Beyond the Classroom: Virtual Reality, Augmented Reality and Haptics for Enhanced Surgical Training and Education. Project Reference: 2023-1-NO01-KA220-HED-000160462

IMMERSIVE SURGICAL EDU

Filippo Sanfilippo

Introduction

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  - Professor II at the Faculty of Informatics, Kaunas University of Technology (KTU)
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  - PhD Fellow, Even Falkenberg Langås
  - PhD Fellow, Muhammad Hamza Zafar
  - PhD Fellow, Syed Kumayl Raza Moosavi
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Introduction

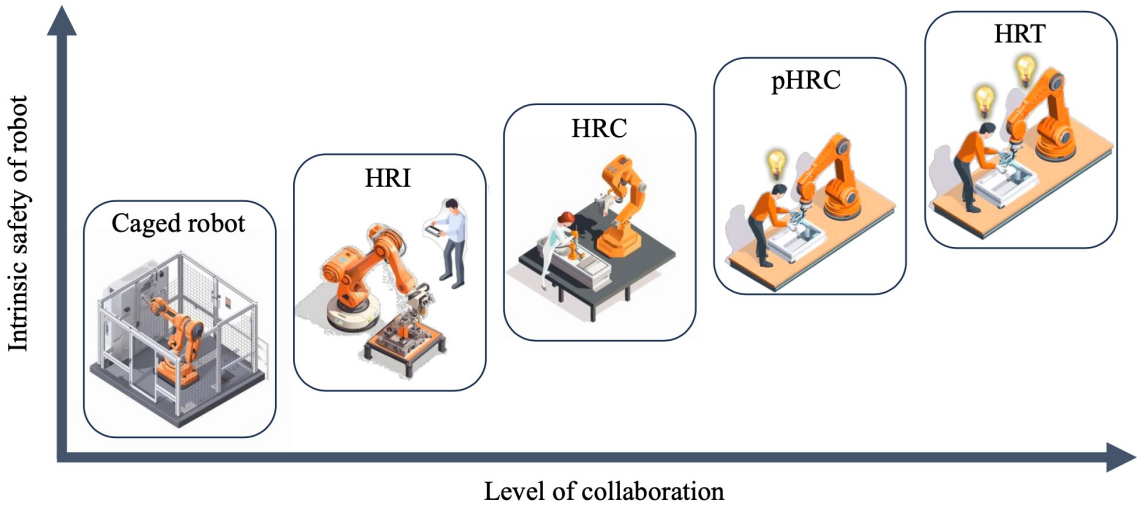

Figure: Transition from caged robots, to human-robot interaction (HRI), to human-robot collaboration (HRC), to physical human-robot collaboration (pHRC), to human-robot teaming (HRT).

[1,2]

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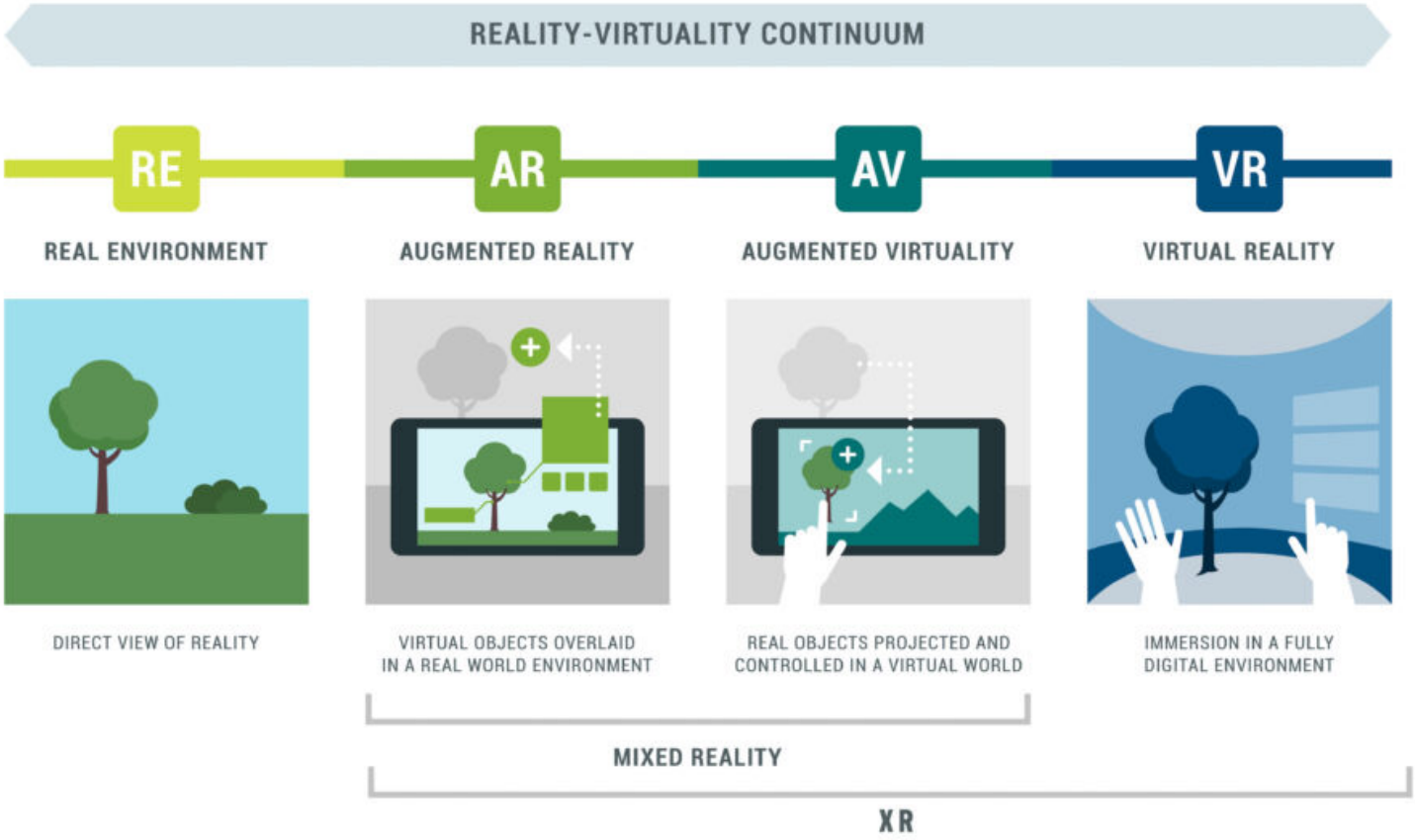
[1] Muhammad Hamza Zafar, Even Falkenberg Langås, and Filippo Sanfilippo. "Exploring the synergies between collaborative robotics, digital twins, augmentation, and industry 5.0 for smart manufacturing: A state-of-the-art review". In: *Robotics and Computer-Integrated Manufacturing* 89 (2024), p. 102769.

[2] Even Falkenberg Langås, Muhammad Hamza Zafar, and Filippo Sanfilippo. "Exploring the synergy of human-robot teaming, digital twins, and machine learning in industry 5.0: A step towards sustainable manufacturing". In: *Journal of Intelligent Manufacturing* (2025), pp. 1–24.

Introduction



Introduction

Table 1. Multi-Sensory Extension of the Reality–Virtuality Continuum

RV Partition	Vision	Audio	Touch	Smell	Taste
RE	Natural vision	Environmental sounds	Physical touch	Natural scents	Natural taste
AR	Digital overlays	3D spatial audio	Wearable haptics	Scent augment.	Limited taste augment.
AV	Blended objects	Virtual audio	Tactile feedback	Simulated scents	Basic taste sim.
VR	Synthetic visuals	360° audio	Force feedback	Digital scents	Synthetic taste

Introduction

Beyond the Classroom: Virtual Reality, Augmented Reality and Haptics for Enhanced Surgical Training and Education (ImmersiveSurgicalEdu), https://immersivesurgicaledu.eu/

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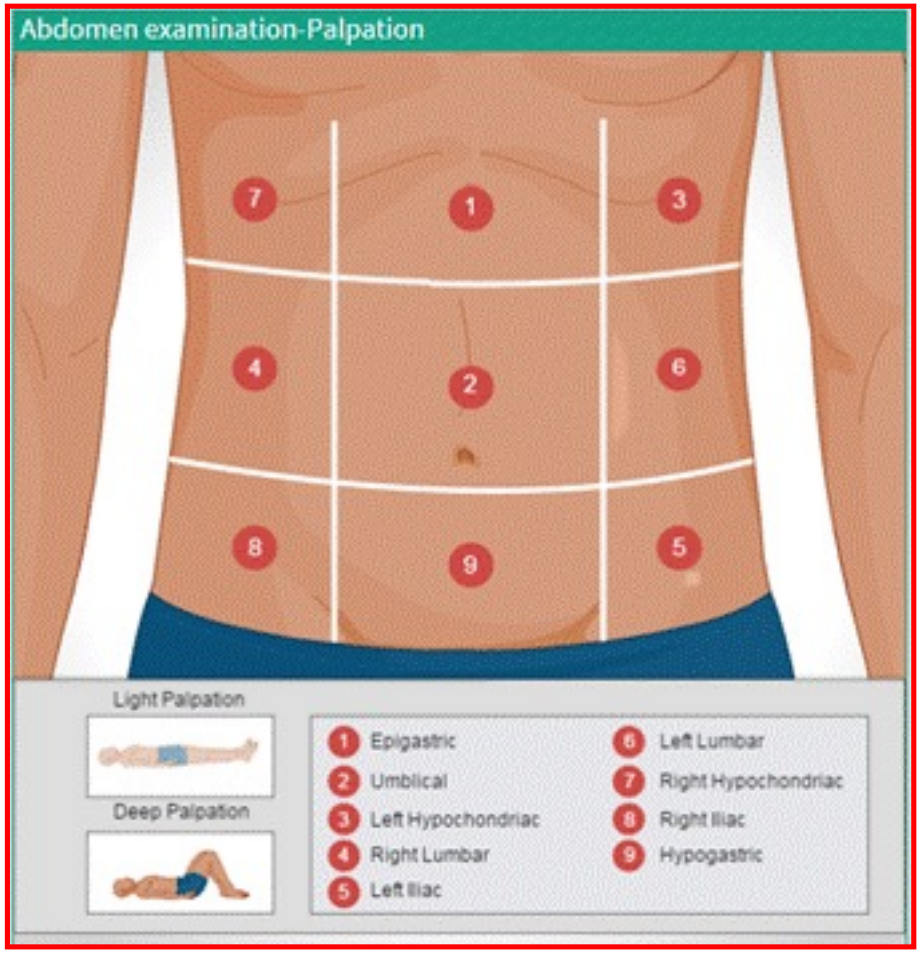
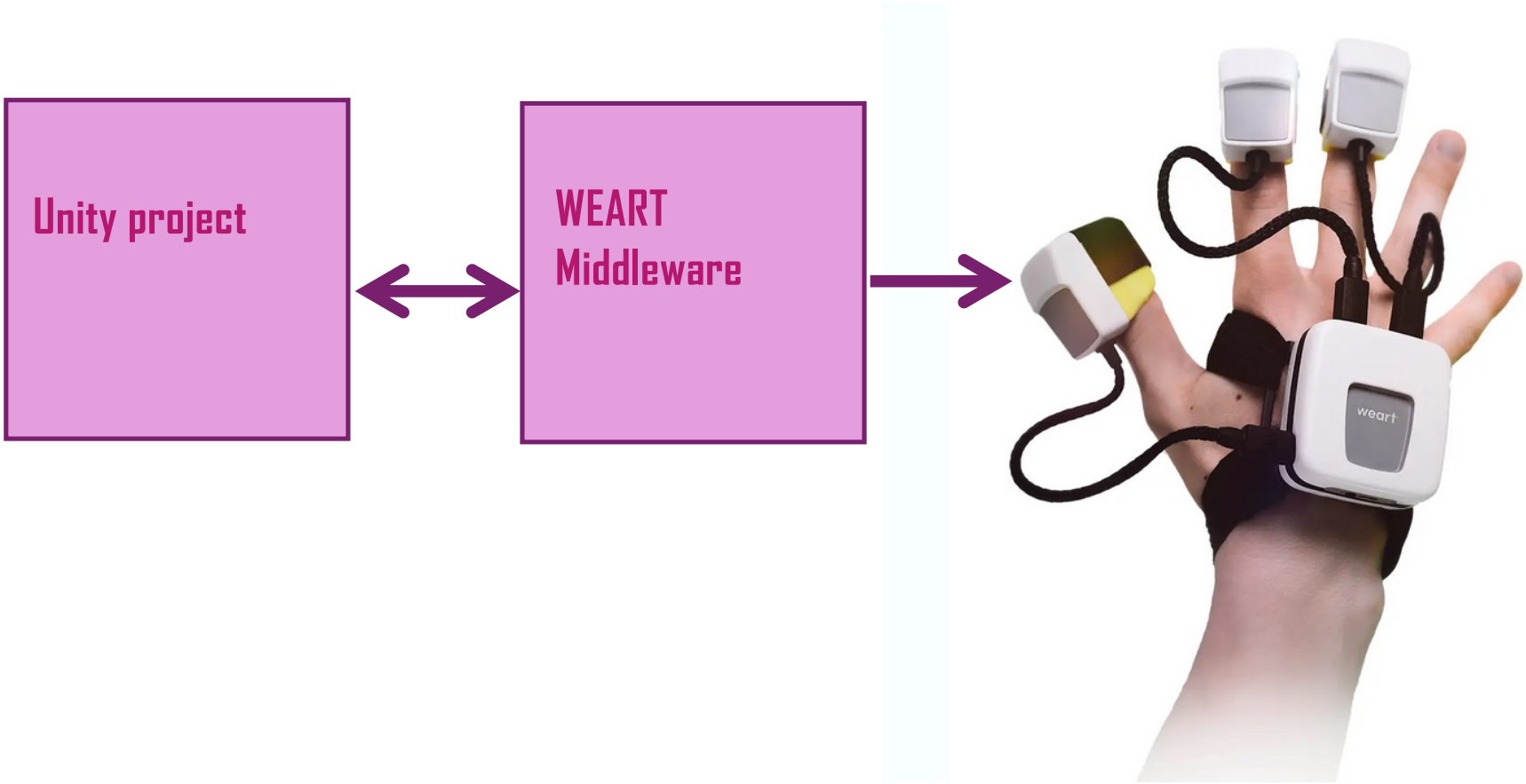
Introduction

Unity

Palpation examination overview

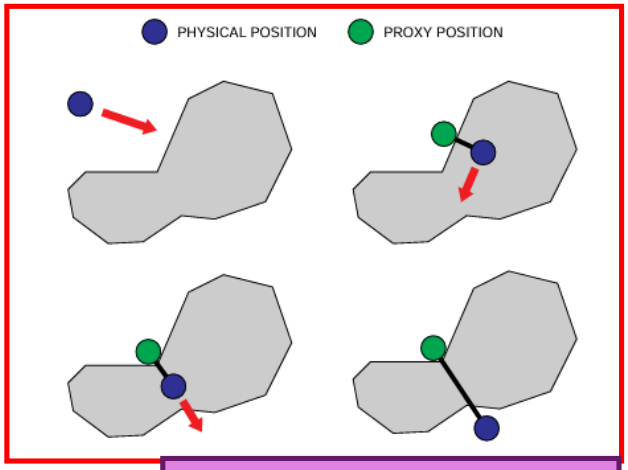


Methodology

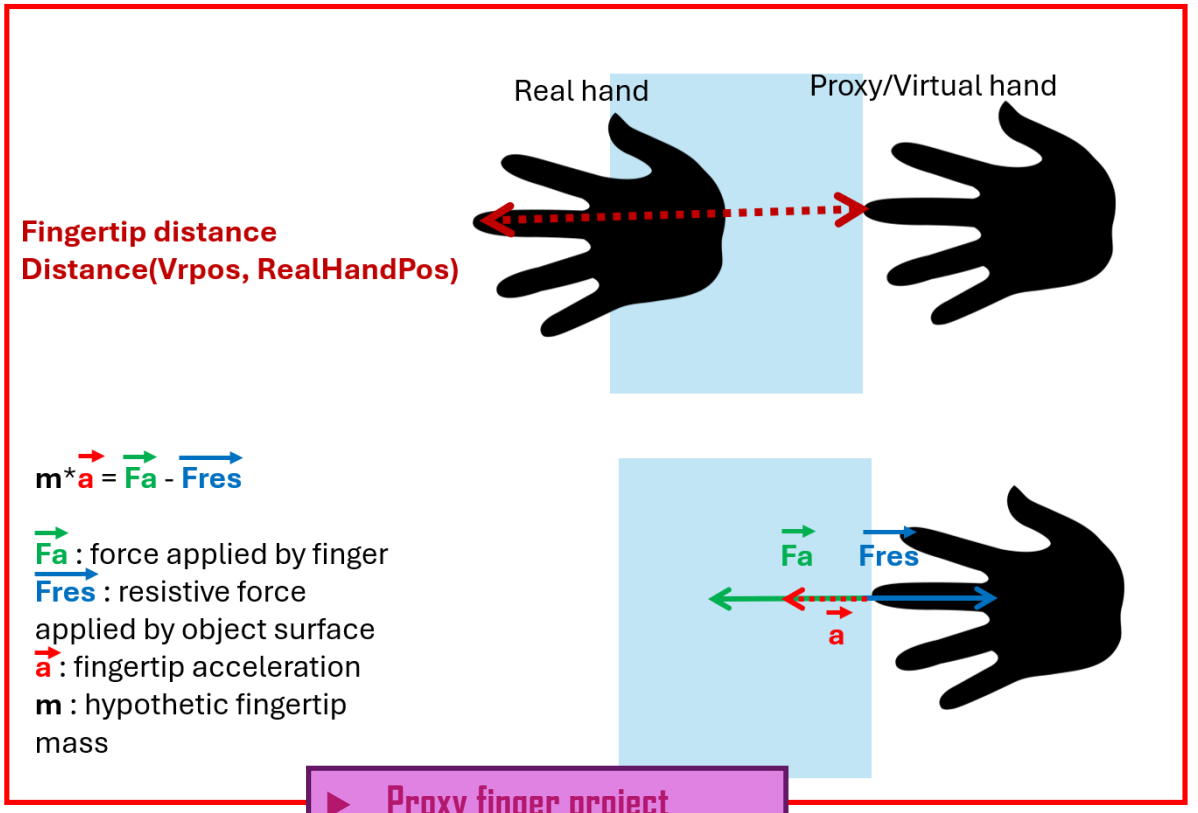


Methodology

Proxy finger method



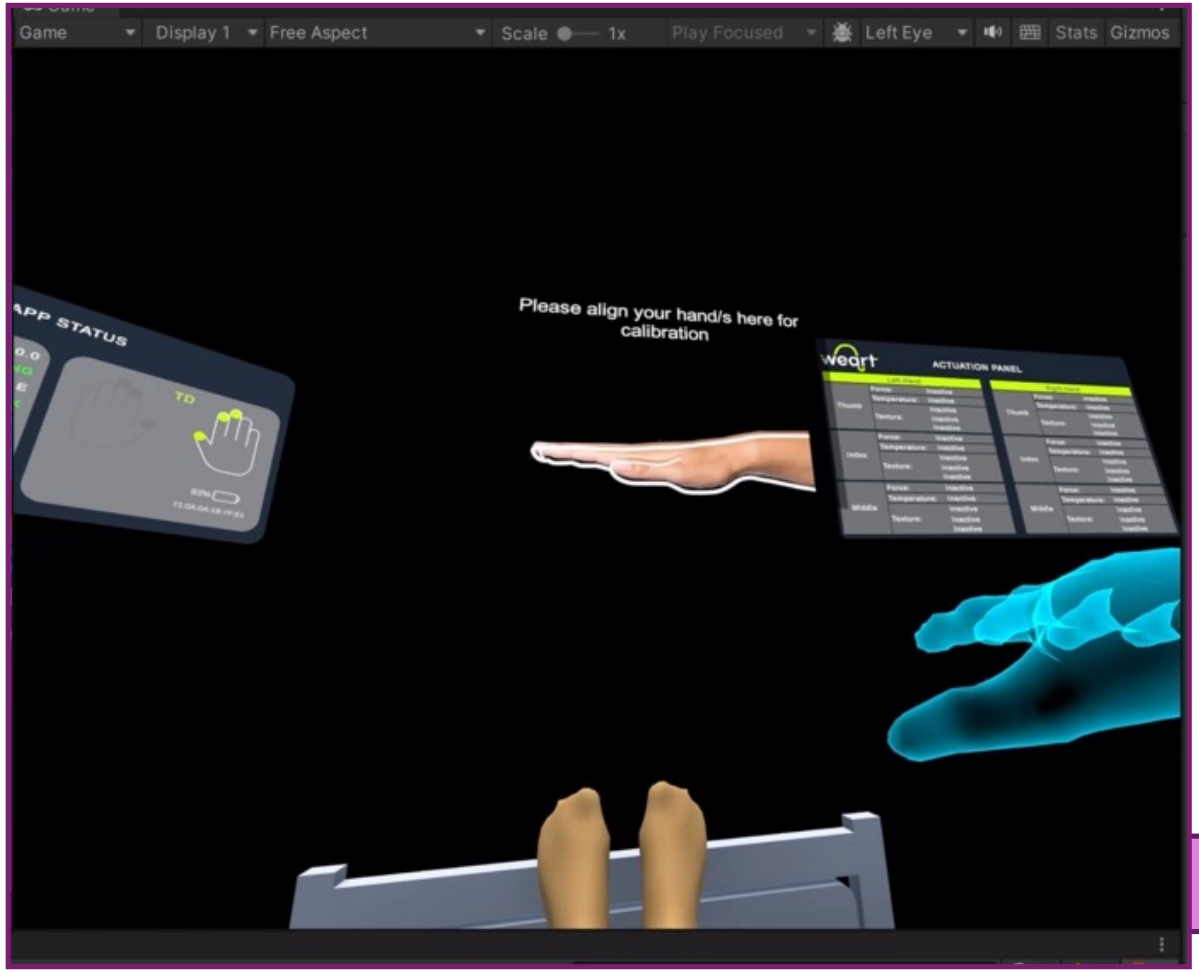
▶ Proxy finger method from state of art



▶ Proxy finger project implementation diagram

Methodology

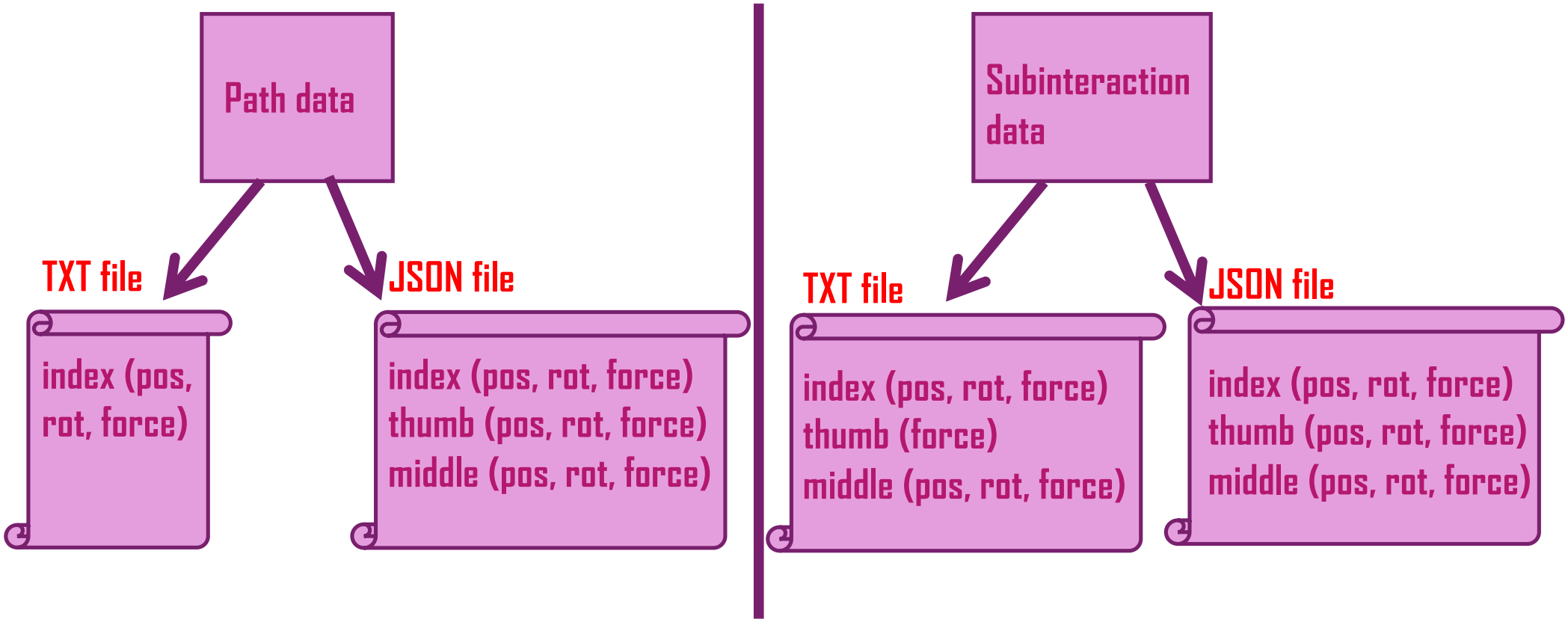
Proxy finger method



- Video showing in game proxy finger and finger press

Methodology

Data recording



Methodology

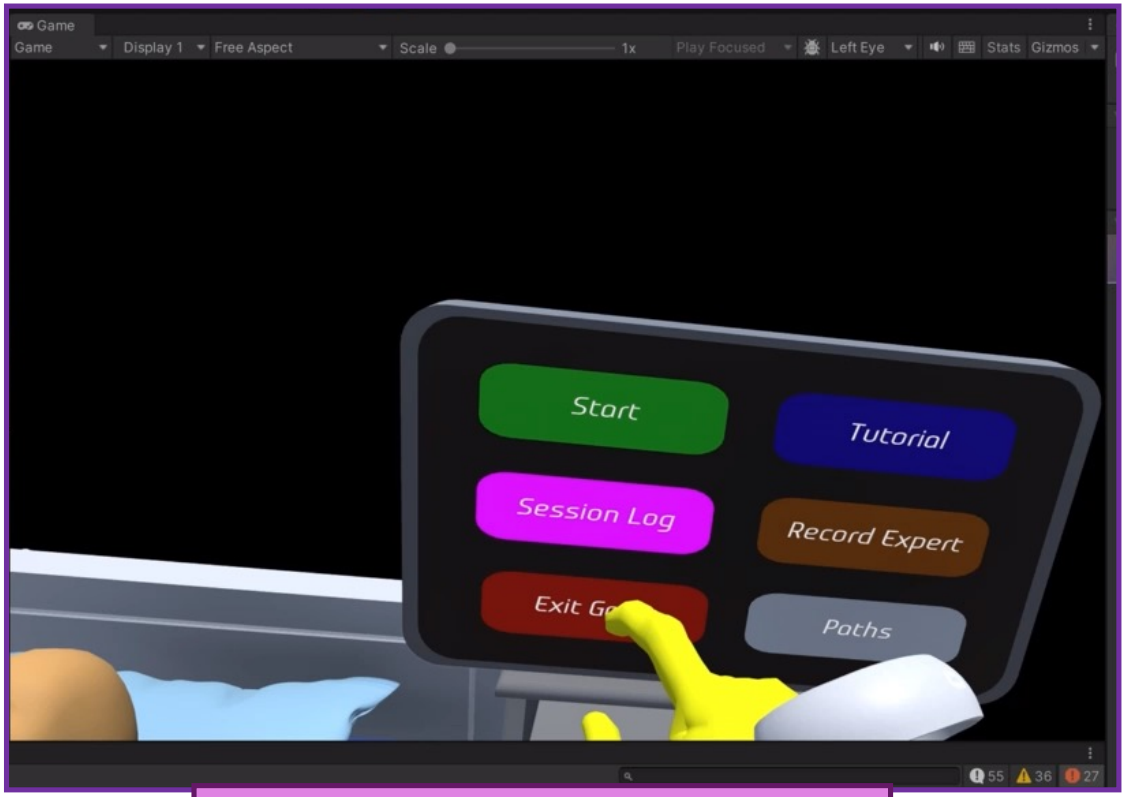
Student evaluation : overview

Complete validation method

Score list:

Force value (index, thumb, middle)
Force time (index)
Position (index, middle)
Rotation (index, middle)

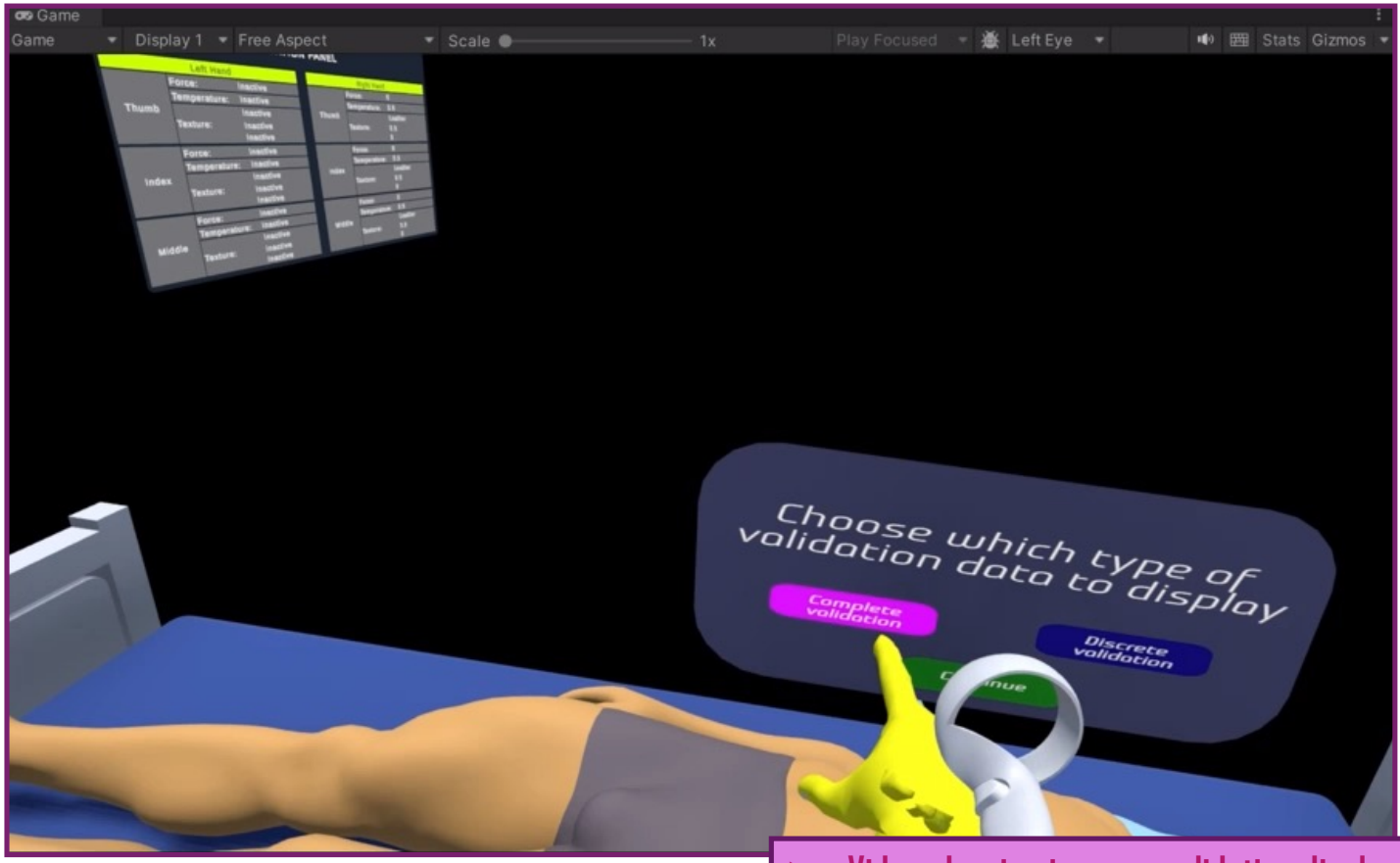
global (mean all scores)



▶ In game canvas for tunning exam difficulty

Methodology

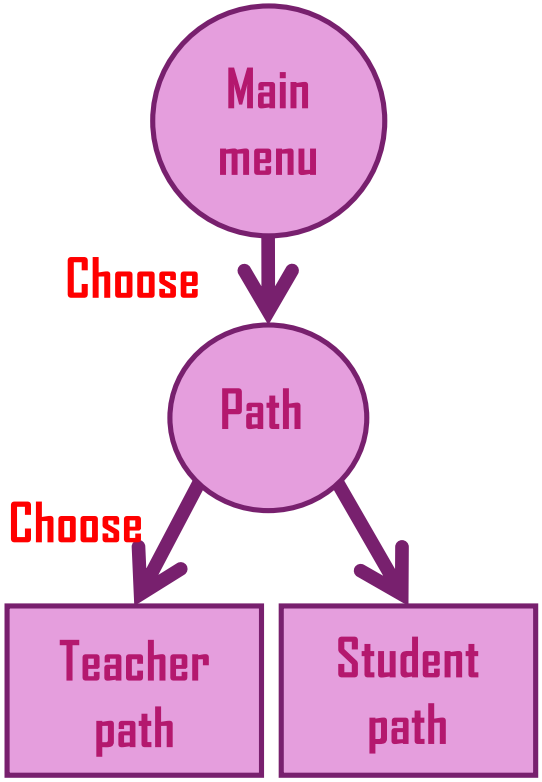
Student evaluation : in game display

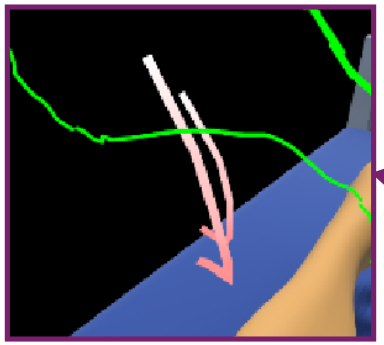


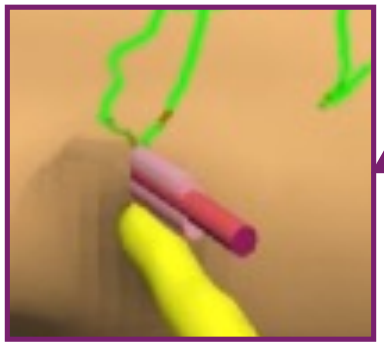
▶ Video showing in game validation display

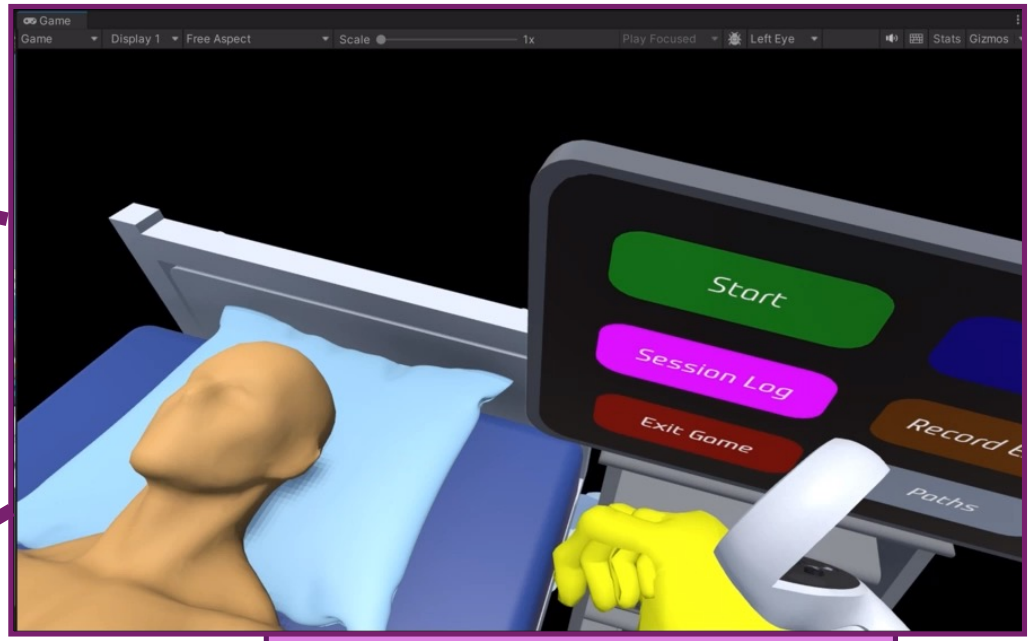
Methodology

Paths and data display







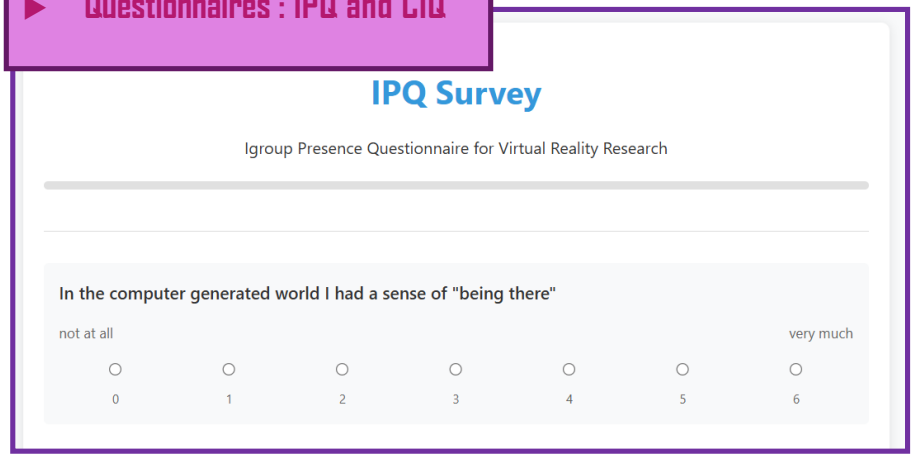


▶ Video showing in game path display

Experiments

Questionnaires and setup

▶ Questionnaires : IPQ and CIQ



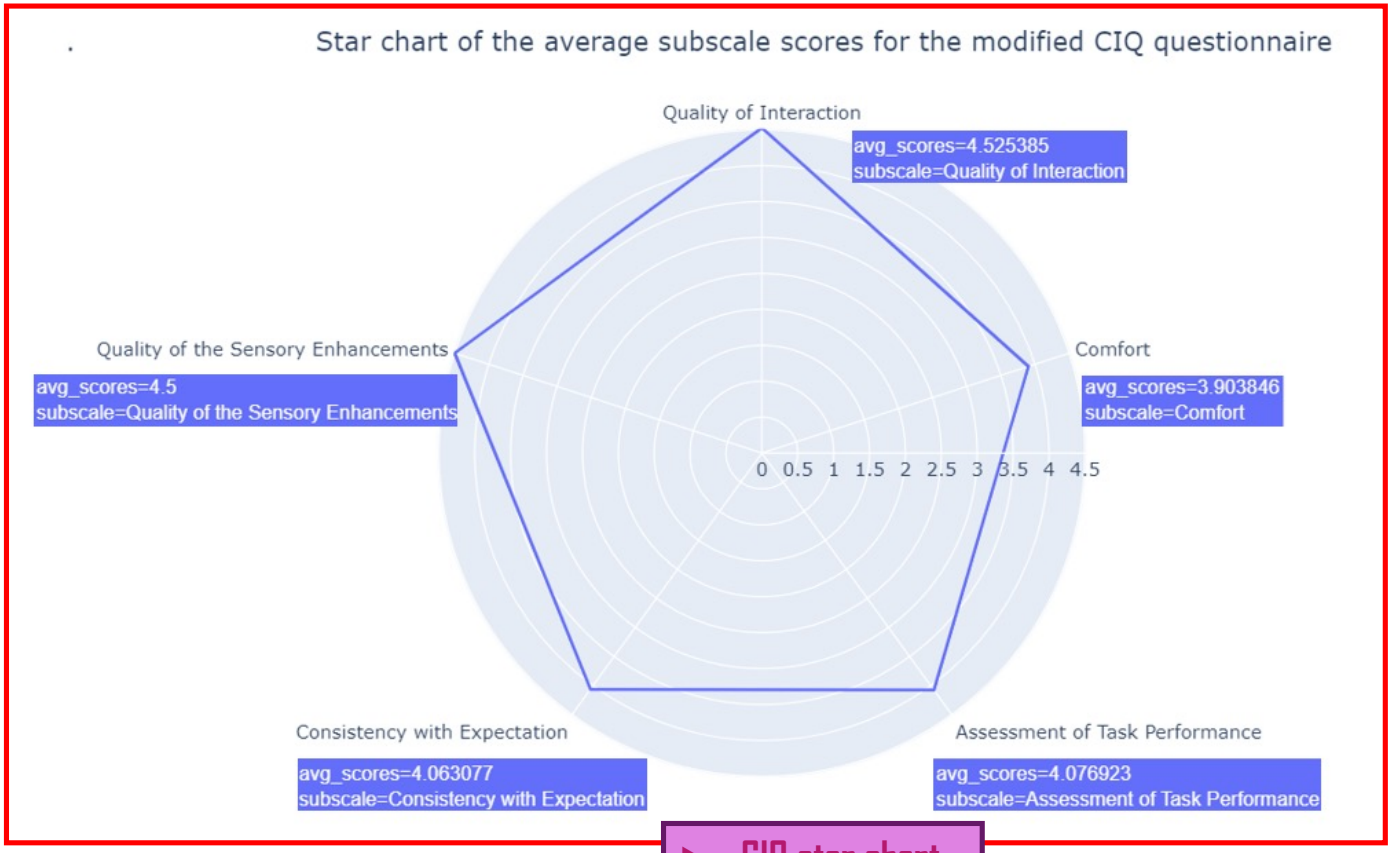
IPQ → Presence/ immerssion

CIQ → Interaction quality

▶ User testing : 2 days / 13 people

Experiments

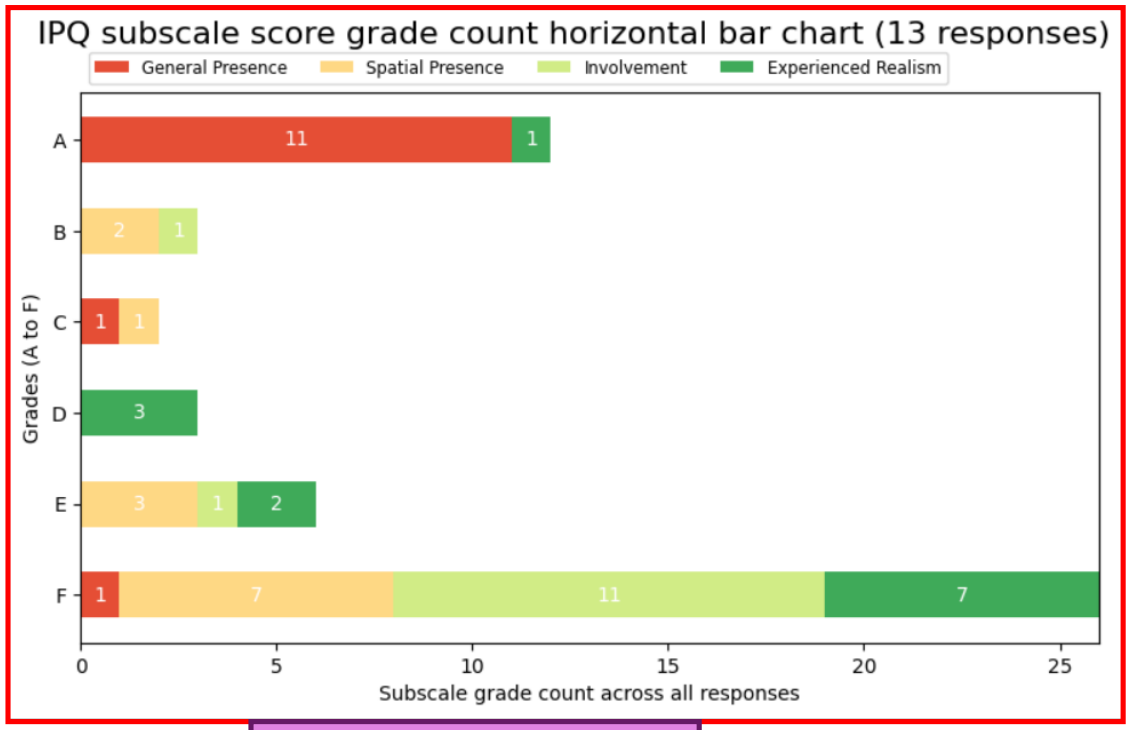
Results and interpretation



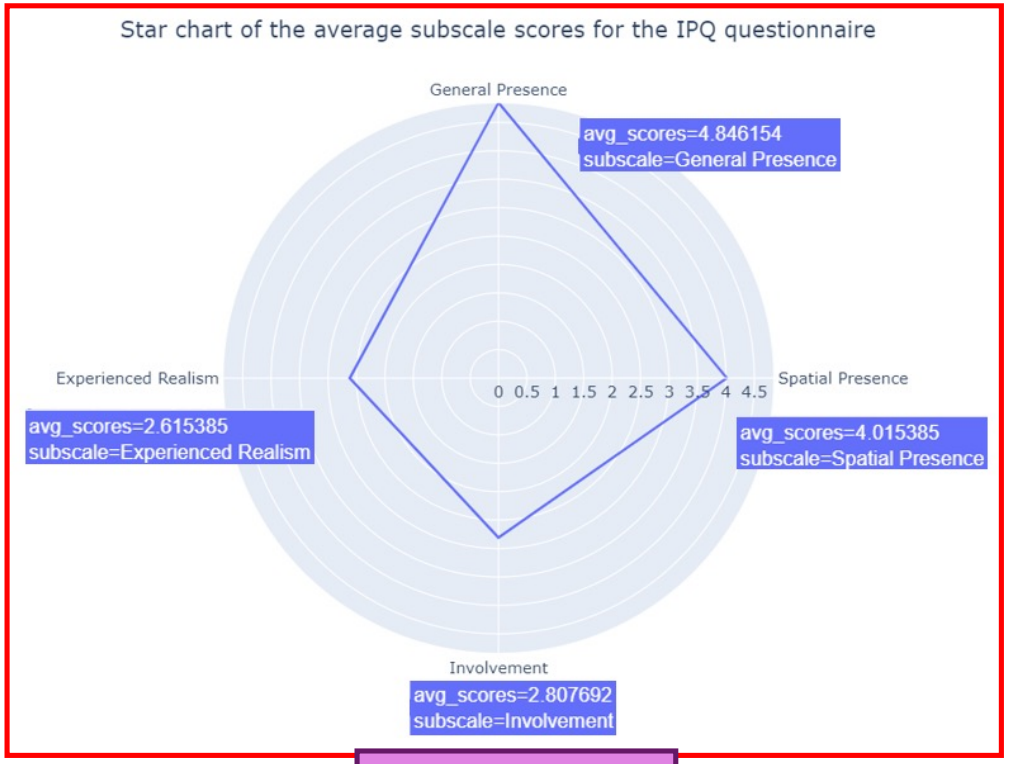
▶ CIQ star chart

Experiments

Results and interpretation



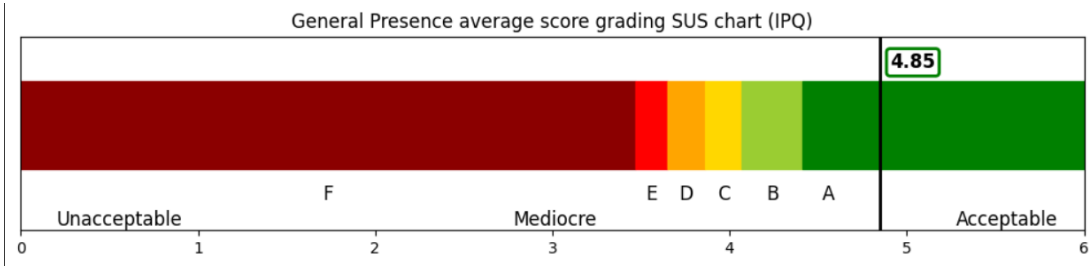
▶ IPQ horizontal bar chart

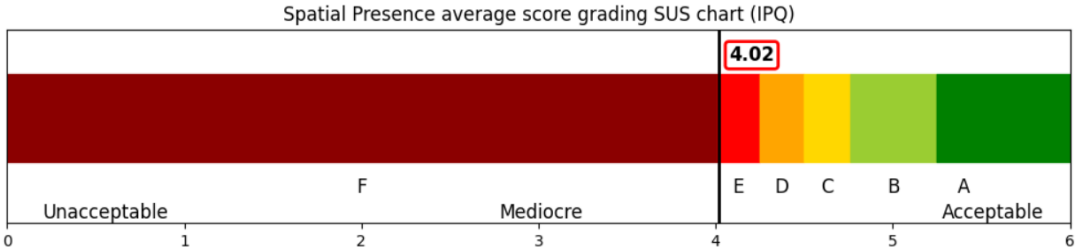


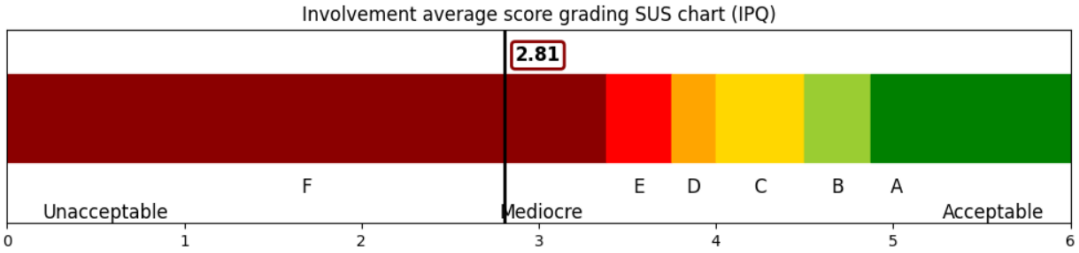
▶ IPQ star chart

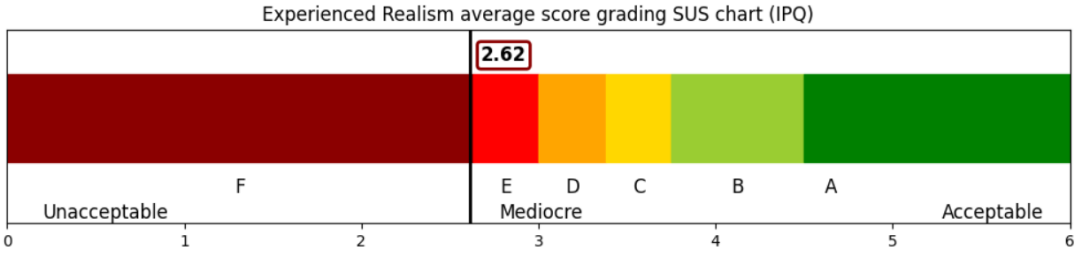
Experiments

Results and interpretation





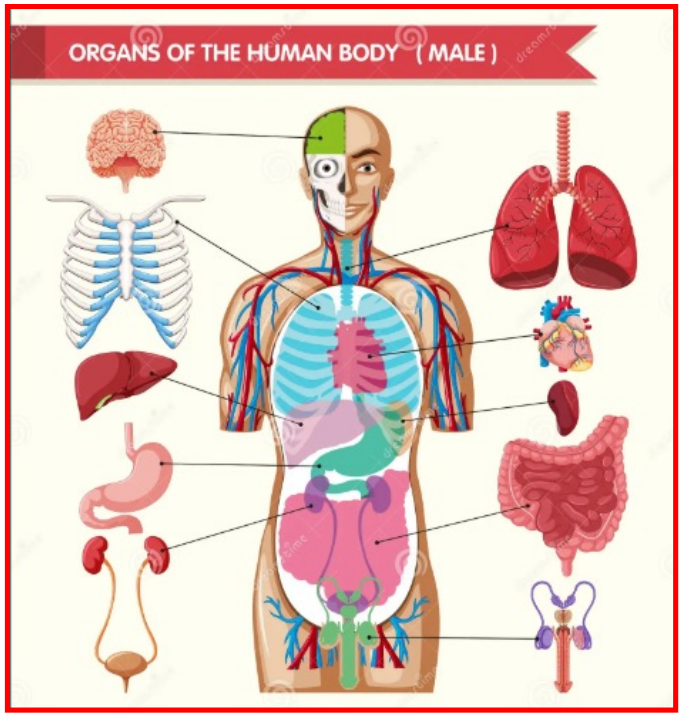


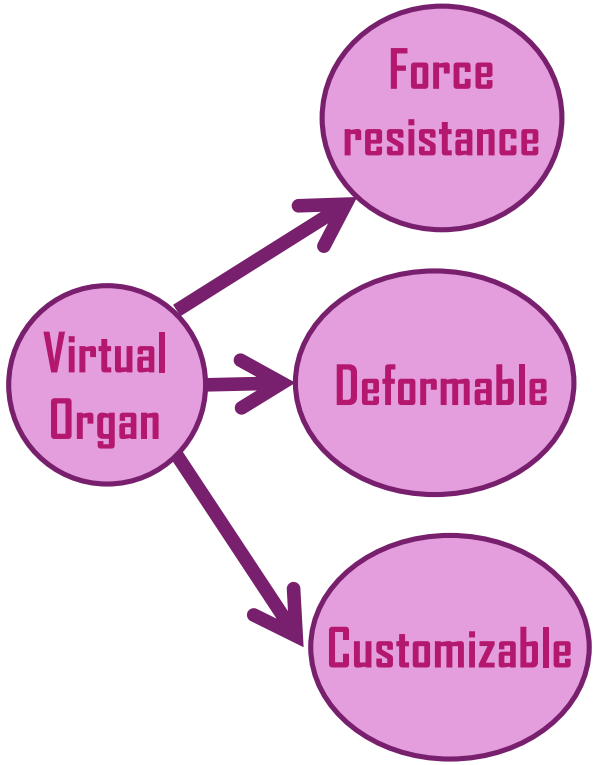


▶ IPQ SUS charts

Limitations and future work

Problems and improvements

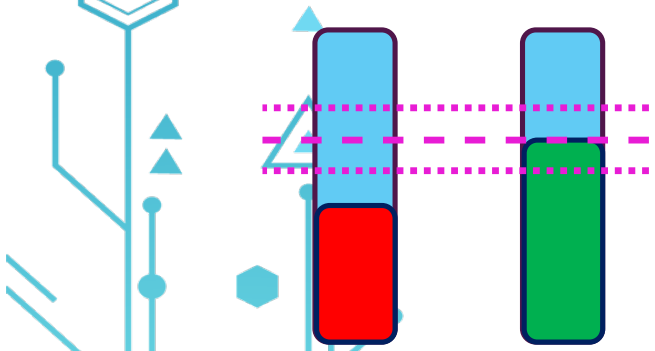




- Virtual organs

Limitations and future work

Problems and improvements



- Evaluation tutorial

- New glove with :
  - sensors around fingers;
  - two hands;
  - use temperature and texture ;

weart

Main Conclusion