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Mixed Reality,
ETH Zurich

BeSAFE v2
- Habitat 3.0 in VR via Unreal Engine.

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1 Introduction

In this project, we aim to address the limitations of synthetic environments, which often lack realism for robot training. Leveraging Habitat 3.0's [1] features, particularly its capability to navigate through an environment with a Meta Quest 3 headset, we utilize Unreal Engine's stunning visual rendering to create a more immersive and realistic simulation.

2 Method Overview

Our simulator applies the server-client architecture:

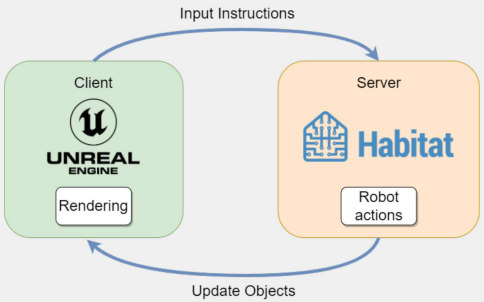

Figure 1: Method overview of BeSAFE v2.

- The server side, hosting Habitat 3.0, updates the environment and the robot according to the inputs received from the client.
- The client side, powered by Unreal Engine(UE), renders the environment on the VR headset and sends user input to the server.

This architecture allows smooth user experience, forwarding calculations to the server while maintaining control of the client side.

3 Client-side Workflow

- We provide an in-game tutorial interface showing the controls.
- The user can manipulate the humanoid in VR with controllers. Available actions include walking, picking up, and throwing.
- All interactable objects are highlighted in the scene.
- A Boston Dynamics Spot robot performs actions in the scene according to the current social task selection.

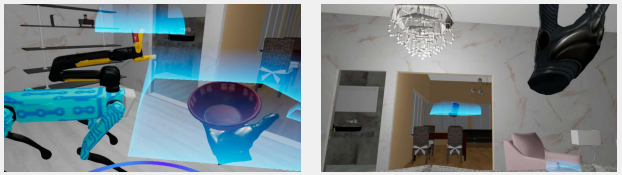

Figure 2: Grab objects from the scene (left) and throw it (right)

4 Social Tasks

There are two types of social tasks implemented for robots in our project.

- Social Navigation: In this task, the robot is supposed to follow the humanoid while maintaining a safe distance.
- Random Pick: In this task, the robot wanders through the scene and picks up objects randomly.

Figure 3: Illustration of social tasks. Left: Social Navigation, where the robot follows the humanoid in the scene. Right: random pick, where the robot picks up objects randomly.

5 Results

We render the same scene in the Habitat 3.0 simulator and our UE program to compare their quality, which shows that UE can render more realistic scenes compared to original simulator.

Figure 4: The rendering results of UE and Habitat simulator. Left: UE; Right: Habitat

6 Discussion

The project enhances the robot development in several aspects:

- Unreal Engine's highly realistic rendering enables robots to better generalize their learned behaviors when transitioning to real-world environments hopefully.
- VR applications offer an immersive experience for both scientists and users, facilitating more precise evaluations of robotic interactions and task performance.

However, the rendered scenes are not yet as realistic as those on PCs due to the limitations of the Meta Quest headset.
Future works involve integrating Habitat's rearrangement tasks, advancing the system's functionality and versatility.

References

[1] Xavi Puig, Eric Undersander, Andrew Szot, Mikael Dallaire Cote, Ruslan Partsey, Jimmy Yang, Ruta Desai, Alexander William Clegg, Michal Hlavac, Tiffany Min, Theo Gervet, Vladimír Vondruš, Vincent-Pierre Berges, John Turner, Oleksandr Maksymets, Zsolt Kira, Mrinal Kalakrishnan, Jitendra Malik, Devendra Singh Chaplot, Unnat Jain, Dhruv Batra, Akshara Rai, and Roozbeh Mottaghi. Habitat 3.0: A co-habitat for humans, avatars and robots, 2023.

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