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

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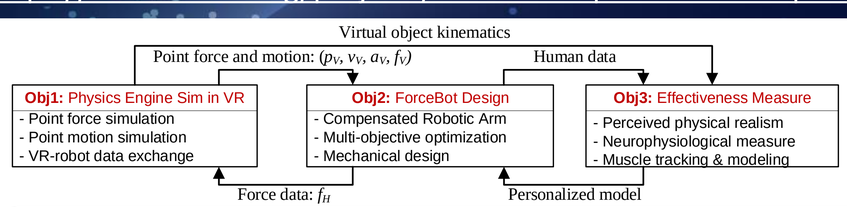
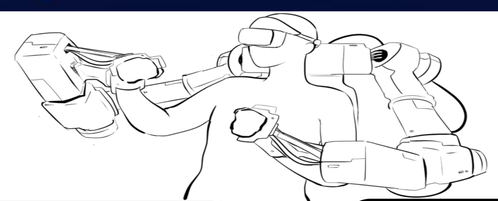
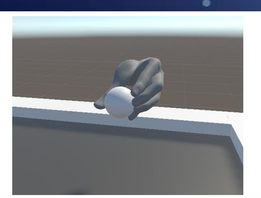
https://www.trecvt.org/projects/forcebot-haptic-force-and-position-feedback-in-virtual-reality







Challenges

- **Haptic Interface Transparency:** Human intention has to be acquired and pair with high dexterity actuators to create an immersive and transparent user experience.
- **Multiple Robotic Sub-systems Integration with VR:** Low latency communication field is required to guarantee simultaneous manipulation between the robots and VR.
- **Ergonomic Human-Machine Interface Design:** Human factors incorporation is required to align restricted robot workspace and safety measurement.

Scientific Impact

- **Robust and low-cost computer platform** for integrating multiple haptic interfaces, high-level controller, and VR rendering with real-time computation capability.
- A versatile simulated test bed allowing the user to experience the human-cobot physical interaction by provides **realistic force and position feedback**, examining the cobot design in the VR space.
- A **dynamic scenario generator** that simulates realistic environment with active motion feedback for training purpose.

Solutions

Technical Approach

- Force-feedback and Multi-objective Optimization Controls Techniques.
- Open-Source Real-time Robotic Controller Platform.
- Human Motion Capture Data Embodied Hardware Design.

Key Innovations

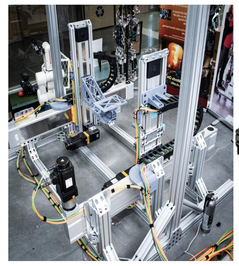
- Virtual Interaction Rendered Realistic Force Feedback.
- VR Integrated Cross-platform Low-latency Communication Field.
- Whole-Body Workspace Mapping into VR Avatar.

New Contributions

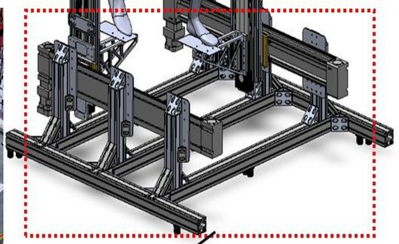
- High Fidelity Whole-Body Sensory Feedback.
- Transparent and Immersive VR Experience.
- Safe and Unrestricted Human-Robot Workspace.

Upper-limb haptic interface
Panda robotic arm with HaptX glove

Virtual Reality Goggle
HTC VIVE VR Helmet



Gait simulator
Two planar gantry system with foot platform



Broader Impact

- Benefits society by providing an immersive VR experience used to generate dynamic scenario, identify risks, provide training, and allow interaction with the simulated world.
- Benefits industry by reducing the complexity and cost of the design process, virtually evaluating prototypes and safety measures before deployment.
- Enhances scientific and technological understanding in the general field of human-robot interaction.
- Introduces students as STEM workforce by establishing collaborations between academia and industry.

2022 NRI & FRR Principal Investigators' Meeting
April 19-21, 2022

Award ID#: 2024772