2021 National Robotics Initiative & Foundational Research in Robotics - Principal Investigators' Meeting

ForceBot: A Robotic Platform for Body-Scale Human Physical Interaction in Embodied Virtual Reality

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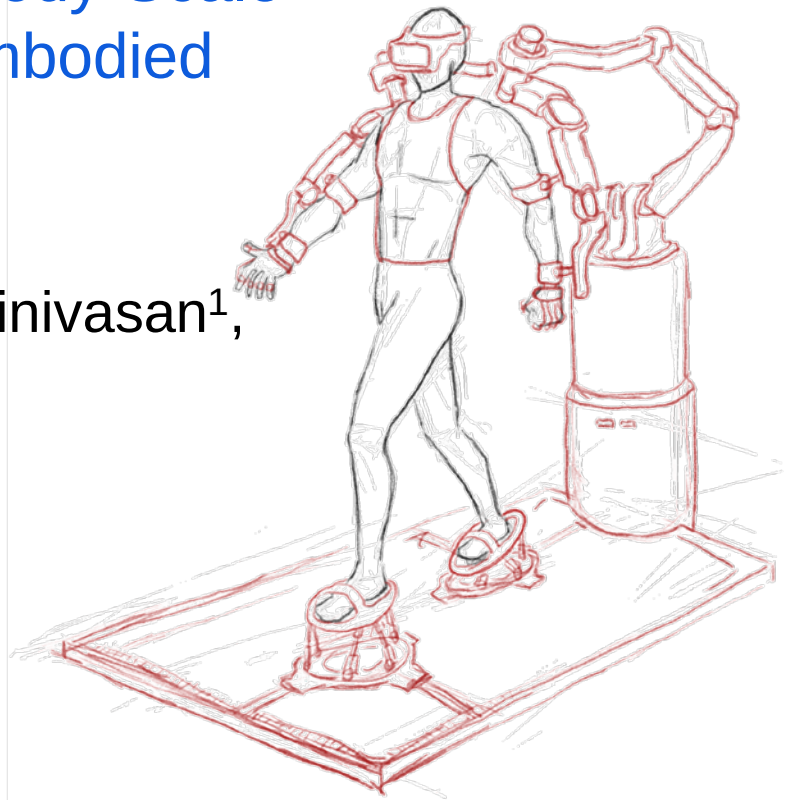
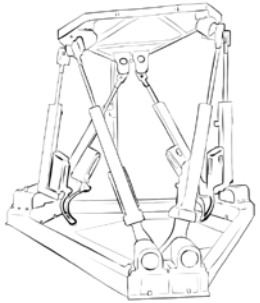


Virginia Tech[1] & University of Florida[2]

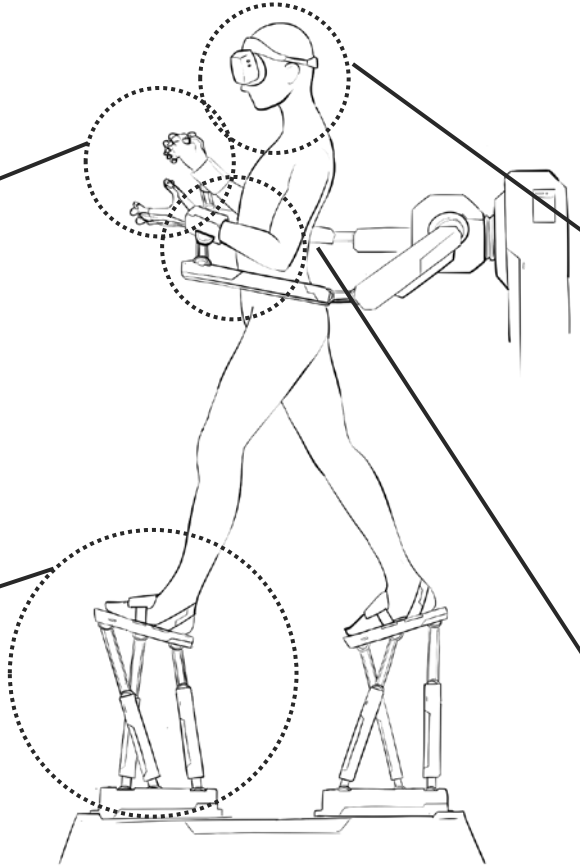
NSF Grant #2024772

Overview: ForceBot aims to provide haptic forces and position feedback in a virtual reality (VR) environment

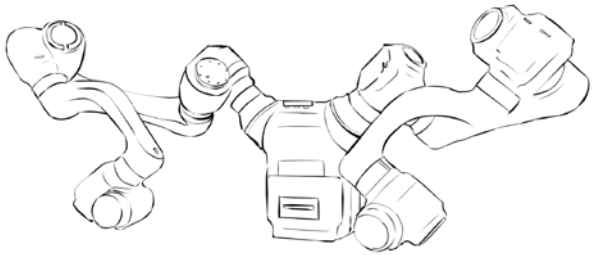
Haptic Feedback
HaptX Glove



Lower-limbs Force Feedback
Stewart Platform



VR Physic Engine Simulation (VRP)
VR goggles



Upper-limbs Force Feedback
Robotic Arms

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Completed Robot Teleoperation using position feedback of VR controllers

- Baxter robot is used instead of Exoskeleton for this preliminary study
- Established Hardware/software communication between VR, Unity, and the exoskeleton/Baxter
- Baxter uses inverse kinematics to compute joint angles based on HTC Vive Controller position/orientation

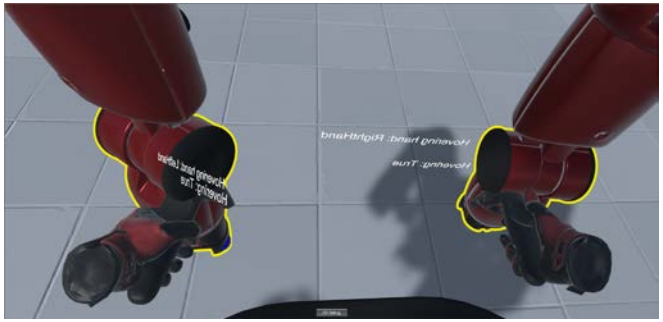

Image taken of Unity Game Engine

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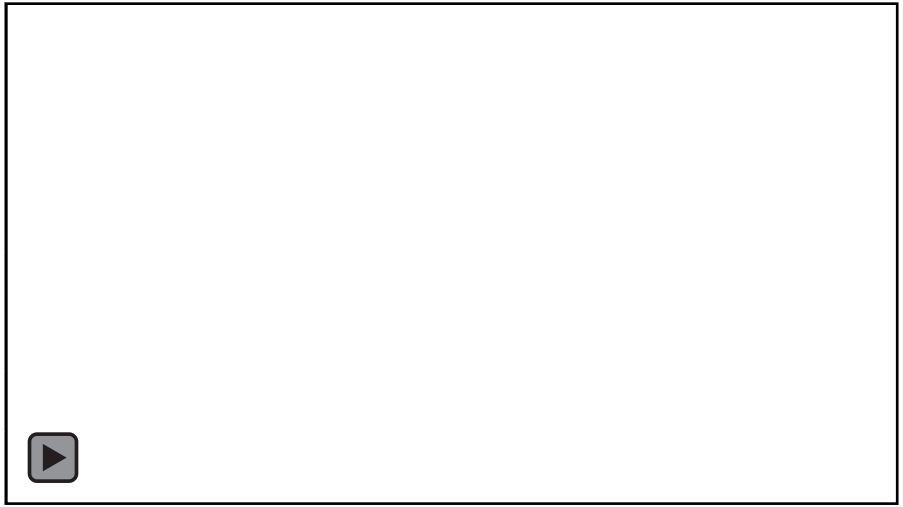
Upper-Exo Simulation in IHMC's Simulation Construction Set (SCS)

- SCS is a simulation platform, developed by IHMC[1], capable of plotting, recording, and saving real-time data
- It allows VT to easily design a controller, simulate a response, and then test it on the exoskeleton within the same platform
- VT has a strong relationship with IHMC team for future support



[1]IHMC: Institute for Human-Machine Cognition

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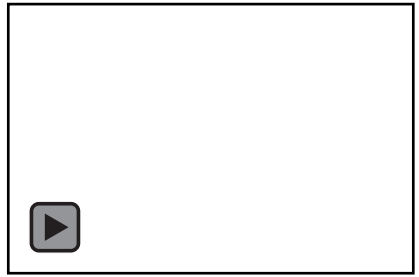
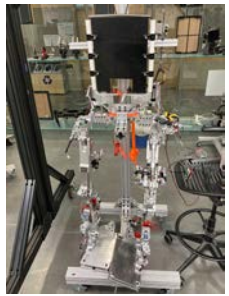
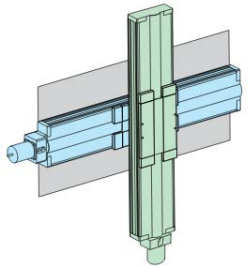
Lower-Body Force Feedback Methods & Challenges:

- **Stewart Platform:**
  1. Infeasible platform dimensions
  2. Angle range of motion requirements increase chance of collapse
- **Exoskeleton OLL-E[1]:**
  1. Water cooling required to achieve the necessary motor torques
  2. Searching alternative actuator to achieve required force
- **Two-axis Gantry robot:**
  1. Walking trajectory requires high accelerations
  2. Examined required force to achieve human foot walking motion







1: Orthotic Lower-body Locomotion Exoskeleton (OLL-E), NSF #1525972, previously developed by the VT TREC Lab

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