XR TELEOPERATION DEMO DEVELOPMENT

RoverXR: Open Source Teleop Demo For Students

UNIVERSITY OF TARTU
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PROBLEM

Teleoperation is an important area of research in robotics and autonomous driving, but it can be challenging for students to understand and appreciate its potential without hands-on experience.
To address this, RoverXR was developed to demonstrate key principles and capabilities of direct visual teleoperation in a clear and engaging way.

M5 Rover C Pro and Joy C Remote use UDP for movement control. Raspberry Pi Zero 1 W and v2.1 Camera Module stream MJPEG video at 720p, 30fps via WebSocket to Godot scene on Meta Quest 2 VR HMD.

Design thinking and iterative rapid prototyping employed.

AR scene with video screen, directional lights, user movable area, play cubes & debug terminal. User area bounded by transparent collision boxes allows user to adjust viewing set up. Background configured transparent, to allow pass-through video of the Quest 2 headset, improving user spatial awareness.

FEATURES

- Godot Engine OpenXR AR Scene
- Raspberry Pi Zero HQ video
- WebSocket low latency HQ video stream
- Custom designed adapter kit
- Builds on existing hardware: M5 RoverC
- Adjustable video quality
- Interchangeable lenses
- Up to 2 hours continuous use
- Tiny, portable & easy to work with
- Open source

COMPONENTS

- Raspberry Pi Zero 1 W v1.3
- Raspberry Pi Camera Module v2.1
- 18650 Wemos Battery Shield
- M5 Rover C Pro
- JoyC Omni-directional Controller
- M5StickC ESP32
- 0.67x Wide Angle, Macro, Fisheye lens kit

github.com/mbz4/edu_teleop_demo

Raspberry Pi Zero 1 W serves WebSocket video frames using picamera2.
Godot AR scene client connects & updates texture with frame data from incoming buffer.

EVALUATION

Results selection of small subjective survey on participant thoughts covered Rover design, setup discomfort level, general driving difficulty, user interface design and how engaging they found the experience to be.

Participants overall expressed having a positive experience.
They found it immersive and enjoyable and provided useful insight for further development.

> "[The Rover] looks really rugged and kind of robust."
>
> "Video [stream] was clear, and I could see where I was going."
>
> "I could /.../ imagine myself in the second place /.../ an interesting feeling."