Next-Generation Healthcare Education:
Leveraging Extended Reality and Spatial Computing with Low-Code and No-Code Content Creation Tools

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Overview

• Computational Medical XR
• Clinical validation for XR training
• Can AI+XR transform medicine?

“Science is more than a body of knowledge; it is a way of thinking.”
Carl Shagan
My Career arcs
Augmenting Human intellect?

Let us consider an "augmented" architect at work. He sits at a working station that has a visual display screen some three feet on a side; this is his working surface, and is controlled by a computer (his "clerk") with which he can communicate by means of a small keyboard and various other devices.

He is designing a building. He has already dreamed up several basic layouts and structural forms, and is trying them out on the screen. The surveying data for the layout he is working on now have already been entered, and he has just coax the "clerk" to show him a perspective view of the steep hillside building site with the roadway above, symbolic representations of the various trees that are to remain on the lot, and the service tie points for the different utilities. The view occupies the left two-thirds of the screen. With a "pointer," he indicates two points of interest, moves his left hand rapidly over the keyboard, and the distance and elevation between the points indicated appear on the right-hand third of the screen.
Head Mounted Displays and natural user interaction?

The sketchpad demo: https://youtu.be/6orsmFndx_o, 1963
Sutherland, I. E. A head-mounted three dimensional display. AFIPS Fall Joint Computing Conference 757–764 (1968)
XR and Spatial computing for medical training?

XR and Spatial computing for education?


Computational medical XR is a new interdisciplinary field, bridging life sciences, with mathematics, engineering and computer science. It unifies computational science (scientific computing) with intelligent extended reality and spatial computing for the medical field. It integrates computational methods from computer graphics, computational geometry, vision and deep learning to solve hard problems in medicine and neuroscience:

- low-code/no-code authoring XR platforms
- XR medical training
- XR surgical planning
- XR operative navigation
- XR for rehabilitation and therapeutics

Intro

Why now for computational medical XR?

“After years of validation and use by early adopters – XR medical technology is poised to move to the mainstream; recent changes in access and cost make XR quite affordable”

Dr. Walter Greenleaf,
Stanford Health Care & Virtual Human Interaction Lab

“The biggest challenges in healthcare are (1) access—there aren’t enough enough good doctors to provide timely care to all who need it (and clinicians are leaving the field in droves due to burn out), and (2) cost—the cost of healthcare has skyrocketed, largely because of increasing labor costs.

AI will solve both of these issues.”

Daisy Wolf and Vijay Pande,
https://a16z.com/2023/08/02/where-will-ai-have-the-biggest-impact-healthcare/
VR simulation-based training for surgical education: where to go next?

- Initial search identified 1,394 articles,
- Of which 61 were included in the final qualitative synthesis.
- The majority (54%) were published in 2019–2021, 49% in Europe.
- The majority of studies (70%) focused on simulator validation.


Current literature pertaining to VR training for orthopaedic residents is focused on establishing validity and rarely forms part of a curriculum. Where the focus is education, the majority are discrete educational modules and do not teach a comprehensive amalgam of orthopedic skills. This suggests focus is needed to embed VR simulation training within formal curricula.
Heads-up computing*

Do our tools really complement us, or are we adjusting our natural behavior to accommodate our tools?

METAVERSE GENERATION (VIRTUAL WORLDS): CODE -> LOW-CODE -> NO-CODE (GENERATIVE AI)
XR draws on AI

“In order to get to ultrarealistic and useful 3D, there’s a need to step beyond hardware and incorporate AI.

Even the most powerful GPU wouldn’t be able to generate high-quality ray-traced 3D models in real time.

Just when Moore’s Law is expiring and graphics as usual has run into a roadblock, AI has appeared as a valuable tool.

It provides us with new and powerful methods to push graphics forward, by being smarter about the rendering process.

We are at the cusp of enormous innovation in the 3D rendering space”

Deep learning and generative AI

“Deep learning takes data points and turns them into a query-able structure that enables retrieval and interpolation between the points.

You could think of it as a continuous generalization of database technology.”

“It is categorically different from even the simplest of embodied biological agents. As in, it’s an entirely different category, with no shared characteristics.

Analogies to the brain are just as misleading as when people used the same analogies to describe computers in the 1950s.”

F. Chollet, Google AI
THE PROBLEM

XR training improves learning outcomes¹, XR content creation cannot keep up with demand:

- **LENGTHY CREATION TIMES: 2 – 8 MONTHS**
- **HIGH AUTHORING COSTS²:** MIN $20K PER MINUTE
- **INFINITE NUMBER OF TRAINING EXPERIENCES TO BE SIMULATED AS DIGITAL TWINS**
- **LACK OF LOW/NO-CODE, CONTENT AUTHORING TOOLS**

METAVERSE LOW-CODE AUTHORING FRAMEWORKS

Numerous authoring frameworks have emerged to sustain the creation of VR/AR applications.

Main characteristics of virtual reality authoring tools: [1]
- Virtual environment creation
- Manipulating and importing 3D objects
- Interactive human characters development
- Artificial intelligence automation

"The most evaluated metrics were usability, effectiveness, efficiency, and satisfaction." [2]

"Our medical virtual-worlds (or digital twins) will seem fundamentally different in the future due to the incorporation of developing technology" [3]

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METAVERSE AUTHORING FRAMEWORKS: MAGES 4.0

MAGES 4.0 introduces
- Automations in VR design-patterns for interaction-design Actions development
- VR recorder to capture and replay VR sessions
- Realistic real-time **cut, tear and drill** algorithms
- AR and mobile (iOS/Android) support
- Dissected edge physics engine
- Edge-cloud **remote** visual rendering
- Optimized networking layer with collaboration of AR/VR devices
- Convolutional **neural network** automatic assessment
- New template applications (open source)

MAGES 4.0: Accelerating the world's transition to medical VR training
Computational medical XR use cases

Medical XR training in action
THE CHALLENGE
Effective Nasopharyngeal Swab Taking Training.

- Effective and riskless medical training.
- Resume training with strict social distancing measures.
- Conform with world-standard hygiene protocols.

THE SOLUTION

- A hardware-agnostic, collaborative training simulation made with MAGES SDK.
- Detailed analytics that inspect user errors and overall progress.
- Immersive, engaging experience for skill transfer from virtual to real world.

THE INNOVATION
Enhancing Learning Experience.

- 16% improvement in sensorimotor performance.
- Increased user satisfaction via gamification.
- Clinical Trial: "Enhancing COVID-19 Diagnostics with VR".

VR is the Future of medical education, and we are pushing further the limits with ORamaVR and MAGES SDK!

Prof. Thomas Sauter, Emergency Telemedicine, University of Bern, Switzerland
VR Training Boosts COVID-19 Diagnostics with Nasopharyngeal Swab Performance.

A VR-based Nasopharyngeal Swab Taking training program led to a significant 16% improvement in sensorimotor skills, increased satisfaction, and enhanced usability among 29 students. Participants expressed higher satisfaction levels with the training, and those trained in VR reported positive feedback regarding emotional engagement and immersion.

VR Enhances COVID-19 Diagnostics Education.

Participants found VR training comfortable and engaging, with strong presence and immersion. Workload ratings were similar for both VR and non-VR groups. The survey affirms VR’s effectiveness in improving COVID-19 diagnostics education.
NYU Langone Health
NYU Langone Health: One of the largest Healthcare systems in the Northeast

THE CHALLENGE
Enhance surgical training for orthopaedic residency.

• Clinically validate VR surgical training for psychomotor skills.
• Improve PGY-1 orthopaedic resident training using immersive VR.
• Improve surgical skills and knowledge in Total Hip Arthroplasty.

THE SOLUTION
Cutting-edge Total Hip Arthroplasty simulation with MAGES SDK.

• Innovative Total Hip Arthroplasty VR Simulation with MAGES SDK.
• Cutting-edge collaborative training for enhanced learning experience.
• Real-time analytics and error detection for optimal assessment.

THE INNOVATION
Revolutionary VR Clinical Trial: 8% Improvement in PGY-1 Surgical Skills.

• Easily modify and extend simulations with the MAGES SDK.
• 8% improvement in PGY-1 in just 2 sessions (Journal of Arthroplasty).
• NYU and ORamaVR receive prestigious AAHKS Fare Grant Award.
• First-ever collaborative VR surgical training, connecting 4 reputable Medical schools.

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THE INNOVATION
Revolutionary VR Clinical Trial: 8% Improvement in PGY-1 Surgical Skills.

“Very nice experience and it will be very fruitful for young surgeons. It’s a great tool and helpful for the training!”

Lazaros A. Poultsides, MD, MSc, PhD, NYU Medical Associate

VIDEO →

Designed in Switzerland
Impact of VR Training on Cadaver Session Scores: A Comparative Analysis

The study found no baseline differences in knowledge or surgical skills between cohorts. However, VR training improved participants' performance during cadaver sessions by 18 points (8%), leading to better skill development.

Assessing the Effectiveness of VR Training on Quiz Scores: A Group Comparison

VR training showed positive trend in written quiz performance, suggesting theoretical knowledge acquisition potential. Further research with larger sample sizes may be needed to establish a significant correlation.

THE CHALLENGE
Enhancing Performance and Reducing Costs for surgical robotic training.

- Enhance trainee performance before robotic training.
- Boost memory retention and psychomotor skills.
- Reduce training cost, while elevating learning outcomes.

THE SOLUTION
Future-Proof Robotic Training with Digital Twins and Custom Escalating XR Simulations.

- XR simulations as 'digital twins' of existing robotic training modules.
- Future-proof and cross-platform training for da Vinci Surgical System.

THE INNOVATION
Revolutionizing Robotic Training: Immersive XR with Minimal Equipment.

- Novel physics-based simulation for robotic training.
- Innovative robotic arm interaction with hand-tracking.
- Train anywhere, any time. Minimal equipment required for simulating the whole robotic experience.

VIDEO ➔
Designed in Switzerland
University Hospital Cologne
One of Germany’s most outstanding medical centers

ORama VR
The most detailed VR collection of Topographical Anatomy.

“Working with ORamaVR on the Bursa omentalis simulations is really exciting for us. No one ever before had this opportunity to do it like that.”

Dr. Rabi Datta
Specialist for Visceral Surgery – Coordinator Medical Education

THE CHALLENGE
Deformities and Rigidity in Cadaveric Anatomy Representations

• Pursuing enhanced effectiveness beyond traditional teaching methods and textbooks.
• Addressing challenges in understanding Omental Bursa (OB) anatomy (collapsed OB, dehydration, autopsy malformation).
• High-quality XR simulation offering cost and time efficiency.

THE SOLUTION
XR Human Anatomy: Surgical Modes & Exploration.

• Collection of 7 custom-made abdominal surgery XR simulations.
• Novel, scalable and immersive XR experience to tackle OB anatomy challenges.
• Visualization and interaction with realistic real-time simulation of soft bodies.

THE INNOVATION
Unique XR Representation of the Topographical Anatomy Courses.

• Largest ever interactive abdominal anatomy and surgery collection of XR simulations.
• Ground-breaking approach to visualization of Omental Bursa morphology.
• 10+ scenarios per simulation.
• An In-Depth First-Person Exploration of Topographical Anatomy from the Inside Out.

VIDEO →

Designed in Switzerland
THE CHALLENGE

Real-World team-based training (crew resource management) for Medical Professionals.

- Training for immediate response and treatment to sudden heart attack.
- Time-sensitive scenario that simulates real-life stress to improve communication and decision-making skills.
- Cost and logistically effective training method compared to traditional ones.

THE SOLUTION

A non-linear, collaborative, gamified simulation.

- A Collaborative VR simulation to precisely replicate real-life scenarios.
- Monitoring user movements, speech, and levels of anxiety by tracking heart rate.
- 100+ possible errors. A truly non-linear operation with random events & branching paths.

THE INNOVATION

Enhanced Cardiac Arrest Resuscitation Training.

- The largest clinical trial on cardiac arrest resuscitation training
- Prospective control group design comparing outcomes from traditional mannequin-based training and VR training participants.
One more thing

What about no-code generative-AI?
JARIA – MAGES SDK
The scene is set for massive change

- Computational Medical XR
- Focus on curriculums not discrete, 1-off simulations
- AI+XR are revolutionizing the field
Welcome to Shift Medical 2023!

Today, we explore the limitless potential of computational medical extended reality.

Imagine a world where diagnoses are made with pinpoint accuracy, surgeries are perfected through virtual simulations, and patients receive personalized treatments through immersive experiences.

With computational medical extended reality, we bridge the gap between technology and healthcare, pushing boundaries and revolutionizing patient care.

Let us embrace this incredible innovation, harnessing its power to transform lives. As we embark on this journey together, remember, the future of medicine lies within our grasp – a future where healing knows no bounds.

Together, let us shape the future of healthcare.
One really last thing
Let’s accelerate world’s transition to computational medical XR!