VR BASED POWER WHEELCHAIR SIMULATOR: USABILITY EVALUATION THROUGH A CLINICALLY VALIDATED TASK WITH REGULAR USERS

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Guillaume Vailland*, Louise Devigne*, François Pasteau*, Florian Nouviale*,

Bastien Fraudet**, Émilie Leblong**, Marie Babel** and Valérie Gouranton**

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Presenter: Ruben Menino, nº mec 89185 MIECT

* : Univ Rennes, INSA Rennes, Inria, CNRS, Irisa, France
** : Pôle Saint Hélier Rehabilitation Center, France

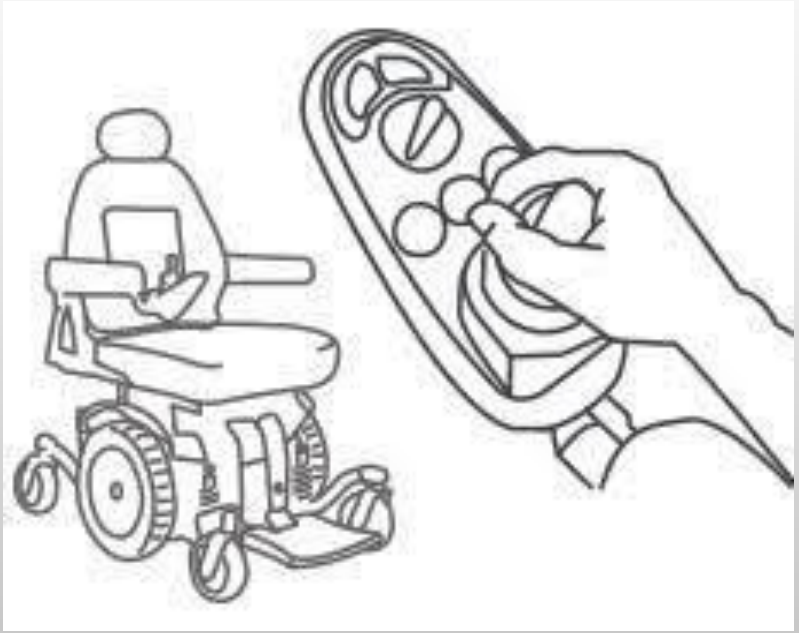
deti universidade de aveiro departamento de eletrónica, telecomunicações e informática

WHY THIS PAPER & RELEVANCE

- High interest in VR technologies
- Quality of experience
- Future

INTRODUCTION

- Power wheelchairs are one of the main solutions for people with reduced mobility
- Too complex to implement and unsuitable for some people
- Sense of presence (SoP)

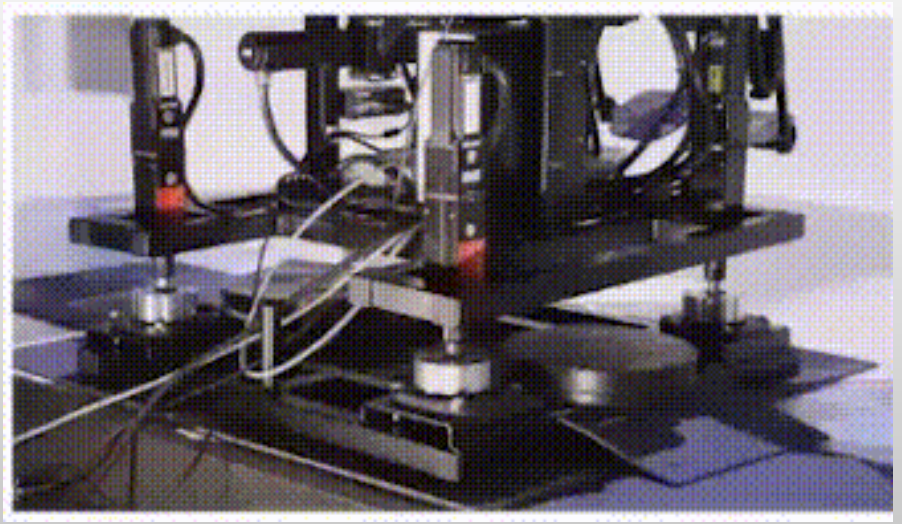


RELATED WORK

- ViEW Simulator:
  - Evaluate acquired skills through a custom level progression
  - Virtual environment displayed on a computer screen
  - Stimulate participant's interest

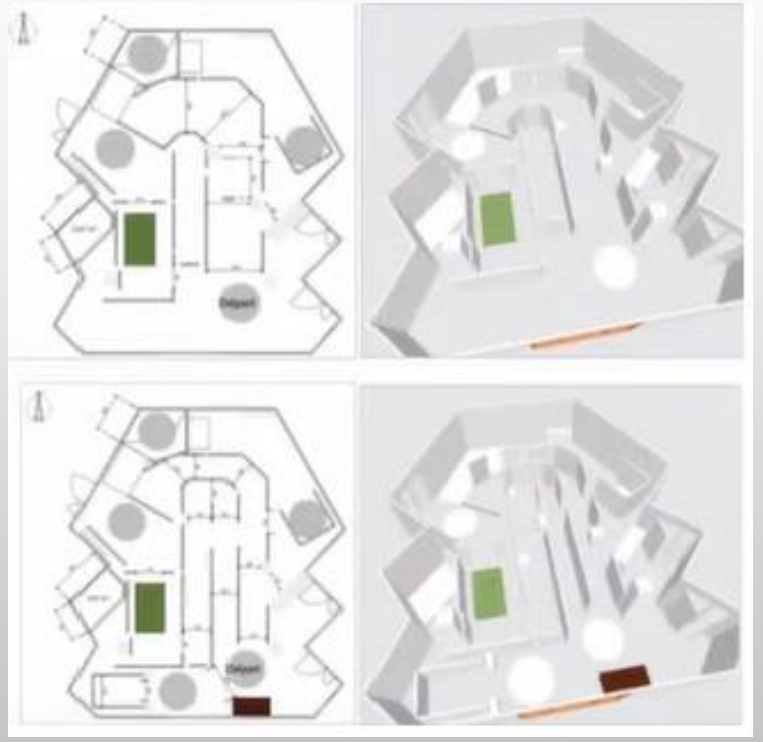
RELATED WORK

- VR based Power Wheelchair Simulator:
  - Designed with clinicians and end users
  - Provides Haptic and Vestibular Feedback



USER STUDY: OBJECTIVES AND HYPOTHESIS

- 3 different circuits of increasing difficulty
- Virtual vs Real driving performances



Objective – Quality of experience

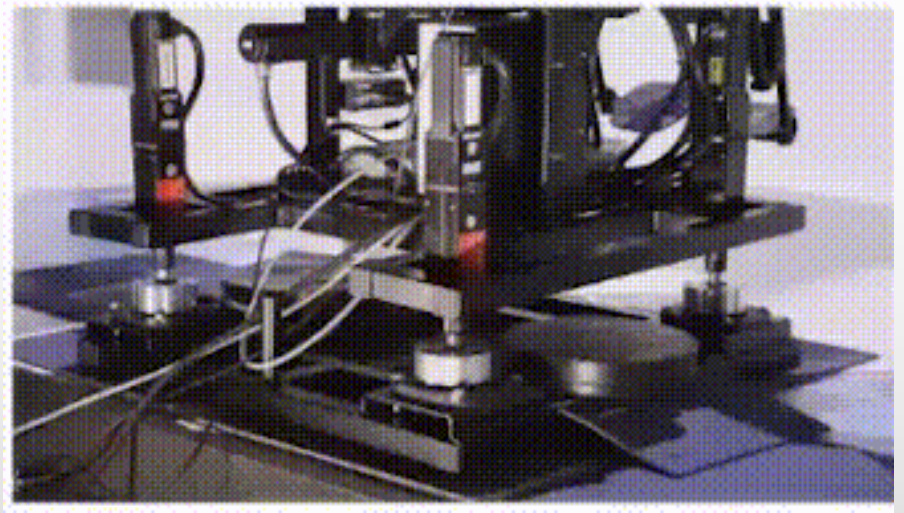
Hypothesis – "In a power wheelchair navigation clinically validated task, regular users perform in the same way in virtual condition using our simulator as if they were in real condition with a real power wheelchair."

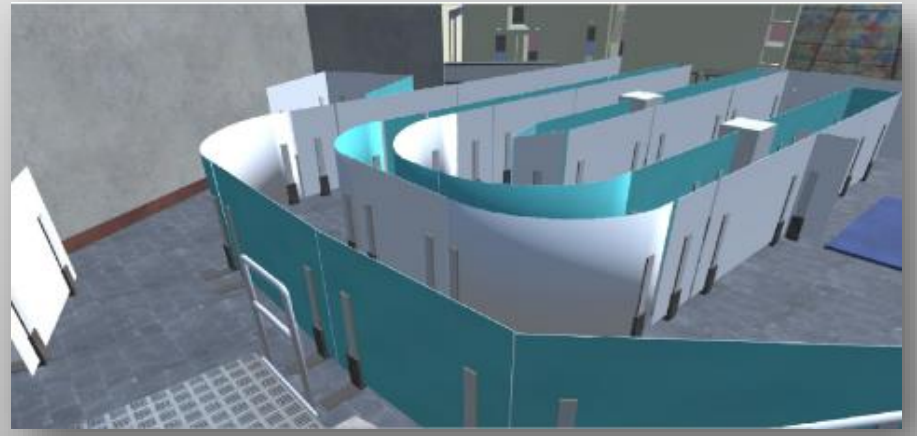
USER STUDY: REAL CONDITION

- Setup
  - Light wooden panels
  - 2 Quickie Salsa M2
  - Vicon

USER STUDY: VIRTUAL CONDITION

- Four degrees of freedom motion platform
- Seat and joystick from a Quickie Salsa M2
- HTC Vive Pro VR Headset



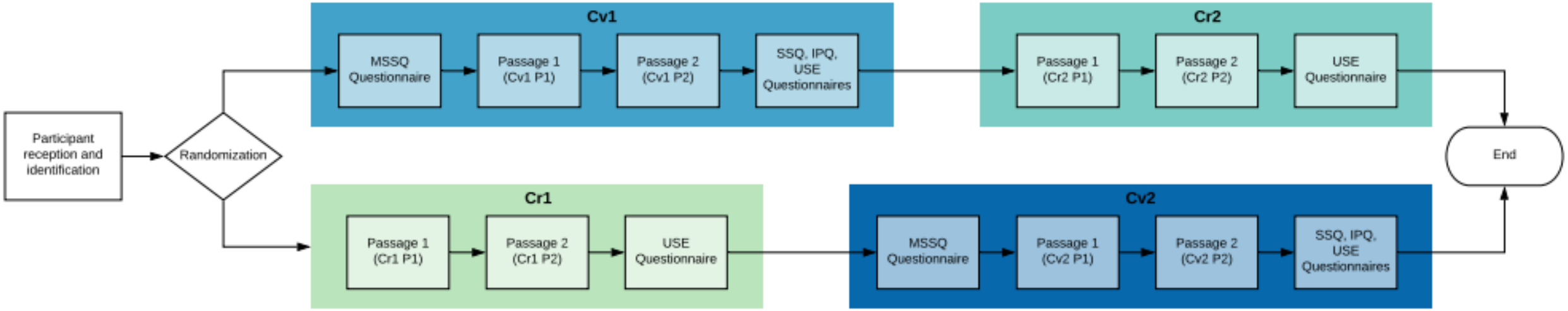


USER STUDY: PARTICIPANTS

- 29 participants with disabilities
- Power wheelchair daily-users
- Nave or new to VR

USER STUDY: PROCEDURE

- **4 configurations**
  - 2 conditions: Virtual (Cv) and Real (Cr)
  - 2 randomly attributed order
  - 2 passages by configuration (P1, P2)c
- **Data collection**
  - Simulator QoE: subjective questionnaires
  - Performance comparison: circuit completion time

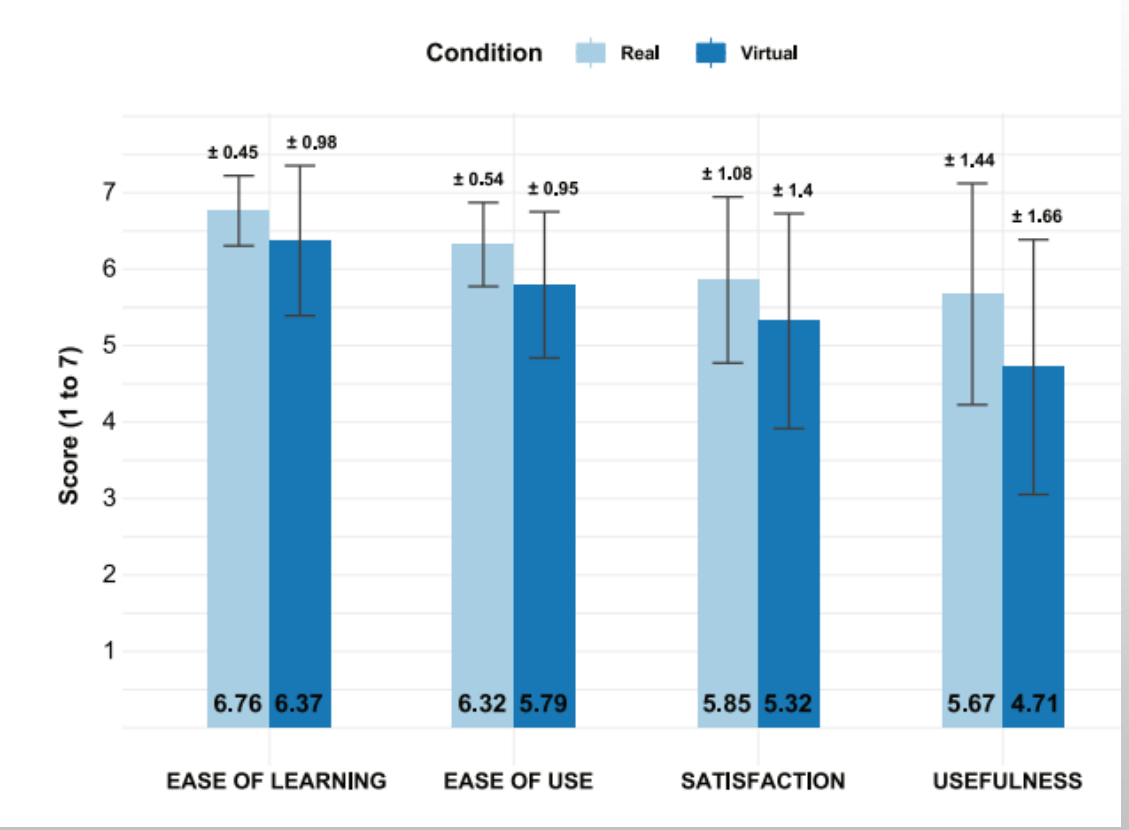


RESULTS - PERFORMANCE

- **Number of participants:**
  - 13 for circuit 1
  - 28 for circuit 2
  - 25 for circuit 3

- **Analysis by order:**
  - Similar completion time means regardless of condition nature
  - Hypothesis validated

- **Analysis by passage in each condition:**
  - Higher completion time means at first passage in virtual condition
  - Could be due to circuit learning



RESULTS - CYBERSICKNESS

- SSQ scores have been calculated using the SSQ reference paper guidelines
- VRSQ instead of SSQ
- High for a clinical context

	Circuit 2	Circuit 3
Nausea	13.63 (*16.3*)	20.61 (*25.49*)
Occulomotor	20.84 (*22.84*)	20.62 (*22.48*)
Disorientation	17.9 (*25.09*)	27.28 (*34.69*)
Total Severity	20.44 (*22.45*)	25.58 (*25.52*)

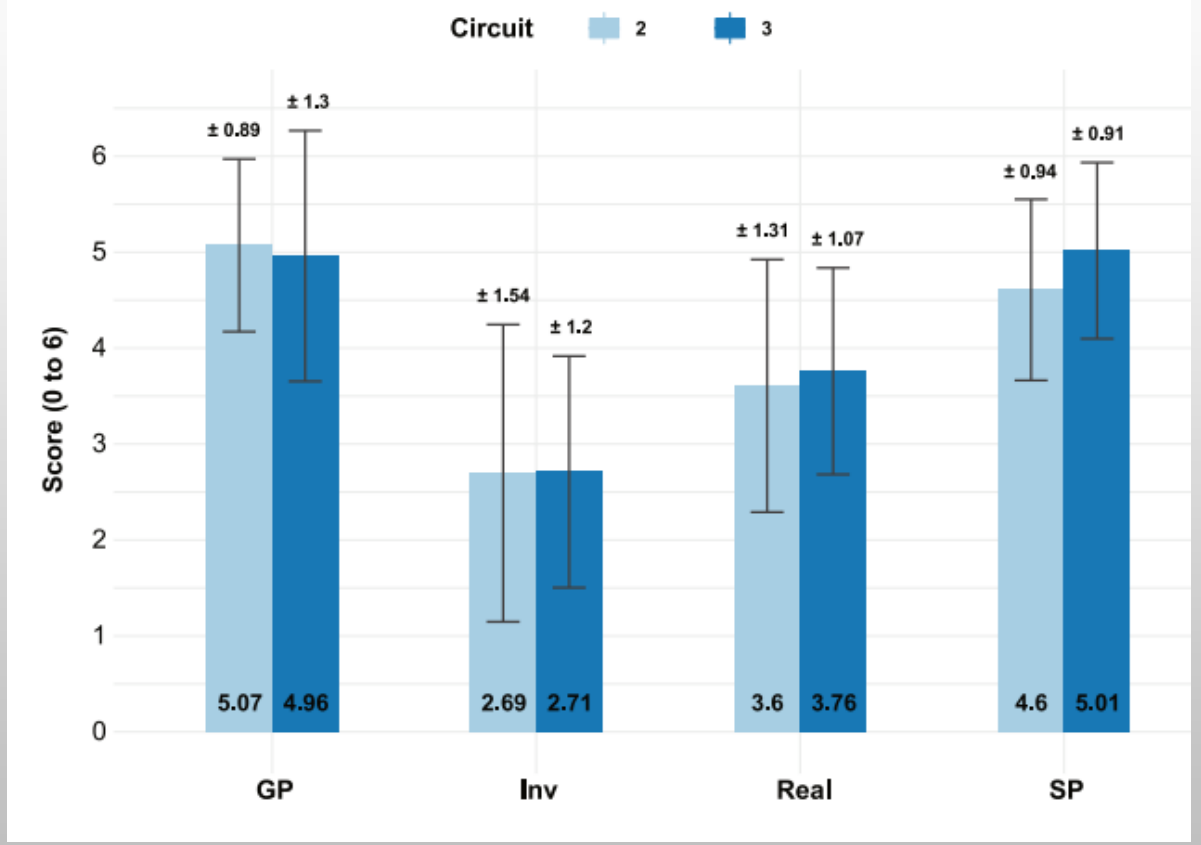
Table 2: SSQ Scores. Mean and (*Standard Deviation*)

	Circuit 2	Circuit 3
Occulomotor	16.96 (*16.89*)	14.67 (*15.83*)
Disorientation	6.43 (*10.02*)	9.07 (*15.4*)
Total Severity	11.7 (*12.58*)	11.87 (*13.56*)

Table 3: VRSQ Scores. Mean and (*Standard Deviation*)

RESULTS – SENSE OF PRESENCE

- IPQ Test – Igroup Presence Questionnaire(scale for measuring the sense of presence experienced in a virtual environment)
- High score for General Presence and Spatial Presence



DISCUSSION – OVERALL STUDY

- Data error
- Learn VR with time
- More precise performance criterion than completion time

DISCUSSION – SENSE OF PRESENCE

- Way to improve sense of presence

- The involvement presence criterion is directly linked to the user susceptibility to forget the real world and concentrate on the virtual goal

CONCLUSIONS

- Quality of experience:
  - Sense of Presence
  - Cybersickness

- Good results:
  - IPQ
  - Participants feedback
  - Positive and promising for the future

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