“Animation Fidelity in Self-Avatars: Impact on User Performance and Sense of Agency”

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1 - Motivation

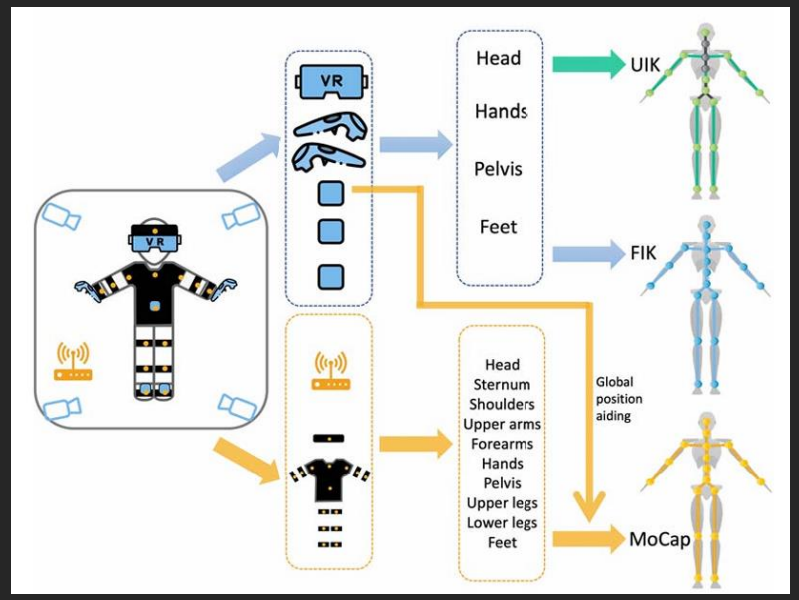
Why did we choose this paper?

- Interesting subject;
- Growing fast;
- Important Technology.

2 - Introduction

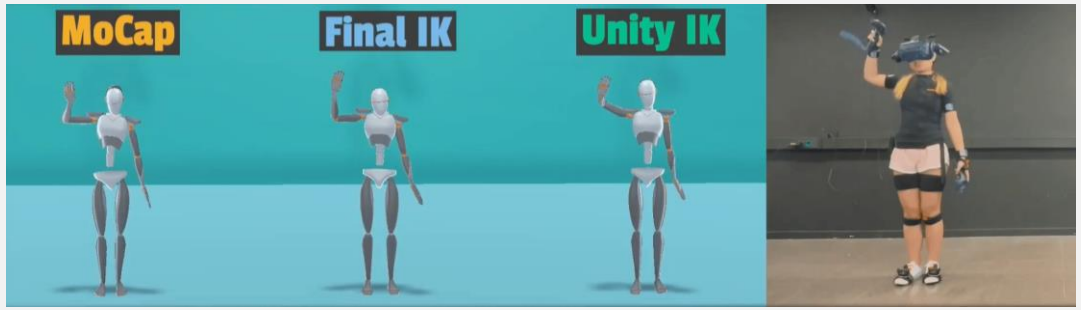
- The importance of fidelity in VR avatar animation;
- Challenges of animating avatars with consumer devices.

3 – Paper Analysis: Experimental Conditions

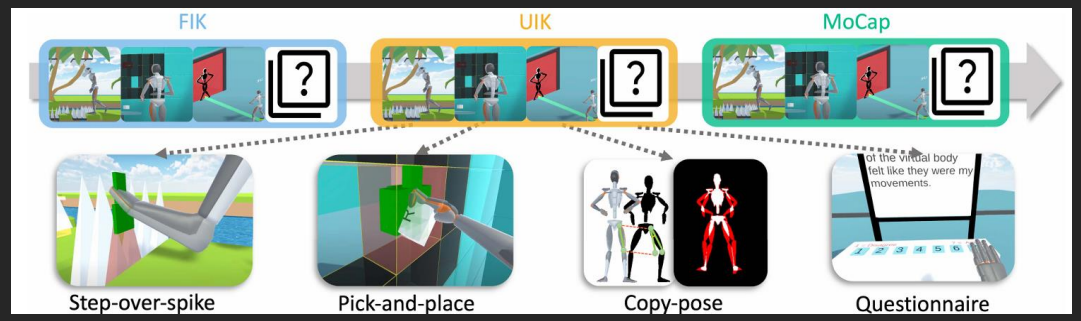


Animation fidelity conditions:

- Unity Inverse Kinematics (UIK);
- FinalIK (FIK);
- Motion capture with Xsens (MoCap).

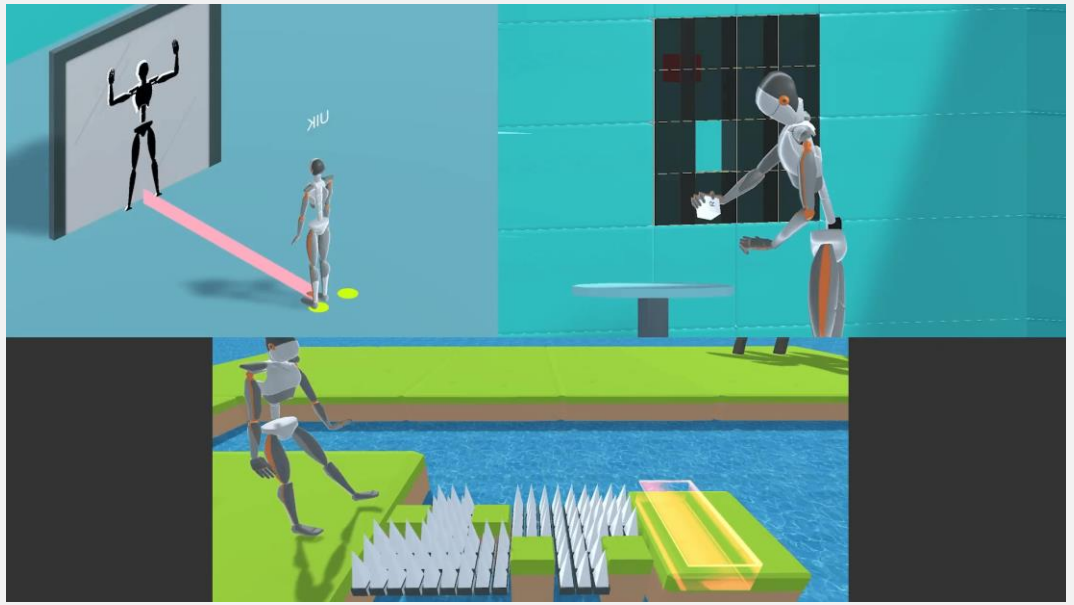


3 – Paper Analysis: Tasks



Study tasks:

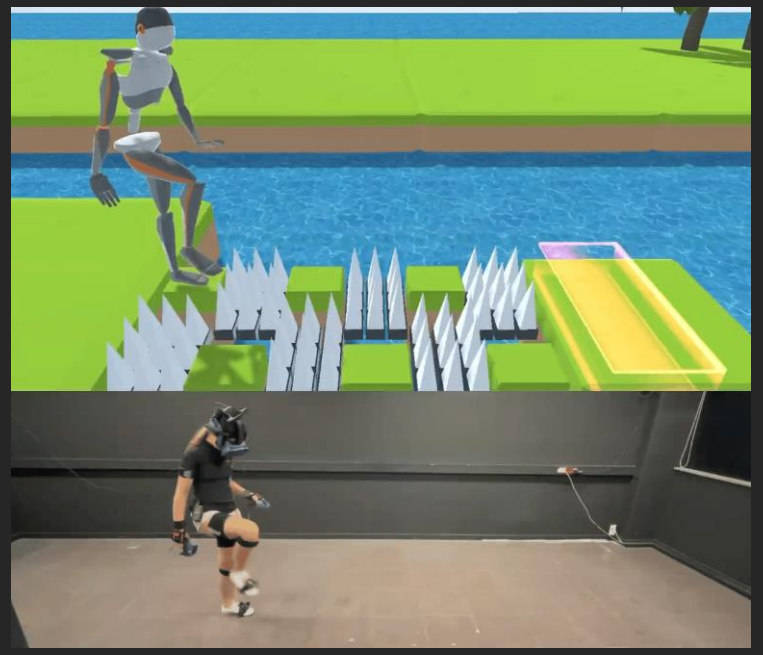
- Step-over-spikes;
- Pick-and-place;
- Copy-pose.



3 – Paper Analysis: Apparatus

- VE was developed with Unity 2020.3 LTS;
- PC equipped with a CPU Intel Core i7-10700K, a GPU Nvidia GeForce RTX 3070 and 32GB of RAM;
- HTCVive Pro HMD with 1440 × 1600 pixels per eye, 110◦ field of view and 90 Hz refresh rate;
- Three 6-DoF HTC Vive trackers 3.0;
- Two HTC Vive controllers;
- Four SteamVR Base Station 2.0;
- High-speed 240fps camera;
- UIK: 32 ms;
- FIK: 33 ms;
- MoCap: 91 ms.

3 – Paper Analysis: Procedure



- 26 participants (22 men and 4 women), one of whom was excluded.

3 – Paper Analysis: Measurements

Agency *- Scoring: (AG1 + AG2 + AG3 + AG4 + AG5 + AG6 + AG7) / 7*

AG1 The movements of the virtual body felt like they were my movements.

AG2 I felt the virtual arms moved as my own arms.

AG3 I felt the virtual elbows were in the same position as my own elbows.

AG4 I felt the virtual hands were in the same position as my own hands.

AG5 I felt the virtual legs moved as my own legs.

AG6 I felt the virtual knees were in the same position as my own knees.

AG7 I found it easy to control the virtual body pose to complete the exercises.

Ownership *- Scoring: (OW1 + OW2 + OW3) / 3*

OW1 It felt like the virtual body was my body.

OW2 It felt like the virtual body parts were my body parts.

OW3 It felt like the virtual body belonged to me.

Change *- Scoring: (CH1 + CH2) / 2*

CH1 I felt like the form or appearance of my own body had changed.

CH2 I felt like the size (height) of my own body had changed.

3 – Paper Analysis: Hypotheses

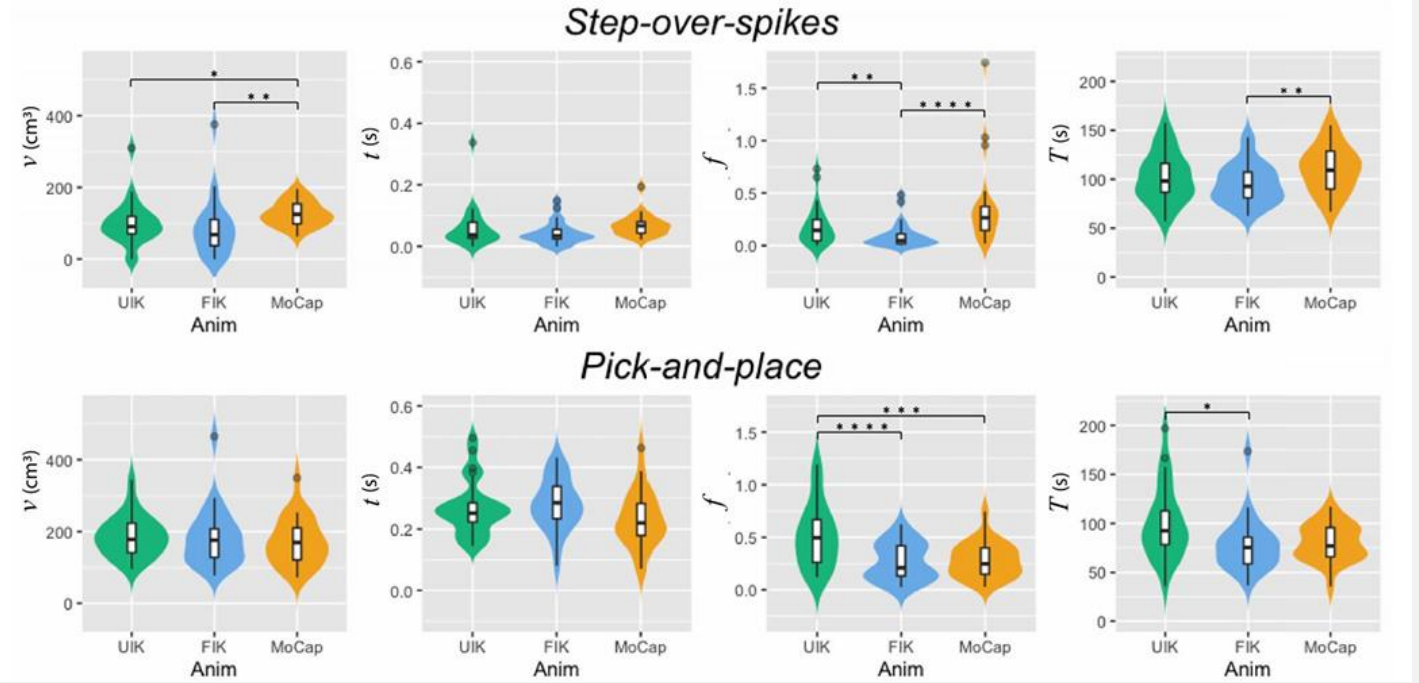
- H1: Animation fidelity impacts performance of the user in step-over spikes and pick-and-place (tasks that require precise interaction with the environment), in terms of unintended collisions and completion time;

- H2: Animation fidelity impacts performance in copy-pose task, which requires accuracy in the body pose;

- H3: Animation fidelity affects the SoE.

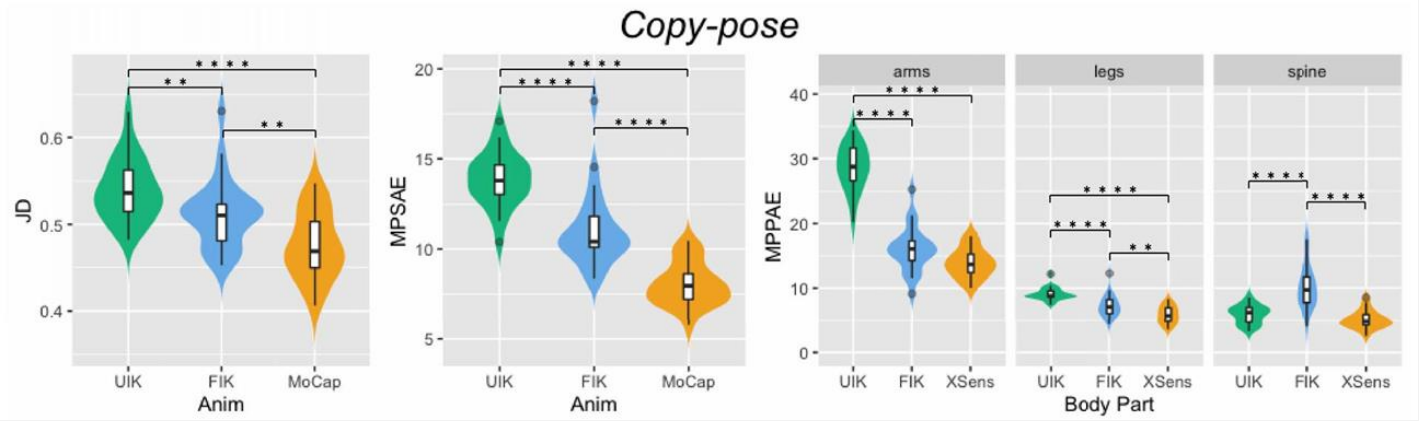
4 – Results: User performance on interaction tasks

	v	t	f	T
Spike-over-spikes Task				
UIK	101.0(61.7)	0.060(0.067)	0.189(0.189)	102.0(25.6)
FIK	**86.2(81.3)**	**0.044(0.038)**	**0.099(0.125)**	**95.3(20.7)**
MoCap	126.0(34.4)	0.068(0.036)	0.361(0.377)	110.0(23.6)
Pick-and-place Task				
UIK	187.0(57.2)	0.271(0.090)	0.516(0.305)	101.0(38.0)
FIK	183.0(81.9)	0.280(0.085)	**0.268(0.178)**	**78.1(27.4)**
MoCap	**171.0(65.9)**	**0.231(0.091)**	0.283(0.166)	80.6(19.0)



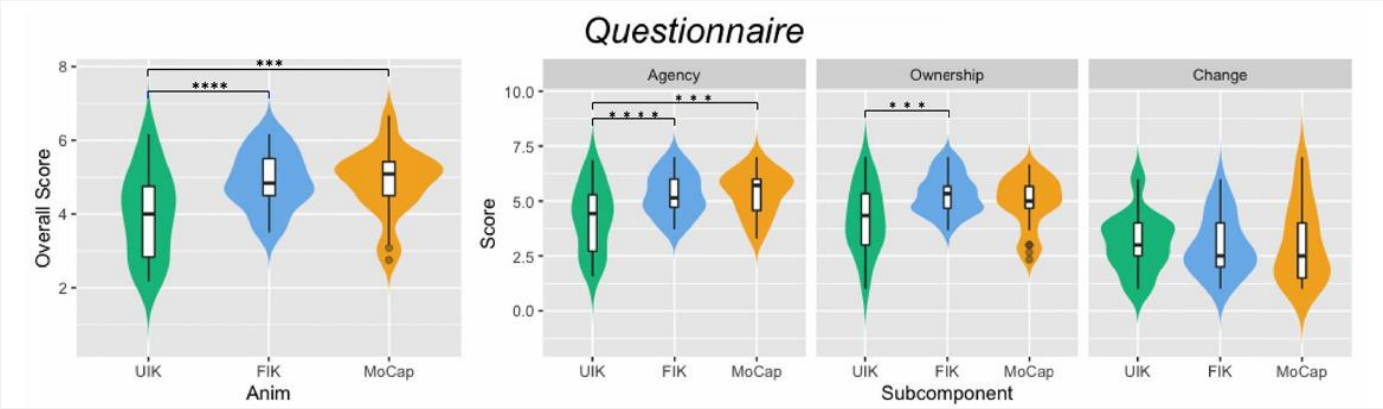
4 – Results: User performance on pose-related tasks

	JD	*MPSAE*	*MPPAE*	
UIK	0.539(0.035)	13.90(1.51)	Arms	28.6(3.45)
			Legs	9.09(0.98)
			Spine	5.90(1.43)
FIK	0.512(0.040)	11.10(2.10)	Arms	16.1(3.45)
			Legs	7.22(1.67)
			Spine	10.1(3.26)
MoCap	**0.476(0.038)**	**8.03(1.19)**	Arms	**13.9(2.23)**
			Legs	**5.85(1.33)**
			Spine	**5.08(1.38)**



4 – Results: Questionnaire results

	Overall	*Agency*	*Ownership*	*Change*
UIK	4.03(1.18)	4.22(1.51)	4.19(1.54)	3.1(1.34)
FIK	**4.91(0.774)**	5.29(0.97)	**5.32(0.92)**	**2.98(1.35)**
MoCap	4.87(0.919)	**5.37(0.99)**	4.91(1.20)	3.08(1.79)



5 - Dicussion

MoCap accuracy:

- Greater accuracy in representing human poses.

Performance in Dynamic Tasks:

- Lower MoCap on obstacles due to positional deviation and latency.

Accurate Interactions:

- MoCap and FIK outperform UIK in interaction accuracy.

5 - Dicussion

Differences between arms and legs:

- Arm poses less precise than legs, noted by participants.

Recommendation for Animation:

- Focus on animating the upper body.

Sense of Agency with Few Devices:

- High sense of agency with smaller set of devices, MoCap does not outperform experience with simple IK.

6 - Conclusion

- IMU system outperforms Inverse Kinematics (IK) solutions in pose accuracy;
- Accurate end effector placement and low latency are critical in direct Virtual Environment (VE) interactions;
- Limitation in accurately matching the avatar to the participant's shape, affecting the reproduction of self-references suggested by some "Copy-pose" targets in VR.

Questions?

Bibliography

- H. Yun, J. L. Ponton, C. Andujar and N. Pelechano, "Animation Fidelity in Self-Avatars: Impact on User Performance and Sense of Agency," 2023 IEEE Conference Virtual Reality and 3D User Interfaces (VR), Shanghai, China, 2023, pp. 286-296, doi: 10.1109/VR55154.2023.00044.