

Title: Simulating alcohol intoxication in AR and VR: The simulation of the coordination impairment induced by alcohol abuse

1. Introduce:

Alcohol abuse are significant global public health issues, having deep impacts on personal health, particularly the brain. These effects include changes in emotions and personality as well as impaired perception, vision, memory and coordination. [1]

With this research, I plan to develop realistic simulations of coordination impairment in VR and AR, which allow users experiencing the alcohol intoxication induced by alcohol abuse.

This could help people understand the serious effects of coordination impairment induced by alcohol abuse. And increase their awareness of the risks of alcohol. I hope this simulation would be a preventative and educational resource.

Developing the realistic simulation of coordination impairment and making users understand the serious effects of alcohol abuse through simulations are the scientific challenges I want to address in this research.

2. Identify:

2.1 What is completed

So far, there is no research specifically focused on simulating coordination impairment in VR or AR, but there are some similar studies.

- 2.1.1 The Fatal Vision Alcohol Goggles
- 2.1.2 Simulating Vision Impairment in AR
- 2.1.3 Upper Limb Rehabilitation with VR
- 2.1.4 Enhancing Cognitive Rehabilitation with AR

2.1.1 The Fatal Vision Alcohol Goggles



The Fatal Vision Alcohol Goggles (FVAG) developed by Innocorp Ltd, could deliver experiences on

impaired driving, underage drinking, and other substance abuse issues. Participants perform simple activities or sobriety tests without and then with the goggles. Performing the activities twice lets participants experience their performance while unimpaired and then impaired.[2]

Danielle McCartney et al. determined the validity of the Fatal Vision Alcohol Goggles (FVAG) in producing alcohol-related impairment in simulated driving. FVAG may have some utility in replicating alcohol-related impairment on specific driving performance measurements. The equipment may offer an alternative approach to researching the impact of alcohol intoxication on simulated driving performance among populations where the provision of alcohol would otherwise be unethical (e.g., prelicensed drivers).[3]

2.1.2 Simulating Vision Impairment in AR/VR



Using eye tracking, Krösl developed a system to simulate cataract vision interactively in augmented reality. Her system presents a number of cataract symptoms (in one or both eyes) to a user wearing a stereoscopic head-worn display (HWD), integrating the symptoms with either the user's live binocular camera view of the real world, previously recorded video footage, 360° images, or live virtual environments.[4]



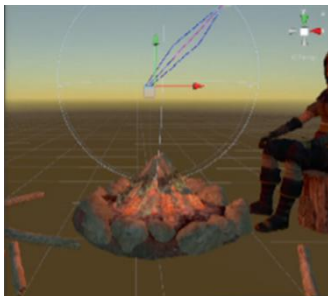
Utilizing effects created in Unreal Engine 3 (later XNA), Lewis et al. [16,17] simulated several types of visual impairments to help spread awareness of them. The simulated impairments were presented in a 3D game or explorable environment on a desktop screen, and were fixed in severity and effect size.[5][6]

2.1.3 Upper Limb Rehabilitation with VR



Oliveira et al. developed a Virtual Reality (VR) serious game to assist during upper-limb physical rehabilitation. The game narrative was carefully designed according to pre-determined gestures that stroke survivors should perform for helping them increase upper-limb movement, based on two modes: 1. Static - survivors use any arm to pick products from a supermarket shelf; 2. Exploratory - survivors move throughout the supermarket to grab all products. The game can also be cast to other devices for understanding and support (i.e., assessment sessions with a therapist team). [7]

2.1.4 Enhancing Cognitive Rehabilitation with AR



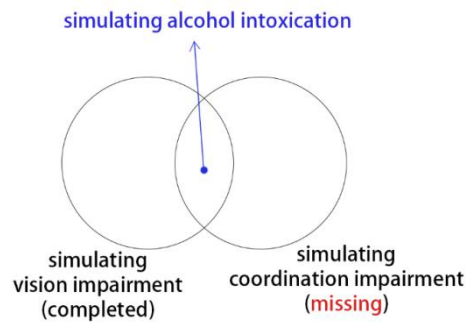
Through the innovative application of AR technology, using Unity software, Hanfu He et al. explored the addition of virtual characters to narrative space centered around a bonfire scene and its impact on improving attention recovery. Their findings underscored the potential of AR as a powerful tool in creating immersive, therapeutic environments. [8]

2.2 What is missing

The research about enhancing cognitive rehabilitation completed by Hanfu He et al. , as well as the Virtual Reality (VR) serious game developed by Oliveira et al. , which could increase stroke survivors'

upper-limb movement through pre-determined gestures, these are very helpful for figuring out how should narrative space be built in VR and AR, but the game did not show the realistic gestures influenced by coordination impairment.

The Fatal Vision Alcohol Goggles, and the researches focused on simulating visual impairment, these are valuable for simulating the vision impairment induced by alcohol abuse. However, it is not enough to simulate realistic alcohol intoxication just with the simulation of vision impairment.



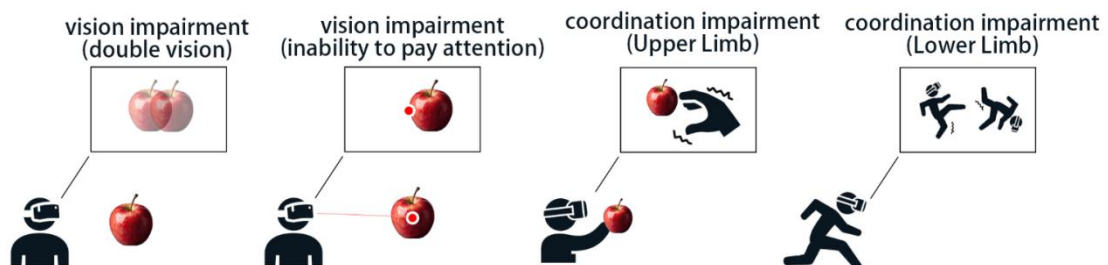
3. Research question

The goal of this research is to develop simulations of coordination impairment in VR and AR, and allow users experiencing the realistic alcohol intoxication induced by alcohol abuse.

In order to reach this goal, there are some questions:

1. How to build the realistic simulation of coordination impairment.
2. How to make users understand the serious effects of alcohol abuse through the simulations of coordination impairment and vision impairment.

I created a image to show what I plan to build for addressing these questions:



4. Method



Devices	Meta quest 3	I have enabled developer mode on my Quest 3. With the strong focus on MR of Quest 3, I plan to build a realistic virtual environment both include real-world objects to simulate alcohol intoxication.
	PC (laptop)	If necessary, I plan to render high-quality visuals with my laptop, to simulate realistic narrative space for enhancing user immersion in VR and AR. In this situation, need to link Quest with PC (USB or WIFI 6).
Build	<p>- Simulating -</p> <p>1. Vision Impairment: Including blurriness, double vision, and delayed visual feedback, are created using shader effects and post-processing in Unity.</p> <p>2. Coordination Impairment: By introducing delayed, exaggerated, and imprecise hand tracking to simulate unsteady movements. (Unity with XR plug, Mediapipe, Python, Opencv, C#)</p>	<p>Basing on <u>the researches on simulating vision impairment</u> have been completed by Krösl; Lewis et al., to create a new type of simulation of vision impairment induced by alcohol abuse.</p> <p>Using hand tracking to create the simulation of coordination impairment.</p> <p>For realistic simulating, I think it is necessary to review more medical literature about alcohol abuse.</p>
	Creating Narrative Space (such like trying to pick up an object, walking on a narrow path, or following a simple maze) (3ds Max)	Using 3ds Max, to create realistic models of narrative space each in VR and AR, enhance user immersion and make users easier understand the serious effects of alcohol abuse (such like driving simulator).
Test	Users perform a series of tasks such as grabbing, moving, and interacting to experience the effects of alcohol-induced impairment.	During the simulation, users receive feedback (task completion time or accuracy) to measure the impact of intoxication, then through the survey to gather user responses.
Assessment	Evaluating the simulation of vision and coordination impairment based on the user responses and educational effectiveness.	Determining if the simulation achieves the goals of accurately simulating the impairment induced by alcohol and if could make users understand the serious effects of alcohol abuse.

TimeLine	Nov. 2024 ~					1st year (Apr. 2025 - Mar. 2026)												2nd year (Apr. 2026 - Feb. 2027)										
	Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Literature Review	█	█	█	█	█																							
Building Vision Impairment						█	█	█	█																			
Building Coordination Impairment									█	█	█	█	█	█														
Creating Narrative Space													█	█	█	█	█											
Test																		█	█	█								
Assessment																					█	█	█					

[1]Marlene Oscar-Berman, Barbara Shagrin, Denise L Evert, Charles Epstein. Impairments of Brain and Behavior The Neurological Effects of Alcohol. Alcohol Health Res World, 1997.

[2]Fatal Vision Alcohol Impairment Education Simulation Event Kit.
fatalvision.com/product/fatal-vision-alcohol-event-kit/

[3]Danielle McCartney, Ben Desbrow, Christopher Irwin. Using alcohol intoxication goggles (Fatal Vision goggles) to detect alcohol related impairment in simulated driving. Traffic Injury Prevention Volume 18, 2017.

[4]Katharina Krösl, Carmine Elvezio, Laura R. Luidolt, Matthias Hürbe, Sonja Karst, Steven Feiner. CatARact: Simulating Cataracts in Augmented Reality. 2020 IEEE International Symposium on Mixed and Augmented Reality (ISMAR), 2022.

[5]J. Lewis, D. Brown, W. Cranton, and R. Mason. Simulating visual impairments using the Unreal Engine 3 game engine. In Serious Games and Applications for Health (SeGAH), 2011 IEEE 1st International Conference on, pp. 1 – 8. IEEE, 2011.

[6] J. Lewis, L. Shires, and D. Brown. Development of a visual impairment simulator using the Microsoft XNA framework. In Proc. 9th Intl Conf. Disability, Virtual Reality & Associated Technologies, Laval, France, 2012.

[7]Sérgio Oliveira, Bernardo Marques, Paula Amorim, Paulo Dias, Beatriz Sousa Santos. Stepping into Recovery with an Immersive Virtual Reality Serious Game for Upper Limb Rehabilitation: A Supermarket Experience for Stroke Survivors. Virtual, Augmented and Mixed Reality, 2024.

[8]Hanfu He, Wei Cui, Yu Wang. Enhancing Cognitive Rehabilitation with Augmented Reality: The Role of Virtual Characters in Attention Restoration. Virtual, Augmented and Mixed Reality, 2024.