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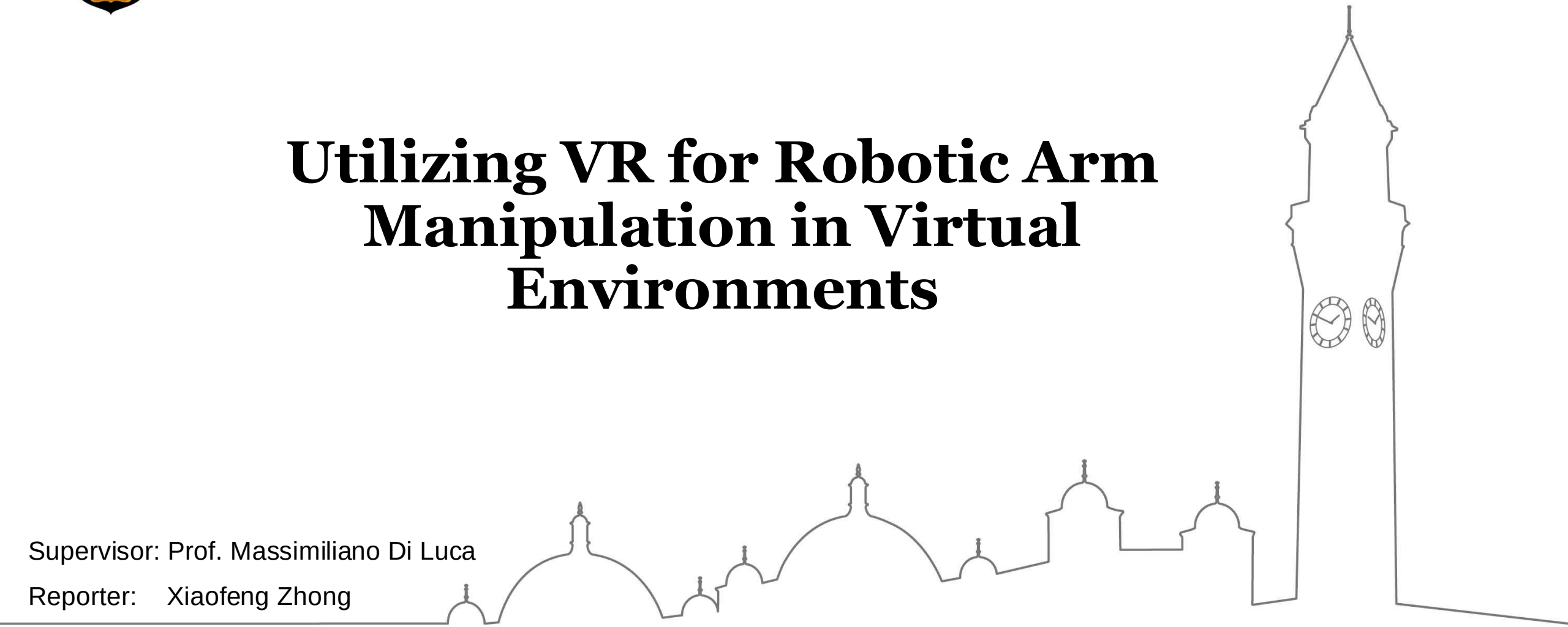
Utilizing VR for Robotic Arm Manipulation in Virtual Environments



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Outline

- Background
- Objectives
- Methodology
- Experiment
- References

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Background

Dangerous work scenes such as

- explosive ordnance disposal
- disaster rescue
- nuclear radiation field

Fig.1 Manual handling of explosives [1]

Fig.2 Robotic handling of explosives [2]

Background

Limitation

complicated, energy-consuming

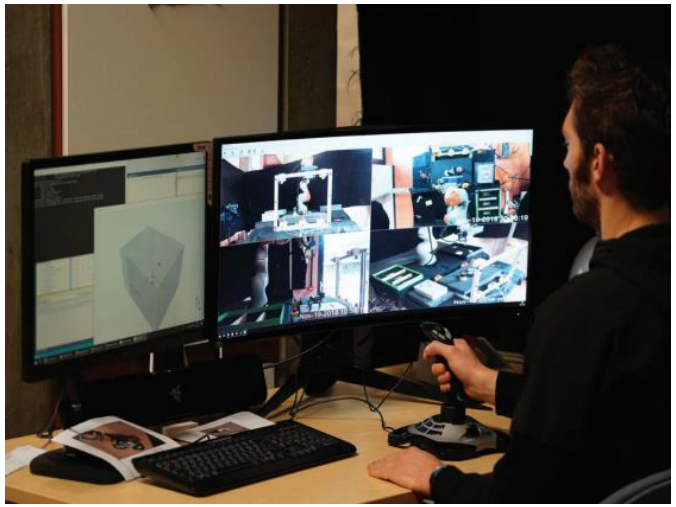

Fig.3 Control robotic arm by joystick [3]

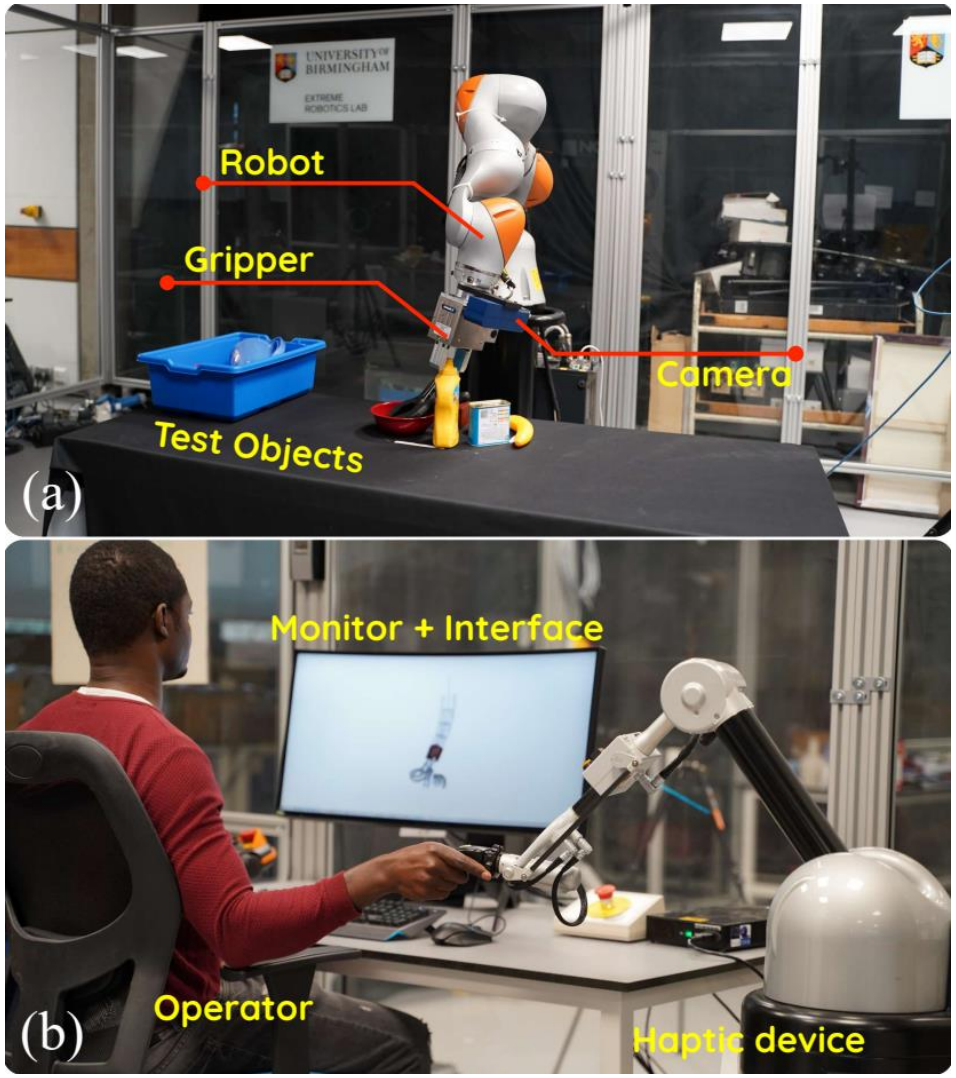

Fig.4 Control robotic arm by [4]

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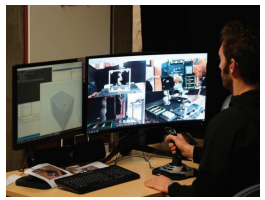

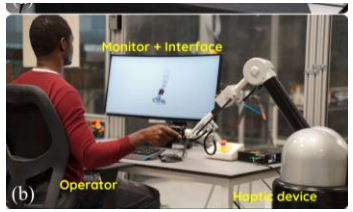

Task Difficulty

2D

Technology

Immersive 3D

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Objectives

- Build a **simulated robotic arm** within a virtual environment.
- Construct a **task scene** in the same virtual setting.
- Enable control of the robotic arm using **hand gestures** without the need for physical handles.
- Implement **specific gestures** to manage the gripping action of the robotic arm.
- Recruit participants to **test** the project and subsequently **analyze the data** collected.

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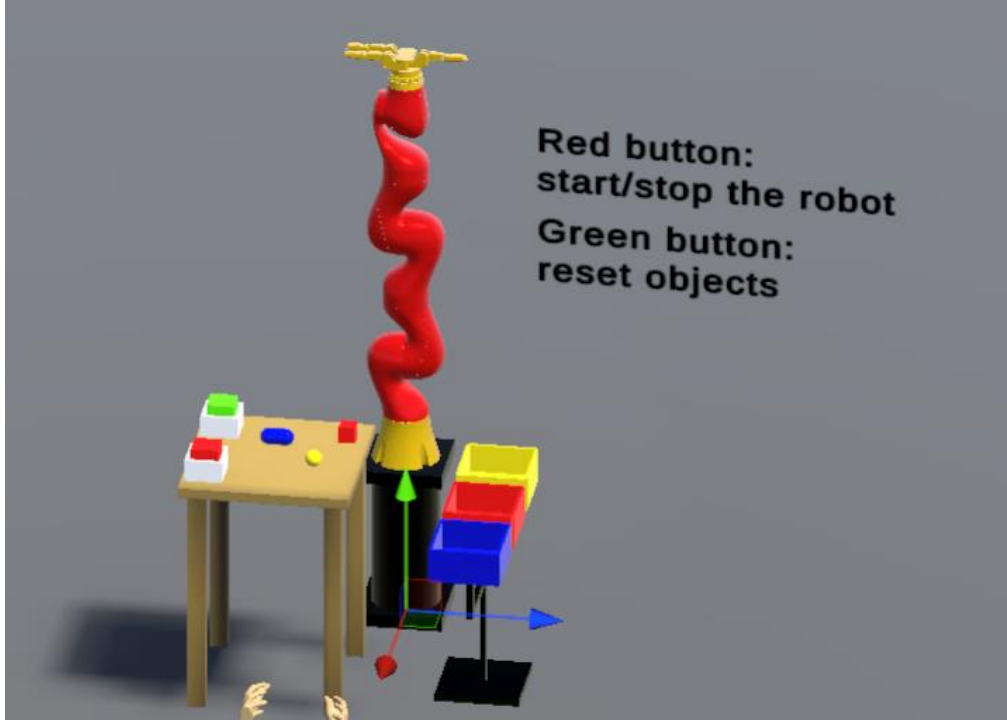
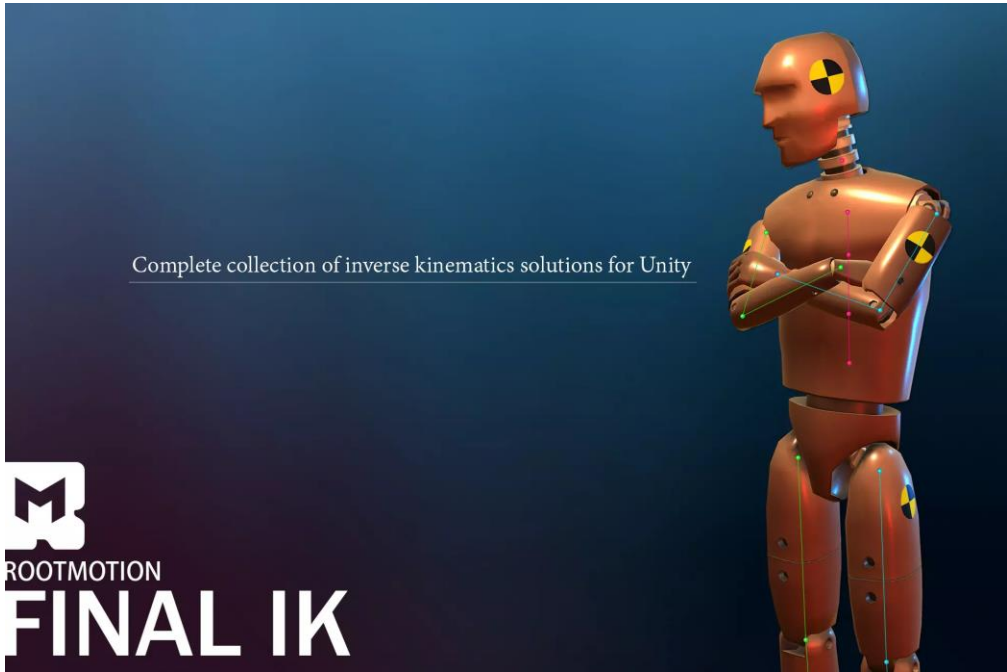
Methodology

- **Simulation Environment Construction:** Unity
- **Gesture Detection:** Oculus Quest 2
- **Kinematic Control:** Inverse Kinematic Algorithm (CCD)
- **Gesture Integration:** Gripping action
- **Experiment Design:** Record data for every participant
- **Data Analysis:** Python on kinematic measures (position, velocity, acceleration and performance etc.)





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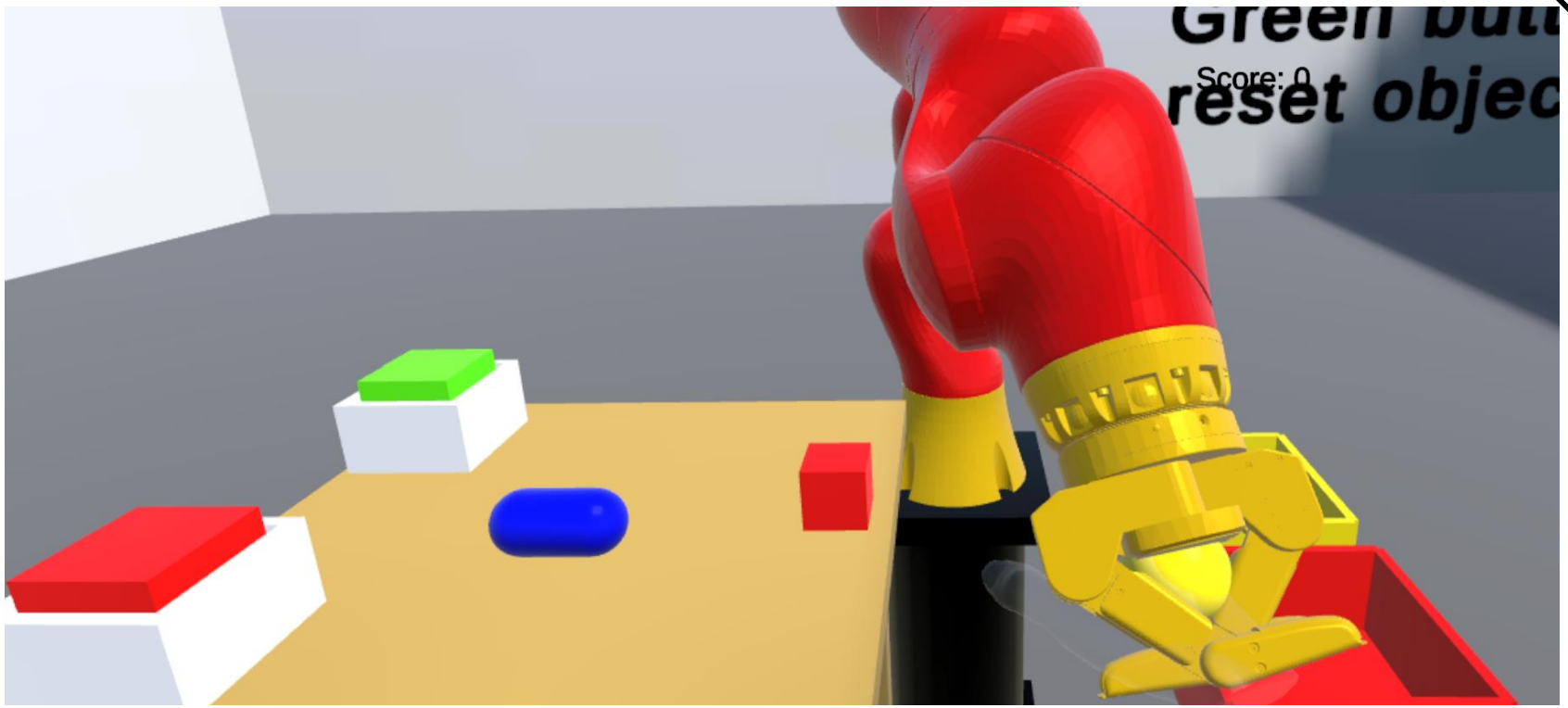
Experimental Setup



View in VR

Real setup

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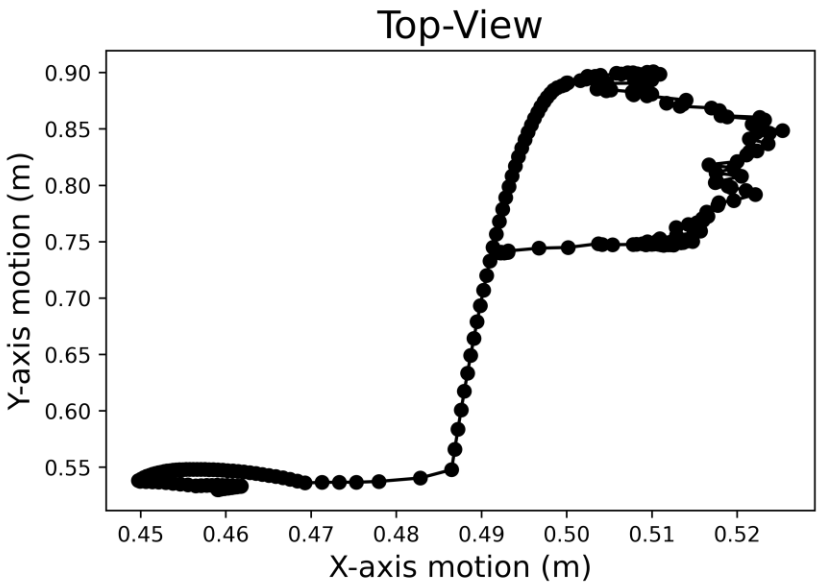
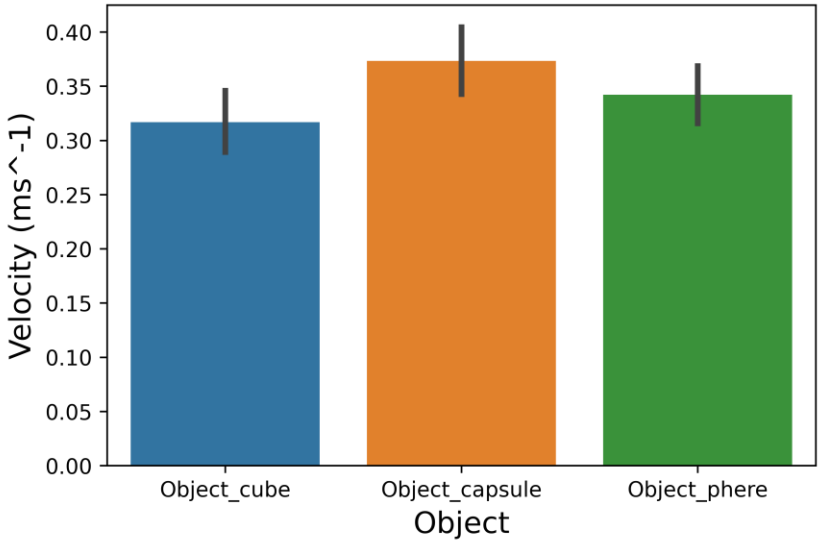
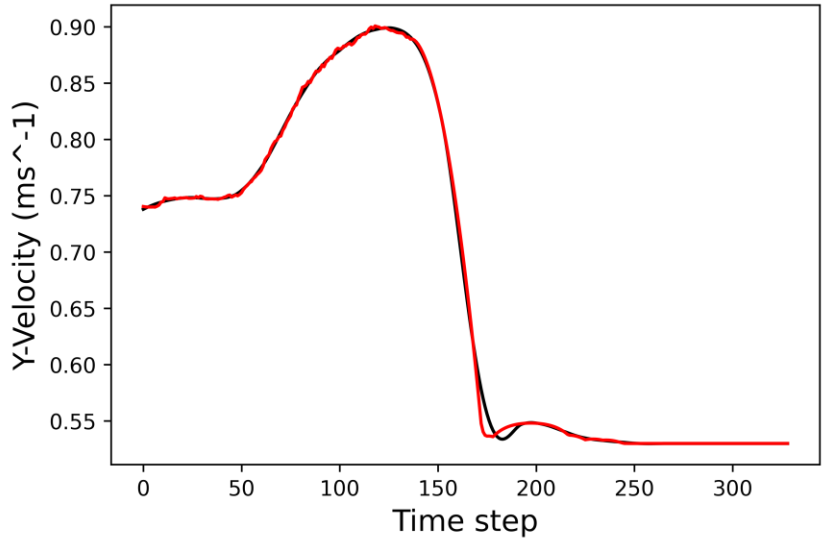
Experimental Data



Top view of the hand's path



Hand speed when holding different objects



Velocity on the Y-axis of the hand

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References

[1] Wu, Y.-N. *et al.* (2021) ‘Characterizing the Effects of Explosive Ordnance Disposal Operations on the Human Body While Wearing Heavy Personal Protective Equipment.’, *Human Factors*, p. 001872082199262. Available at: https://doi.org/10.1177/0018720821992623.

[2] Xinglang Zhang *et al.* (2022) ‘Kinematics Analysis of a five-degree-of-freedom lightweight Explosive Ordnance Disposal robotic arm’, *ACM Cloud and Autonomic Computing Conferen*ce [Preprint]. Available at: https://doi.org/10.1109/cac57257.2022.10056037.

[3] Ortenzi, V. et al. (2019) ‘Singularity-Robust Inverse Kinematics Solver for Tele-manipulation’, 2019 IEEE 15th International Conference on Automation Science and Engineering (CASE), pp. 1821–1828. Available at: https://doi.org/10.1109/coase.2019.8842871.

[4] Maxime Adjigble, Rustam Stolkin, and N. Marturi (2023) ‘Haptic-guided assisted telemanipulation approach for grasping desired objects from heaps’, arXiv.org [Preprint]. Available at: https://doi.org/10.48550/arxiv.2307.07053.

Thank You

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