Geometric Algebra for Impactful Computer Graphics in XR

Dr. George Papagiannakis

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&

Prof. University of Crete,

Affiliated Researcher at FORTH

Visiting Prof. University of Geneva

CGI2024

Overview

- *GA as single virtual human enabling simulation framework?*
- *Key enabling R&D projects*
- *Key Innovation projects for social impact*

Midjourney prompt:
“a there and back again hobbit house looking from inside towards outside through the open door, cinematic, atmospheric lighting”

From computer graphics **systems** to virtual human **algorithms** to geometric computational **models**


TECHNOLOGIE Réalité et images de synthèse mêlées

LE TOURISME EN 3D EST NÉ


VHD++ Development Framework:
Towards Extendible, Component Based VR/AR Simulation Engine
Featuring Advanced Virtual Character Technologies

Abstract

1. Introduction: The Demand

2. Motivation: Curbing Complexity

2.1. Common Experience: Facing Complexity


UNIVERSITÉ DE GENÈVE

FACULTÉ DES SCIENCES
ÉCONOMIQUES ET SOCIALES
Département de systèmes d'information
Professeure Nadia Magnenat-Thalmann

FACULTÉ DES SCIENCES
Département d'informatique
Professeur José Rolim

An Illumination Registration Model for Dynamic Virtual Humans in Mixed Reality
THÈSE
présentée à la Faculté des Sciences de l'Université de Genève
pour obtenir le grade de Docteur ès sciences, mention informatique

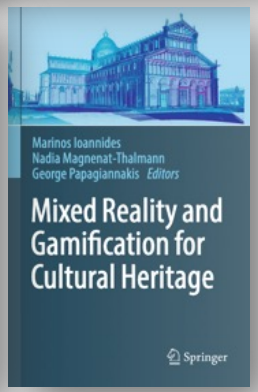
par
Georgios Papagiannakis
de
Crète (Grèce)

Thèse N° 3795

GENÈVE
Atelier de reproduction de la Section de physique
2006


Preface for Special Issue on Geometric Algebra in Computer Science and Engineering

Dietmar Hildenbrand, Eckhard Bitzer* and George Papagiannakis


Marinos Ioannides
Nadia Magnenat-Thalmann
George Papagiannakis *Editors*

Mixed Reality and Gamification for Cultural Heritage

Springer


Nadia Magnenat-Thalmann · Jian Zhang · Jinman Kim · George Papagiannakis · Bin Sheng · Daniel Thalmann · Marina Gavrilova (Eds.)

LNCS 13443

Advances in Computer Graphics

39th Computer Graphics International Conference, CGI 2022
Virtual Event, September 12–16, 2022
Proceedings

Springer

MOREMEDIA

IEEE Computer Graphics and Applications

Metaverse: Technologies for Virtual Worlds

IEEE COMPUTER SOCIETY

UNIVERSITÉ DE GENÈVE

FORTH
Foundation for Research & Technology - Hellas

ORama VR

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 coaxed 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.

STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA

SRI

Republished in abridged form in ***Vistas in Information Handling***, Howerton and Weeks [Editors], Spartan Books, Washington, D.C., 1963, pp. 1-29, titled "A Conceptual Framework for the Augmentation of Man's Intellect."

October 1962

AFOSR-3223

Summary Report

AUGMENTING HUMAN INTELLECT: A CONCEPTUAL FRAMEWORK

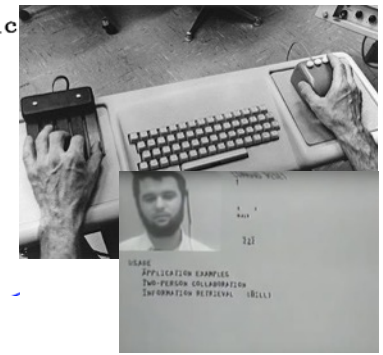
Prepared for:

DIRECTOR OF INFORMATION SCIENCES
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
WASHINGTON 25, D.C.

CONTRACT AF 49(638)-1024

By: D. C. Engelbart

SRI Project No. 3578

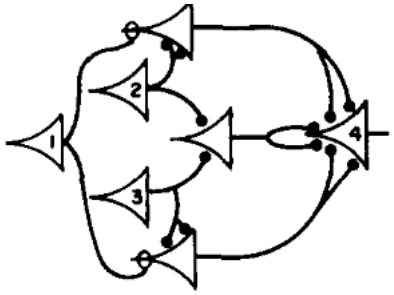


Engelbart, Douglas. "Augmenting human intellect: A conceptual framework. Summary report." *Stanford Research Institute, on Contract AF* 49, no. 638 (1962): 1024.

"Mother of all demos": https://youtu.be/B6rKUf9DWRI , 1968

Simulating the human brain?

Establishment of a new research program at Cornell Aeronautical Laboratory, Inc. is proposed, with the objective of designing, fabricating, and evaluating an electronic brain model, the photoperceptron. The proposed pilot model will be capable of "learning" responses to ordinary visual patterns, or forms. The system will employ a new theory of memory storage, (the theory of statistical separability), which permits the recognition of complex patterns with an efficiency far greater than that attainable by existing computers. Devices of this sort are expected ultimately to be capable of concept formation, language translation, collation of military intelligence, and the solution of problems through inductive logic.



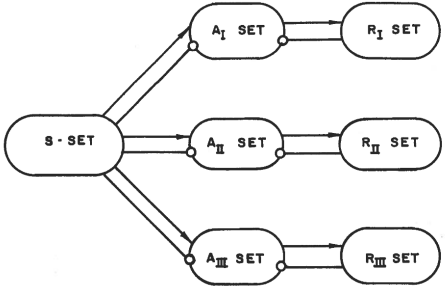
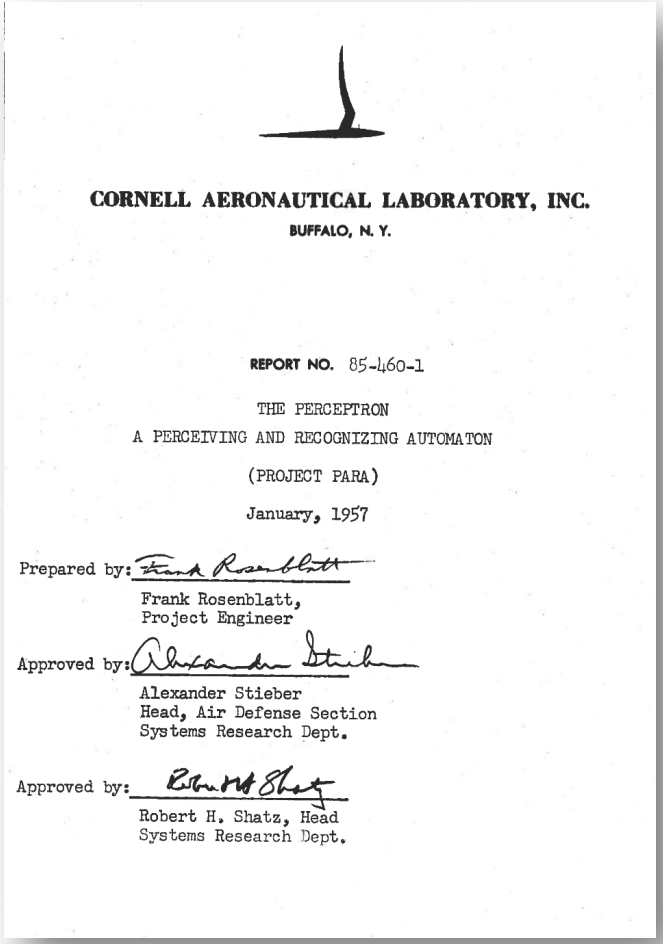


FIGURE 2

ORGANIZATION OF A PERCEPTRON WITH THREE INDEPENDENT OUTPUT-SETS



CORNELL AERONAUTICAL LABORATORY, INC.

BUFFALO, N. Y.

REPORT NO. 85-460-1

THE PERCEPTRON

A PERCEIVING AND RECOGNIZING AUTOMATON

(PROJECT PARA)

January, 1957

Prepared by: Frank Rosenblatt

Frank Rosenblatt,
Project Engineer

Approved by: Alexander Stieber

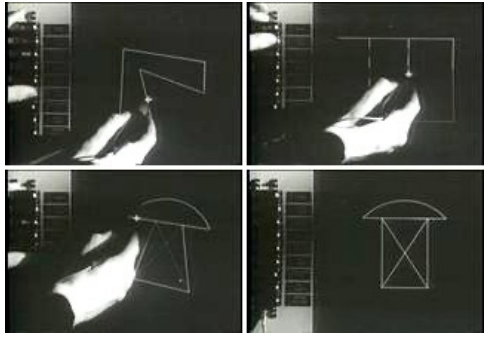
Alexander Stieber
Head, Air Defense Section
Systems Research Dept.

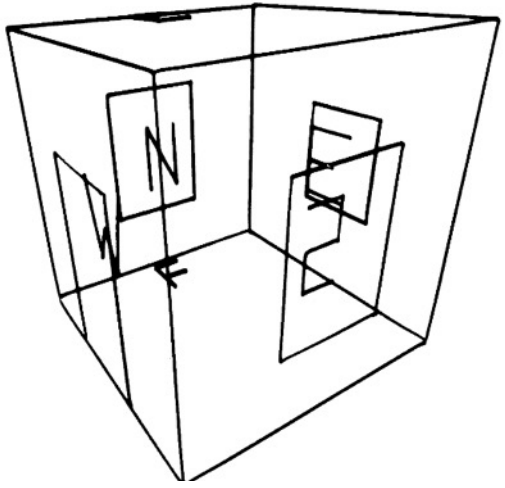
Approved by: Robert H. Shatz

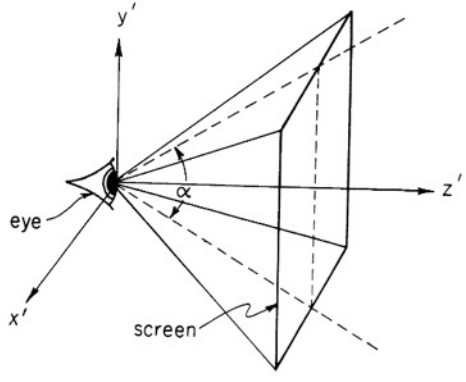
Robert H. Shatz, Head
Systems Research Dept.

- F. Rosenblatt, the perceptron - a perceiving and recognizing automaton, 1957
- McCulloch, W. & Pitts, W. A LOGICAL CALCULUS OF THE IDEAS IMMANENT INNERVOUS ACTIVITY. Bulletin of MathematicalBiophysics, Vol. 5, pp. 115-133 (1943)

Head Mounted Displays and natural user interaction?





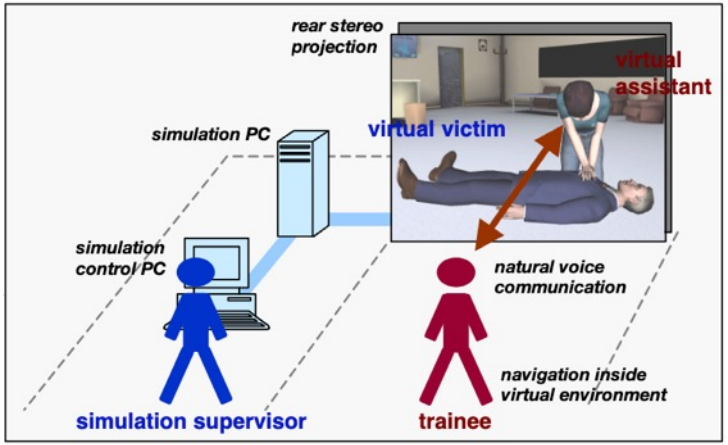


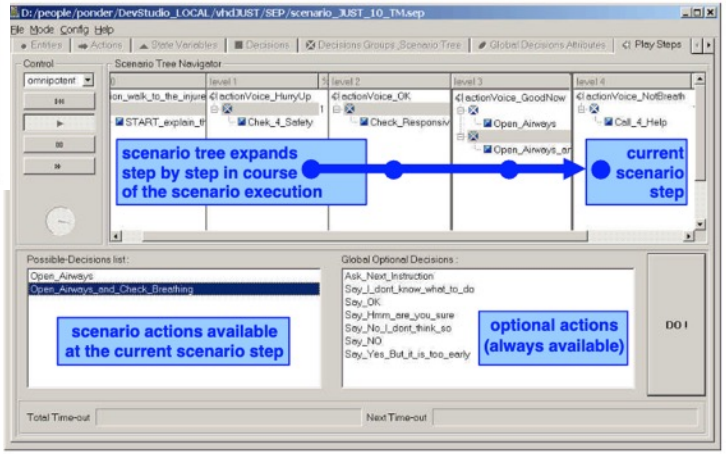
The sketchpad demo: https://youtu.be/6orsmFndx_o,1963
Sutherland, I. E. A head-mounted three dimensional display. *AFIPS Fall Joint Computing Conference* 757–764 (1968) doi:10.1145/1476589.1476686. https://youtu.be/eVUgfUvP4uk

Augmented Reality for education?

Papagiannakis, G. *et al.* Mixing Virtual and Real scenes in the site of ancient Pompeii. *Computer Animation and Virtual Worlds, John Wiley and Sons Ltd* 16, 11–24 (2005)

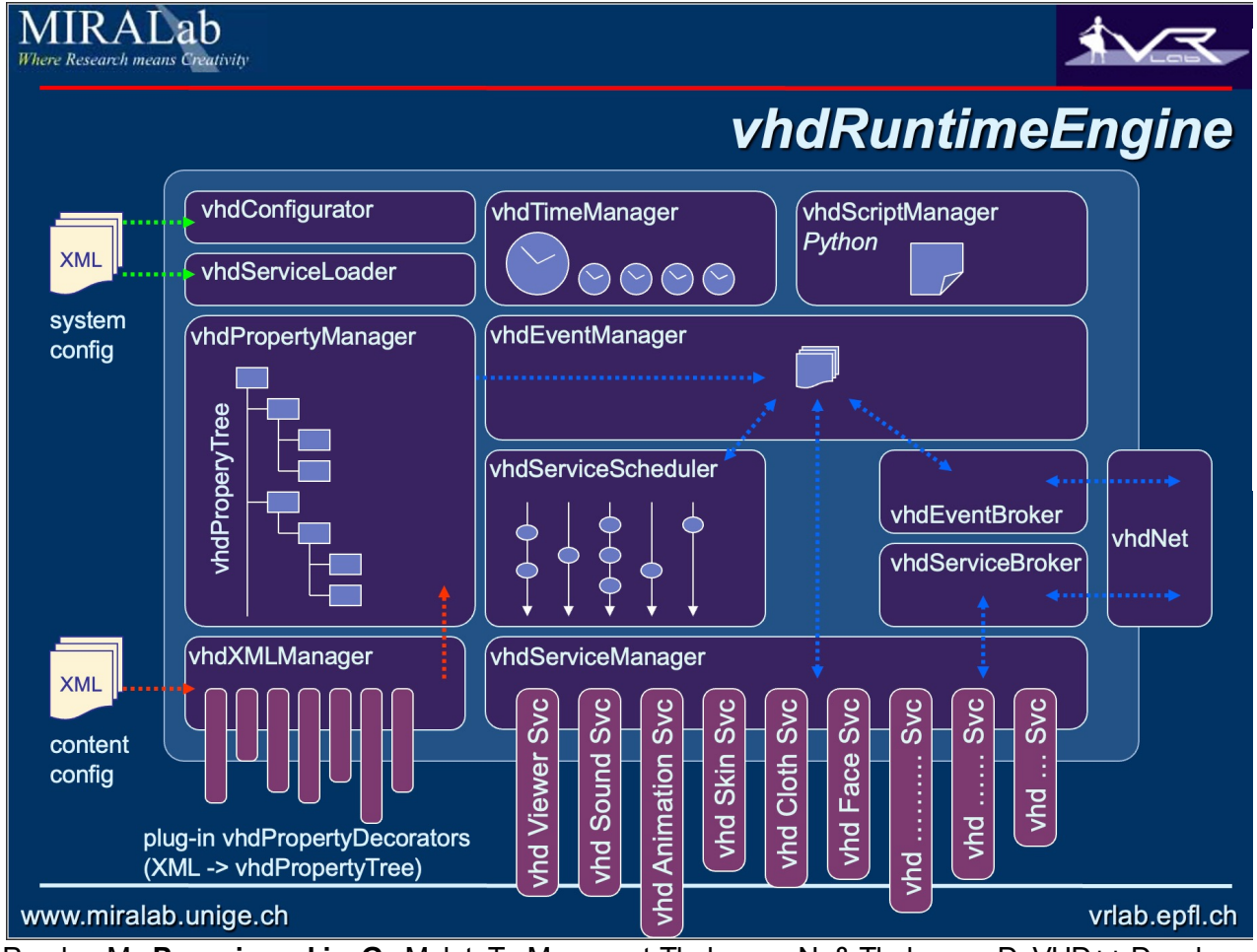
Virtual Reality for medical training?

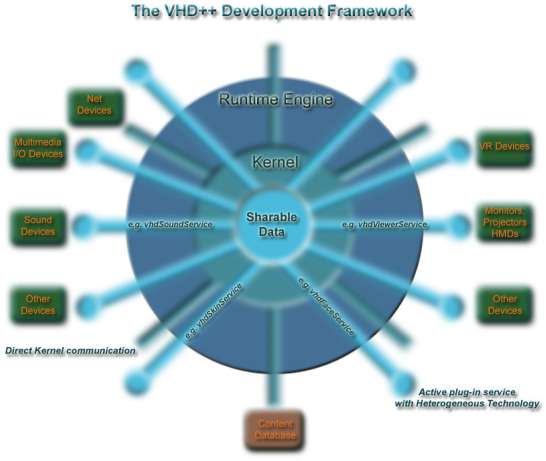




Michal Ponder, Bruno Herbelin, Tom Molet, Sebastien Schertenlieb, Branislav Ulicny, **George Papagiannakis**, Nadia Magnenat-Thalmann, and Daniel Thalmann. 2003. Immersive VR decision training: telling interactive stories featuring advanced virtual human simulation technologies. DOI:https://doi.org/10.1145/769953.769965

Authoring systems for VR/AR virtual human simulations?





Ponder, M., **Papagiannakis, G.,** Molet, T., Magnenat-Thalmann, N. & Thalmann, D. VHD++ Development Framework: Towards Extendible, Component Based VR/AR Simulation Engine Featuring Advanced Virtual Character Technologies. (Computer Graphics International 2003). doi:10.1109/cgi.2003.1214453.

Geometric Algebra for character animation blending

Figure 1: *Comparison between animation blending techniques for skinned characters with variable complexity: a) quaternion linear blending (QLB) and dual-quaternion slerp-based interpolation (DQB) during real-time rigged animation, and b) our faster geometric algebra (GA) rotors in Euclidean 3D space as a first step for further character-simulation related operations and transformations. We employ geometric algebra as a single algebraic framework unifying previous separate linear and (dual) quaternion algebras.*

Vertex interpolation example using quaternions expressed as GA rotors:

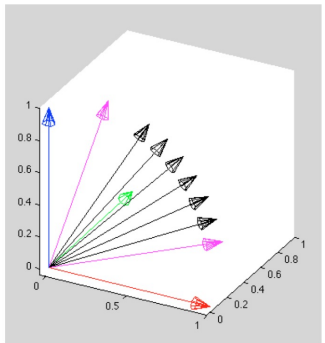
```
clear
clc
clf
p = quaternion(0,0,1,1)% point P above [3.14, 0.7071, 0.7071, 0]
p = p.normalize
q = quaternion.angleaxis(pi/2,[0,1,0]) %rot by axis v=j (Y axis) by 90 degrees
[angle,axis] = AngleAxis(q) % retrieve angle and axis: 1.5708, [0,1,0]
ql = conj(q) %q-1
p2 = q * p * ql % P' new point, result is : i+j, thus point is P'(1,1,0)
qInt = slerp(p,p2,0.5) % (0.0) + i(0.40825) + j(.8165) + k(0.40825)

%corresponding code in Geometric Algebra
%point interpolation experiment: P(0,1,1) rot Y(e2), 90 --> P'(1,1,0)
clf
draw(e1,'r');draw(e2,'g');draw(e3,'b')
P=unit(e2+e3)
R=gexp(-I3*e2*pi/2/2)
Rp=R*P/R

% rotor interpolation between two interpolated points
n=8
Rtot=Rp/P
Rstep = gexp(sLog(Rtot)/n)
Rint = Rstep*P/Rstep

for i=1:n-1
    draw(Rint, 'black')
    Rint = Rstep * Rint
end

draw(P,'m')
draw(Rp,'m')
```



Objectives:

- Develop a novel, integrated framework using geometric algebra (GA) rotors for skinned character animation blending.
- Demonstrate that GA rotors can perform faster and more efficiently than standard quaternion and dual quaternion implementations.

Results:

- GA rotors demonstrated faster computation times and lower memory usage compared to traditional quaternion-based methods.
- Validated the approach through comparative analysis showing GA rotors outperforming quaternion linear blending (QLB) and dual quaternion blending (DQB).

Innovation:

- Introduced the use of Euclidean geometric algebra (GA) rotors as a robust and efficient alternative to traditional quaternion-based animation techniques.

Papagiannakis, G. Geometric algebra rotors for skinned character animation blending. Technical Brief, ACM SIGGRAPH ASIA 2013, Hong Kong, November 2013 1–6 (2013).

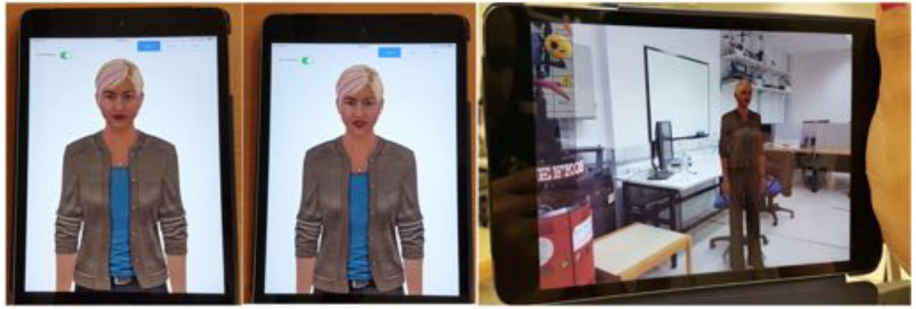


Figure 1: *Mobile, AR, life-size gamified virtual characters powered through a fast, automatic animation pipeline with procedural body animation, speech and lip-sync.*

Figure 5: *Process of Geometric and Photometric AR scene authoring under one minute in outdoors (top) as well as indoors (bottom) environments.*

Geometric Algebra for character animation in AR

Objectives:

- Develop a fast and robust pipeline for populating mobile augmented reality (AR) scenes with gamified virtual characters using modern mobile devices.
- Integrate advanced character animation and rendering techniques to enhance the realism and interactivity of AR scenes.

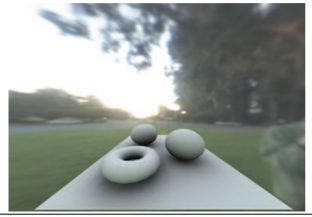
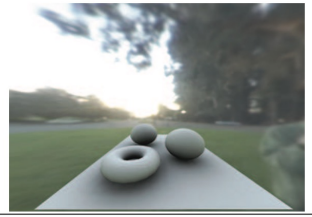
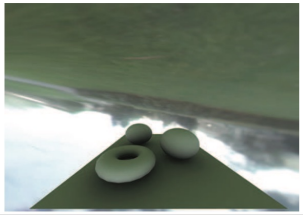
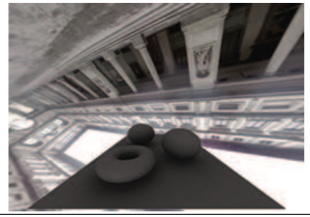
Results:

- Successfully implemented a methodology to author AR scenes with life-size, animated virtual characters in less than one minute using smartphones and tablets.
- Achieved efficient and realistic character animation and rendering through the integration of the SmartBody USC framework and a dPRT global illumination algorithm.

Key Findings:

- The use of Geometric Algebra rotors for handling object rotations in AR scenes significantly improves visual quality and avoids issues like Gimbal Lock.

Papaefthymiou, M., Feng, A., Shapiro, A. & Papagiannakis, G. A fast and robust pipeline for populating mobile AR scenes with gamified virtual characters. Siggraph Asia 2015 Mob Graph Interact Appl 1–8 (2015) doi:10.1145/2818427.2818463.

Rotation	CGA rotors	Rotation matrices	MSE (%)
[-0.54, 0, 0.83, 0]			2.97%
[0.08, 0.59, 0.11, 0.79]			2.62%
[-0.23, -0, 0.97, 0]			1.52%
[-0.09, -0.21, 0.41, 0.87]			4.15%

Geometric Algebra for spherical harmonics lighting

Objective:
- Extend precomputed radiance transfer (PRT) by representing spherical harmonics (SH) with CGA entities for efficient light rotation.

Results:
- Achieved faster SH rotation performance and reduced memory usage by using CGA rotors instead of traditional rotation matrices.
- Demonstrated superior visual results and lower mean square error compared to Ivanic rotation matrices.

Innovation:
- Introduced the use of conformal geometric algebra (CGA) to represent and rotate spherical harmonics (SH)
- Enabled the representation of SH with CGA rotors (4 numbers) as opposed to 9x9 sparse matrices, significantly reducing memory requirements and computational overhead.

Papaefthymiou M, Papagiannakis G. Real-time rendering under distant illumination with Conformal Geometric Algebra. Math Meth Appl Sci. 2017;1–16. https://doi.org/10.1002/mma.4560

Gamified rendering and animation framework for mobile virtual characters

Fig. 12.5.3 Life-sized AR crowd simulation on mobile device (left) and on FibRum HMD (right) (© by ACM 2016 Reprinted with Permission).

Fig. 12.7.1 Life-sized AR character on mobile device at Asinou church (Figure created by the authors)

Objectives:
- Develop a robust methodology for authoring life-sized AR/VR virtual characters and crowd simulations using modern mobile devices.

Results:
- Achieved efficient and realistic virtual character animations and crowd simulations in AR environments using mobile devices.
- Implemented a complete AR/VR pipeline, integrating tools like SmartBody for animation and Metaio SDK for markerless SLAM-based tracking.

Innovation:
- Utilized GA and CGA to handle rotations, translations, and dilations of virtual characters, avoiding the need for multiple mathematical representations.
- Compared the performance of different GA code generators (Gaigen, libvsr, Gaalop) to identify the most efficient solutions.

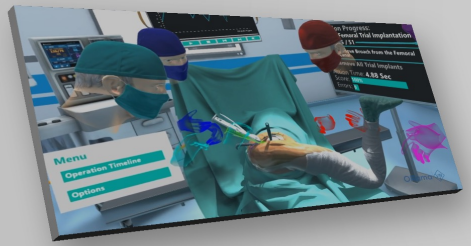
Papaefthymiou, M. *et al.* Gamified AR/VR Character Rendering and Animation-Enabling Technologies. in *Mixed Reality and Gamification for Cultural Heritage* vol. 2014 333–357 (Mixed Reality and Gamification for Cultural Heritage, 2017).

NYU Langone Health

NYU Langone Health: One of the largest Healthcare systems in the Northeast

ORama VR

The Effectiveness of VR Surgical Training



NEW YORK UNIVERSITY

"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

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.

VIDEO →

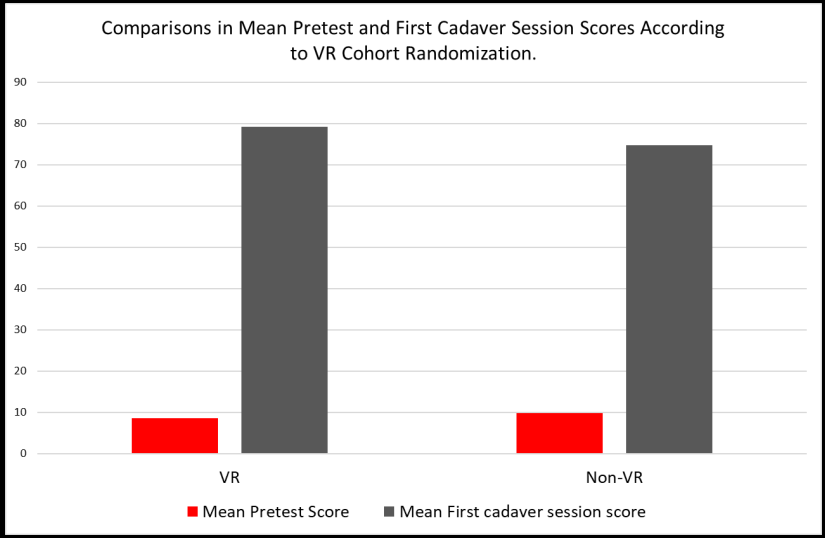
Designed in Switzerland

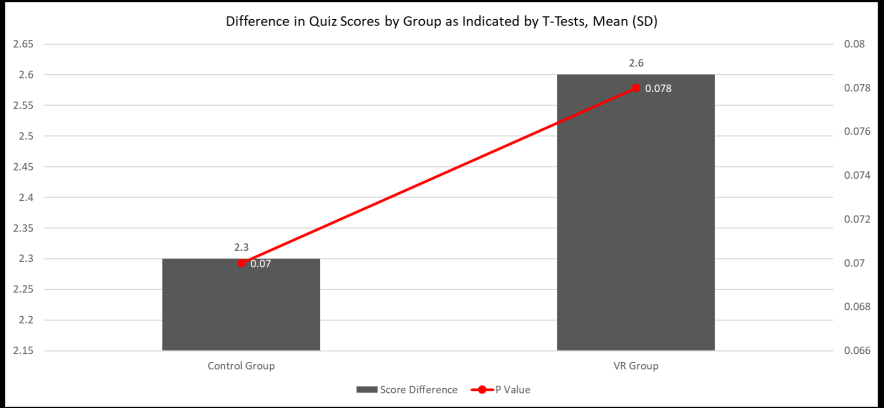
Hooper, J. et al. Virtual Reality Simulation Facilitates Resident Training in Total Hip Arthroplasty: A Randomized Controlled Trial. The Journal of Arthroplasty 34, 2278–2283 (2019).

NYU Langone Health
Clinical Trial Main Results

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 significantly improved participants' performance during cadaver sessions by 18 points, 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.**

Hooper, J. et al. Virtual Reality Simulation Facilitates Resident Training in Total Hip Arthroplasty: A Randomized Controlled Trial. The Journal of Arthroplasty 34, 2278–2283 (2019).

CLINICAL TRIAL →


FIRST-EVER SHARED COLLABORATIVE ORTHOPAEDIC SURGERY IN VR

VIDEO →

Deform, cut and tear a skinned model using CGA

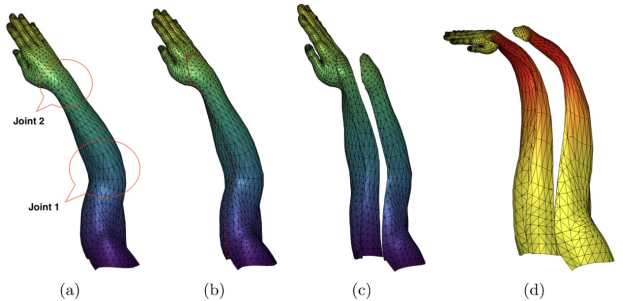


Fig. 2. Cutting module intermediate steps. (a) The original animated model. (b) The model where the (red) intersection points of the cutting plane and the mesh are calculated and re-triangulated. (c) The model after the cut. (d) The model is deformed by a rotation (axis $= (0, 1, 1)$, 0.7 rad), a translation (vector $= (13, 0, 0)$) and a dilation (factor $= 0.5$) at joint 1 (elbow), as well as another rotation (axis $= (0, 1, 1)$, 0.3 rad) at joint 2 (wrist). Note that minimal artifacts occur in the final result. The vertices in (d) are colored depending on the influence of joint 1 which is mostly deformed. The vertices in (a)–(c) are colored based on their z coordinate. (Color figure online)

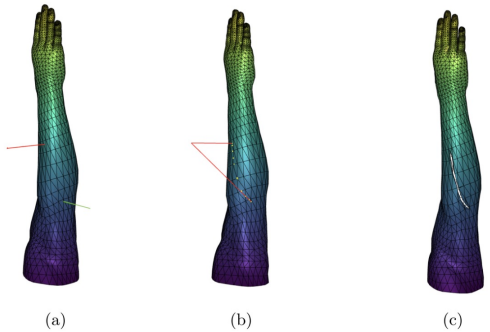


Fig. 3. Tearing module intermediate steps. (a) The original animated model and the scalpel's position at two consecutive time steps. (b) The plane defined by the scalpels (depicted as a red tringle) intersects the skin in the magenta points. (c) The intermediate points are used in the re-triangulation, and are «pushed»away from the cutting plane to form an open tear.

Objective:
- Develop an integrated rigged character simulation framework using Conformal Geometric Algebra (CGA) to support real-time cuts and tears, maintaining deformation topology.

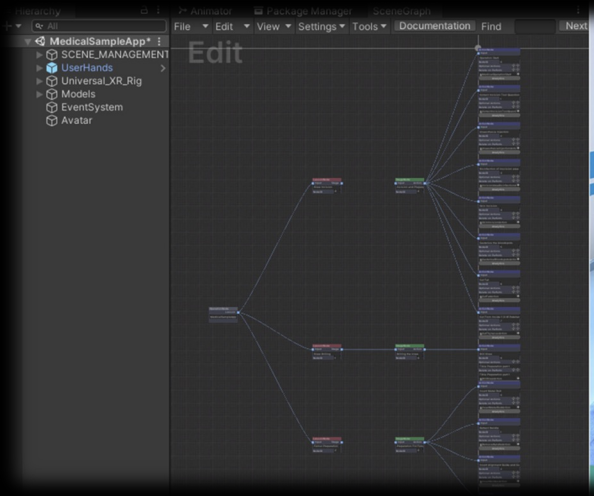
Results:
- Successfully implemented CGA for real-time character animation, allowing both pre- and post-animation cuts and tears.
- Achieved efficient, accurate deformations with minimal artifacts, validated through comparative analysis with traditional methods.

Innovation:
- Combined model animation and cutting/tearing under a single CGA framework, enabling seamless integration of various transformations.
- Introduced novel algorithms for real-time planar cuts and partial tears on skinned models, facilitating realistic surgical simulations.

Kamarianakis, M. & Papagiannakis, G. Advances in Computer Graphics, 37th Computer Graphics International Conference, CGI 2020, Geneva, Switzerland, October 20–23, 2020, Proceedings. Lect Notes Comput Sc 434–446 (2020) doi:10.1007/978-3-030-61864-3_37.

ORama VR

MAGES 4.0



MAGES 4.0 introduces

- Automations in Actions development
- VR recorder to capture and replay VR sessions
- Realistic real-time cut, tear and drill algorithms
- AR and mobile (ios) 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)

P. Zikas *et al.*, "**MAGES 4.0: Accelerating the World's Transition to VR Training and Democratizing the Authoring of the Medical Metaverse**," in *IEEE Computer Graphics and Applications*, vol. 43, no. 2, pp. 43-56, 1 March-April 2023, doi: 10.1109/MCG.2023.3242686.

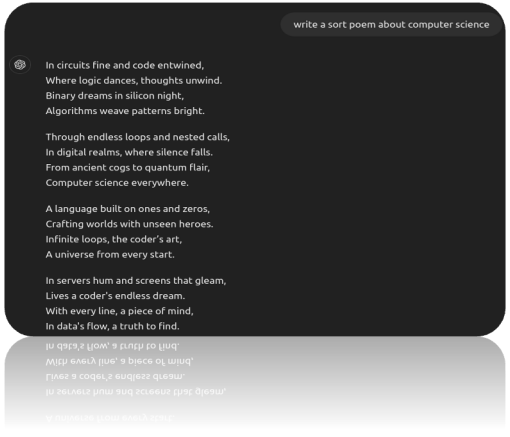
ORama VR

MAGES 4.0

VIDEO →

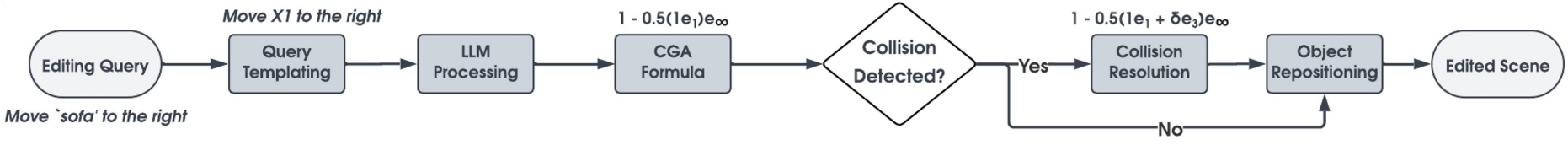
Generative Models and Content Creation

Generative Models have revolutionized content creation



- ✓ Text-to-text generation
- ✓ Text-to-image and video generation
- ✓ Text-to-music generation

Editing the Generated Scene

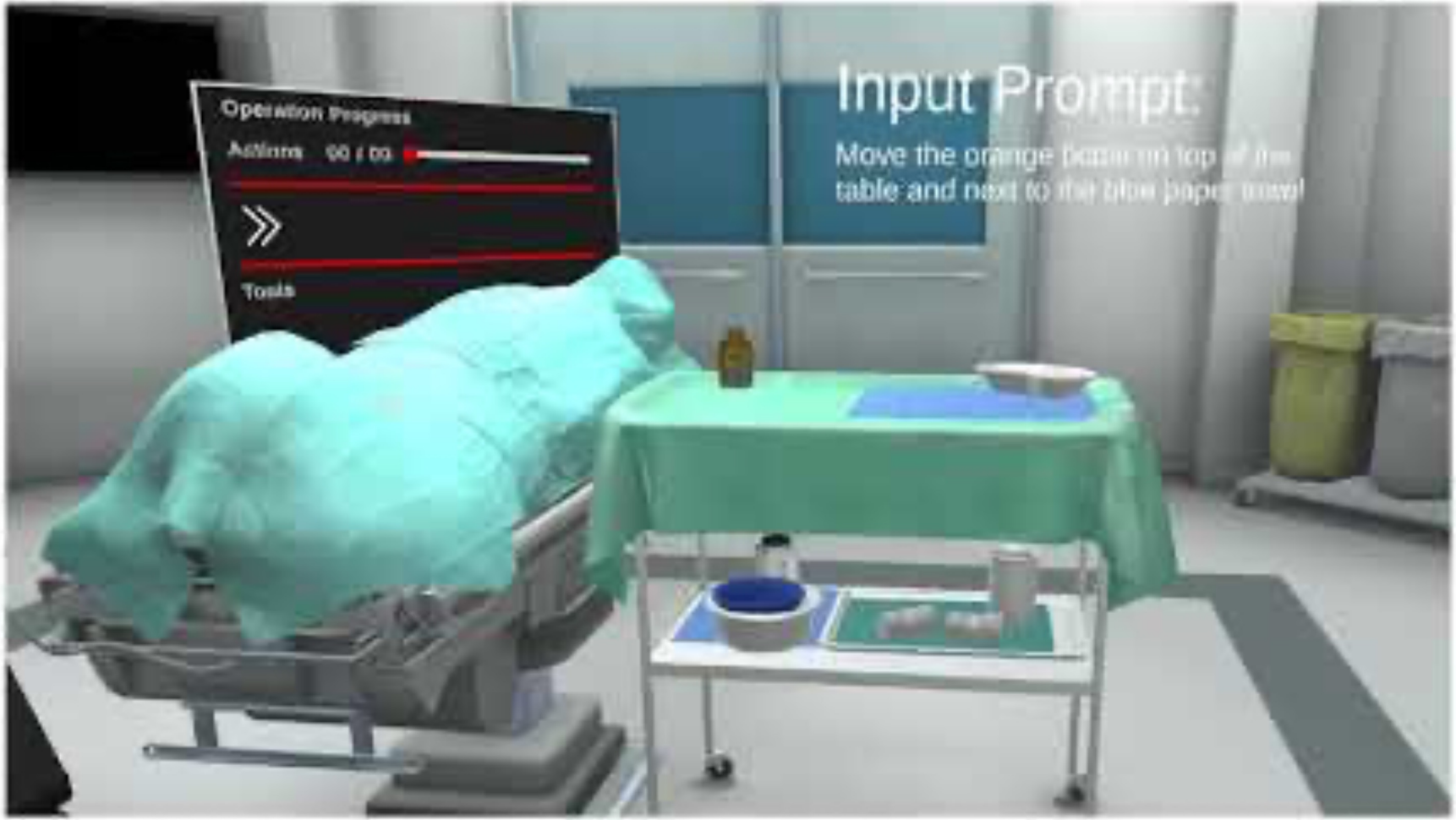


1. Convert user queries into templated forms.

1. Generate Conformal Geometric Algebra transformations M=TRD

2. Address potential collisions by adjusting transformations

3.1. Qualitative Results - Simple Queries



P. Kolyvakis, D. Angelis, M. Kamarianakis, G. Papagiannakis, Geometric Algebra Meets Large Language Models: Instruction-Based Transformations of Separate Meshes in 3D, Interactive and Controllable Scenes, ACM SIGGRAPH ASIA, 2024 *(submitted)*

European Commission

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CORDIS Menu

high fidelity Presence and Interaction: convergence of computer graphics, vision and robotics for improving human-robot and human-computer interaction

Results in Brief

More realistic virtual characters

An EU team extended and consolidated key mathematical techniques for improving the realism of computer-generated characters. In addition, the partnership devised means of improving computer capacities to interpret and respond to human movement.

DIGITAL ECONOMY

© Thinkstock

The simulated characters populating virtual worlds, for example in training scenarios, are often unrealistic and unbelievable. Achieving realism (known as 'presence') requires several key advanced graphics technologies.

With EU funding, the project HIFI-PRINTER aimed to unite essential high-fidelity presence technologies, to make computer-generated characters more lifelike and believable. The single-member project ran between April 2011 and March 2014, and was administered under the Seventh Framework Programme (FP7) as part of the Marie Curie Action programme.

Project researchers studied a novel framework, based on geometric algebra, allowing real-time simulation. Unlike previous disjointed techniques, the new method unifies and smoothes various simulation technologies.

Marie-Curie Intra-European Fellowship: HIFI-PRINTER

Objective:
- Develop high-fidelity presence and interaction technologies by integrating computer graphics, vision, and robotics to improve human-robot and human-computer interaction.
- Create a unified, real-time simulation framework using Geometric Algebra (GA) to enhance the realism and effectiveness of virtual and robotic characters.

Results:
- Established a novel mathematical framework based on GA, unifying diverse geometric graphics techniques for seamless application in humanoid robots and virtual characters.

Innovation:
- Developed a GA-based framework that integrates various character simulation technologies, facilitating seamless transitions between virtual and robotic applications.
- Advanced the state-of-the-art by creating a unified framework that avoids disjointed geometric techniques, allowing for more cohesive and realistic simulations.

Hifi-PRINTER (Marie-Curie IEF: 274669, 01/04/2011-30/03/2014): Principal Marie-Curie Research Fellow Scientist, EU contribution: 218,000.00 EUR

European Commission

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CORDIS Menu

Initial Training Networks for Digital Cultural Heritage: Projecting our Past to the Future

Results in Brief

New ways of preserving Europe's cultural heritage

The EU-funded ITN-DCH project has used innovative modern technologies to capture and digitise Europe's diverse and unique cultural heritage.

SOCIETY

© Izabela Miszczak, Shutterstock

Cultural heritage is the cornerstone of European history. From the tangible to the intangible and including books, images, paintings, maps, artefacts, sites, uniforms, music, folklore and theatre, cultural heritage is everywhere. As a result of its ubiquity, cultural heritage is not only important for the creation of a common European identity, but also for the continent's social and economic development.

Marie-Curie Integrated Training Network: ITN-DCH

Objective:
- Utilize innovative modern technologies to capture and digitize Europe's diverse and unique cultural heritage.

Results:
- Developed methodologies for integrating physical and virtual objects, enhancing the usability and reusability of cultural heritage in real-world applications.

Innovation:
- Implemented a comprehensive system covering the entire lifecycle of cultural heritage from capture to presentation.
- Utilized a variety of modern tools (e.g., drones, multispectral devices) for comprehensive data collection and 3D modelling.
- Developed new forms of personalized services mixing physical and virtual objects for educational, tourism, and entertainment applications.

ITN-Digital Cultural Heritage (Marie-Curie ITN 608013, 01/10/2013-01/10/2017): Principal Investigator, EU Contribution: 310,706.00 EUR


ORama VR
Operation Progress:
Lesson 1: Knee Incision
Actions: 0 / 68
Cut Epidermis
Operation Start
Action Time: 13.98 Sec
Score: 100%
Errors: 1

150+

Years outdated medical educational residency model: master - apprentice

10M

Medical professionals' shortage by 2030

5B

People lack access to affordable surgical & anesthesia care according to WHO

The Anatomy Lesson of Dr. Nicolaes Tulp, 1632, Rembrandt, Mauritshuis museum, The Hague, Netherlands

OUR MISSION

Accelerate world's transition to medical XR training:

1. Democratize XR content development and access
2. Increase medical XR curricula adoption
3. Increase trainee competency & proficiency

WE HAVE BUILT THE LEADING MEDICAL-XR AUTHORING, TRAINING & ASSESSMENT SOFTWARE PLATFORM

The only platform that closes the loop between creation, education and feedback:

- For **Educators**: Create, Record, Publish your medical XR training simulation
- For **Learners**: See, Do, Teach to achieve competency, proficiency, expertise
- Objective **metrics**, performance **analytics** and **AI co-tutors** for all

unity Verified Solutions Partner

EPIC MEGA GRANTS RECIPIENT

NVIDIA Inception Program

ORama VR

2019 AUGGIE AWARDS BIGGEST SOCIETAL IMPACT

European Commission

AAHKS AMERICAN ASSOCIATION OF HIP AND KNEE SURGEONS

Funded by the European Union NextGenerationEU

Swiss Accelerator innovation project supported by

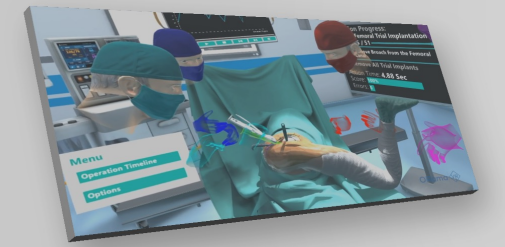
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Innosuisse – Swiss Innovation Agency

EIC & INNOSUISSE NRE PROJECTS

ORama VR



Swiss Accelerator innovation project supported by

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

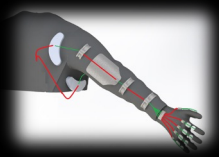
Innosuisse – Swiss Innovation Agency

European Innovation Council

Funded by the European Union
NextGenerationEU

REVIRES-MED

Revolutionary VR Simulation-based Medical Training Platform,
1.7% success rate for EIC



Physics-based VR simulations with highest-fidelity **realism.**
C**utting** & **tearing** engine based on **Geometric Algebra** and **Machine Learning**. **VR –editor** for **automated** Content creation & **editing tools**.
Technical **scale-up.**
Experimental novel haptics glove & jacket.
Validation with **15 medical simulations.**

Total budget: 1.7M
PC: OramaVR

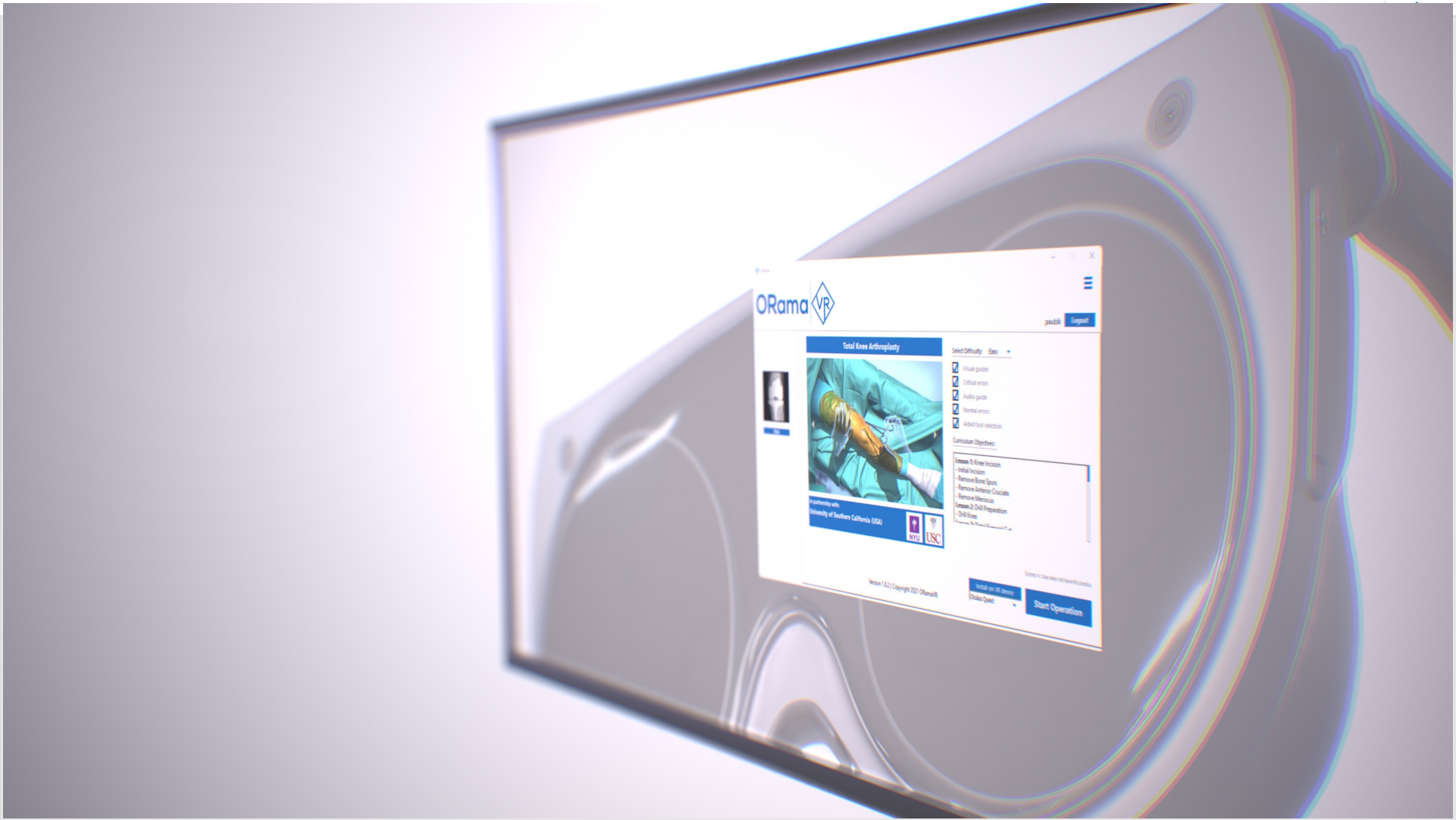
OMEN-E

Open MEdical Neural metaverse
6% success rate for Innosuisse

Generative AI, no-code Neural authoring platform.
Rich Open Access medical VR training **template** simulation **Library.**
Always-on sessions in an **Open Metaverse.**

Total budget: 2.4M
PC: ORamaVR

Designed in Switzerland



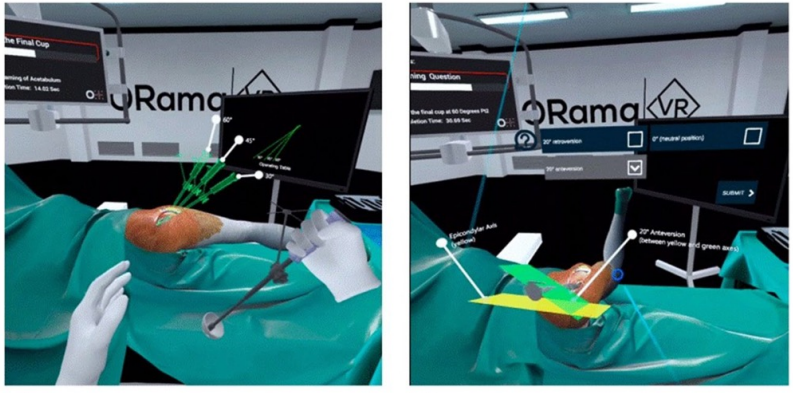
VIDEO →

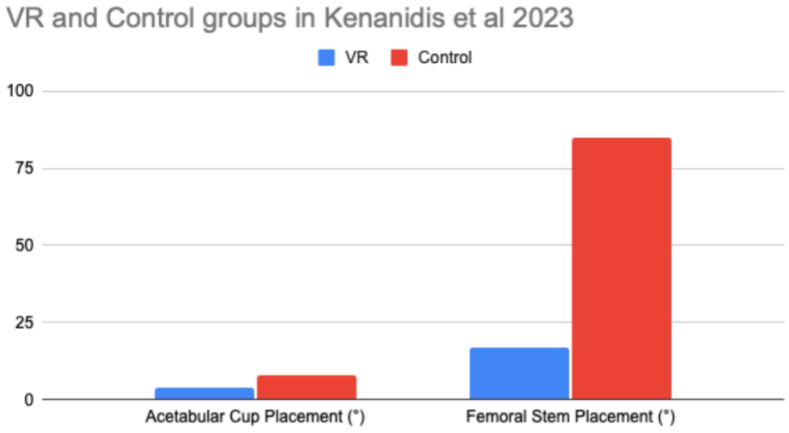
DOES IT WORK?

We have proven that medical XR training facilitates

a) skills transfer from the virtual world to the real
b) reduction of medical errors

- 8+ published medical XR clinical trials & pilot studies
- 50+ scientific publications on computational medical XR





Kenanidis et al 2023, Aristotle University, (N=101), Journal of International Orthopedics, 80% reduction on errors for Femoral Stem Placement and 50% for Acetabular Cup Placement after VR training

OUR PARTNERS – ON TRACK TO BECOMING CATEGORY LEADER

ORama VR

HEALTHCARE INSTITUTIONS

ENSURE **PROPER**, **CONTINUOUS TRAINING** OF YOUR PERSONNEL, FEWER MEDICAL **ERRORS** AND OPTIMAL PATIENT **OUTCOMES**.

University of Michigan

INSELSPITAL
UNIVERSITÄTSSPITAL BERN
HÔPITAL UNIVERSITAIRE DE BERNE

University of Cologne

Fayetteville State University

USC

NYU Langone Health

Hellenic Republic
National and Kapodistrian University of Athens
EST. 1837

SWISS FOUNDATION FOR INNOVATION AND TRAINING IN SURGERY

WGU

MED-TECH COMPANIES

ENABLE COST-EFFECTIVE, **CONTINUOUS** TRAINING FOR ALL YOUR MEDICAL **DEVICES** IN XR **SIMULATIONS** YOU EASILY CREATE & UPDATE.

ZIMMER BIOMET

Roche

SOFMEDICA
LIFE SAVING INNOVATION

MED XR CONTENT-CREATORS

BETTER, **FASTER**, MORE **COST-EFFECTIVE** MEDICAL XR CONTENT CREATION FOR ANY **THERAPEUTIC**, **DIAGNOSTIC** OR **SURGICAL** OPERATION.

NON NOCERE

HUG Hôpitaux Universitaires Genève

FORTH
INSTITUTE OF COMPUTER SCIENCE

UNIVERSITÉ DE GENÈVE

NHS
The Leeds Teaching Hospitals
NHS Trust

VIRED
Virtual Dental Training Tool

IML Institute for Medical Education

WE'RE ON A FAST (AND EFFICIENT) GROWTH PLAN

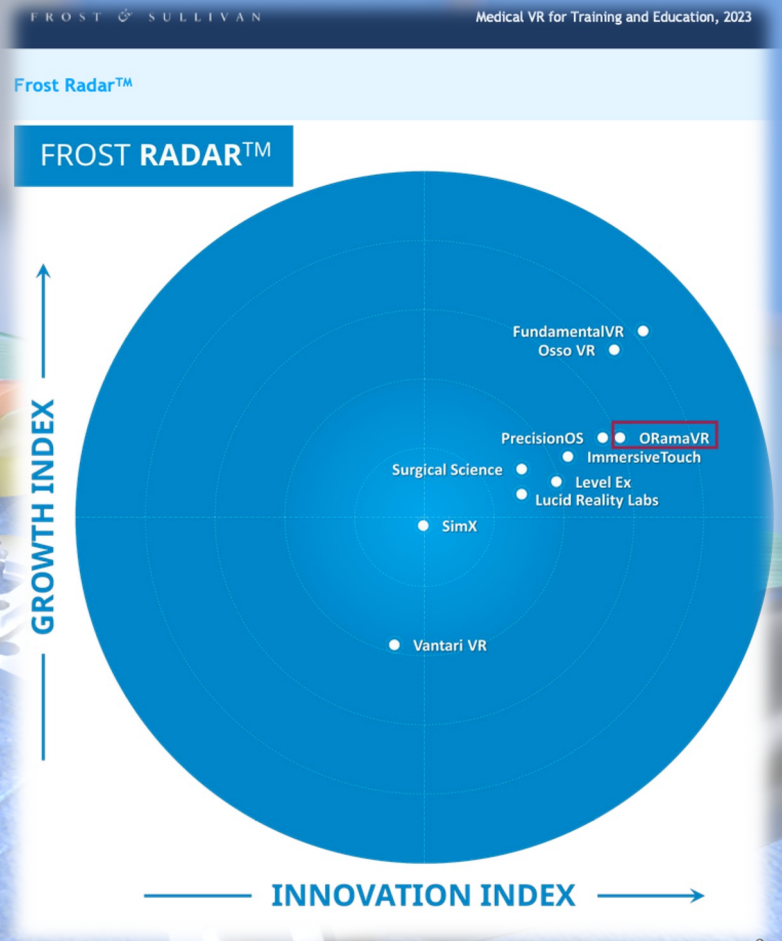
ORama VR

168%
CAGR

9,200+
CLIENT TRAINING SESSIONS

30+
B2B CLIENTS WORLDWIDE
10 different countries
7+ B2B subscribers on SUITE
10+ medical schools/institutes,
2+ medical device companies,
1 surgical training center on SIM
European Commission,
Innosuisse on NRE R&D

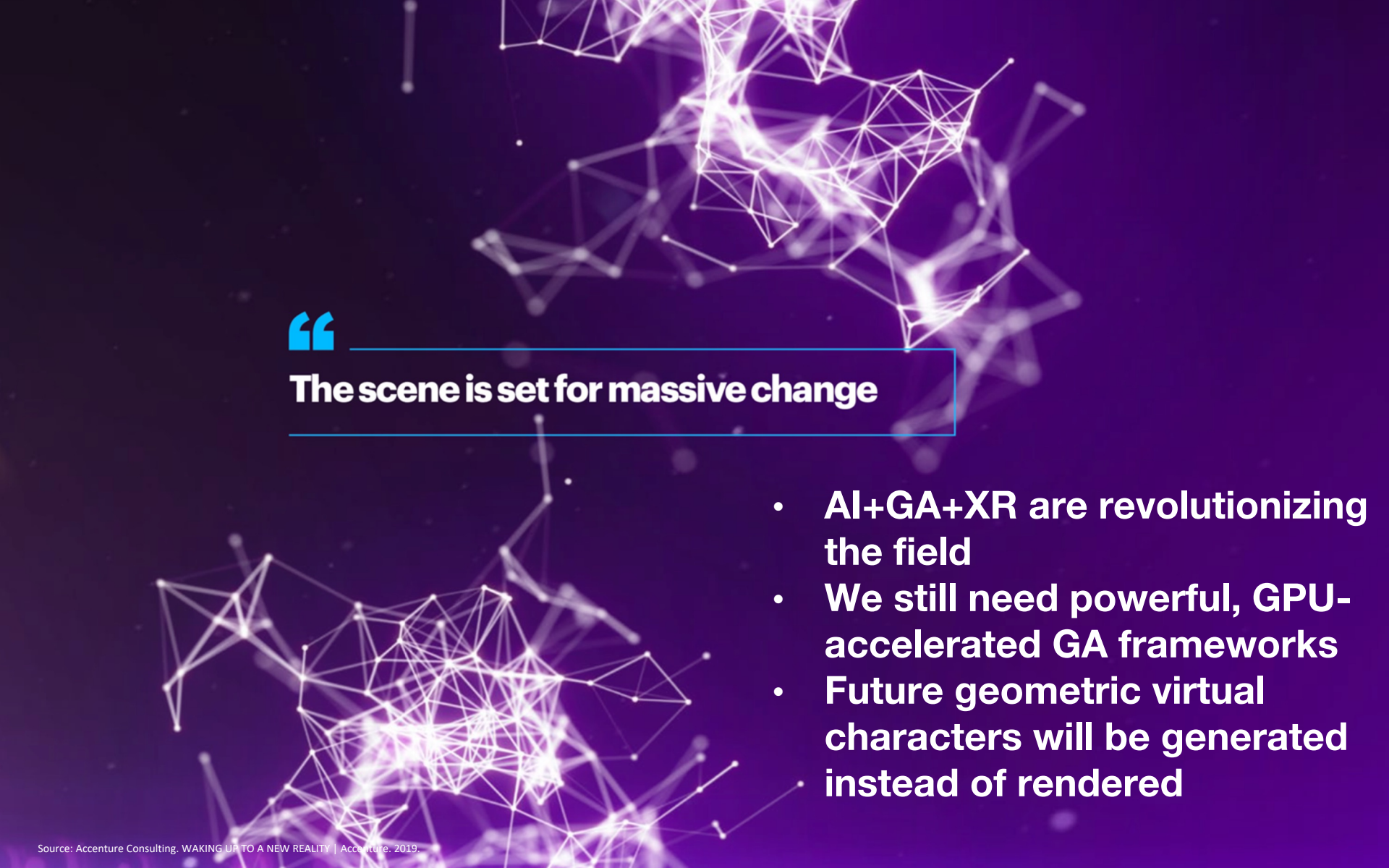
53 SIMs
Created so far with MAGES SUITE,
43 in pipeline



Next steps?

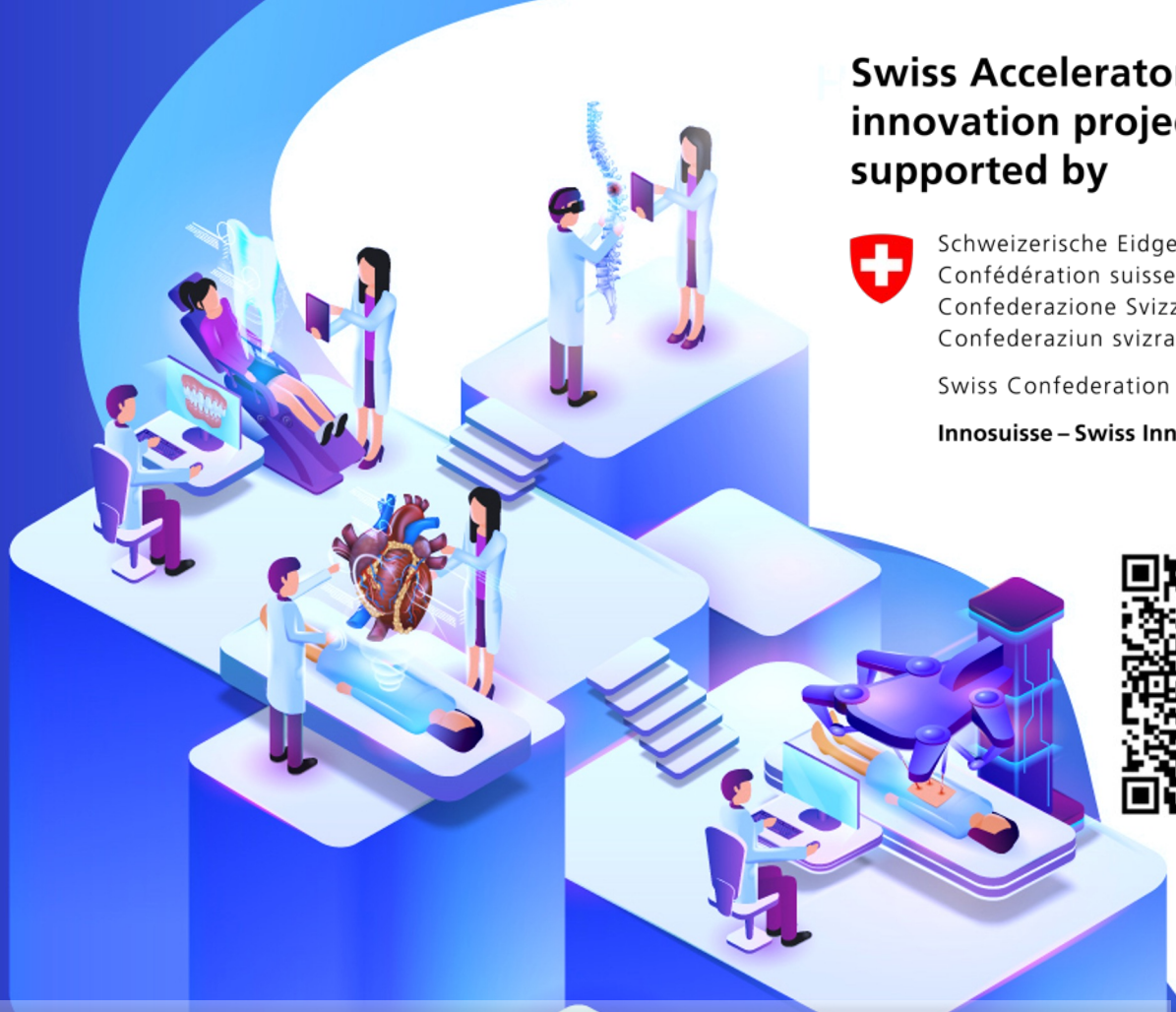
- Stanford Digital Health Centre
- genAI Text2XR: neurosymbolic GA and XR
- Embodied AI: world model vs latent space

Stable Diffusion prompt:
“an explosion of colorful powder”



- AI+GA+XR are revolutionizing the field
- We still need powerful, GPU-accelerated GA frameworks
- Future geometric virtual characters will be generated instead of rendered

Source: Accenture Consulting. WAKING UP TO A NEW REALITY | Accenture. 2019.



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Innosuisse – Swiss Innovation Agency

Funded by the European Union
NextGenerationEU

Greece 2.0
NATIONAL RECOVERY AND RESILIENCE PLAN

fidal field trials beyond 5G

INDUX-R

Dr. George Papagiannakis
Prof. University of Crete,
Affiliated Researcher at FORTH
Visiting Prof. University of Geneva
&
ORamaVR co-founder, CEO
george@oramavr.com

FORTH Foundation for Research & Technology - Hellas

ORama VR

UNIVERSITÉ DE GENÈVE

Let's accelerate world's transition to XR training!