Politecnico di Torino
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
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Interaction in Virtual Reality Simulations

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1. Introduction / Context

Virtual Reality (VR) has become a formidable technology for generating captivating and immersive simulations, allowing users to interact with computer-generated environments in a natural and intuitive manner. Nonetheless, the design and development of effective interaction techniques in VR pose significant challenges.

2. Goal / Objectives

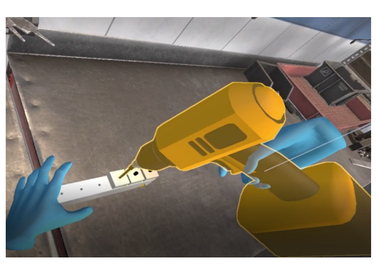
The aim of this research is to tackle some of the open problems in this field, encompassing, e.g., the modeling of physical phenomena and their integration in interactive simulations, the implementation of highly believable virtual environments capable to replace real experiences, as well as the study of the design and use of computer technology interfaces between the users and the simulated experiences.

3. Methods

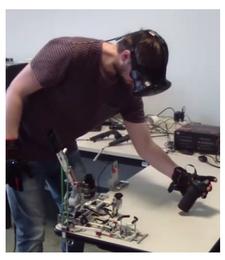
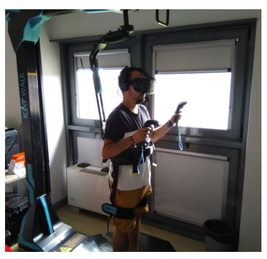
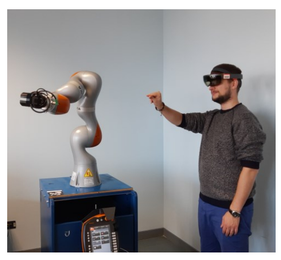
3.1 Simulation

Simulation comes into play when it is required to accurately represent real world phenomena in the virtual experience. For example, a VR training experience for **emergency** operations (e.g., firefighting), would greatly benefit from a physically accurate fire [1] and smoke [2] simulation. Similarly, the simulation of active **manual tools**, like an electric screwdriver [4], would require a sufficient level of haptic fidelity.





3.2 Interaction


Interaction is relevant for any VR interactive experience, as it pertains the need to make the interaction between the user and the virtual elements as natural and transparent as possible. Tasks such as **locomotion** [3] or **hand interaction** [4] still rely on quite unnatural metaphors, and this fact has huge impacts on core aspects like, e.g., immersion, usability and cybersickness.

4. Contents

To analyze the effectiveness of the devised scenarios and to evaluate the performance of the involved technologies, a number of user studies have been carried out, involving both domain experts and generic users. The results allowed to quantify the advantages related to the use of the proposed virtual experiences with respect to traditional approaches [1], and to identify the best configuration of technologies and techniques to maximize such benefits [3,4].

5. References

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3. A. Cannavò, D. Calandra, F. G. Pratticò, V. Gatteschi and F. Lamberti, "An Evaluation Testbed for Locomotion in Virtual Reality“. in *IEEE Transactions on Visualization and Computer Graphics* **27** (3), pp. 1871–1889 (2021).
4. F. G. Pratticò, A. Cannavò, D. Calandra and F. Lamberti, “A breakdown study of a mockup-based consumer haptic setup for virtual reality”. *IEEE Consumer Electronics Magazine*, pp. 1-14 (2022).