Interactive 3D Web-Based Environments for Online Learning: Case Studies, Technologies and Challenges

Felix Hamza-Lup, Ph.D.
Prof. of Computer Science
Armstrong Atlantic State University
Savannah, GA

Special thanks to all my colleagues, students and collaborators involved in these projects

International Conference on Mobile, Hybrid, and On-line Learning, Feb. 1-7, 2009
Outline

• Interactive Interfaces – Input/Output channels (I/O)

• Engineering: Virtual Interactive Engineering on the Web

• Medicine: Neuro-Pathways

• Chemistry and Physics: Electrolysis

• Technologies

• Challenges

• Demos
Interactive Interfaces

- **Learning** is about **Knowledge** transfer:
  - K today is orders of magnitude higher than 50, even 10 years ago (specially in technical fields)
  - still same main methods for teaching & learning:
    - concept understanding
    - some level of memorization
      - “I hear and I forget. I see and I remember. I do and I understand” – Confucius

- Knowledge transfer occurs through (social) interaction
  - Engagement (major issue today – cells good & bad)
  - Immediate feedback (Interactive speed … seconds)
  - Real-world contexts (relate to real world contexts)
Input/Output Channels

- We have 5 senses (I believe we have more …) but let’s assume we have only 5:
  - I hear (hearing), I see = (vision), I do (haptic), [taste, smell]
  - Input: all 5 (for most people)
  - Output: mainly haptic, (also I can make sounds)

- Technology allows us to simulate:
  - Sounds - for some time now (radio, etc.)
  - Vision – (tele=remote, visor=vision) TV
    - (!) Charley Chaplin – no sound, black/white, 2D
    - later – with sound, even later – color
    - (!) majority is still 2D
    - oh! you think computer applications are 3D
    - you are wrong – most GUIs 2D – move the mouse in 2D
    - (!) I believe next step will be 3D – widespread
  - Haptic (touch) – just now booming (cheap hardware)
  - Taste – do we want to simulate this ?
  - Smell – this is possible, interesting to explore
I will focus on

• Vision (3D)
  – natural, exciting, larger bandwidth
  – issue 1: 3D visualization hardware – already here (cheap)
  – issue 2: 3D content -> new standards X3D – already here
  – issue 3: Tools to develop and author – almost here

• Interactivity
  – if see the outcome of my actions I have impression that “I do”
  – issue 1: real-time
    – software support – efficient algorithms – almost here
    – hardware support – powerful CPU/GPU – already here
  – issue 2: communication
    – (software & hardware – the Web) here for some time now and the “beautiful” fiber optics – lots of bandwidth still unused. (of course it is also about latency … 50 ms average – Austin-Sydney 2003)
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Virtual Interactive Eng. on the Web (VIEW)

• Motivation
  – Our engineering students use GaTech facility near Savannah for the Material Engineering labs
  – It is Ok but these devices must be maintained and experiments supervised
  – No room or ($) to develop replicate the lab at AASU

• Solution
  – Why not replicate the environment in 3D ?
  – Even further: make it available online, accessible anytime/anywhere
    (!) as a supplement for teaching the course

• Engineering Materials
  – Materials testing
  – Structural Damage
  – Stress parameters
3D classes or 3D Projection for the entire class:
- No additional software (just a plug-in)
- Available online
- Cheap
⇒ Does produce engagement (students)
  "cool", "awesome", "can we play now", "let me see, give me those glasses"

3D Interactive
Real-World Context
- may upload different samples
- may download the plot in Excel (etc.)
- may perform same visual analysis of the distortions in the material

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VIEW

• Assessment
  – Currently under assessment with 2 sections of engineering majors, approx 40 students

• Mechanical Assembly/Disassembly
  – Under development
    • Electric toothbrush model
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Neuro-Pathways

Right Cerebral Hemisphere
(Temporal Lobe & Superior Temporal Gyrus)

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Neuro-Pathways

• A need: Collaboration with Mercer Medical School

• Medical students historically have difficulty conceptualizing and projecting the 3D aspects of neural pathways from 2D text materials and electronic resources.

• The basis of a neurological exam relies on the physician’s ability to visualize very complex neuro-anatomical relationships to make highly accurate diagnosis.
Neuro-Pathways

• Issues with neuro-anatomy
  – extremely complex
  – cannot be dissected and easily visualized in an anatomy lab

• We hypothesize that the ability to visualize neuro-anatomical pathways in 3D significantly improves and compensates for the students’ clinical deficits allowing them to localize discrete lesions.
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Physics and Chemistry
- Electrolysis -

- Chemistry and physics pose difficulties in understanding the concepts, actions, and phenomena when learned through the traditional method.

- The psycho-pedagogical difficulty comes from the process of theoretical concepts formation.

- 3D visualization may play a significant role in the formation of a conceptual framework for understanding complex phenomena [10]
Physics and Chemistry - H$_2$O Electrolysis -

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Physics and Chemistry
- H₂O Electrolysis -

- 3D Window in the HTML text page
- Interaction ability: speed, viewpoint, etc.
- Animation of the phenomena
- Can be used on Projector in class

- Getting closer to Anyone, Anywhere, Anytime paradigm
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Technologies

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

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Technologies

• eXtended 3D (X3D)
  – ISO standard for real-time 3D computer graphics on the Web
  – VRML successor, but much better
  – XML compliant
  – provides a special technology called Scene Authoring Interface (SAI) to enable the developer to dynamically modify or create X3D worlds

• X3D Web Browser Plug-in(s)
  – Light-weight
  – Free or very cheap (e.g. Bit Management Contact Player)
  – Easy to install by non-geek
Technology
- 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.
Technology
- 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.

• Asynchronous JavaScript and XML (AJAX) and other toolkits can be used
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Challenges

• Interactivity
  – Polygonal representation – keep nr. of polygons at a decent level
  – “Decent” network connection
  – Rendering “ok” on any hardware newer than 1999

• Content & GUI
  – Design
  – Guided tours, otherwise the student will be lost
Challenges

- **3D interfaces**
  - All menus provide 2D interaction
  - We need 3D: e.g. Mouse, P5 glove
  - 3D visualization hardware tuned to specific need & budget

- **3D navigation**
  - User not familiar
  - Developer not familiar
  - Designer not familiar
  - May require additional hardware – motion tracking
Demo Time!
Thank you

cs.armstrong.edu/felix

www.neuro-pathways.org

www.3drtt.com