Friedrich-Alexander-Universität
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HRI interface comparisons (VR, AR, bio-signal-based)

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Why compare?

Introduction

- Dictate direction of future research
- Best option for current use in industry

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Use Cases

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- Use cases
  - VR
    - Control motion of robot over internet
  - AR
    - Display important robot information (range of motion/wear and tear)
  - Bio-signal-based
    - Give swift feedback to robot

Devices

General comparison

- Devices
  - VR
    - VR-Headset (Oculus Rift, HTC Vive, Meta quest pro)
  - AR
    - Tablet, Smartphone, AR-Glasses (Google glasses)
  - Bio-signal-based
    - Implants, Wearables

Cost

General comparison

- Cost
  - VR
    - Expensive Headsets (gets cheaper through gaming)
  - AR
    - Cheap, no special devices necessary (most of the time)
  - Bio-signal-based
    - Can be cheap on low end, and very expensive on high end

Ease of use

General comparison

- Ease of use
  - VR
    - Uncomfortable for long periods of time
  - AR
    - Really simple
  - Bio-signal-based
    - Easy for wearables, permanent augment for implants

Intuition

General comparison

- Intuition
  - VR
    - Ego perspective and controller in hands → high intuitivity
  - AR
    - A bit better than controlling from computer, but way worse than VR
  - Bio-signal-based
    - Wearables: can be good depending on implementation (move arm muscles to move robot arm)
    - Implants/EEG: highest possible Intuition, just think of what the robot should do

Future Potential

General comparison

- Future Potential
  - VR
    - Good for taking over control of “almost fully” autonomous systems remotely
    - Form factor needs to be improved
  - AR
    - Integration into traditional glasses or even contact lenses
  - Bio-signal-based
    - Implants/EEG: huge potential to merge with robots and full control of a robot with a human's thoughts

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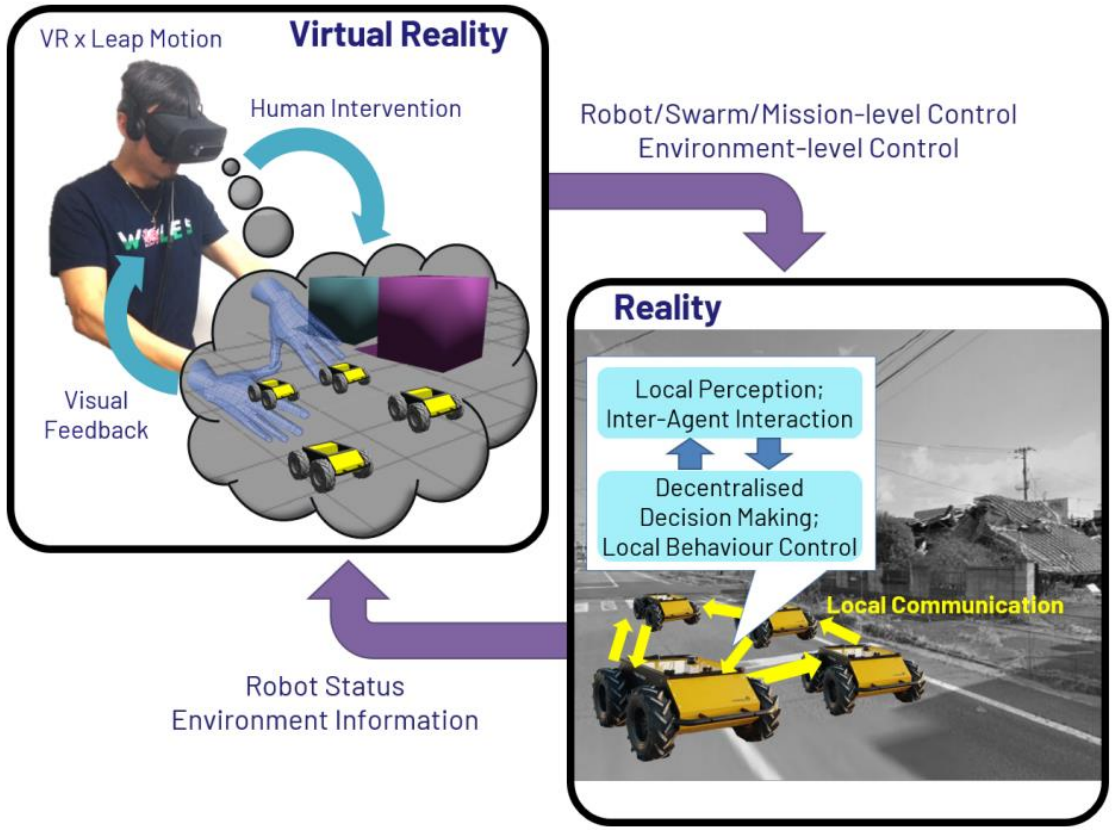
Specific Example for VR

Omnipotent Virtual Giant for Remote Human–Swarm Interaction

- Control over swarm of robots like a swarm of ants
- Placing virtual objects in path of robot via environmental manipulation
- Teleoperation possible
- Intuitive and feasible but might need training
- Large amounts of robots might increase latency and inhibit intuitivity



(Jang et al., 2021)

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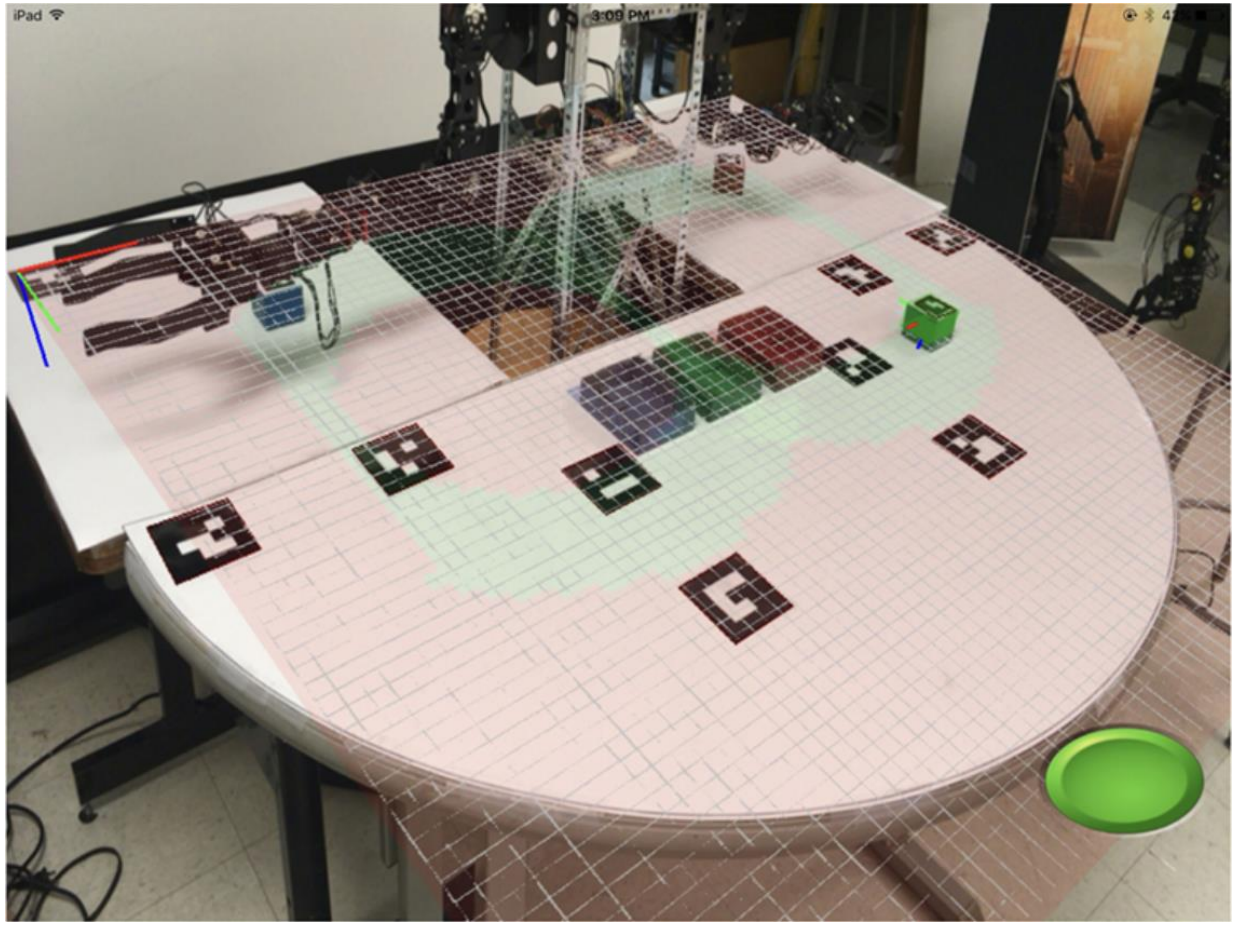
Specific Example for AR

Mobile Mixed-Reality Interfaces That Enhance Human–Robot Interaction in Shared Spaces

- Visualization of information about robot in shared space
- Pointing Tablet at workspace
- Showing range of motion of robot
- Pre render potential future moves of the robot



(Frank et al., 2021)

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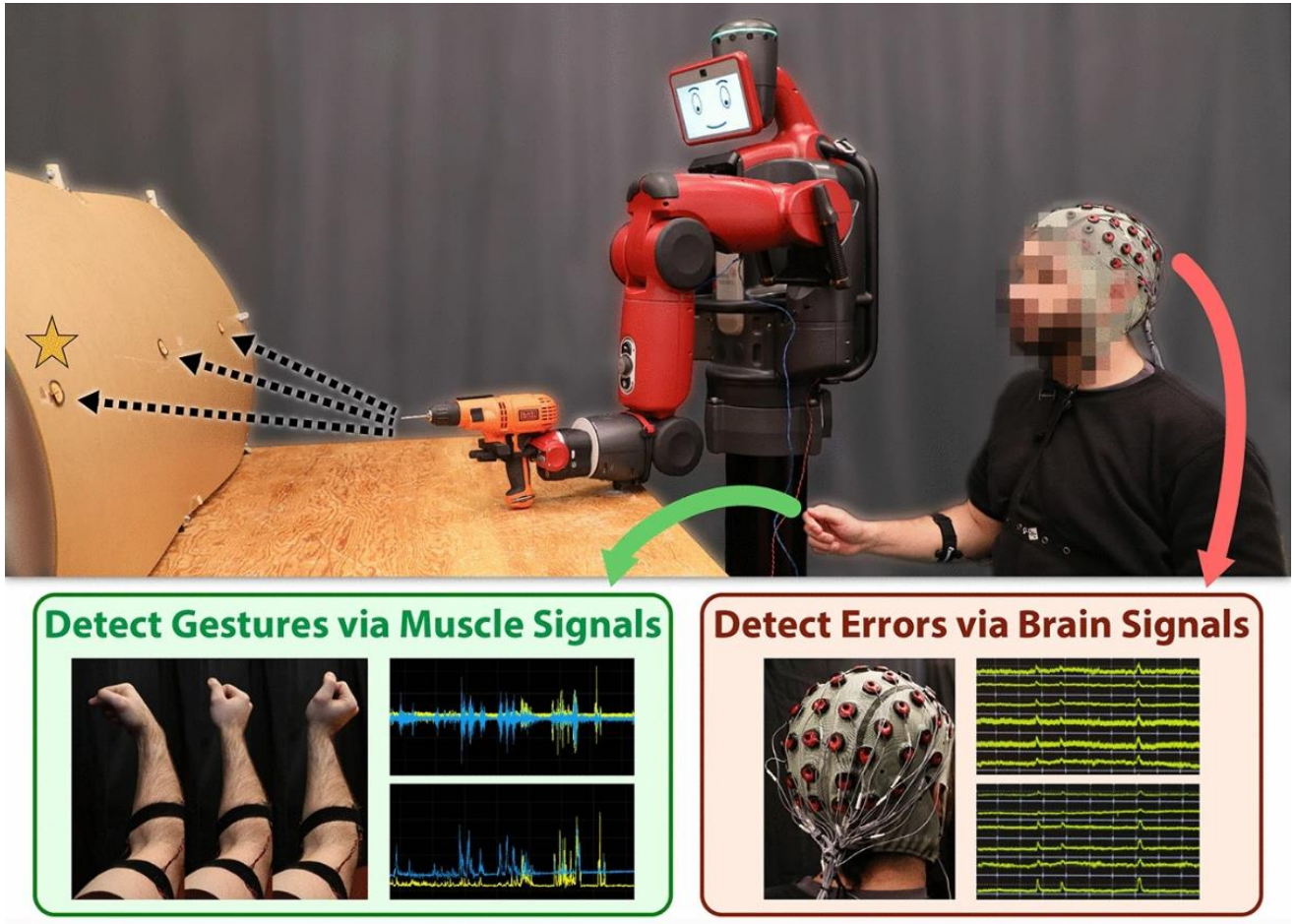
Specific Example for bio-signal-based

Plug-and-play supervisory control using muscle and brain signals for real-time gesture and error detection

- Classification of left and right hand gestures via muscle signals (EMG)
- Error recognition through brain function (EEG)
- Combination in hybrid system
- Tested on 7 subjects (Plug and Play) to reduce barrier of entry for new users
- Shows potential, but more training data needed



(DelPreto et al., 2020)

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Best path forward

Best path forward

- End goal:
  - Bio-based, control robots with human thoughts
- Intermediate steps
  - Depending on how fast EEG Implants develop
    - AR seems like a nice cheap solution for a variety of problems
    - VR only for special problems useful (when intuition necessary, remote work)

Literature

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