

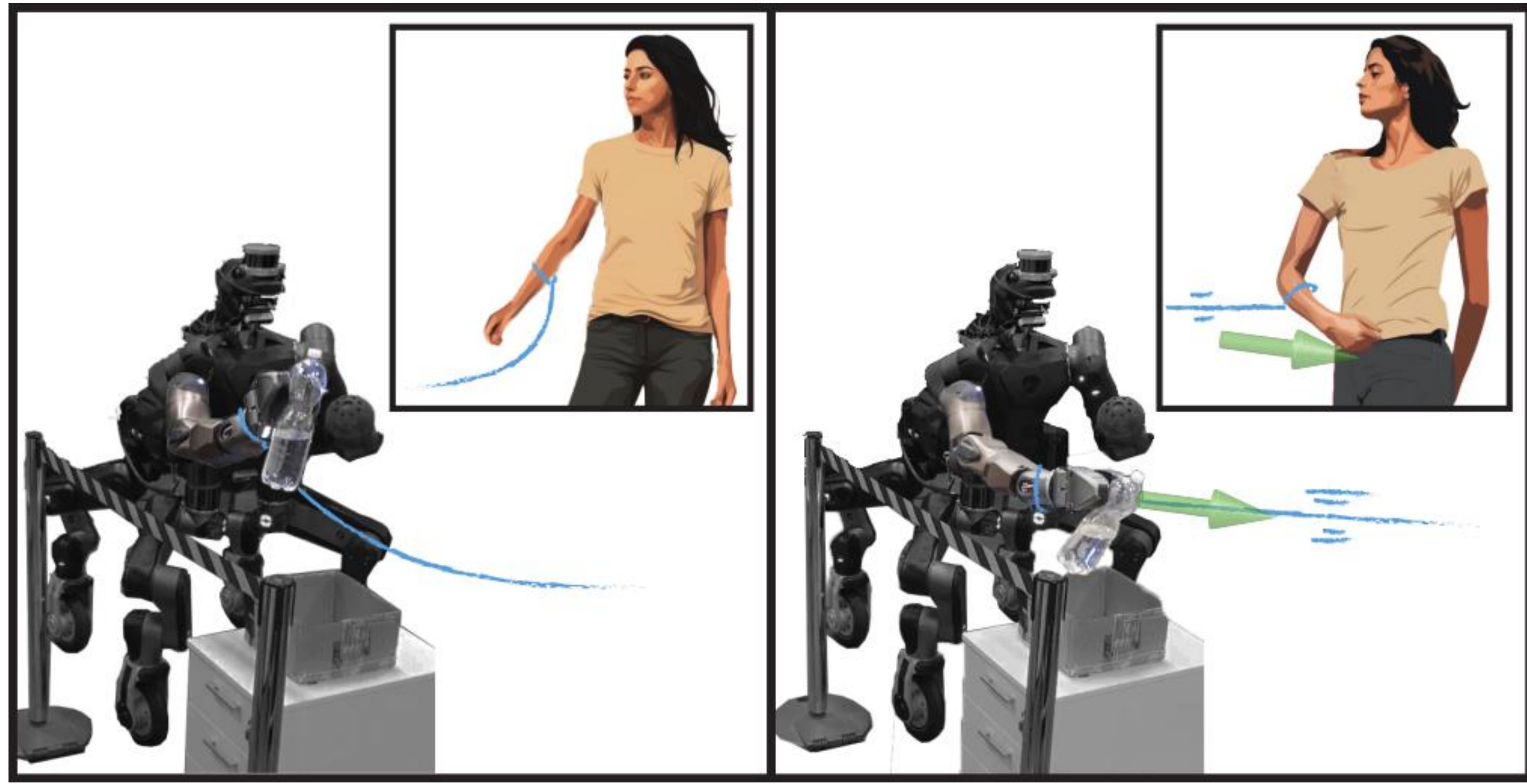


Wearable Haptics for a Marionette-inspired Teleoperation of Highly Redundant Robotic System

Davide Torielli^{1,3}, Leonardo Franco², Maria Pozzi^{1,2}, Luca Muratore¹, Monica Malvezzi², Nikos Tsagarakis¹, and Domenico Prattichizzo^{1,2}

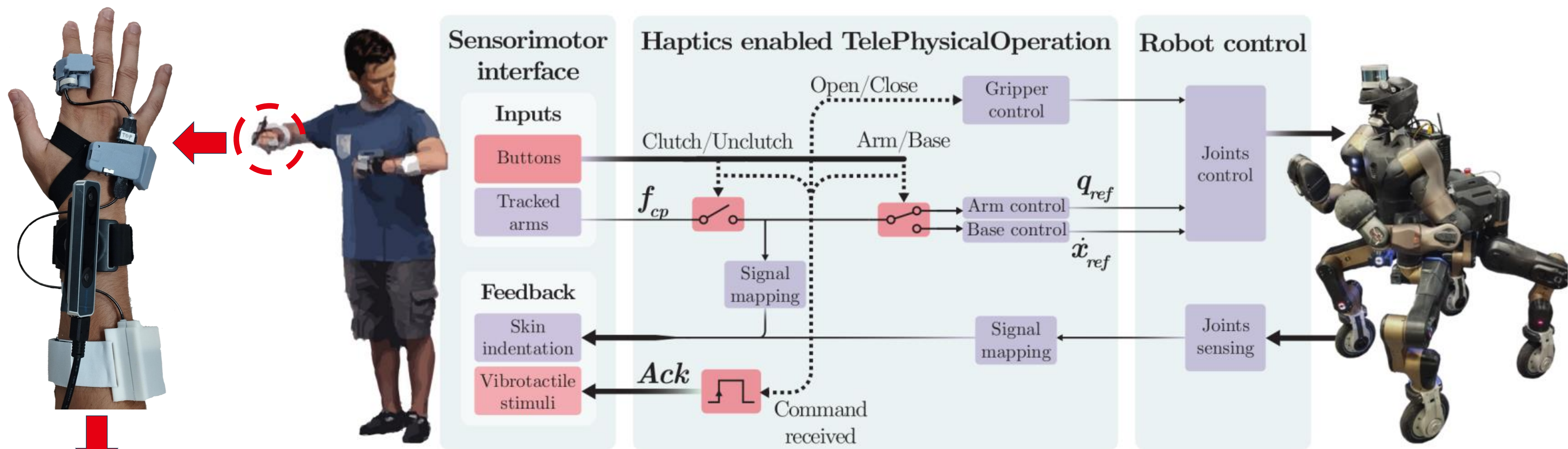
¹HHCM lab, IIT, Genova, Italy ²DIISM, University of Siena, Italy ³DIBRIS, University of Genova, Italy

The **TelePhysicalOperation**[1] interface allows to **virtually interact** with the robot through **virtual forces**, resembling the **"Marionette"** interface. The robot can be controlled **at a distance** by exploiting the intuitiveness of a **physical human-robot interaction** in a virtual manner. One limitation was the absence of haptic feedback which is instead available in a real physical "Marionette" through the use of the ropes by the marionettist.

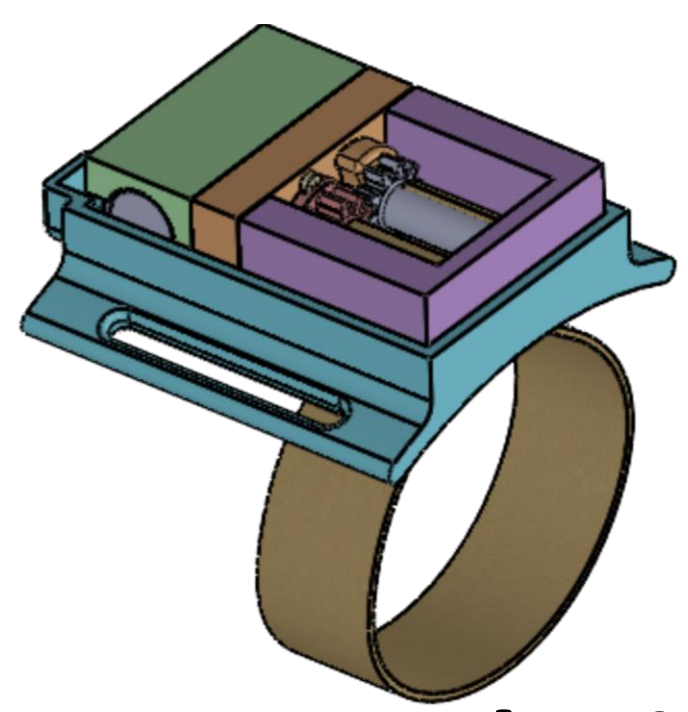


With the **"Marionette"** type interaction interface, virtual ropes are defined to let the operator push and pull the selected robot links[1]

With the **wearable haptic interface**, the user feels the of increasing of the tension of the virtual rope

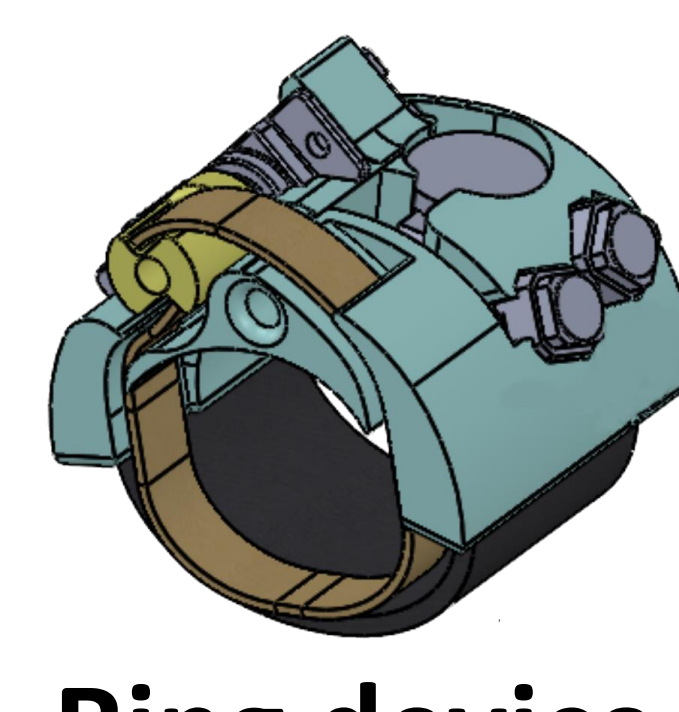
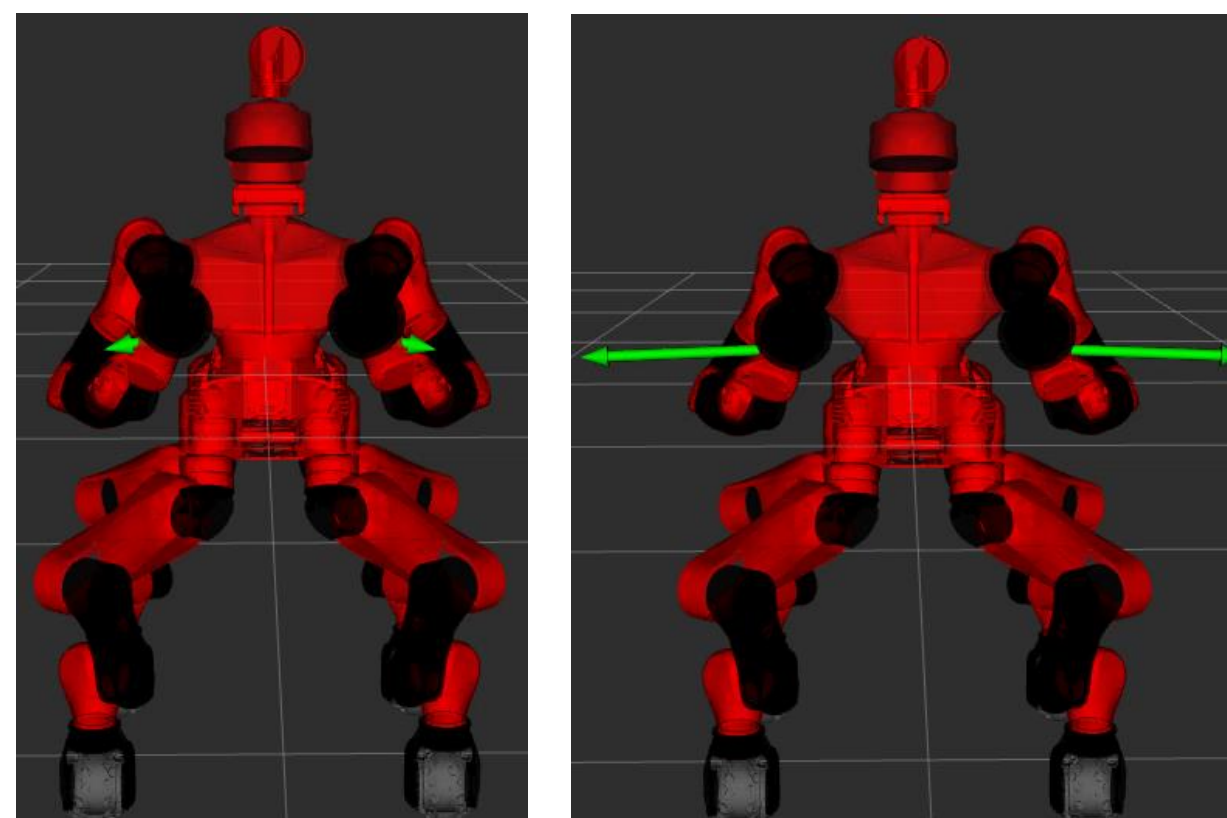


Sensorimotor interface



Forearm device

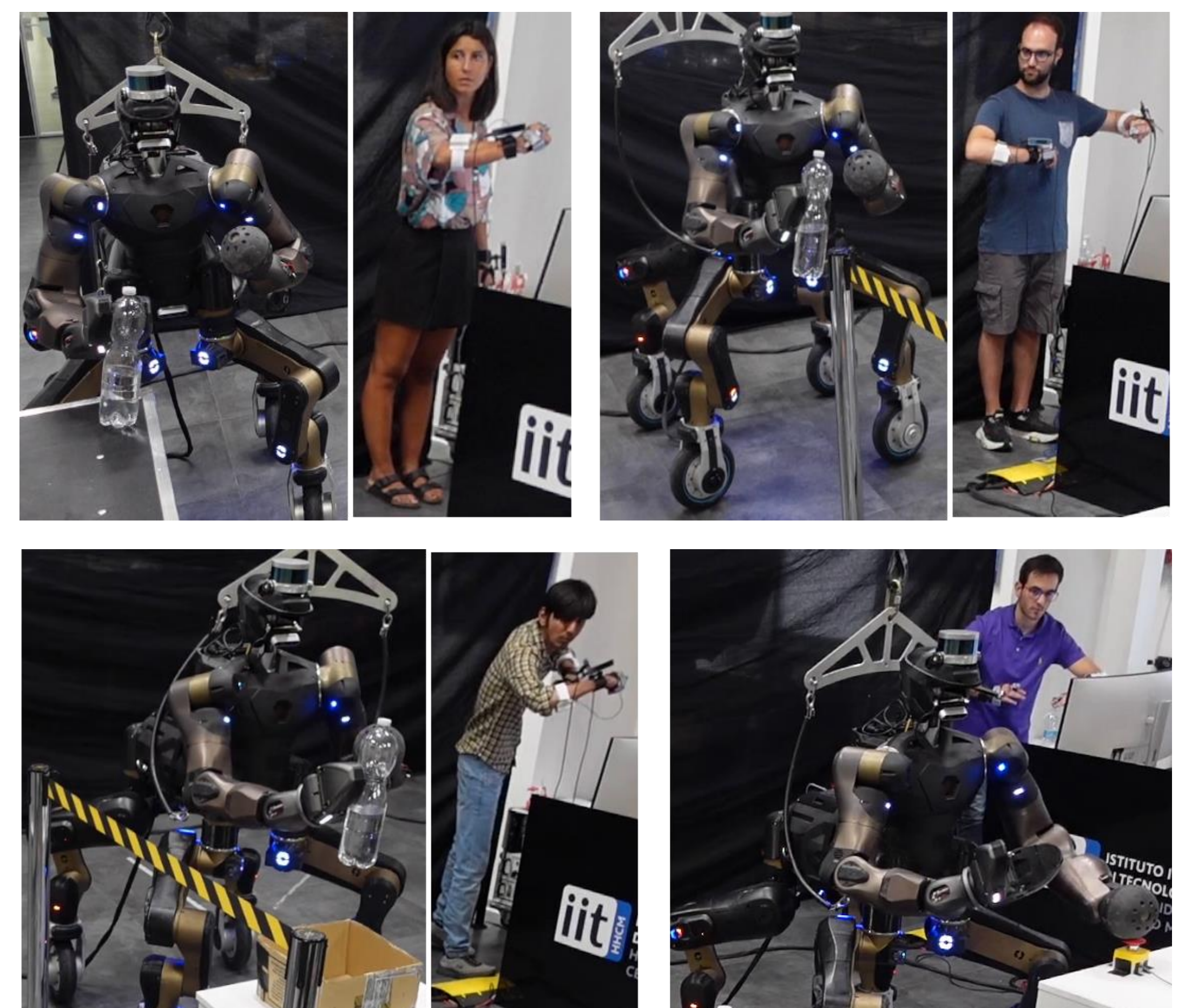
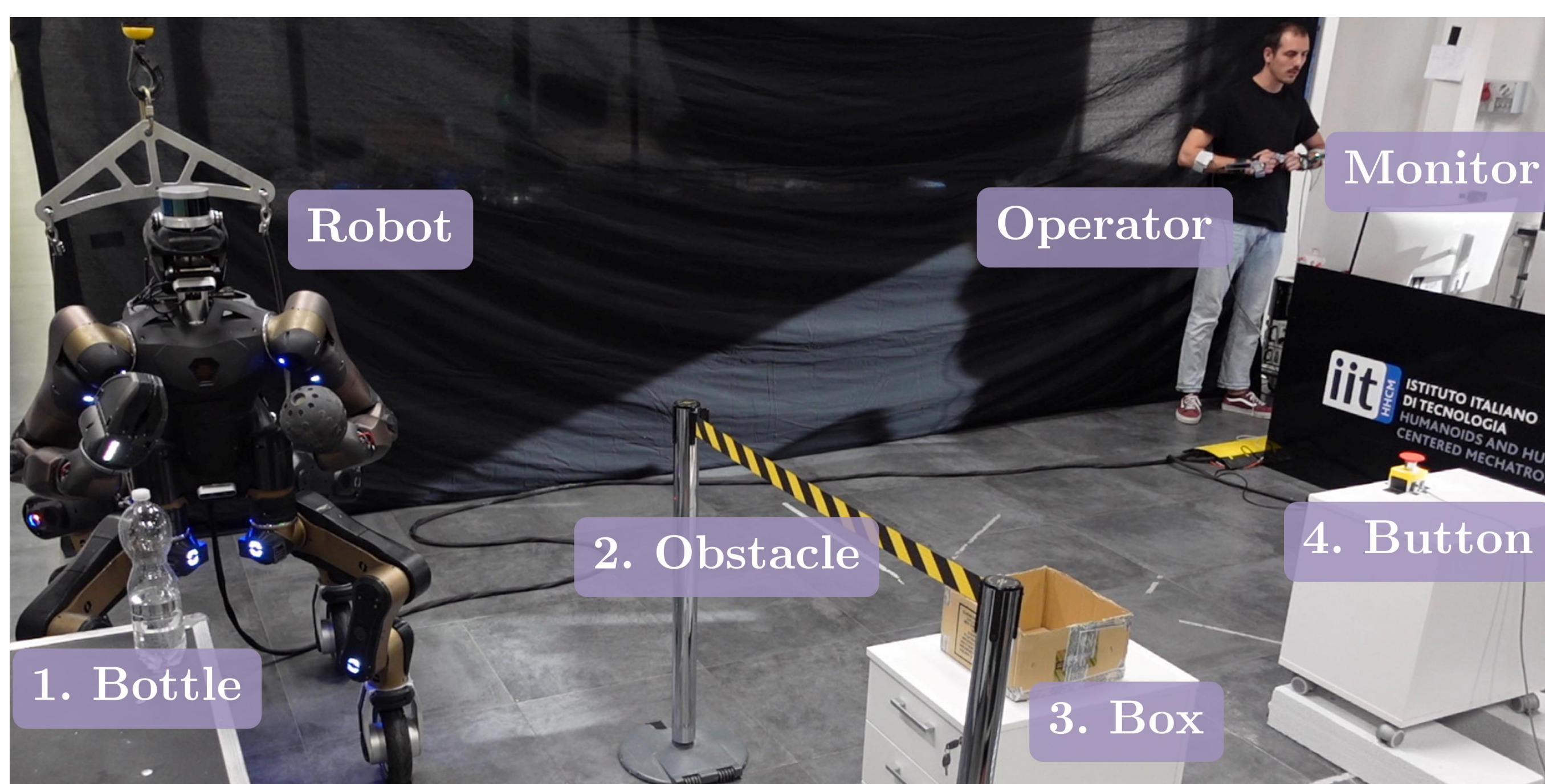
Indentation : Magnitude of the virtual force applied
Vibrations: Button ACK



Ring device

Indentation : Robot EE environment contacts
Vibrations: Button ACK
Buttons: Additional discrete inputs

Experiments



12 naive participants controlled the CENTAURO robot in a loco-manipulation mission, comparing modalities with and without the haptic interface

[1] D. Torielli, et al., "TelePhysicalOperation: Remote Robot Control Based on a Virtual "Marionette" Type Interaction Interface", in IEEE RAL, 2022