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Animated interactive 3D cartography in VR applications

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Abstract:

More and more 3D geovisualizations are using game engines to visualize their 3D landscapes and 3D city models. With the help of a game engine, 3D geovisualizations can be used for a wide variety of end products. Game engines can render individual high-resolution images and videos. However, the strength of a game engine lies in the interaction and dynamic change of a 3D scene. Desktop, mobile, and web applications are possible, as well as using hardware from XR.

Virtual reality headsets allow the user to be completely immersed in a virtual world. With the help of motion controllers, the user's various accurate movements can be transferred to the virtual world. 3D geovisualizations using a VR headset can be more immersive and interactive than desktop solutions. In VR applications, however, the clarity of a 3D geovisualization can be lost due to the new ego perspective and sensory overload. In VR, 3D cartography can assist in the specific transfer of information. As part of the research project, various visual approaches were developed based on thematic 2D maps in combination with interactivity and different variants of animations.

Video game developers have been using cartographic visualization methods for a long time to help user navigation. These technical solutions are increasingly being examined from a cartographic perspective. These technical solutions can be used and transferred within a game engine for a cartographic application.

Based on this, various approaches to developing cartographic visualization methods were tested. These can be different elements consisting of a variation of 2D, 3D, and particle objects. Similarly, rendering the complete 3D scene or only of a selected sub-area can be supplemented with map-like 2D visualization methods, such as post-processing.

If a game engine is used, the developer has many options for implementing interactive functionalities. The interactivity means that the application is not a purely static presentation method. Users can potentially control the navigation and have setting options for various visualization methods.

Another aspect is the implementation of animations. Game engines contain a variety of options for animating individual or many elements in real-time. This includes animations such as the movement of cars and people in a 3D city to make the 3D application appear more realistic. However, animations can add further variables to the various cartographic visualization methods. This includes the dynamic movement and scaling of individual symbols in 3D space. It is also possible that 3D geometries can be deformed, and 2D graphics (2D objects and textures) can be animated with the help of gifs. The orientation and speed can be used as an additional parameter.

Particle systems allow the representation of liquids, smoke, or more abstract visual effects like sparkling. The unique feature of a particle system is the very large number of relatively simple graphic objects that together form a dynamic and complex object. The animation and number of these individual graphic objects can be linked to specific variables.

Selected visualization approaches were implemented in two thematic VR application scenarios, which were developed using Unreal Engine 5. The thematic VR application scenarios are flood simulations or lighting simulations. Both represent a problem or danger that can be animated.

This contribution discusses the possibilities and difficulties of designing cartographic elements in VR applications. In particular with a view to animated and interactive forms of 3D visualization.

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