

Real-Time VR Teleoperation of a Franka Arm for Construction Automation and Human-Robot Interaction

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Introduction

- ☐ Tele-operated robotic systems still rely on expensive, Windows-only VR software, which introduces latency and excludes many research labs that use Linux.
- ☐ We demonstrate that consumergrade Meta Quest hardware can control a Franka robot on Linux with less than 20 ms end-to-end delay, enabling low-cost, intuitive humanrobot interaction for research and remote manipulation.
- Our pipeline is fully open-source and self-contained Unity, ROS 2 nodes, and real-time control run on a Jetson Nano RT, so any lab can reproduce the setup in a single day.

Key Technologies

- ☐ Franka Research 3 ☐ ROS-TCP Connector
- ☐ Meta Quest 2 ☐ ROS 2 Humble
- □ ALVR & SteamVR □ Jetson Nano (RT)
- ☐ Unity 2022
- ☐ Franka Ros2



Video Link

Workflow Meta Quest 2 Controller 6 Degrees of Freedom Poses STEAM VR Meta Quest 2 Sends each fresh pose packet over USB-C 6-DoF controller VR frame submit – blank scene poses (OpenVR) Encoded blank frame from unity to **WORK STATION - 1** satisfy protocol **GPU Enabled** control **Project** PoseStamped messages sent over **ROS-TCP-Endpoint** Publishes quest poses via Ros2 topics Transformation and franka_cartesian Calibration of Poses NVIDIA. control package Joint commands generated from Desired end-effector pose desired end-effector pose **JETSON ORIN NANO** Activates cartesian Joint states and sensor feedback to pose controller ROS 2 **WORK STATION - 2** franka_vr_control Real-time kernel package Cartesian pose set-points FRANKA RESEARCH 3 FRANKA_ROS **∷:ROS2**

Results and Impacts

- ☐ Achieved smooth, real-time XR teleoperation on Linux using consumer-grade Meta Quest hardware, allowing operators to control the Franka arm as naturally as a handheld tool.
- ☐ Demonstrated millimeter-level placement of mock bricks and sensors, indicating readiness for masonry alignment, bolt seating and structural monitoring tasks.
- Offering an open-source platform that can be used for operational training and site automation in the future.

Future Work

- Add an eye-in-hand vision module (Intel RealSense) and train a vision-language model so the robot can recognize construction materials and follow spoken commands ("stack two bricks", "hand me the wrench").
- Develop semi-autonomous task macros-the operator points once in XR and the robot finishes precise placement or tool delivery without continuous joystick-style guidance.
- ☐ Integrate onsite progress logging: the robot captures depth images, tags objects, and streams data to BIM databases for real-time construction monitoring.

Acknowledgements

Executes motion in real-time









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