Virtual and augmented reality tools to demystify clinical complexity

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http://www.eng.mu.edu/vizlab/  http://www.eng.mu.edu/cvtec/

Motivation

Immersive experiences allowing for motion in realistic environments:
- active learning
- critical thinking
- improved performance

Particularly useful when training in the physical world is complex, dangerous or logistically challenging.

e.g. a diver is more likely to recall instruction when it is learned in water rather than on land.
**What is an immersive experience?**

**immersive**

[ih-mur-siv]

adjective

1. noting or relating to a digital technology or image that actively engages one’s senses and may create an altered mental state
2. noting or relating to activity that occupies most of one’s attention, time or energy
3. experiences that facilitate full body motion of a participant
4. Covers a large portion of your field of view

Adapted from Dictionary.com & Patel et al. 2006

**What is an immersive experience?**

- Adjectives:
  1. Noting or relating to a digital technology or image that actively engages one’s senses and may create an altered mental state.
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**Types of Immersive Technology**

**Virtual Reality (VR):**
- Uses head-mounted displays (HMD)
- Computer-generated world
- Manipulate objects using controllers
- For example, Ready Player One

**Augmented Reality (AR):**
- Overlays digital info on the real-world
- Enhances real world using digital details
- Creates new layers of perception
- For example, Pokémon Go

**System Components**

Display source onto which a specific environment is generated and adapted through the movements of one or more users.
What’s the point?

Immersive visualization, augmented reality and virtual reality are not just for video games or hobbies.

They allow us to break down complex situations and show them in ways that are natural and realistic to improve understanding.

Our application today is clinicians and patients.

However...beware the Hype Cycle

1. Content creation can be challenging, and takes time
2. Is there a benefit of immersion to clinicians and/or patients?
3. Results should be linked to outcomes

Content creation can be challenging & takes time

MARVL opened Jan. 16, 2014 with shared resources to create immersive content for research, teaching, industry and outreach initiatives

- Goal is to create custom immersive content and teach the theory related to this area
- To replicate to data across a range of platforms
- Large-scale immersive environments

Criteria for assessing viability are clearly defined.
Usefulness is paying off.
E.g. computational fluid dynamics (CFD)

CFD helps analyze this complexity for analysis and improvements

E.g. CFD in arteries...the old way

E.g. Immersive CFD in arteries
Immersive VR can facilitate active learning

VELOCITY
-2 m/s  2 m/s

SPEED
2 m/s  2 m/s

*E.g.* the way we typically teach velocity as compared to speed

The prior immersive approach facilitates active learning!

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Is immersion beneficial to clinicians and/or patients?

"In VR we are currently still at the stage similar to that of the transition between theater and movies. Movies were originally just another way to show...

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E.g. Immersive viewing of medical imaging data

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Ho3lens AR demonstration

Outcomes-based research using immersive VR

- >350,000 patients get radiation therapy (RT) for cancer annually
- 60% of patients experience anxiety during the preoperative stage of RT treatment, and 80% develop anxiety postoperatively
- Reports describe a virtual environment for RT originally created for students training to be radiation therapists
- 45% of breast cancer patients receiving RT treatment suffer from clinically-relevant levels of anxiety
- A similar approach might be useful to alleviate anxiety and related issues in breast cancer patients undergoing RT

VR-based exposure therapy

- Exposure Therapy is the gold standard in psychology
- There are limitations to implementing with all cancer patients
- VR-based Exposure Therapy for RT could realistically display anxiety-provoking stimuli in a convenient, safe and controlled environment

Objective: Reduce anxiety levels while increasing preparation and understanding for breast cancer patients receiving radiation therapy by allowing them to virtually undergo treatment prior to their actual treatment
Clinical Trial – immersive VR for cancer patients

Study Design
- Multi-site, Randomized Controlled Trial involving 36 patients
- Experimental group (VR experience) vs Control (standard video)

Measures
- Visual Analog Scales
- State-Trait Anxiety Inventory
- Informational Needs Scale

Oculus Rift VR demonstration

Exponential research – VR publications in PubMed
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