Extended Reality for the Operating Room

Unlocking the Potential of Technological Advances for Surgical Interventions

Dr. Anke V. Reinschluessel - 17. June 2025 - CARS 2025, Berlin

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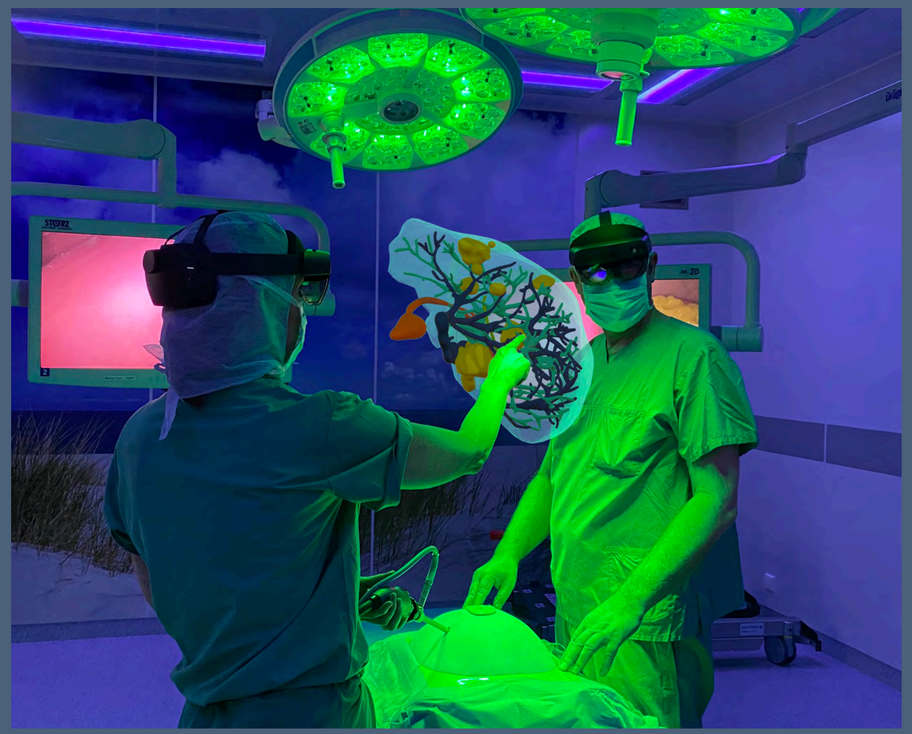
Dagstuhl Seminar XR4OR
Feb 2025

The vision is to transform clinical care through **intelligent XR** environments that integrate **advanced visualisation**, **intuitive interaction**, and **AI-assisted decision support**.



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By creating **responsive**, **context-aware** spaces, we aim to **enhance medical teams' capabilities** - giving them **superpowers** — while **maintaining patient safety** and **reducing cognitive load**.

Challenges & Opportunities

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Remote Collaboration

Multimodal Rendering and Data Integration

Interaction and AI

…

Robotics

Robustness and Uncertainty

…

Deformable Tissue

Evaluation and Metrics

…

Patient Perspectives

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Challenges & Opportunities

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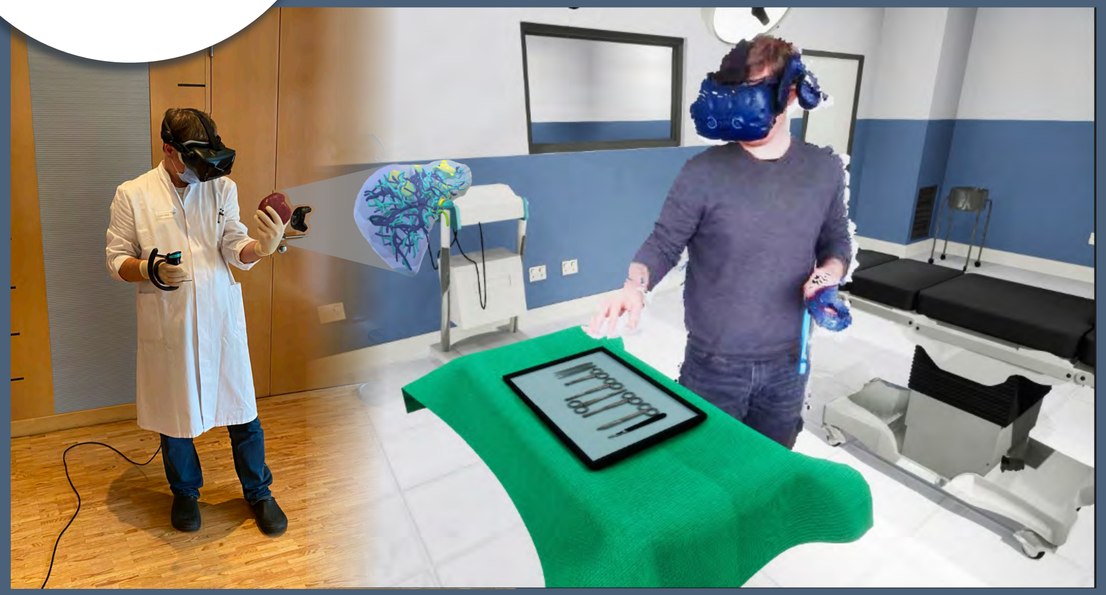

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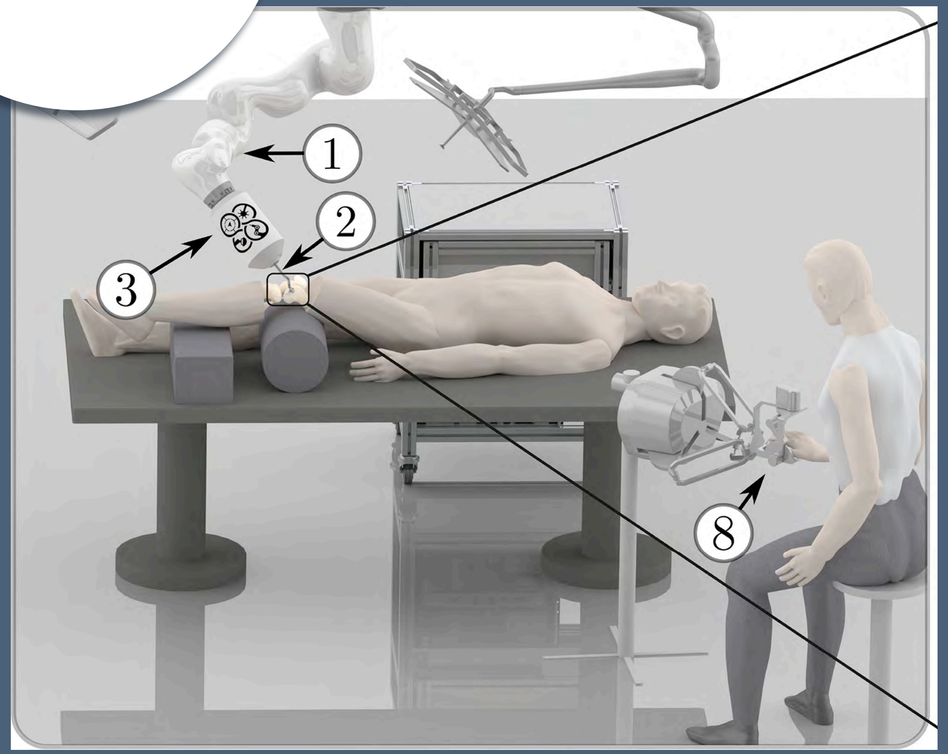
What aspects are required for successful remote collaboration?

- Enhancing the immersion, embodiment, and availability of multimodal information
- Standardizing and integrating surgical environments for seamless interaction.

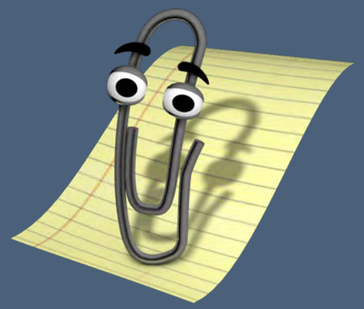
Robotics



- Preoperative Planning and AR Projection
- Real-time Tracking and Registration
- Network Infrastructure and Latency
- Human-Robot Interaction and XR Interface Design

© Eugster M, Merlet J-P, Gerig N, Cattin PC, Rauter G. Miniature parallel robot with submillimeter positioning accuracy for minimally invasive laser osteotomy. *Robotica*. 2022;40(4):1070-1097. doi:10.1017/S0263574721000990

Interaction and AI



Interaction

- Interaction standards and devices
- Usability and comfort of XR devices
- Suitable interaction techniques for secondary tasks
- Information overload and stress reduction
- Human-AI collaboration

AI

- Intelligent Monitoring/ Situational Awareness
- Closed-Loop Task Management
- Context-aware interactions
- Coordination of overall plans and changes
- Managing communications, interruptions, and distractions

Patient Perspectives

- AR for Preoperative Planning
- VR for Shared Decision-Making
- AR for Enhanced Communication

- Usability & Accessibility
- Cost & Integration

Evaluation and Metrics

- Surgeon-related clinical outcomes
- Patient-related clinical outcomes
- Usability
- Financial impact
- Data integration

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Robustness and Uncertainty

- Development Environment
- Open XR Standards
- Intuitive User Interaction
- Real-Time Accuracy Feedback
- XR Surgical Simulations/Recordings
- Standardised XR Testing Protocols
- Integrated Speech and AI Interaction

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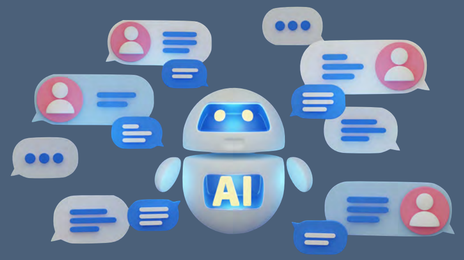

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