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Development and use of virtual reality in geovisualisation: an overview

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Abstract:

In recent years, the use of the technology of Virtual Reality (VR) has increased. This technology has been described since the 1960s, with the first initial tests to establish the technology in the 1990s. The real breakthrough was made in the 2010s by the companies Oculus[1] (now part of Meta), HTC[2] and Google. They successfully did not offer the technology at astronomical prices (Dörner et al., 2019, pp. 26-28).

Head-mounted displays (HMDs) allow users to be almost entirely engaged in the virtual environment. A stereoscopic process is used here, which provides the user with a three-dimensional environment experience. The immersion is further enhanced by addressing other senses, such as hearing and tactile (touch) (Dörner et al., 2019, page 14). Sutherland (1965) already constructed an ultimate display in mind, which leads the user into Caroll's Wonderland. Current HMDs already come very close to Sutherland's description.

The use of so-called "low-cost devices" is still increasing because the investment costs are relatively low compared to an expert system. For example, in 2014, Google established the Google Cardboard[3], a particularly low-cost VR headset that uses the smartphone as a display (Coburn et al., 2017). In addition to HMDs, there are also CAVEs (Cave Automatic Virtual Environment), which place the user in a room whose walls use projectors to create a virtual environment. However, again, the costs and setup are too immense for broader applications, which is why many developments focus on the use of HMDs.

With the increasing use of HMDs, geoscience has also opened up new research tasks with VR in recent years. These include crisis management for a region, noise mapping, illustrative teaching, urban and spatial planning, or cartography (Herman et al., 2018). All of the research mentioned above fields focus on the visualisation of geodata. The goal of geovisualisation is to provide a cartographic and an explorative representation at the same time so that users extract knowledge from it. This approach corresponds to the "human-in-the-loop" concept. According to this concept, data is pre-processed and visualised interactively. Then, the user interacts and uses his expert knowledge to generate new impulses (Dransch et al., 2019). The combination of geovisualisation and VR is the next step, from two-dimensional screens and the use of scales to one-to-one models and new perspectives for the user.

The advantages of VR in geovisualisation are, on the one hand, the provision of additional methods of data visualisation and new opportunities for users to discover patterns and anomalies (Cöltekin et al., 2020). On the other hand, new levels of immersion, presence and interaction have been achieved that feel natural to a user (Lochhead & Hedley, 2021). The user can dive into the world - they can view spatial data at the original scale, walk through it, interact and follow the development over time.

This contribution wants to provide an overview of current developments of geovisualisations in the virtual environment. It will be shown which challenges can occur during implementation and which advantages result in different use cases. These include, for example, new, virtual possibilities of measurement or the representation of simulations from new perspectives - as projects have already done using the example of Caribbean coral reefs (Hruby et al., 2019) or an Arctic Clyde Inlet (Lütjens et al., 2019).

[1] https://store.facebook.com/de/quest/products/quest-2/

[2] https://www.vive.com/us/product/

[3] https://arvr.google.com/cardboard/

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