Soft Manipulation under AR Human-Robot Interaction System

Description

In this project, we want to enhance our AR human demonstration collection system by integrating the ManiSkill2 benchmarking environment [1]. This system allows humans to interact with a real robot and manipulate objects within a safe simulation environment. The core focus of our project will be on improving soft manipulation techniques.

![ManiSkill2 soft-manipulation environment](image1.png)

Figure 1: Left: ManiSkill2 soft-manipulation environment. Right: Our AR human demonstration collection system.

The ManiSkill2 benchmarking environment is built on the SAPIEN simulation framework [2] and addresses common challenges researchers face when using benchmarks to learn versatile manipulation skills. It offers the ability to gather samples at a high rate of around 2000 frames per second (FPS) using a GPU and 16 processes on a regular workstation [1]. The primary emphasis of our project will be on enhancing soft manipulation capabilities. ManiSkill2 includes a variety of soft-object manipulation scenarios alongside traditional rigid object manipulation tasks. Unlike rigid objects, soft objects represented as mesh structures involve multiple faces, which can potentially slow down network transmission. Our goal is to explore efficient methods of transmitting soft manipulation data while maintaining the natural and comfortable feel of human interaction. We will also focus on preserving the high quality of demonstrated trajectories.

Tasks

This project will involve hands-on tasks to test and improve the integration of the ManiSkill2 framework into our AR human demonstration collection system, including Unity and C# development. The student will actively engage in the following tasks:

- **Exploration:** Familiarize yourself with the ManiSkill2 framework and our existing AR system.
- **Simple Integration of ManiSkill2:** Integrate the rigid-object environment from ManiSkill2 into our AR system.
- **Advanced Integration of ManiSkill2:** Integrate the soft-object environment from ManiSkill2 into our AR system.
- **Algorithm Evaluation:** Run popular imitation learning baselines for soft manipulation environments.

References
