Development of an interactive VR flight simulation with ArcGIS SDK for Unity and a hang glider

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Abstract:

Virtual reality (VR) provides many opportunities for presenting geospatial content in an immersive way. In this work, we explore the possibilities to create a VR flight simulator with a virtual hang glider flying over a local GIS scene. The user can navigate through the VR scene with a VR headset, while sitting in a hammock chair and using a wooden bar with a mounted controller for steering.

For this work, we chose Unity 2021.2.8f1 as a development environment and combined it with the ArcGIS Maps SDK plugin for building the landscape with GIS data. The ArcGIS Maps SDK was officially released in June 2022 and allows the Unity user to create local or global GIS scenes. After defining the scene type, Unity users can add basemap layers and data layers as GIS content. For our VR experience, we chose a local scene with a World Imagery Basemap and enhanced it with LoD2 buildings as data layers.

We chose Unity's Universal Render Pipeline (URP) for integrating the ArcGIS Maps SDK. The URP provides graphically better results than 3D scenes. Moreover, a URP scene is better suitable than a High Definition Render Pipeline (HDRP) scene, due to issues with shadow and movement in VR.

The next step was to add a virtual 3D hang glider to the Unity project. A hang glider is a flying device without motor, which is steered by shifting the body's center of gravity and a steering frame. A hang glider is more suitable for a VR device than other airplanes or flying devices, since the steering and flying experience can be easily reconstructed.

Since we wanted the user to sit slightly reclined in the hammock chair, we chose to create a 3D model of a trike kite. A trike is an ultra-light airplane, which is steered in a similar manner as a hang glider.

The 3D model of the trike kite was created in Autodesk 3ds max. Since too many details can create performance problems in VR, we created a low-detail model (see Figure 1). This model was then textured by using standard material in 3Ds max. After we created the 3D model, we exported it in FBX and imported it in Unity.

Figure 1. Local scene with LoD2 buildings, a basemap and the hang glider (trike kite)

The steering of the hang glider and the VR flight were implemented with two C# scripts for Unity and a steering device mounted to a hammock chair (see below).

The first script ensures that the hang glider flies into the right direction. The second script allows for the actual movement and controls the flight speed.

In Unity, we created a new parent object called ArcGIS Map for our local scene with the LoD2 data. This parent objects contains the ArcGIS Map Script contained in the plugin, and the hang glider and the player as child objects. In the ArcGIS Map object, the user can define the origin position and the map extent. We chose an origin position next to the city's central landmark and an altitude of 500 meters above sea level.

We then made minor notifications for graphically upgrading the Unity project. For instance, we placed the sun in a more realistic position. We also downloaded a skybox from the Unity assets store.

Finally, we constructed the hammock chair to improve the immersion of the application. It consists of a metal half-arch standing upright with a C-shaped foot. We equipped it with a wooden bar as steering device, to which an HTC Vive controller was connected (see Figure 2). The users can place their hands to the wooden bar, rotate the bar, and their movement is subsequently passed on to the VR experience.

Figure 2. Hammock chair with HTC Vive controller.

For less experienced users, the application can create motion sickness. We experienced this in user tests when the control device was used too fast and abruptly. After those user tests, the sensitivity of the application was reduced. As a conclusion, we recommend that the users only use the control device for navigating and not move their head or the hammock chair. We plan to use this setup to inspire future students and show the potentials of geovisualization for visualizing geodata in an immersive way.

Next steps for this project include integrating an Arduino microcontroller, a gyroscope, the Uduino plugin and exploring Oculus Quest instead of a PC-VR headset. At the time of writing, there were still unresolved issues with this setup we hope to fix in the near future. There is a lot of potential in such VR hang-gliding applications, for instance in tourism (Yardi & Aksöz 2021).

References

Yardi, Z., Aksöz, E.O., 2021. Evaluation of Virtual Hang-Gliding Applications in Terms of Tourism with Swot Analysis. *Journal of Tourism & Hospitality, 10:467.*