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Robotic Arm-Driven Immersive Bimanual Teleoperation System

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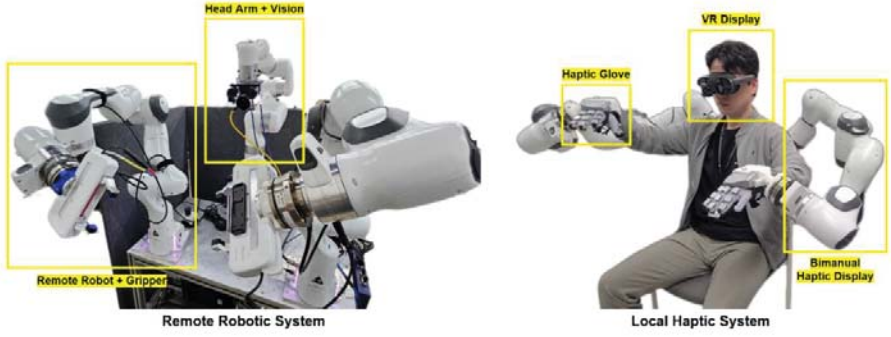

Figure 1. (Left) The remote robot system, including a bimanual robot equipped with a gripper to follow the operator's arm movements, and a camera-equipped robot to track the operator's head movements. (Right) The local human interface, consisting of a robot-arm based bimanual haptic display, a haptic glove, and a VR headset.

***Abstract*— We demonstrate a robot arm–based immersive bimanual teleoperation system that unifies bimanual manipulation, 6-DoF haptic feedback, and head-tracked stereoscopic vision.**

Keywords—Haptics, Teleoperation, Bilateral teleoperation

I. Demonstration

This demo showcases an immersive bimanual teleoperation system that integrates a local-side bimanual haptic display and VR headset with a remote-side dual-arm robot and head-coupled vision system.

On the local side, two 7-DoF collaborative robot arms deliver precise 6-DoF force/torque feedback to the user's hands, while a commercial VR headset provides real-time stereoscopic video captured from the remote environment. The robot arm base configuration is optimized to maximize workspace coverage, dexterity, and force-rendering capabilities [1]. Additionally, transparency is further enhanced by our energy-based friction compensation methods [2].

On the remote side, a pair of robot arms mirrors the operator's motions for bilateral manipulation. A third "head" arm tracks and replicates the operator's head movements. It carries a stereo camera pair that streams viewpoint-locked imagery directly to the VR headset, ensuring immersive, intuitive visual feedback.

During the hands-on demo session, attendees will engage in realistic bimanual tasks, experiencing immersive haptic and visual sensations. This demonstration highlights the practicality and potential of our system for real-world telepresence applications in fields such as remote manufacturing and immersive XR collaboration.

References

[1] J. -K. Lee and J. -H. Ryu, "Optimizing Setup Configuration of a Collaborative Robot Arm-Based Bimanual Haptic Display for Enhanced Performance," in *IEEE Robotics and Automation Letters*, vol. 9, no. 3, pp. 2367-2374, March 2024.

[2] H. T. Dinc, J. -K. Lee and J. -H. Ryu, "Model-Free Energy-Based Friction Compensation for Industrial Collaborative Robots as Haptic Displays," in IEEE/ASME Transactions on Mechatronics, vol. 30, no. 2, pp. 1038-1049, April 2025.