ForceBot: A body-scale physical interaction cobot in Virtual Reality (VR)

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Abstract: The ForceBot project proposed the design, construction, and assessment of a VR co-bot, to simulate physical interaction with virtual objects at the user's hands, arms, and feet. ForceBot utilized a pair of HaptX haptic gloves for haptic feedback, a pair of planar gantry systems for lower-body motion, and a pair of robot arm for upper-body motion, elevated these critical components to create an immersive experience across the whole body.

As the virtual reality technology emerging, VR simulation have recently become crucial to studying human-robot interaction. This project aims to close the gap between exoskeleton and the actual implementation. Furthermore, it provides a valuable platform for studying human-machine interaction. Applications of ForceBot includes virtual task training simulator, implementation of human-robot system, exoskeleton emulator, or tele-operation system.

ForceBot will examine few fundamental classes of force feedback as building blocks of human-object interaction in VR from static force feedback to dynamic motion. ForceBot will sense the force and torques to interpret the human intention of interact with user's surrounding environment through the robotic system, then feed the information to the physics engines in VR for motion and force simulation at the contact point. The simulation result will be sent back to ForceBot providing the simulated result forces as the interaction force. Such a project requires a wide range of professions to cooperate, including biomechanics, mechanical design, control, communication, and system integration. ForceBot builds on previous robotic control work by the Virginia Tech TREC lab involving whole-body-control and force feedback, along with multi-objective optimization controls techniques.

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