MUNI
FI

Intuitive VR Control Interface of Heavy Machinery

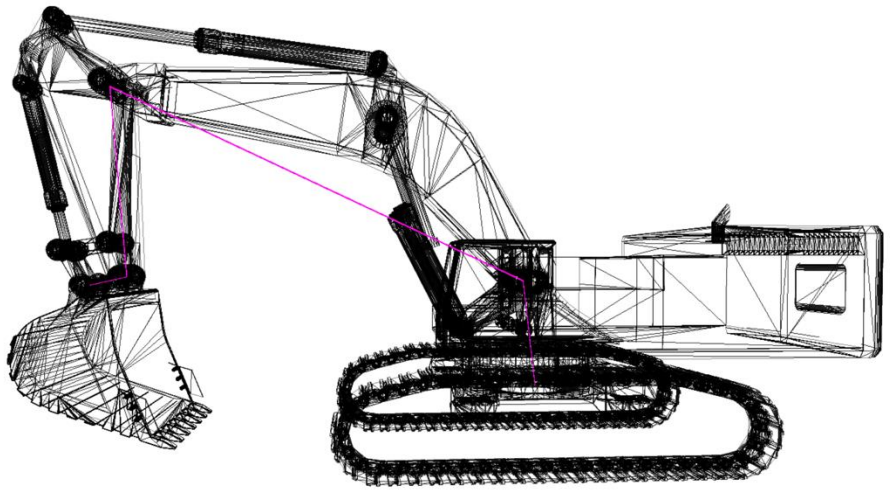
Alena Neumannová

Assignment and Goals

- Design an intuitive **VR control system** for heavy machinery
- Create a virtual space with an interactive and **realistic machine model**
- Visualize machine inertia and positional differences
- **Simplify** complex machinery controls using VR
- Conduct a user study to compare the designed **VR system with traditional controls**

Motivation

- Explore the **Potential** of VR
- Real-World **Impact** and **Relevance**
  - Enhancing Current Systems
  - Making Remote Control More Natural
- **Innovation** in Interaction



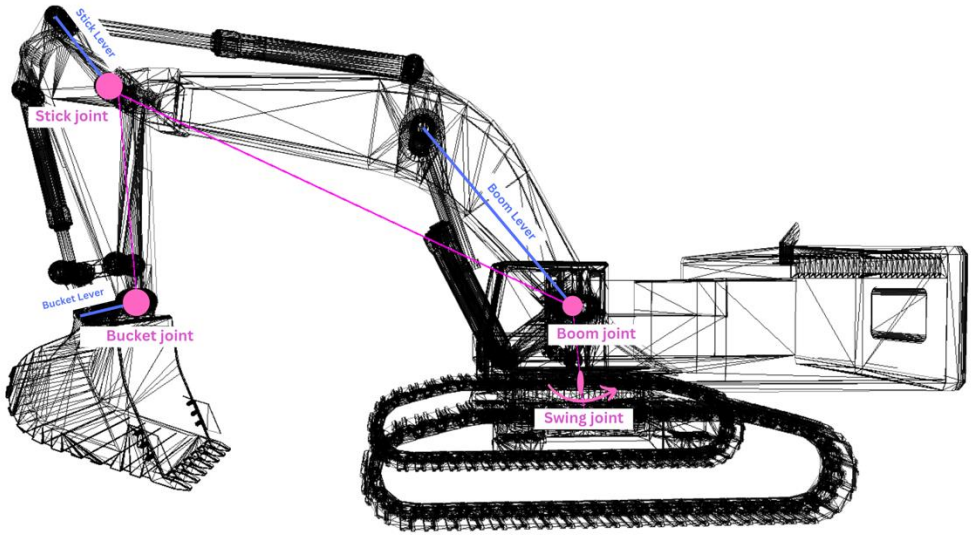
MUNI FI

Technologies

Meta Quest 2

Design

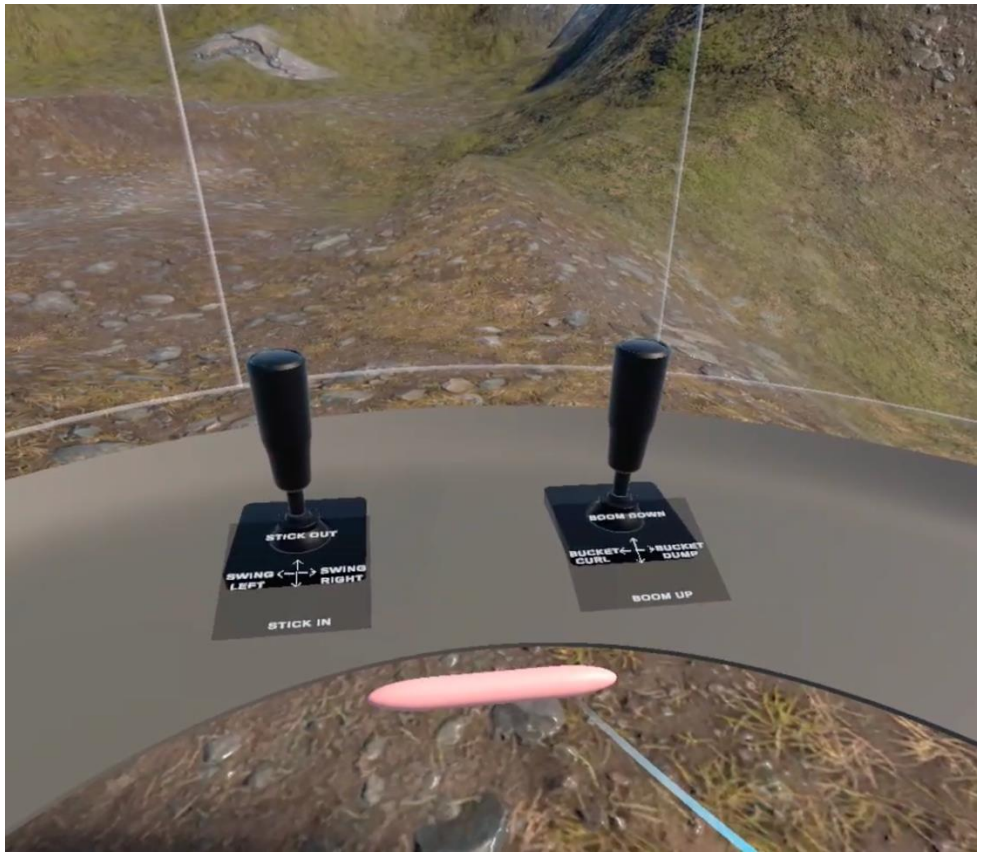
Realistic excavator

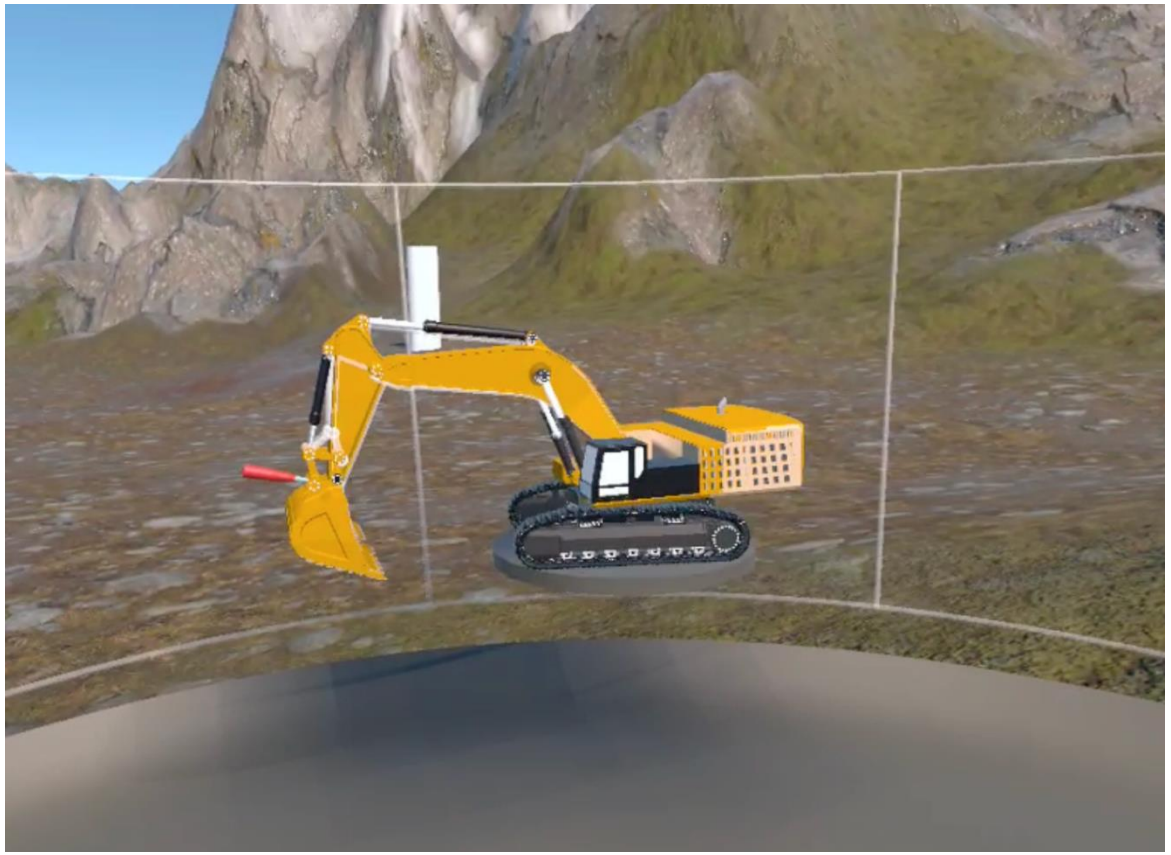


MUNI FI

Design

Control systems

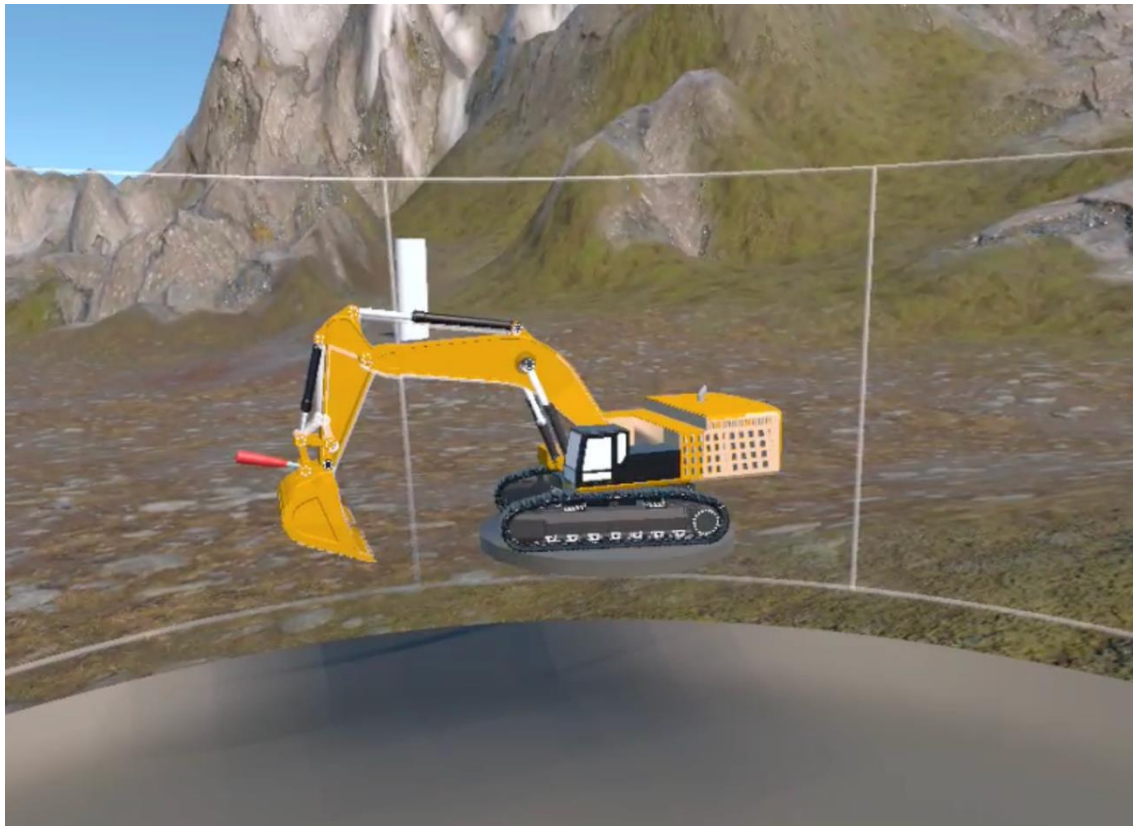


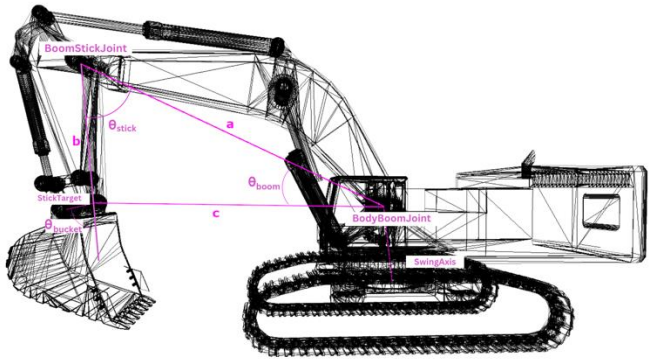


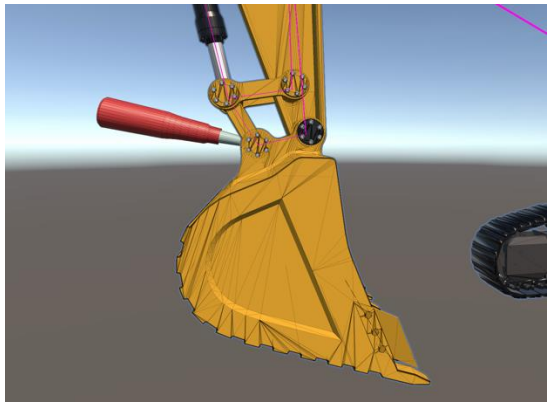
MUNI FI

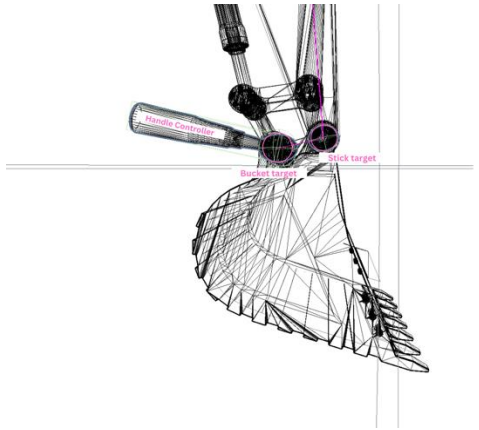
Design

The Miniature Controller





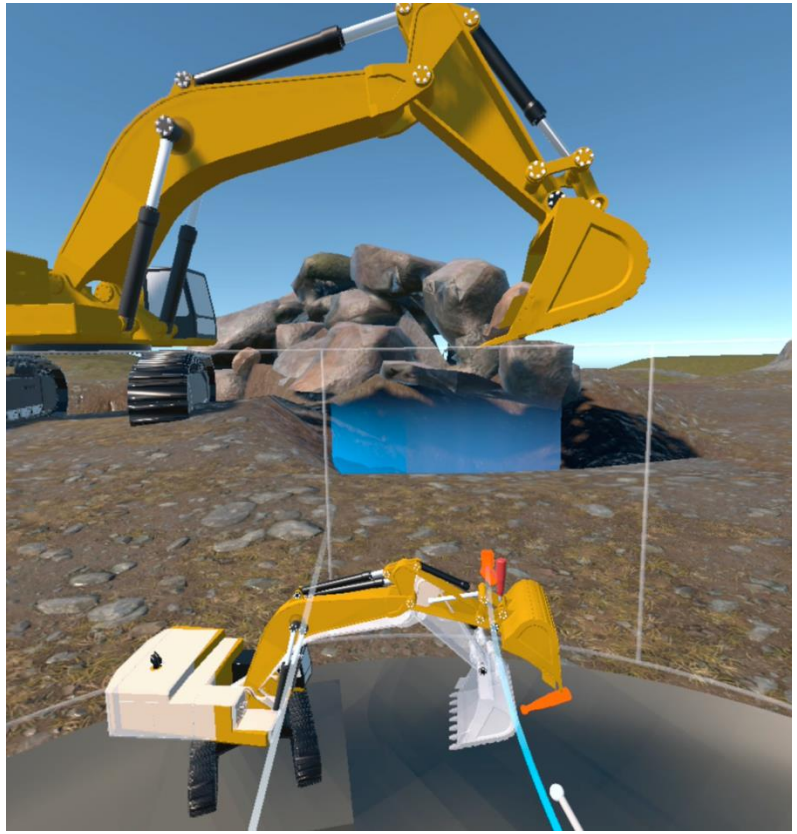


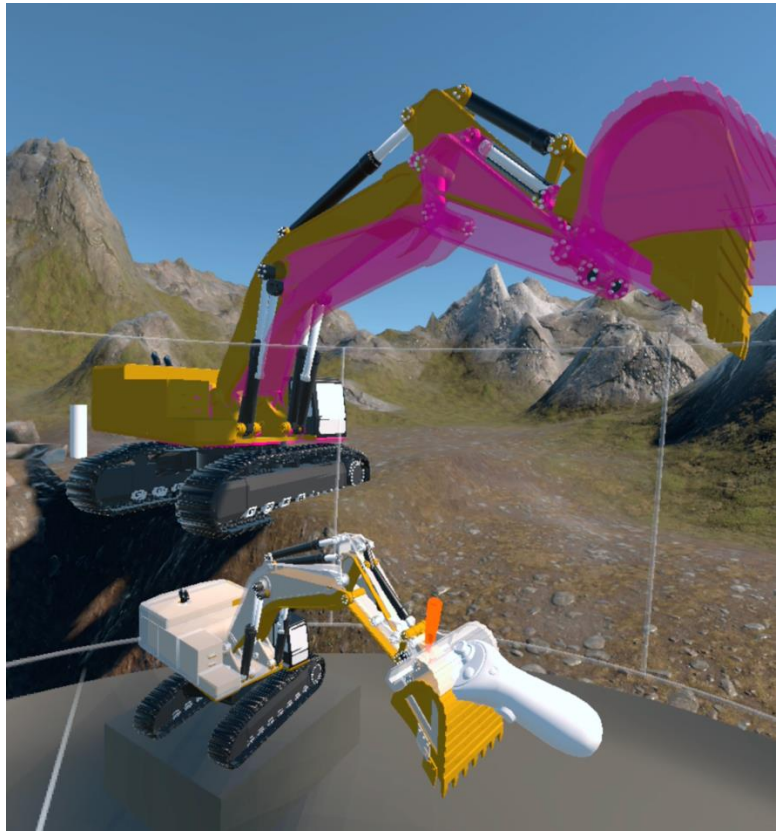


MUNI FI

Design

Visual Feedback





MUNI FI

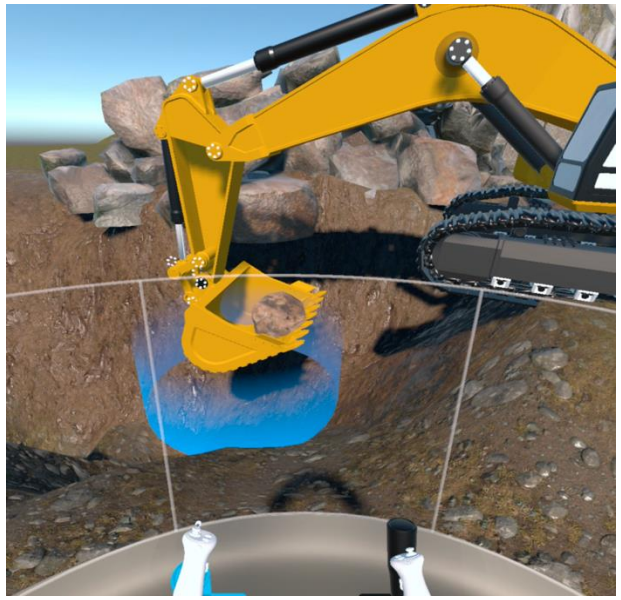
Hypotheses

1. **Speed**
2. **Accuracy**
3. **Precision**
4. **Cognition**

User study

- **9 diverse users** with varied familiarity with VR.
- **Ghost Task** (positioning) and **Bucket Task** (loading/unloading).
- Speed, accuracy, error rates, cognitive workload, usability.

Ghost task



Bucket task

MUNI FI

Hypotheses Results

- **H1 (Speed) -** *Confirmed*
  - The Miniature controller **enabled faster task completion** in both tasks.
- **H2 (Accuracy) -** *Partially confirmed*
  - Miniature controller was **more accurate in some aspects**, but **not consistently across all metrics**.
- **H3 (Error Rate) –** *Rejected*
  - Users made more errors with the Miniature controller.
- **H4 (Cognitive Workload) –** *Confirmed*
  - Miniature controller required significantly less mental effort.

Results

- **Speed vs. Accuracy** Trade-off:
  - Miniature controller → Faster but higher error rate due to sensitivity.
  - Joystick → Slower but more precise.

- User Preference:
  - Miniature controller was **easier** to learn, more **intuitive**, and **preferred**.

- Future Improvements:
  - Adding **haptic feedback** and **movement isolation** for better control of the Miniature interface.
  - Testing with more diverse participants and tasks.

Thank you

MUNI
FI