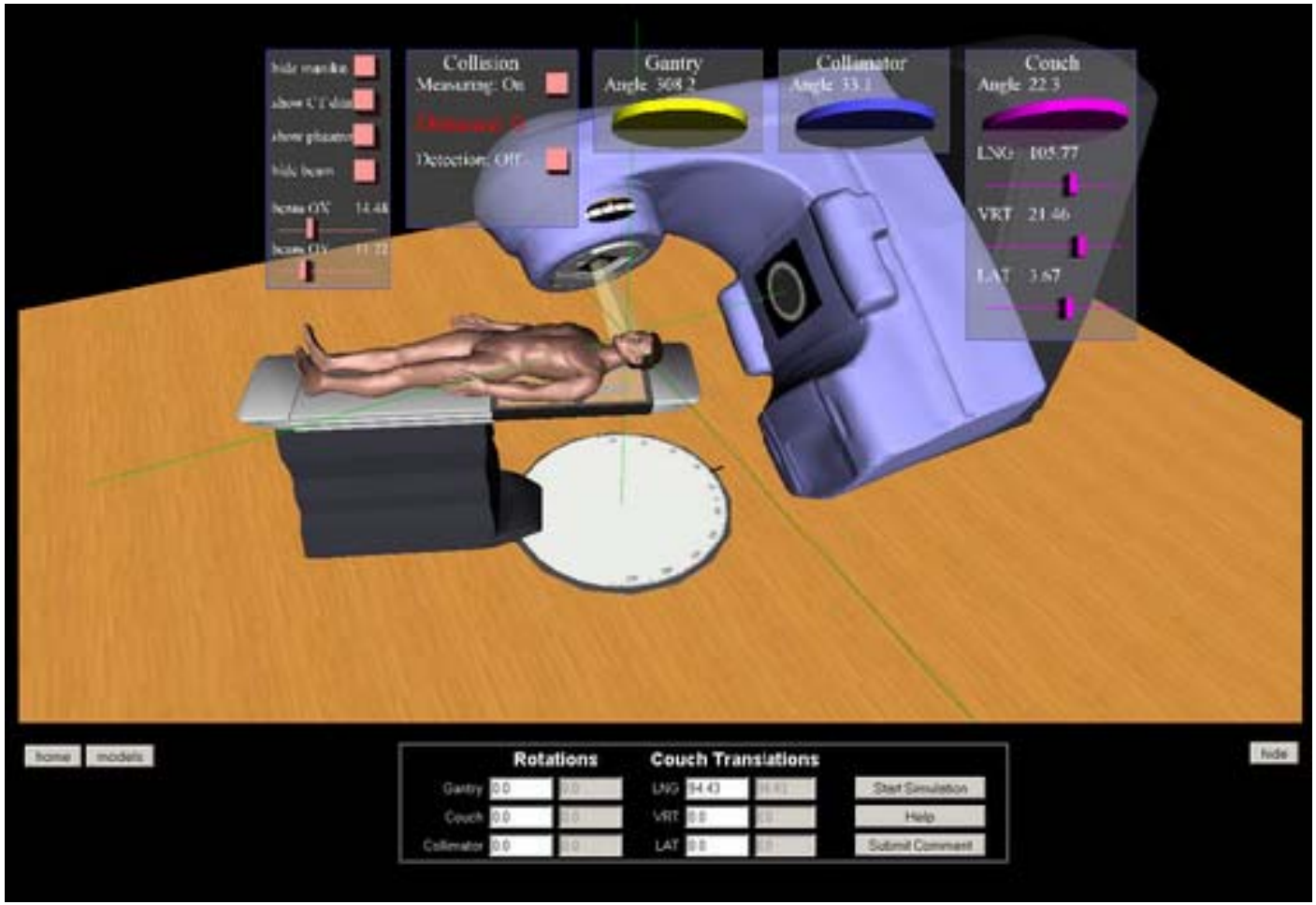


Figure 3: 3DRTT Simulator with X3D GUI

3DRTT with HTML/Java Script GUI

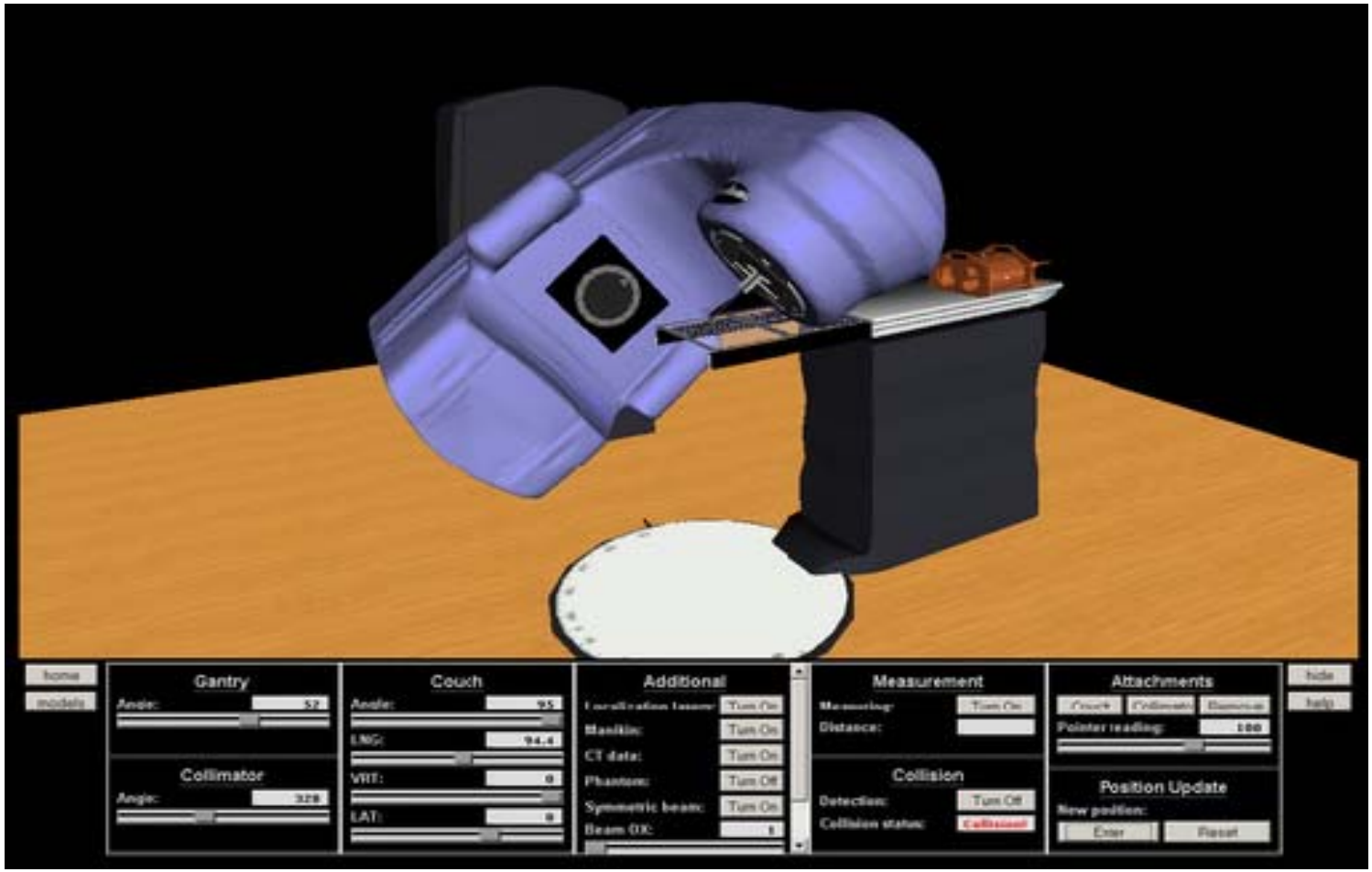


Figure 4: 3DRTT with HTML/JavaScript-based GUI

Haptek16 (e-Learning Module)

- HaptEK16 is designed to assist students in understanding Pascal's principle and other difficult concepts of hydraulics.

- Simulator includes three simulation modules:
  - pressure measurement,
  - hydraulic machine
  - hydraulic lifting simulation

- Students interact with the 3D scene using a haptic device.

- Implementation: Python + X3D + Sense Graphics' H3D API (http://sensegraphics.com).

e-Learning Module – Haptek16

Figure 5: Students using the HaptEK16 hydraulics module

e-Learning Module – Haptek16

- Python is a rapidly growing object-oriented programming language that offers strong support for integration with other toolkits and APIs.
- H3D is an opened X3D-based haptic API.
- H3D's haptic extension to X3D is an excellent tool for writing hapto-visual applications.
- SenseGraphics extended their API with scripting capabilities for rapid prototyping.
- In HaptEK16:
  - geometry and scene-graph structure defined in X3D
  - application and user interface behaviors described using Python and wxPython.

e-Learning Module – Haptek16

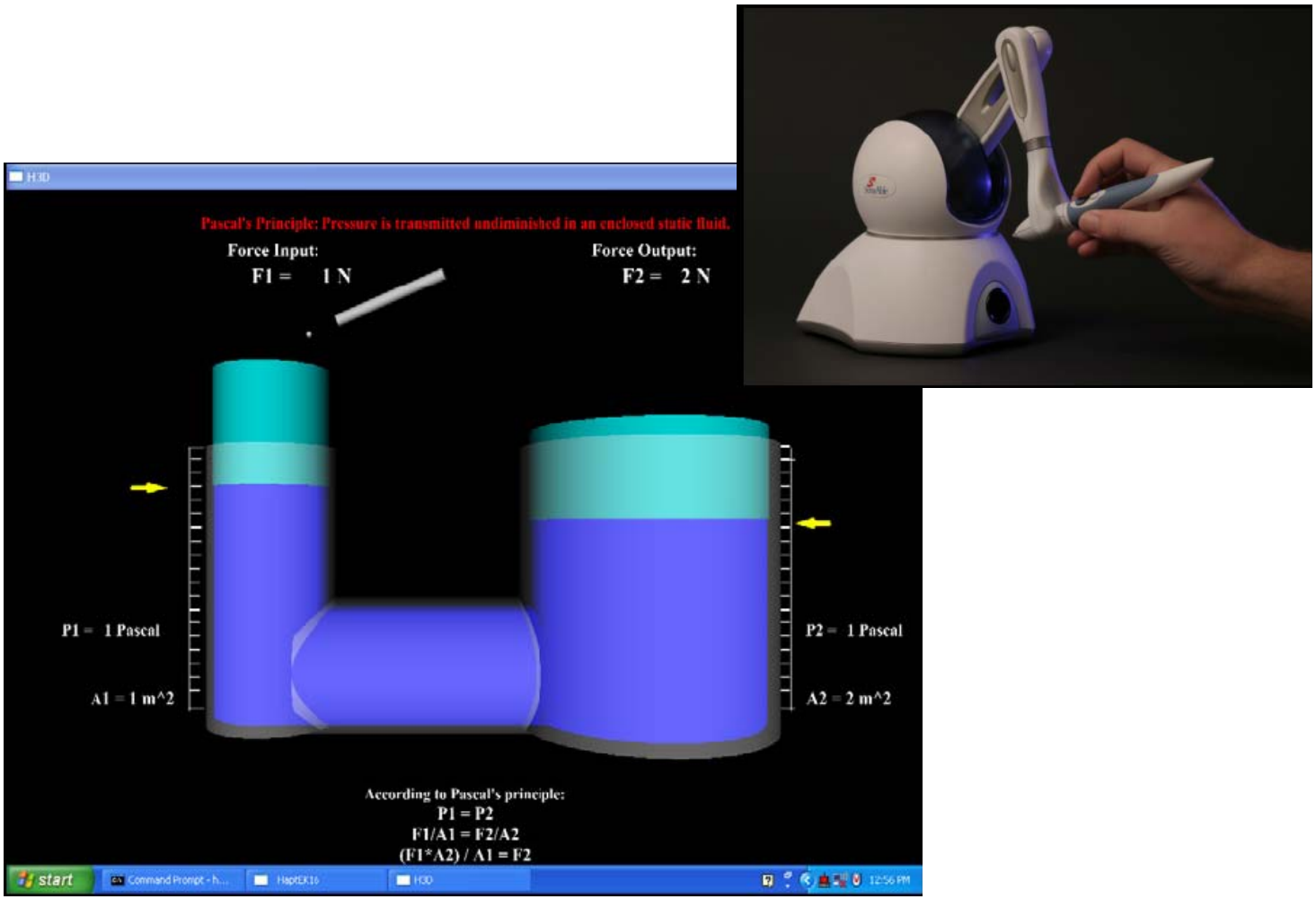


Figure 8: HaptEK16 screenshot and corresponding Phantom® Omni™ device from Sensable Technologies

Conclusion

- 3DRTT:
  - an example of a web-based system that through X3D improves the efficiency of the user-interface interaction
  - easy access, simple control, and advanced capabilities of 3D visualization.

- HaptEK16:
  - has the potential to augment or replace traditional laboratory instruction with an interactive interface
  - offers enhanced motivation, retention, and intellectual stimulation

- Considering the advances in software and hardware technology, we will see many applications of haptics and 3D graphics in near future web-based information systems and applications

Thank you

- More info:

www.cs.armstrong.edu/felix/news/

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