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Vision and Challenges of Developing VR-Based Digital Anatomy Learning Platforms and a Solution Set for 3D Model Marking

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Abstract : Anatomy classes are crucial for general education of medical students, whereas learning anatomy is quite challenging and requires memorization of thousands of structures. In traditional teaching methods, learning materials are still based on books, anatomy mannequins, or videos. This results in forgetting many important structures after several years. However, more interactive teaching methods like virtual reality, augmented reality, gamification, and motion sensors are becoming more popular since such methods ease the way we learn and keep the data in mind for longer terms. During our study, we designed a virtual reality based digital head anatomy platform to investigate whether a fully interactive anatomy platform is effective to learn anatomy and to understand the level of teaching and learning optimization. The Head is one of the most complicated human anatomy structures, with thousands of tiny, unique structures. This makes the head anatomy one of the most difficult parts to understand during class sessions. Therefore, we developed a fully interactive digital tool with 3D model marking, quiz structures, 2D/3D puzzle structures, and VR support so as to integrate the power of VR and gamification. The project has been developed in Unity game engine with HTC Vive Cosmos VR headset. The head anatomy 3D model has been selected with full skeletal, muscular, integumentary, head, teeth, lymph, and vein system. The biggest issue during the development was the complexity of our model and the marking of it in the 3D world system. 3D model marking requires to access to each unique structure in the counted subsystems which means hundreds of marking needs to be done. Some parts of our 3D head model were monolithic. This is why we worked on dividing such parts to subparts which is very time-consuming. In order to subdivide monolithic parts, one must use an external modeling tool. However, such tools generally come with high learning curves, and seamless division is not ensured. Second option was to integrate tiny colliders to all unique items for mouse interaction. However, outside colliders which cover inner trigger colliders cause overlapping, and these colliders repel each other. Third option is using raycasting. However, due to its own view-based nature, raycasting has some inherent problems. As the model rotate, view direction changes very frequently, and directional computations become even harder. This is why, finally, we studied on the local coordinate system. By taking the pivot point of the model into consideration (back of the nose), each sub-structure is marked with its own local coordinate with respect to the pivot. After converting the mouse position to the world position and checking its relation with the corresponding structure's local coordinate, we were able to mark all points correctly. The advantage of this method is its applicability and accuracy for all types of monolithic anatomical structures.

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