Thesis Project Portfolio

Development of Hyperrealistic 3D Avatars for Virtual Cycling Simulation Using Advanced Character Creation and Animation Techniques

(Technical Report)

Enhancing Accessibility and Usability in 3D Modeling Education for Novice Learners

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

In my technical report, I integrated hyperrealistic 3D avatars and dynamic animation workflows into the Nsoria Shift virtual cycling simulator to overcome the limitations of static, low-fidelity character representations. The development pipeline involved Blender for base modeling and retopology, Reallusion Character Creator and FaceBuilder for 3D scanning and facial model generation, Substance Painter for high-resolution texture mapping, and Unity for skeletal rigging, facial blend shapes, Levels of Detail, mesh decimation, and real-time rendering. I created ten optimized avatars and a comprehensive set of cycling animations, including different riding positions, mounting, braking, and crashing, synchronized with the simulator's physics engine. Performance benchmarks on mid-range hardware confirmed stable 60 FPS frame rates and efficient memory usage. Also, user studies reported a marked increase in visual engagement. My investigation revealed two main drawbacks: visible texture seam artifacts and a lack of adjustable anthropometric parameters for personal customization. Future work will look into texture-blending algorithms, a customization interface for body types and facial features, and more usability testing to improve avatar interactions with the environment.

Educational technology has changed how children and beginners learn and explore complex subjects, such as coding and physics, by providing intuitive and interactive environments that encourage active learning. In my STS paper, I investigate how interactive educational platforms, such as Scratch, have changed learning for novices but leave 3D modeling behind because of the steep interface complexity. I review literature, classroom observations, and interviews with middle school educators. I apply Actor-Network Theory to Tinkercad as a case study. I argue that designers' simplicity goals, teachers' pedagogical strategis, and students' spatial reasoning skills must be continuously aligned withing a socio-technical network for 3D

modeling tools to be effectively adopted. My analysis identifies different barriers such as overloaded “spaghetti” interfaces in 3D tools, limited built-in guidance in beginner platforms, and inadequate support for self-regulated learning. Additionally, educators face significant challenges integrating 3D modeling tools into the classroom because of the limited professional development and curricular alignment issues. Equipment limitations can also make VR adoption difficult. In response, I propose a design that incorporates tutorials, VR visualizations, and real-time progress tracking.

Both my STS paper and technical report show that creating educational tools requires solid engineering and an understanding of how people use those tools. In my technical project, I built 3D avatars and animations for the Nsoria Shift cycling simulator. I focused on mesh optimization, texture mapping, and real-time performance. Along the way, I experimented with different 3D platforms, such as Blender, Reallusion Character Creator, and Unity. As a relative beginner in those platforms, I kept mental notes on each interface’s ease of use. I tracked which workflows felt intuitive and where menus were confusing. Those firsthand experiences of getting familiar with new tools made me understand novice users and how steep learning curves can block curiosity. In my STS paper, I investigated barriers in current 3D platforms and examined Tinkercad’s classroom use through Actor-Network Theory. By combining both approaches, I can propose solutions that create a connection between what is technically possible and usability. For example, working with avatars made me understand the value of real-time feedback and intuitive workflows, and my STS paper identifies the need for built-in tutorials and easy onborading that match classroom lessons.