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Full-Body Interaction in Mixed Reality using 3D Pose and Shape Estimation

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1. ABSTRACT

We present a pipeline that enables natural full-body interaction with virtual objects in an MR environment. Through a user study, we demonstrate the pipeline's usability and effectiveness.

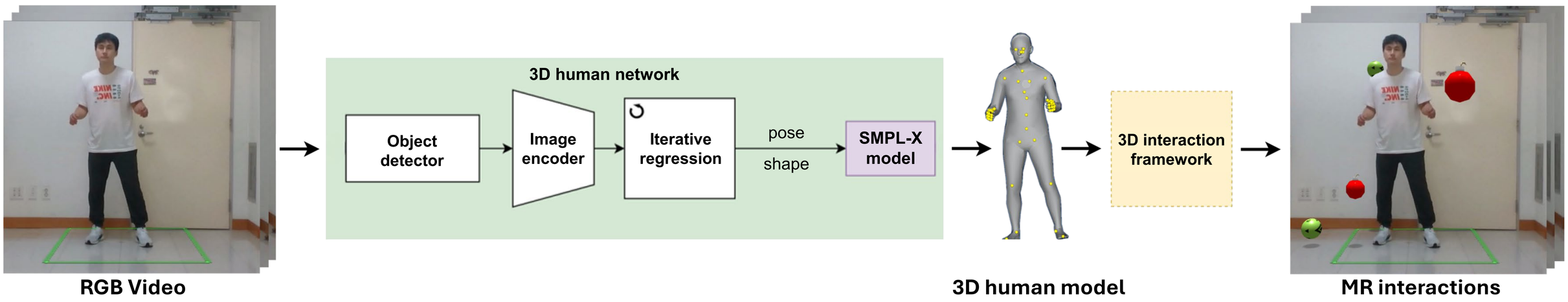


Figure 1: Our full-body interaction system's pipeline consists of 3D human network and 3D interaction framework.

2. METHODOLOGY & SETUP

The first component of our pipeline shown in Fig. 1 is named 3D human network. The object detector is located at its front end, and the detected human RGB image is passed to the image encoder, followed by its iterative regression module. It returns the 3D pose and shape of the SMPL-X, from which a human mesh is reconstructed. The human mesh is taken as a proxy that detects collisions with virtual objects. The second component, 3D interaction framework, is built upon Unity engine.

Our setup is sketched in Fig. 2. In the user study, 37 participants played in a bomb avoiding game (Fig. 3). We use three colliders as shown in Fig. 4. For experiment, additional collider 'combined' is used, defined by combining all three colliders. When testing combined, collisions are simultaneously tested for each collider. Each collider's usability is evaluated prior to testing the combined version, which is used to assess their effectiveness.

3. USER STUDY & RESULTS

Fig. 5 presents the post-questionnaire results obtained using the SUS and NASA-TLX, along with the corresponding analysis. Notably, **mesh** achieved the highest score.

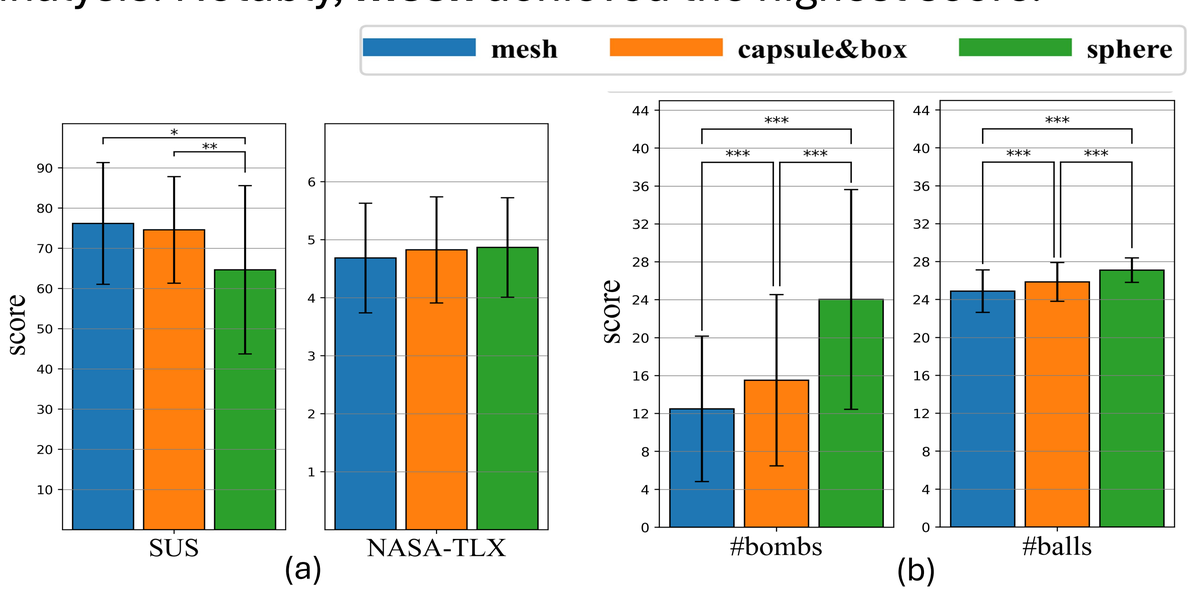


Figure 5: Qualitative analysis with the paired t-tests: (a) **Usability**. (b) **Effectiveness**.

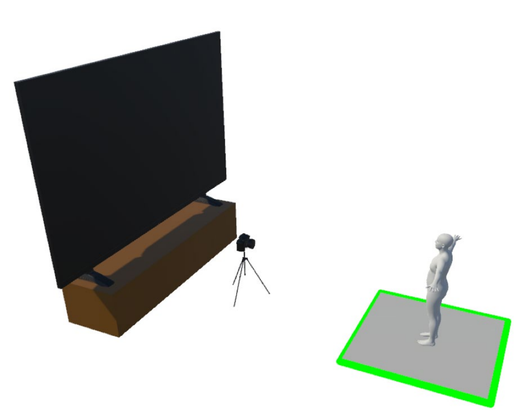
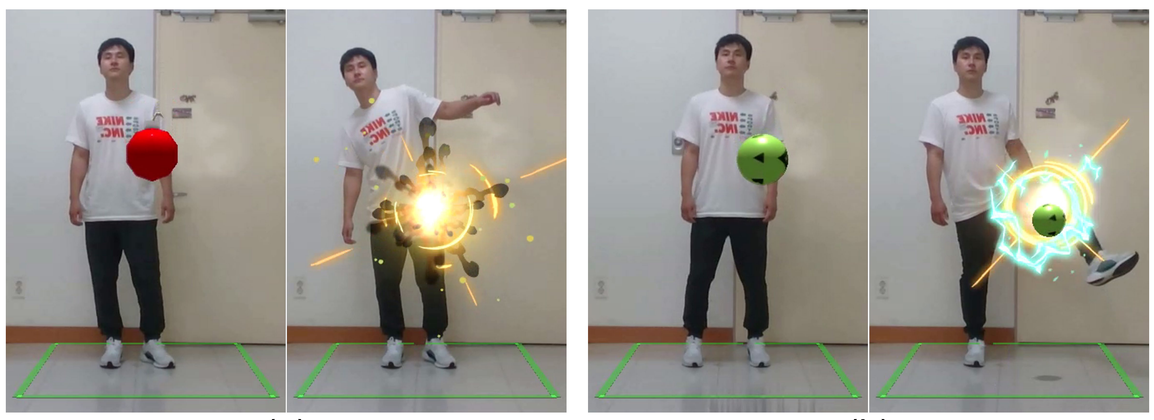
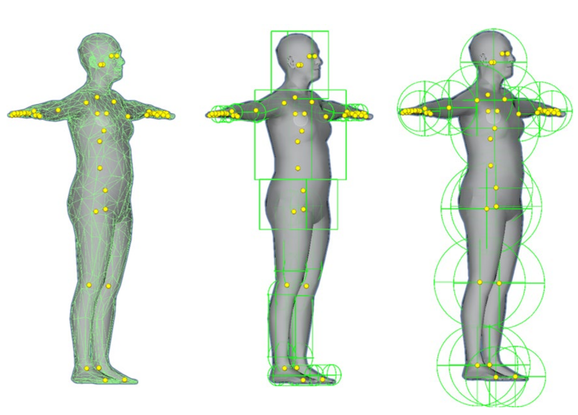


Figure 2: Experimental setup: Our MR environment.



(a) (b)

Figure 3: Bomb avoiding game: (a) Failure to avoid a red bomb results in the user losing scores and the bomb exploding. (b) The user successfully touches a green ball with his leg and earns scores.



(a) (b) (c)

Figure 4: Representations of colliders: (a) **mesh**. (b) **capsule&box**. (c) **sphere**.

4. CONCLUSION

We present an MR pipeline that enables natural full-body interaction with 3D virtual objects using a single RGB feed. A user study evaluated the impact of human reconstruction on these interactions. Comparisons with two baselines lacking detailed shape information demonstrated improved usability and effectiveness with our human model.