



Augmented Reality Framework for Visualizing Airborne Infectious Pathogens in the Operating Room during Surgery

Rahmat Rizal Andhi DC07 

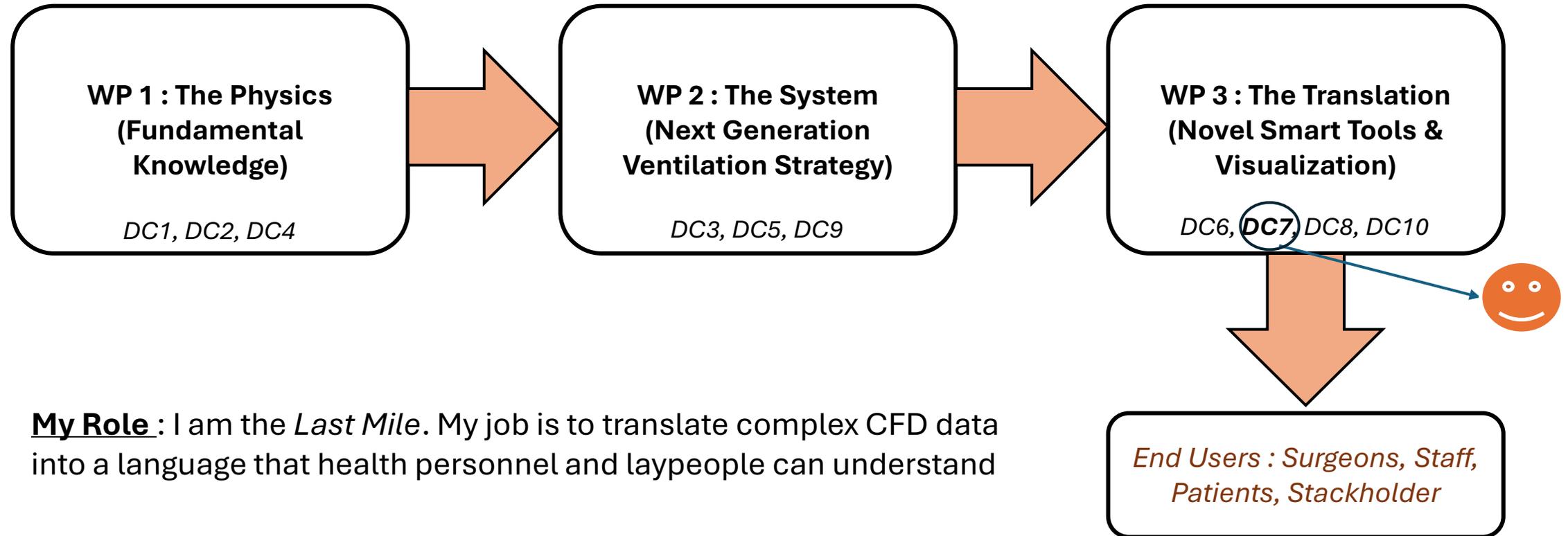
3D Research Coordinator (St Olav's Hospital, Future Operating Room)

PhD Candidate (NTNU, Computer Science)

Spv : Gabriel Kiss, Guangyu Cao, Frank Lindseth, Jan Gunnar Skogås



The HumanIC Project Workflow*



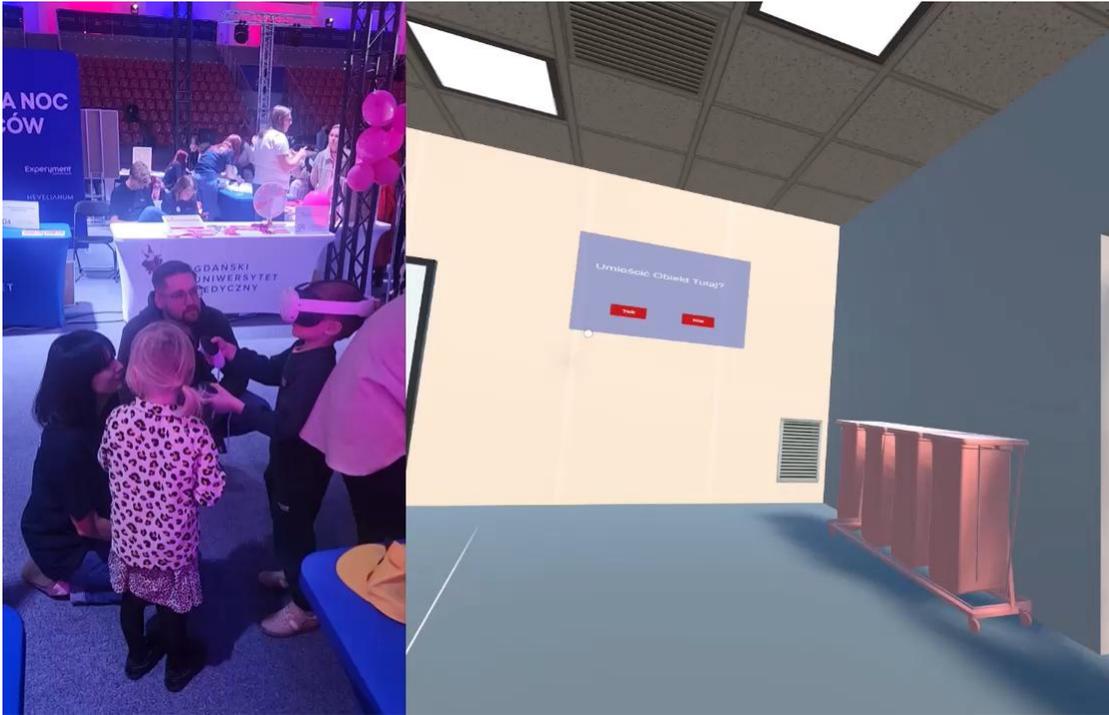
My Role : I am the *Last Mile*. My job is to translate complex CFD data into a language that health personnel and laypeople can understand

*Source : Grant Agreement document (Associated with document Ref. Ares(2023)4821496 - 11/07/2023)

HumanIC project has received funding from the European Union's Horizon Europe research and innovation program under the Marie Skłodowska-Curie (HORIZON-MSCA-2022-DN-01, project no 101119726)



Can VR Actually Teach ‘Airflow’?



Validation Study : European Researcher’s Night (Gdansk)

Question : Can laypeople (children/families) understand HVAC concepts via Virtual Reality Application?

Method : Gamified VR Airflow Simulation (Unity3D) – Interactive Play

Result : Users intuitively grasped the ‘invisible risk’ in the operating room

Conclusion : VR and digital twin of OR can be used to visualize indoor airflow and airborne particle simulation to non-expert / laypeople

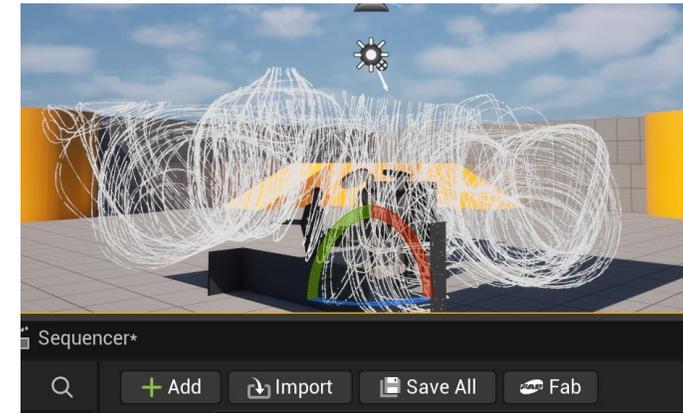
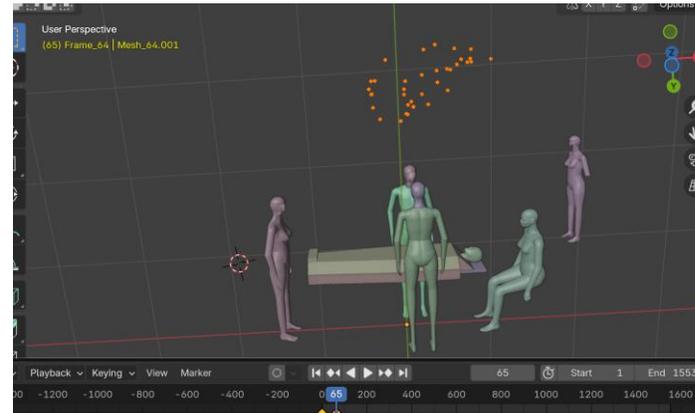
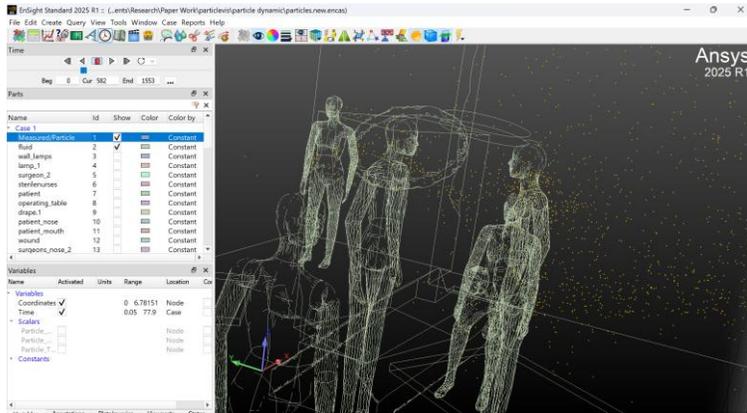
**Source : IEEE ICME 2026 Short Paper Draft ‘Gamifying the Invisible: An Immersive Framework for Demystifying Sterile Airflow’*

The Technical Bridge : From CFD to VR

The Challenge : CFD tools (Ansys) and VR tools (Unreal Engine) do not speak with the same language.

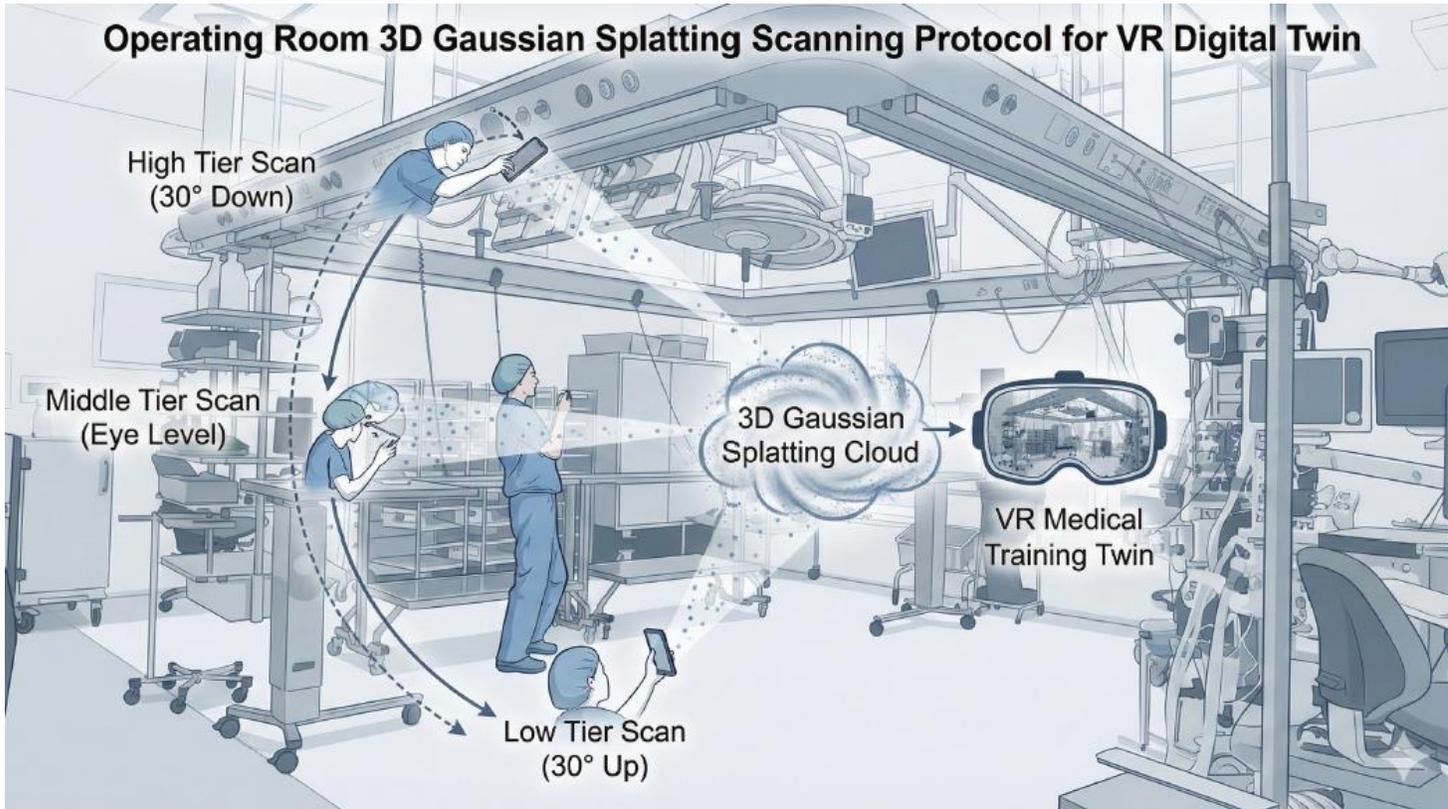
The Solution : A Lagrangian-Based Middleware

- **Step 1 :** Extract Particle Tracking Data (Ansys)
- **Step 2 :** Python Middleware (Blender3D)
- **Step 3 :** ‘Baking’ Physics (Velocity, Age, Temp) into Mesh Vertex Attributes
- **Step 4 :** Import simulation ‘animation’ inside Game Engine (Unreal)



**Source : Roomvent Conference 2026 Abstract Submission ‘From CFD to Immersive Reality: A Lagrangian-Based Immersive Workflow for Real-Time Visualization of Contaminant Dispersion in Operating Rooms’*

Visual Fidelity : 3DGS for Digital Twin



Question: To build a Digital Twin, do we need use the expensive DLSR to scan the OR?

Findings : Evaluated DLSR vs Insta360 vs Smartphone cameras to scan OR for 3DGS.

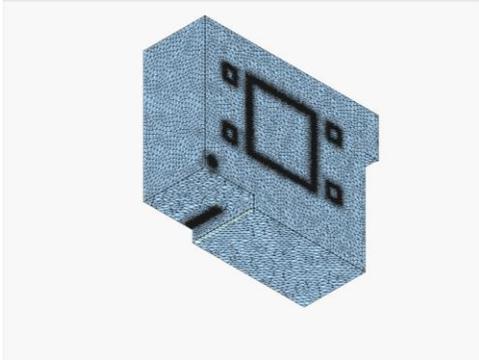
- **Pixel Accuracy (PNR)** : DLSR wins
- **Structure Accuracy (SSIM)** : Smartphone wins (Samsung)
- **Perceptual Quality (LPIPS)** : Smartphone wins (Iphone)

**I need to remove Insta360 from competition because its wiped all its competitor*

Conclusion : In the context of VR Simulation, using 3DGS, in the OR, smartphones cameras is more suitable for 3D scanning because ‘Perceptual Structure’ >>> ‘Pixel Perfection’

**Source : XR Salento 2026 Paper Draft ‘Evaluating the Viability of Smartphone Camera for 3D Gaussian Splatting Operating Room Digital Twin Reconstruction’*

3DGS Performance on the RTX 4090



Simple Geometry

489,188 (Triangles)

89,2 (Avg. FPS)

1,245 MB (Memory)

11,2 ms (Latency)



Immersive Mesh

66,563 (Triangles)

72,4 (Avg. FPS)

2,187 MB (Memory)

13,8 ms (Latency)



3DGS

8,000,000 (Splat)

38,1 (Avg. FPS)

4,562 MB (Memory)

26,2 ms (Latency)



3DGS Optimize

1,800,000 (Splat)

72,6 (Avg. FPS)

2,893 MB (Memory)

13,8 ms (Latency)

**Source : ISMAR 2026 Paper Draft 'Optimizing VR Visualization of Indoor Airflow and Airborne Particles Dispersion in the Operating Room using 3D Gaussian Splatting and Mesh-Based Techniques'*

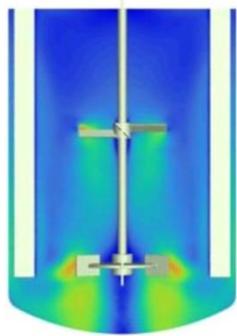
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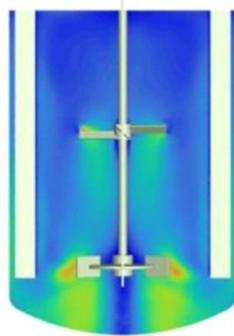
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the European Union



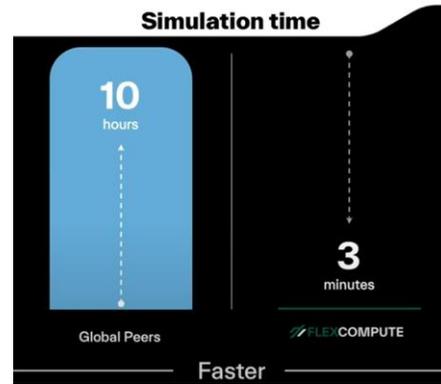
What Next ? XR-AI



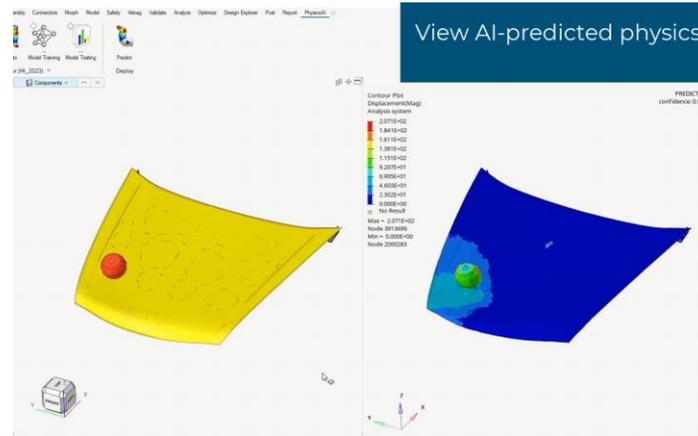
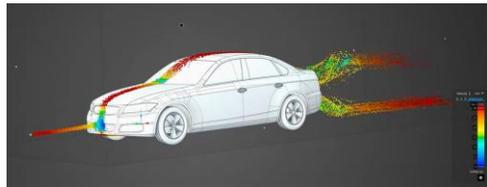
Fluent
2 Hr on 24 Cores



SimAI
~30 sec



FLEXCOMPUTE Flow360



Next Step : User validation to user (Qualitative Measurement)

Real-Time CFD : Instead of calculating physics (solving), we are now predicting the pattern (inference)

Future Direction : Real-Time Surrogate Modeling (AI) – Inference at the Edge.

Goal : To allow the surgeon to interact with the room and see the airflow change instantly (10 ms) – *literal real-time simulation.*

Stay tunes at

<https://human-ic.eu/>

